Inside Cover
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ANNUAL UTRAC WORKSHOP ON TRANSPORTATION RESEARCH NEEDS

2009 PROCEEDINGS

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for confirming the facts and the accuracy of the data presented herein. The contents of this report do not necessarily reflect the official views or policies of the Utah Department of Transportation (UDOT).

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An annual workshop (known as the UTRAC Workshop) was held on April 7, 2009 to discuss and prioritize the research needs of the Utah Department of Transportation (UDOT) in preparation for the 2010 fiscal year. Participants included UDOT managers and employees, Federal Highway Administration (FHWA) staff, individuals from other government agencies, researchers from local universities, consultants, contractors, and other interested parties. Problem Statements, describing research needs of the Department, were submitted prior to the workshop and then evaluated, modified, and prioritized by working groups at the workshop. This document describes the UDOT research prioritization process, the UTRAC Workshop, and the resultant list of prioritized Problem Statements.

The UTRAC Workshop included a plenary session, with a keynote address by Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering at Brigham Young University, an update on the status of various ongoing research projects, and the presentation of the Trailblazer Award to Ralph L. Wadsworth Construction Company representatives Ralph Wadsworth, founder, and Kip Wadsworth, President and CEO, as well as Guy Wadsworth, president of Wadsworth Brothers Construction, for their valued contributions to UDOT’s efforts in Accelerated Bridge Construction. Much of the workshop was devoted to the evaluation of Problem Statements by groups organized by topic area. The ten topic area groups were: Construction, Maintenance, Materials and Pavements, Environmental, Planning and Asset Management, Traffic Management and Safety, Geotechnical, Structural, Hydraulics, and the newly-created Engineering Technology. Each group used a voting process to determine the most important research needs in their discipline, in ranked order. A total of 68 unique Problem Statements were considered, and 42 statements were prioritized. Of those statements, 13 have been listed for potential funding by the Research Division.

The workshop was held at the Larry H. Miller Campus of the Salt Lake Community College. A total of 144 people participated.
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EXECUTIVE SUMMARY

The Research Division of the Utah Department of Transportation (UDOT) held its annual UTRAC Workshop on April 7, 2009, at the Larry H. Miller Campus of the Salt Lake Community College in Sandy, Utah. The purpose of the workshop was to discuss and prioritize the research needs of the Department in preparation for the 2010 fiscal year. The 144 workshop attendees included people from various divisions within UDOT, the Federal Highway Administration (FHWA), other government agencies, three research universities in Utah, consultants, contractors, and other interested parties.

Since its inception in 1993, the Utah Transportation Research Advisory Council (UTRAC) Workshop has provided guidance to the UDOT Research Division in the allocation of research funding and efforts. Research needs were identified by Problem Statements submitted in advance of the workshop. These Problem Statements were then evaluated, modified, and prioritized by ten discipline area working groups at the workshop. Each group used a voting process to determine the most important research needs in their discipline, in ranked order.

This year, a total of 68 unique Problem Statements were considered at the workshop, and 42 of those were prioritized. Of the 42 prioritized Statements, the top 13 have been listed for potential funding by the Research Division, comprising total project budgets of $607,800.

The UTRAC Workshop also included a plenary session, with a keynote address by Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering at Brigham Young University. Dr. Hotchkiss used his presentation to emphasize that research has the potential to save lives, money, and the environment. He highlighted some of his work in designing, testing, and building various culverts and illustrated the necessity for cooperation among researchers, agencies, and others involved in design, test, and building processes by sharing examples from his studies. Particular attention was devoted to the creation of culverts that would allow for fish passage without compromising the stability of the road or reducing the ability of the culvert to divert floodwaters, all while minimizing costs. The presentation succeeded in giving extra motivation to workshop attendees as they considered their research needs.

During a lunchtime plenary session, the UTRAC Trailblazer award was presented to Ralph, Guy, and Kip Wadsworth, leadership of Salt Lake area contractors, for their skilled and efficient work related to recent Accelerated Bridge Construction projects. The Wadsworths not only provided their companies’ services at fair prices to UDOT and to the state’s taxpayers, the results of their work impressed all who saw the results. Most notably, the Wadsworths also showed their own enthusiasm for the project and its potential benefits. Together, they comprise the 15th presentation of this prestigious award and the first occasion wherein the UDOT Research Division honored multiple award recipients.

This report summarizes the agenda and proceedings of the 2009 UTRAC Workshop and presents the final list of Problem Statements recommended for funding and the priority lists developed by each of the discipline area working groups. A list of all the Problem Statements considered during the workshop along with the complete text of each Problem Statement is also included.
The 13 Problem Statements ranked for potential funding are shown below, including the funding priority, the Problem Statement number and title, the discipline area each falls within, and the approximate budget anticipated.

<table>
<thead>
<tr>
<th>Funding Priority</th>
<th>Prob No.</th>
<th>Problem Title</th>
<th>Discipline</th>
<th>Approx Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>09.01-2</td>
<td>Project Earned Value</td>
<td>Construction</td>
<td>$47,000</td>
</tr>
<tr>
<td>2</td>
<td>09.02-1</td>
<td>Using Unmanned Aircraft to Help Solve UDOT Problems</td>
<td>Maintenance</td>
<td>$50,000</td>
</tr>
<tr>
<td>3</td>
<td>09.03-1</td>
<td>Mechanistic Characterization of Soils and Aggregates</td>
<td>Materials and Pavements</td>
<td>$75,000</td>
</tr>
<tr>
<td>4</td>
<td>09.04-2</td>
<td>Determining National Register Eligibility for Post-War Historic Bridges</td>
<td>Environmental</td>
<td>$50,000</td>
</tr>
<tr>
<td>5</td>
<td>09.05-1</td>
<td>Understanding the Economics of Transportation in Utah</td>
<td>Planning and Asset Management</td>
<td>$50,000</td>
</tr>
<tr>
<td>6</td>
<td>09.06-3</td>
<td>Evaluation of Utah Work Zone Practices</td>
<td>Traffic Management and Safety</td>
<td>$25,000</td>
</tr>
<tr>
<td>7</td>
<td>09.07-5</td>
<td>Lateral Pile Resistance Behind MSE Wall Abutments</td>
<td>Geotechnical</td>
<td>$50,000</td>
</tr>
<tr>
<td>8</td>
<td>09.08-3</td>
<td>Evaluation of MATACRYL as a Waterproofing Membrane on Bridge Decks</td>
<td>Structural</td>
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<td>Hydraulics</td>
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<td>Engineering Technology</td>
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<tr>
<td>11</td>
<td>09.03-5</td>
<td>Improving Concrete Performance with Sustainable Long-Life Concrete Specifications</td>
<td>Materials and Pavements</td>
<td>$50,000</td>
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<td>12</td>
<td>09.07-3</td>
<td>Assessing Corrosion of MSE Wall Reinforcement</td>
<td>Geotechnical</td>
<td>$21,600</td>
</tr>
<tr>
<td>13</td>
<td>09.10-2</td>
<td>Phases I &amp; II: CADD Platform Independent drawings</td>
<td>Engineering Technology</td>
<td>$30,000</td>
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</tbody>
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INTRODUCTION

The UDOT Research Division is charged with promoting, executing, and implementing research activities within the Utah Department of Transportation in order to advance the mission of the Department and increase its use of new products and techniques. A key component of the execution of this charge is the UTRAC Workshop, which is an annual collaborative event held to discuss and prioritize the research needs of the Department.

The 2009 UTRAC Workshop was held on April 7, 2009, at the Larry H. Miller Campus of the Salt Lake Community College in Sandy, Utah. The results of this workshop will contribute significantly to the development of UDOT’s research programs for the 2010 fiscal year.

The UTRAC Workshop also serves to satisfy federal regulations relating to the use of federal research funds. Research efforts at UDOT depend on support from federal funds. Federal regulation mandates that states certify the proper use of these funds and stipulates that they develop, establish, implement, and document a management process that identifies and implements research, development, and technology transfer activities to address priority transportation issues. The UTRAC Workshop is a key element in the identification portion of this process and aids the Division in allocating research funding and efforts.

Initiated in 1993, the UTRAC Workshop is named for the Utah Transportation Research Advisory Council, a group of UDOT leaders who were originally assigned with overseeing the prioritization process. In the current application of this process, the Research Division invites UDOT staff and other interested parties to submit Problem Statements prior to the workshop and then gather for the purpose of evaluating those statements and prioritizing UDOT’s research needs.

Attending the 2009 workshop were 144 individuals representing various UDOT divisions, the Federal Highway Administration (FHWA), other government agencies, the three research universities in Utah, consulting firms, contracting companies, and other people with interest in transportation research.

Research needs were identified by Problem Statements that were submitted prior to the convening of the workshop. These Problem Statements were assigned to one of ten discipline area groups of workshop attendees: Construction, Maintenance, Materials and Pavements,
Environmental, Planning and Asset Management, Traffic Management and Safety, Geotechnical, Structural, Hydraulics, and Engineering Technology. The Traffic Management and Safety Group did not meet at the UTRAC Workshop; they held their prioritization session at a different time. The Engineering Technology group is new as of 2009 and was created to serve arising needs in design function and the increasing influence of technology in engineering fields. A voting process was instituted within each group for the purpose of determining which Problem Statement was most important in relation to their needs as a discipline. The remaining Problem Statements were also ranked in order of importance.

The 2009 UTRAC Workshop considered a total of 68 unique Problem Statements. Of these Problem Statements, 42 were prioritized, and 13 were ultimately selected for potential funding. Lists of all the submitted and prioritized Problem Statements are included in this Proceedings document, along with the complete text of each statement.

Among other workshop details, this Proceedings document also includes the agenda of the workshop, the text of the addresses given by the UDOT Director of Research and Bridge Operations, Shana Lindsey; keynote speaker, Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering at Brigham Young University; the presentation of the Trailblazer award to contractors Ralph, Guy, and Kip Wadsworth; and a report on the status of current UDOT research projects by Research Program Manager, Blaine Leonard.
RESEARCH PRIORITIZATION PROCESS

Process Overview

The process of prioritizing research needs for the Utah Department of Transportation (UDOT) is based around an annual collaborative workshop organized by the UDOT Research Division. This workshop has come to be known as UTRAC, which is an acronym for the Utah Transportation Research Advisory Council, a group of UDOT leaders who were previously assigned to oversee the prioritization process. In the current prioritization process, UDOT staff, FHWA staff, key consultants, research partners, contractors, and people from associated agencies gather to evaluate and prioritize UDOT’s research needs. These needs are defined by Problem Statements submitted by many parties prior to the workshop. Available funding is applied to the highest priority Problem Statements as determined during the workshop through a voting process.

The annual UTRAC Workshop was initiated in 1993 and has been very successful. The process has been modified several times and underwent some significant revisions in 2005.

The key steps employed in the 2009 research prioritization process at UDOT are shown below. Although the UTRAC Workshop played a central role in the process (step 6), a number of steps were needed before and after the workshop to make the process complete. The steps were:

1. Identifying key leaders in the Department to lead the Problem Statement generation process in each of ten discipline areas. Those areas were:
   a. Construction
   b. Maintenance
   c. Materials & Pavements
   d. Environmental
   e. Planning & Asset Management
   f. Traffic Management & Safety
   g. Geotechnical
   h. Structural
   i. Hydraulics
   j. Engineering Technology

2. Assigning a person from the Research Division staff to work with each discipline group.

3. Providing background information to the group leaders on the prioritization process and their role in it.

4. Soliciting Problem Statements from each of the discipline area groups and other stakeholders and making the leader for that group responsible to lead the Problem Statement development process. The Problem Statement submission deadline was set about one month ahead of the
workshop. Emphasis was placed on the need to identify a key UDOT Champion for each Problem Statement and to have a plan for implementation. Problem Statements were accepted from any entity and did not need to come through the discipline group or its leader. Tools provided to each group leader included:

a. List of Problem Statements from the past year.
b. Problem Statement form (revised from previous years).
c. Suggestions about coordinating with contractors, consultants, and key researchers during this early stage in the process to ascertain their needs, interests, and resources.

5. Reviewing of the submitted Problem Statements by a Research Division staff member for each discipline group. Their review usually included a literature search to determine if similar work had been performed in Utah or elsewhere or if significant knowledge on the topic could be provided to the discussion. Project scopes were evaluated to ensure that well-defined work tasks and clear deliverables were envisioned. Implementation plans were also required in the scope statements. As needed, revised Problem Statements were proposed to group leaders.

6. Convening a one-day workshop to review the Problem Statements and prioritize them. The workshop included 144 people from UDOT, FHWA, key consulting and construction firms, three research universities in Utah, other state agencies, and other parties interested in transportation research. Elements of the workshop included:

a. Keynote address from Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering, regarding the potential for research to save lives, money, and the environment with examples from his work in the state of Washington, which emphasized fish passage through culverts.
b. Presentation of the status of research projects initiated following previous UTRAC workshops, by Blaine Leonard, Research Program Manager.
c. Division into ten working groups to evaluate the Problem Statements, discuss scopes and deliverables, and establish priorities. Background information was presented by the authors of the Statements. A total of 68 unique Problem Statements were evaluated by the groups (discounting duplications). The number of submitted Problem Statements per group ranged from 4 to 15. The groups also heard brief presentations on selected ongoing projects. This year, the Traffic Management and Safety group met at a different site and time to complete a separate but similar process.
d. Prioritization of the statements through a two-step voting process using weighted ballots that minimized the ability of any one subgroup to dominate the process (UDOT participants dominated the voting scheme, irrespective of the number of people present).
e. During breaks throughout the day, groups were able to interact to share ideas, gather supporting information, and provide input on cross-discipline problems.

f. Each discipline group concluded the workshop by submitting a list of their top four to five projects, in order of priority, a total of 42 unique Problem Statements.

g. Members of each discipline group also completed surveys to determine possible changes to the program that could improve the 2010 UTRAC Workshop.

7. Assembling the prioritized Problem Statements from each discipline group into a master list of research priorities, comprising the 42 unique, prioritized Problem Statements.

8. Sorting the assembled Problem Statement list by order of priority so that the top priority of each discipline group was shown first, followed by the second priority, and so on. Reviewed and refined this list, considering input from research project managers and UDOT’s senior leaders.

9. Applying the anticipated available research funding to the priority-order Problem Statement list, starting at the top of the list and working down, ultimately resulting in a list of 13 projects which could possibly be funded during the 2010 fiscal year.

10. Presenting the priority list and funding scenario to the Director of Research and Bridge Operations for input and approval.

11. Assigning Research Division staff as Project Managers for each of the projects, and discussing possible Principal Investigators for each.

12. Submitting the final funding list for approval by the Department and FHWA as part of the annual Research Program funding document.

13. Initiating the research projects by assembling Technical Advisory Committees, refining scopes and preparing contracts.
2009 UTRAC Workshop Team

Each year, it takes a large group of people to organize and execute the UTRAC Workshop. The following people were involved in 2009:

Director of Research and Bridge Operations: Rukhsana (Shana) Lindsey

Deputy Director of Research: Michael Fazio

Chair of UTRAC Event: Blaine D. Leonard

Problem Statement and Workshop Coordinator: David Stevens

Workshop Logistics Team: Esther Olsen, Amanda Holm, Richard (Barry) Sharp, Debbie Heim, Elaine Chatfield

UTRAC logo, posters, signs, and photography: Brook Bowen (Bowen Design Works)

FHWA Liaison: Steven Call
2009 Discipline Group Leaders and Research Contacts

Group 1: Construction
  Group Leader: Kris Peterson
  Research Contact: Debbie Heim

Group 2: Maintenance
  Group Leaders: Richard Clarke
  Research Contact: Barry Sharp

Group 3: Materials and Pavements
  Group Leader: George Lukes
  Research Contact: Ken Berg

Group 4: Environmental
  Group Leader: Becky Stromness
  Research Contact: Michael Fazio

Group 5: Planning and Asset Management
  Group Leader: John Thomas
  Research Contact: Abdul Wakil

Group 6: Traffic Management and Safety (convened offsite)
  Group Leader: Robert Hull
  Research Contact: David Stevens

Group 7: Geotechnical
  Group Leader: Jon Bischoff
  Research Contact: Blaine Leonard

Group 8: Structures
  Group Leader: Fred Doehring
  Research Contact: Daniel Hsiao

Group 9: Hydraulics
  Group Leader: Denis Stuhff
  Research Contact: Kelly Burns

Group 10: Engineering Technology
  Group Leader: Craig Hancock
  Research Contact: David Stevens
2009 UTRAC Workshop Basic Agenda

The UTRAC Workshop was held on April 7, 2009, at the Larry H. Miller Campus of the Salt Lake Community College, in Sandy, Utah. Attending the 2009 workshop were 144 individuals representing various UDOT divisions, the Federal Highway Administration (FHWA), other government agencies, three research universities in Utah, consulting firms, contracting companies, and other people with interest in transportation research. The workshop consisted of two main sessions and three breakout sessions. During the breakout sessions, discipline groups discussed, modified, and prioritized Problem Statements. The complete Workshop Agenda is included in the Appendix of this report. The basic outline of the sessions was as follows:

Introductory Plenary Session:
- Welcome – Shana Lindsey, Director of Research and Bridge Operations
- Keynote Address – Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering, Brigham Young University
- Research Program Status – Blaine Leonard, Research Program Manager
- Workshop Instructions – Blaine Leonard, Research Program Manager

First Breakout Session:
- Presentation of current research projects, Problem Statement presentations, discussion, and first prioritization voting

Lunch Session:
- Presentation of Trailblazer Award – Shana Lindsey, Director of Research and Bridge Operations, and Jim McMinimee, Director of Project Development
Second Breakout Session:
Problem Statement Refinement and discussion: Deliverables, Tasks & Budget
Final Prioritization Voting
Completion of Workshop Feedback and Evaluation

Each workshop participant was given a packet of information, which included an agenda, a list of breakout groups and room assignments, a list of all the Problem Statements being considered by each group, and a copy of each of the Problem Statements being considered by the group to which the participant was assigned. The Group Leader and Research Advisor assigned to each group were each given a binder containing a copy of every Problem Statement being considered by all the groups, ballots for voting in their group, and a spreadsheet (on a flash drive) to be used to tally the ballots. They were also given an instruction sheet on how to manage the group and the voting process.
UTRAC WORKSHOP ACTIVITIES

Opening Remarks

Shana Lindsey, Director of Research and Bridge Operations:

I would like to welcome all of you here to UTRAC. I would also like to thank you all for being here because, without you, we can’t have UTRAC. We’re here to serve you—the customers—and we want to make sure that we do that today and meet all your needs. I appreciate all of you being here to help us help you. Last year we had a successful year in research; this year we’re going to have a better one. I want to point out that we had a lot of successes last year. One of the successes we had last year was the implementation toward accelerated bridge construction. We had major successes, and we received multiple awards. I don’t know if you noticed that displayed outside were a lot of awards on a table. I want you to know that those awards are “we” awards. They’re not a research award; they’re not just a UDOT award; they are industry awards, and it’s all of us who have earned those. We have been recognized not only in the state but also nationally with AASHTO as well as internationally with the International Road Federation. So, please, if you get a chance, visit that table and pat yourself on the back for helping us toward those implementations.

So ABC is old news now, right? Everybody knows what that is, and we’re good at doing it here in Utah. The next step is APC. How many of you know what that is? We’ve been doing ABC; now we’re going to be doing APC: Accelerated Project Construction. We want to accelerate the whole thing; we want to get in and get out, and any help toward that would be awesome. The public loves us for it, and we’ve gotten a lot of support from the industry, from the traveling public, and from the legislators with funding. The next step that we’re doing through research is planning a scan tour to visit another state that’s done prefabricated pavements, and that will help us toward Accelerated Project Construction. We want to start working on Geotechs and other things that we can accelerate when we do Accelerated Project Construction. We want to standardize things so it’s not so hard to do Accelerated Construction. It’s already a standard that we can choose. We want to continue those efforts.

I want to ask you and challenge you today, as you develop your problem statements that will get funded in the future, to focus on implementation. Don’t just come up with the solution for that research, but also determine how we are going to implement the solution. What are we going to do? What are the tools that are needed to develop that implementation? Do we need to develop a training tool for the solution? Do we need to develop a visualization thing for people to visualize that technology? Do we need to develop PowerPoint presentations? Those things are already done by the PI’s because they’re presenting this stuff at TRB, and we can use those same tools to implement our solutions here in Utah. So, champions, please make a note of that. Please
make sure we include that in our problem statements, and make sure that we put aside funding to be able to implement the projects that we’re doing. That has been the success in research. We’re not just doing research that’s sitting on the shelf; we are actually doing research that we are going to implement, not ten years from today, but right away. We’d like your help with that.

We’re going to have a lot of fun today. Put your fun hat on, and you are going to make it fun. Michael Fazio, where are you? Michael is going to introduce the keynote speaker. Thanks, everyone. Have fun today.

(applause)

Keynote Introduction

Michael Fazio, Deputy Director of Research:

Good morning everyone. It’s nice to see you and visit with you, my friends and colleagues. It is my pleasure to introduce Dr. Rollin Hotchkiss as the keynote speaker this morning. Dr. Hotchkiss joined the Civil and Environmental Engineering Department at Brigham Young University in 2005 after spending seven years at Washington State University and nine years at the University of Nebraska in Lincoln. He teaches classes on subjects such as Fluid Mechanics, Open Channel Flow, and Stream Restoration. His research interests include extending the useful life of reservoirs and mitigating the impacts of roadways on stream crossings. Over the years, he has advised more than 40 students and graduate students, and he has published more than 30 journals, almost 100 conference papers, and 25 reports on these topics.

Most recently, Rollin has been helping UDOT develop culvert design procedures that account for fish passage. Rollin has taught short courses about culvert design to hundreds of practicing engineers in more than 25 states. He is married to Deanna Hotchkiss, and they have four children and six grandchildren.

It’s been my pleasure to have been working with Dr. Hotchkiss. I had to read this summary, and it’s nice, but it doesn’t really pay a proper tribute to an outstanding man. I came to know Dr. Hotchkiss through work and through UDOT working in Hydraulics. He is a national leader in his field of fish passage, and not just fish passage, but also other environmental work in the field of Hydraulics and Hydrology. He’s very knowledgeable on these matters. I spent a bit of time with him and took a class from him, and I enjoyed it all very much.

Please welcome Dr. Hotchkiss.

(applause)
Keynote Address

Dr. Rollin Hotchkiss, Professor of Civil and Environmental Engineering:

Well, thank you Michael. Let’s have some fun!

I’ve only got, as you can see, about 520 slides. That’s an unusual challenge for a room full of people like me, so let’s see how it goes. I really don’t have that many slides; it’s just my unique sense of humor coming out here.

In the year 2000, I found myself at a meeting of the Bonneville Power Administration—the BPA—in Portland, Oregon. Their headquarters is an impressive building. I was in the spotlight, trying to defend a proposal that I had written to look at ways that we could help juvenile salmonids move downstream. They were in a big hurry!

The problem in the Northwest, as many of you are aware, is that many dams on the Columbia River and others block passage for adult salmonids moving upstream, migrating to spawn, and for juveniles trying to move downstream. The upstream problem has not been completely solved, but mostly. The problem is getting the juveniles to the outlet.

Juveniles move downstream in the springtime, and they come upon a reservoir with a dam a mile wide. There is a passage place for the juveniles, but it may be only 20 feet wide. How do the juveniles find it? My proposal was to look at some basic research on how to help them do that. BPA’s question for me was, “How long is it going to take to implement this?” I said, “Well, we’ve got to do the small scale tests,” which I’ll share with you in just a moment, “then we’ll need to do some prototype tests, and then we need to wait for a life cycle of the salmon to see if it works, so about five years.” They said, “Sorry, we can’t wait that long. We need an answer in a year.”
I thought that was unusual, considering that they were looking at the life cycle of a fish, and there’s no way to tell if the research would be useful or not until after several life cycles. They reluctantly funded the project.

For our test, we created turbulence similar to that found in natural rivers where juvenile salmonids are raised. We reproduced that signal using a pulsating jet like those that might be found in a hot tub. As a matter of fact, the inspiration for this idea came while I was sitting in a hot tub. My back was being massaged by these pulsating jets, and it reminded me of alternating shutting vortices off of a boulder. So we went forward, and we came up with some tests in a raceway where we tested the hypothesis: can induced turbulence decrease residence time for juveniles moving downstream? We set up, in plain view, twin raceways with different treatments. To make a long story short, yes, we found a way that we could decrease the residence time of juveniles as they moved downstream. That was successful research.

Now let’s revisit where the Bonneville Power Administration is this morning. Seven years later, they did not implement that research. It did not go to the prototype scale, and they’re no closer to a solution than they were before. “Hurry up and wait, or hurry up and try something else” is the theme of a lot of the research we’re asked to do.

April 7, 2009—I think that’s today—can you hear the trucks outside? They’re coming down I-15 now from Washington DC with all the money that’s been promised in a stimulus package. Of course that has to be done with shovel-ready projects right? We live in a hurry-up world. That was announced this morning with APC, right? A hurry-up world. So the question that I’d like to treat with you this morning is this: “What is the role of research in a hurry-up world?” I’m going to divide this presentation into the categories you see there, and of course we already know that research saves time, money, lives, and the environment.
Now you should know that I’m looking through rose-colored glasses this morning: the glasses of a water resources engineer, because that’s what I know. I’m not going to be talking about structures, geotech, roll-out pavement, or anything else. I’ll stick to what I know a little bit about. As I prepared for this talk this morning, I kind of reviewed the things that I’ve done over the years, and I was surprised to see how much of my research has really been related to transportation. “Water resources,” you say. “What does that have to do with transportation?” Well, it’s stream crossings, bridges, and culverts. You can see I’ve spent a significant part of my career in transportation-related research. I especially would like you to notice the bottom one there. Twelve of my 25 project reports have been in transportation, and that is including implementation—how to get it done. Academics, every once in a while produce, something useful, and that’s the project reports at the bottom.

Before I go any further, I would like to thank the UDOT Research Team. At the bottom of this cartoon it says, “Primitive think tanks,” so I’d like to acknowledge Blaine Leonard, Michael Fazio, and Denis Stuhff over there—the UDOT Research Team—for working with me since I came here three years ago.

Now, how does research save time and money? Primarily, in the office, it saves design time. Design time can go from guesswork to real work as we provide results of research that can computerize or standardize the research or design in complicated situations. I hope to illustrate that. I’ve got some examples. Perhaps this could decrease the flood of work being farmed out to consultants as has been happening over the years now from several departments of transportation. You can do it faster if you can do it in-house.

Research Saves Time and Money
- Decreased design time
  - More work is outsourced
  - If design takes less time, keep more of it in-house
  - Requires computerized methods for new, more complex design methods
- Five examples
Example number one comes from Eastern Washington State. I was at Washington State University for several years before coming here. The problem was how to design a culvert that would allow fish to swim upstream. The photograph here shows some beautiful salmon, and that’s the end of their migration. They may have come hundreds of miles only to be stalled a half a mile away from where they were raised with a culvert like this. So how can you design a culvert? Well you need to know what kind of discharge to use, and all of a sudden that is no longer a simple hydraulics calculation but a biological one. And when we mix biology and hydraulics, it gets pretty interesting.

The caption on this one says, “Well, time for our weekly brain-stem-storming session.” It was my pleasure at that time, and continues to be my pleasure, to work with fisheries, biologists, ecologists, and scientists of that kind to solve a problem involving biological hydraulics. Here’s the approach that we took: we had to define fish passage flows. And the question was, “When might fish be moving in the environment? When might they want to go upstream or even downstream?” Then, as usual—those in hydrology will recognize this—we developed regression equations that related watershed characteristics to the discharge level of interest. The nice thing about this, though, is that we tried to implement it in a very easy way. All of the equations were already pre-solved in a GIS shape file. And I’d like to share an example with you from Tonaska Creek in Okanogan County in Washington. This involved several small watersheds, one right after the other, on a creek. I’ll show you how we did this.
A culvert was to be placed right by the red dot. This is the watershed that drains to that culvert location. In our GIS shape file, we had pre-embedded fish passage design flows for a watershed upstream and for one downstream that went as far as this point. Because those equations had already been pre-solved there was no calculation necessary of the flows for those two watersheds. The only thing the engineer had to do was to combine the drainage areas, add up the flows, and be done with it. This has proved to be very popular in the state of Washington for fish passage flows: combining statistical regression and GIS such that the equations are already pre-solved. It’s very easy to find the answer that you need that way.

The second example of how research can save time comes from the state of Nebraska. On the left side of this photograph is a Union Pacific Railroad crossing of Big Papillion Creek. At the crossing, the stream had eroded its bed downstream from the railroad, badly eroding the embankments nearly to the point of failure. The Corps of Engineers was in a big hurry to find out what they should do. They had done some computer modeling but recognized that, for a physical model, a computer model doesn’t always answer the questions. We were able to put together a physical model of this situation and, in a matter of months instead of years, came up with an answer that they could use. A few months later, the following construction season, they were able to build what we had modeled in the lab.

The reason I show this slide is because here in the State of Utah, we’re very lucky to have facilities up at Utah State at the Utah Water Research Lab, one of the premier laboratories in the country for doing this kind of work. And UDOT can call on them as necessary to help in projects such as these. I don’t get any reward for this, I just like to collaborate, and I’ve been around the country enough to know we’ve got a great facility here in Utah.
The third example is an unusual situation that is more common than we initially thought. It’s called a broken-back culvert. This is an elevation view, standing sideways and looking at a culvert. There are many situations across the country where there is a great elevation drop across a roadway. This may be due to a channel incising, cutting into its streambed in the upstream direction. As a result, there’s a great elevation difference between the up- and downstream sides. It might be along the side of a mountain or a hill, and you’ve got to get the water from here to there. The trouble is that when you do that, it accelerates and can really cause erosion problems downstream. So a broken back culvert says, “Let’s accelerate the water, but on the downstream side, let’s have a flat section here where we might be lucky enough to produce a hydraulic jump.” Do you remember that from school? You have supercritical flow, and then there’s this cool looking hydraulic jump that you see when you go white water rafting. If we could produce that inside of a culvert barrel then we don’t have to worry about the erosion downstream. The problem is that there were no design procedures for this kind of installation. So, in a project with the Nebraska Department of Roads several years ago, we created a computer program to analyze this situation. The results have been published in the literature, but I’m proudest of this one: an article that appeared in TRB news under the series Research Pays Off. The State of Nebraska has used this design for hundreds of culverts, and the software was developed with federal money so it’s free to download and has been downloaded across the country a lot. I believe it’s being used here in the State of Utah. This saves time and money because now you can analyze the possibility of a hydraulic jump within the barrel and save the money on energy dissipation downstream. The design also saves probably dozens of hours. There are occasions when even academics can come up with something that’s useful and actually saves time.

Now, we discovered something while we were doing that research. This cartoon says, “I’ve got good gnus and bad gnus.” The good news is that oftentimes a hydraulic jump will occur in a barrel of a broken back culvert. The bad news is that sometimes it won’t. When it doesn’t, you’re shooting water out at 25-30 feet per second downstream toward that channel. Well that’s no good. So what can be done to actually induce, to create a hydraulic jump within a culvert barrel?
This is a combination of working with the Department of Roads and the academic side, the research side. Kevin Donner, who’s a good colleague of mine from the Nebraska Department of Roads, thought, “Well, wait a minute. You know when you pour a bridge deck, oftentimes you’ll have steel plates underneath? What if we used bridge decking as a form to pour concrete in a boxed culvert? When you’re all done you would have ridges in the boxed culvert that looked like the steel planking, so what can be done with that?” We attempted to reproduce that in the laboratory, in a laboratory flume. Here we have water going from the top to the bottom and from the front to the back over 2x4’s that had been specially shaped to look like that steel bridge decking. Then, in an effort that will be familiar to many of you, we measured the Manning’s $n$ value, or the resistance to flow. The resistance to flow is very high, and it tapers off as discharge increases through the culvert barrel. Their target: they wanted a Manning’s $n$ of 0.035, which is not like water flowing over concrete. It’s like water flowing over a gravel bed coming out of the Wasatch Mountains. Now here’s the unresolved issue in this case: can this be built? It has yet to be built. We don’t know about the practical matter of using these steel bridge forms in pouring concrete. That’s for them to try to figure out, but at least we can demonstrate that they can achieve what they want to if they can figure out the construction technique.

Here’s another example. Sometimes the very simplest things become the most difficult. Let’s say that you’re living in an urban area in Salt Lake City or Utah Valley, and a mall or some business is constructed, and they need to reduce runoff from their concrete pavement. One way to do that is to construct a detention pond and get the water out of that pond. How do you get the water out of the pond? You simply send it through a pipe. Well there are a lot of losses associated with that. In the upper right hand corner, this is water coming out of a sharp-edged exit. It’s about a foot in diameter, and I find it particularly beautiful. See the contraction here? It’s a tremendous amount of contraction through this sharp-edged exit. That seems like a waste of energy. An entrepreneur, a private citizen, came up with the idea of using donuts, which are rings that would be placed on the inside of this detention pond to try to smooth out the losses that are so easily evident right here.
And here’s how it looks. In the upper right is the unaffected contracted flow. In the lower left and in the lower right are pictures of the flow patterns with those donuts in place. We were able to increase discharge by 25 percent just by putting these rings on the inside of a tank! Now obviously this has application not only in detention ponds and transportation, but in all chemical industries that involve fluids flowing out of a tank. Sometimes the easiest setup still requires some research to save time and money.

I’d like to share a couple of examples of how research can save lives, and this is from the water resources industry. Corrugated metal pipe culverts have some real advantages: they’re lightweight, they’re easy to transport, and they can be built in the field. They also have some disadvantages: they float, and in this flood—about a 100-year flood in the Pacific Northwest—these large corrugated metal culverts floated out of the ground. They can actually float right through the embankment section of the roadway. What can we do to prevent this from happening? It may not be rocket science, yet the answer to this question can actually save lives, as is evident in this photograph of a very dangerous and obviously life-threatening crossing.

Floating culverts are a problem. As I teach fluid mechanics, we always talk about buoyancy and things like that, but it’s really hard to appreciate the power that buoyancy has until you show a photograph like this, do a few calculations, and realize that they can float up right through the embankment.

On a more mundane topic, though, I’ve also done research on curb inlets. If you want to have fun this morning at this meeting, let’s talk about curb inlets. Perhaps it’s not the most exciting topic, but a well-designed curb inlet that takes advantage of flow in a gutter section will reduce spread. And if you reduce spread, you can reduce hydroplaning. As I drive to work every day from Springville up to the BYU campus, I know there is a spot on Highway 89 where, if it’s raining, the road is going to have an inch of water across it. I know that from experience, but to watch drivers suddenly realize that they want to avoid this and watch them change lanes dangerously or go through and have the big rooster tail of water… It’s a dangerous situation. Research on such a simple topic as curb inlets can actually save lives.
Now, what about floods that exceed the design return period? As you know, in water resources we only design culverts and street drainage systems for a certain return period storm. After that, you’re kind of on your own. Why do we do that? If we were to design every bridge, every culvert, and every storm sewer to successfully pass, say, a 500-year flood, we couldn’t afford to build it. There’s always some inherent risk. In this situation, Western Nebraska experienced ten inches of rain in nine hours. Their annual rainfall is 22 inches, so they got about half their annual rainfall in less than half a day. This greatly exceeded the design return period. So what do we do?

Here’s a non-standard crossing of I-15 resulting in the death of the driver of this truck. He could not stop in time and lost his life as a result. This was a non-standard crossing built in the 1960s when the interstate system was first developed. Contrast that with a box culvert just to the east of this location that was functioning properly. This greatly exceeded the design return period, and you can tell by the tremendous erosion that this thing is just barely hanging on, but it’s passing what has been estimated to be a 700-year flood. It’s functioning! It’s barely hanging in there, but recent improvements in culvert design saved that section of the interstate and, obviously, the problems that could’ve happened had it failed.

Finally, I’d like to talk about some projects about saving the environment. Actually “saving the environment” sounds touchy-feely. What we’re all trying to do—and I have yet to meet a person who does not want to do this—is to build projects that are as compatible with the environment as possible as we move forward. That’s really what this is talking about.

In the last ten years or so there’s been a big move toward providing passage through culverts for all sorts of aquatic organisms like this creature right here. In the past we designed culverts to pass the 50-year flood at a particular depth upstream. Now how are you going to design a culvert for this guy? In the state of Utah, it’s quite challenging because we
have some non-Olympic swimmers here. In the lower left hand corner [of the slide] we have the sculpin, and in the lower right hand corner we have the long-nosed dace. You can see the scale as indicated in those boxes. How do you design a culvert so these guys can move up- and downstream? Well, who cares? So what if they can’t? Eventually, we would lose the species, and whether you think that’s good or bad, the Endangered Species Act will tell us that it’s not going to happen. Now Utah faces the challenge of designing culverts not for these Olympic salmonids—a steel head adult salmon can leap ten feet. We’re talking about designing culverts for these types of fish. They don’t catch air—they’re kind of like me when I try to jump—so it’s pretty challenging.

In the last five years, through research, some new methods of designing culverts have come along, and the bottom line is, “The wider, the better.” In the upper photo, you see a photograph of a newly-designed culvert for fish passage. It has a couple of features. The first feature you’ll notice is how wide it is. It actually spans the channel through which the water’s flowing. The other thing you’ll notice is there’s no bottom on the culvert. Actually, there is a bottom on the culvert; it’s just buried by about 3 feet. Providing natural substrate is more amenable to critter passage, including fish, than a bare-naked concrete or corrugated metal pipe. The culvert on the bottom here has also been designed for fish passage; it’s just not that large.

Here’s the argument, “Gee whiz, if you make these culverts so wide, why don’t you just go to a bridge?” And that’s been happening more and more often. Another argument is that we can’t afford to put in such culverts. There are some other benefits, though, that have yet to be quantified. For example, a wider culvert will decrease the velocity downstream. Decreased velocity downstream reduces maintenance issues and long-term maintenance costs downstream. A lot of departments of transportation are fighting against this trend of going in for wider culverts because of the increased capital costs. One of the research questions we have not answered is, “What are the life cycle costs, and, over the life of a culvert, say, 30 years, would it be cheaper in the long run to put in a wider culvert at the beginning anyway to reduce those maintenance costs downstream?”

This is kind of where we’re headed now in the design of culverts. I would like to give you an example of how this really comes out. In the Methow Wildlife Area up in North Central Washington, an existing culvert needed to be replaced. It wasn’t the worst culvert I’ve ever seen; it was 2.8 meters wide. Nonetheless, water, as it comes out
of the culvert, was tumbling right here. Juvenile fish couldn’t make the leap. So if you’re going to replace this culvert with a new one, you’ve got a golden opportunity. What are you going to do? I’ll explain what we’re looking at now. This is a bar chart, and on the x-axis are several different methods that have come forward in the past five years for designing culverts that will allow a fish to pass. On the y-axis is the span of a culvert. Here’s the span that was replaced: 2.8 meters. Notice that all of the other alternatives inevitably result in a wider culvert, but all of these will successfully pass fish upstream.

That’s kind of the direction we’re headed. Though there are lingering questions that are very irritating about this kind of design, and it goes to address differences between natural resources scientists and hydraulic engineers who are all about optimizing. I’ll illustrate what I mean. As you took your basic class as an undergraduate in open channel flow, I’m sure that you were told that the velocity around the perimeter of a culvert is actually zero and that the non-uniform velocity increases toward the top and center until the red spot there. That’s the maximum velocity. Right now, all of your hydraulic engineers in Utah and others around the country cannot take advantage of this well-known fact. We had to design a culvert assuming that the velocity was uniform across that cross-section. That means we’re using bigger barrels than we probably have to because we can’t take advantage of the slower flows in a culvert. Well we can kick and scream and argue that this doesn’t make sense and that it’s not logical, but we don’t have the data to back it up. So how do we get the data? After a while, like this cowboy on the roof with a gun whose buddy says, “Well, they tell me you’re pretty handy with a gun,” every culvert starts to look the same if you’ve only got one option. If you’ve only got one tool in your belt, you’re going to use that for everything. What we’re trying to do in some current research is to provide some choices. So let’s go to the field! Let’s see what nature can tell us.
Using one of the fleet vehicles from the UDOT Motor pool, we go out to the field and find out what’s going on. The question is, “What can we learn from fish?” The first thing we have to do is collect them. This is kind of fun. You go out with an electro-shocker in your backpack. Here’s a man standing in the water holding an electrically charged probe; that was not me! And we have a net down here, and we’re collecting native Utah fish like this one right here. Once they’re collected, we inject a dye into their eye or another body part, and then we go out four or five months later and we repeat the exercise, but this time on the upstream side of a culvert. That answers the question of what can make it through and what can’t.

We also have to know how fast and how long these native Utah fish can swim. To do that, we collect the non-endangered species and bring them to the lab. We put them on the equivalent of a treadmill, which is a small hydraulic flume. The water goes down the flume slowly at first, then a little faster, then a little faster, then a little faster, and the fish is hanging on for dear life until it gets exhausted, and it gets plastered against a net downstream. That’s how you do it. I remember taking a stress test one time, checking out the heart. The doctor was in the room reading a book while I was on the treadmill. Of course I wanted to be the macho man, right? I was near death before I finally gave up and got off the treadmill! Well this is what we do with fish to find out how fast and how long they can swim, and we learned some interesting things in the process.

This is a long-nosed dace. For lower velocities, it just casually holds itself in the flow by flapping its tail. As the velocity increases, though, it puts down its pectoral fins until it touches the bottom of the boundary, kind of hanging on, and then it puts its nose down and arches its body, creating negative lift. That helps it hold in the flow longer than it normally would. These animals aren’t stupid. They’ve been around for a long time.

Then what do we do? While we try to document the obvious, what we’ve done is come up with some basic experiments. I’ll show you a video here in a minute. This is another long-nosed dace. Fortunately, when you put these in a flume, they really try to swim upstream. That’s nice. We don’t have to encourage them; it’s just instinct. They take off looking for a safer place. As I start the video, the water is going very fast, faster than this fish can really hold on. It’s looking for a place to hide. So the fish goes upstream, and we place concrete cylinders there as refuge.
There it is. We thought the fish would hang out behind this, but look at the beating it’s taking behind this concrete cylinder. It just can’t hang on! Eventually the fish says to itself, “To heck with this! I’m going upstream.” Upstream about half a meter, it finds a resting place. We didn’t expect that. We thought it would rest behind the cylinder.

So then we do a kind of forensic analysis, and we realize, for those of you who have worked in this area, that the cylinder produces alternating shutting vortices at a particular frequency. The width of that cylinder compared to the body length of the fish was such that it was beating the fish to a pulp. The fish was resting upstream from the cylinder instead of downstream. Well, that’s okay; it just was different from what we anticipated. This illustrates the basic problem of research in experimentation with fish.

You see a lot of variables up there. The only one that’s highlighted is roughness. There are a lot of experiments that could be conducted. We chose to look at just one possible combination, and here’s what we found. You’ll see red bars and blue bars on this graph. The blue bar means that we tested fifteen fish without any cylinders in the flume whatsoever—no place for them to hide. When we had cylinders in the flume, we tested different fish—same species, same time of year—and we had eighteen of those. Then the question was, “How many of those fish could make it to the upstream side of my flume, or, in other words, a culvert?” How many could make it upstream without those concrete cylinders in place? Absolutely none. Zero. How many could make it with them in place? The answer is eight out of eighteen, or about 40%. That’s a good start. What else can we learn?
This is a little bit of a complicated figure. What we have here is distance in the flume. This is downstream, and this is upstream, so as the fish goes from downstream to upstream, it’s fighting against the current. This is a depiction of time. In the first five minutes, where did we see the fish? When there weren’t any cylinders there, the fish were kind of hanging out downstream, and as time went on, they really weren’t able to go very far upstream because the water was moving too quickly. When we put in those simple concrete cylinders, you’ll notice a progression from left to right that shows how long it took the fish to move upstream, resting in each case.

This will provide the hardcore data to prove what we’ve already known, which is that fish take advantage of resting places just like we do. If you go up the stairs in a ten-story building, you’ll rest on the landings. We just didn’t have the data.

Now what can be done with this? The potential result is that design engineers will have more flexibility; they won’t have to design every culvert as if they were the same. They can take advantage of the information that we provide. They can design a culvert with a wide span, or they can make one a little bit narrower and put some stuff inside to provide resting places for fish. As a design engineer, what I like to have is choices. I really like to use common sense whenever possible, and if we can provide those choices through the results of research, then I think we’re all better off.

Saving money in time: this is the last major example I’d like to share with you. I was at a national meeting a few years ago with Denis Stuhff. He came up with a phrase that stuck nationwide. He said: “baby boomer culverts”—about our age, exceeded their design life, and ready to retire. “Baby boomer culverts.” There are a lot of them out there. Imagine replacing these culverts completely by ripping up the roadway. How do you think our traveling public would like that? They wouldn’t like it very much. So what are we going to do? There are more than sixty thousand of these in the state of Utah that UDOT administers alone.

It’s an example of dimly lit engineers. Around the country various engineers have come up with what they think is a great idea, and it goes something like this: “Hey, wait a minute! If we just get some plastic pipe and run it inside the old pipe, our problem is solved.” They might be challenged. They might be told, “Well, you’re
going to decrease the cross-sectional flow area.” And the engineer, proudly, with his dimly-lit light bulb above his head, says, “Well, yeah, but we reduce the Manning’s $n$, increasing the velocity and maintaining the capacity of the culvert.” Well, that’s just great, and you know, for some installations, that is just great.

I always tell my graduate students that my job as their advisor is to tell them what exhilaration means. Graduate students will come into my office with a breakthrough on their research, and I’ll remind them. I’ll say, “How do you feel right now?” And they’ll say, “Well it’s an exhilarating feeling!” Then I remind them that exhilaration is the feeling you get when you have a great idea and don’t know what’s wrong with it yet. I share with them what’s wrong with their idea, and they turn, dejected, and leave the office. That’s the role of a graduate advisor; isn’t it? It doesn’t always happen that way, but the problem here is that these fish are saying, “Well, thank goodness we all made it out in time. Of course we’re equally screwed now.” What once may have provided fish passage, with its new slick interior, may become a barrier.

The impetus for this research actually occurred right here in Utah. A Logan canyon corrugated metal pipe culvert needed to be replaced, and a new one was designed which would provide for fish passage. I hope I don’t offend anybody in the room, and Denis you’ve got to help me if I get this wrong, but the folks at the maintenance yard had a great idea. They had this plastic pipe sitting around. “Why don’t we just put in plastic pipe?” It actually wasn’t called for, but, hey, what a great idea! Within a short period of time there were no trout upstream. Zero. Well, that’s no good. So Denis and his counterpart came up with a very imaginative idea. This image is a cross section of the culvert in question—circular pipe and this little V-notch weir. Denis, I still don’t know how you got those things in there—kind of put them on a stringer and pushed them up in the pipe, then pulled a string, and they all stood up. The diameter of the pipe was so small that no one could crawl in there. That was very imaginative.

Well, from that start, what can we do to have our cake and eat it too? That is, how can we take advantage of this technology that would allow us to replace culverts quickly and not lose fish passage capabilities? So we’ve addressed this topic, since you’re not going to find any published journal articles on this around the country. My graduate student last year, at the peak of the Fall colors, went to New England. He got a very inexpensive flight; he paid more for the rental car than he did for the airline
ticket. He visited Maine and Vermont. We went to California to look at the states that are actually doing this, and what we found is, most commonly, that they will slow the water down in a plastic pipe by providing back water. That is, a weir at the bottom backs water up into the culvert. Of course, now we’ve got to have the tools to analyze the capacity of the culvert, and we have them in place.

I’d like to summarize now. Research can save time, money, lives, and the environment. It takes effort, especially when we’re on the second order of questions, questions that cross disciplines and allow us to work with other people. It does require patience, vision, and determination. Here on the right hand frame you see the late Sean Stanley as he was. No, he is still alive. He is still with us, but sometimes gauging a stream can be pretty dangerous business.

My last slide: sometimes you find unexpected results. We were measuring bed load transport. That is the transport of sediment along the bed of Hobble Creek downstream from the golf course. And you find things you don’t expect. Be careful when you’re out there. It may hurt!

That’s all I have for you. I hope you found this interesting and agree with me that research can save time, money, lives, and the environment. Thank you.

(applause)
Status of UDOT Research - Introduction

Michael Fazio, Deputy Director of Research:

Now we’ll have Blaine tell us about all we’re doing in research. He’ll recap all our work and where we are with research and give you a broad picture of our work.

(applause)

Status of UDOT Research

Blaine Leonard, Research Program Manager:

Thank you very much.

As Michael indicated, I want to talk to you a little bit about the status of some of the research we have going on in the research group to sort of stimulate our thinking as we go into our breakouts. I also want to talk a little bit about the scheme for today so we understand what we’re about to do. Before I do that, however, I want to thank Rollin for his insightful presentation and for helping us to understand the value of research. I appreciate his insights and his time in doing that. I also want to thank him for all the work he’s done for UDOT over the past several years. We appreciate the good work he’s done.

I also want to take an opportunity to thank several people who have helped put this together. I’ve been occupied on some other things lately, and I’ve delegated a lot of the things that I typically do for UTRAC. Many of you may not know David Stevens. He’s standing in the back with the light blue golf shirt. Raise your hand David. David is new to the research group. You’ve probably seen e-mails from him, but may not have met him. He joined us last Fall, and he has done a lot of work in getting ready for this UTRAC, and I appreciate all of his time. Michael Fazio has also done a lot in the organization, and of course Esther Olsen and Amanda Holm, who are at the check-in table, have helped prepare all of the handouts and all of the materials and have helped organize the room here. Elaine Chatfield back at Research has also helped facilitate a little bit. I want to thank all of them for all of the work that they’ve done.

(applause)

As you’re well aware, I’m technologically challenged. If you don’t know that, you’ll figure it out here pretty quickly.
Our UTRAC process has multiple steps. In the process the way we do it now, we solicit problem statements in advance of the workshop today, and then we hold this workshop where we evaluate those statements and prioritize them. After the workshop, we then evaluate the priority problem statements, look at the amount of funding we have, and match the funding to the projects. We decide how many we can get done, get those approved by the Federal Highways, and then initiate each of those projects.

Last year we had about 140 attendees at UTRAC with nine practice area groups. We started out with 51 unique problem statements. I say “unique” not because they were unique necessarily, although some of them were, but some problem statements were used in multiple sessions, and so it might have looked like we had more than that. 35 of the 51 were prioritized by your breakout groups, and we were able to fund nine of those. Now that’s a smaller number than in the past, and I’ll describe that in a minute, but we did too many in the past, so we had to do some catch-up here. If you want to see which ones those are, we post them on our UTRAC website, so you can go there and look at each of the problem statements. They’re also in our annual proceedings document that we prepare and post.

I want to quickly walk through the nine problem statements that were prioritized last year.

The Construction group came up with one on HMA temperature placement limitations. We’re probably going to work on that in-house. It’s taken us a while to figure out the scope of that project and the best way to do it. David Stevens is managing that.

Failure of surface courses beneath pavement markings is one that came out of Maintenance, and we’re still working on the scope of that one, Betty Purdy is the champion.
In Materials and Pavements, we’re looking at full-depth reclamation with asphalt. The scope of work is being refined. Spencer Guthrie down at BYU is working on that for us.

In the Environmental group, we’re refining and enhancing UDOT’s habitat quality index. This is a project that was started a number of years ago on the Legacy Highway to identify the quality of habitat for various wildlife, and this is really another phase of that project. Michael Fazio’s the project manager and Tom Twedt at BioWest in Logan is the principal investigator on that project.

In Planning and Asset Management, we’re looking at land use planning. Eric Rasband is the champion, and we’re presently preparing a contract with Xuesong Zhou at the University of Utah.

In Traffic and Management, we’re looking at automated delay estimates for traffic signals. Mitsu Saito up at BYU is the principal investigator, and the contract is just being finalized to get that work rolling this summer.

In Geotechnical, Dr. Rollins is helping us look at wick drain effectiveness in sensitive clays. This is another of a series of projects we’ve had looking at wick drains and how they impact our embankments in transportation. We are currently looking at suitable sites to conduct that research.
In the Structural area, we’re looking at GFRP reinforced lightweight pre-cast bridge deck panels for Accelerated Bridge Construction. As Shana mentioned, there’s a lot of work going on in the department related to Accelerated Bridge Construction, and Chris Pantelides up at the University of Utah has this project well underway.

In the Hydraulics area, we’re looking at design discharge estimates in Utah for small watersheds, and Steve Burian and Christine Pomeroy at the U of U are well underway on this research.

Those are the nine projects that we pulled out of UTRAC last year and that we were able to fund.

As I mentioned, there were 35 prioritized projects last year. These were the nine that were placed on our funding list, and we dedicated about $420,000 to these projects. All told, we have, in the Research Division, about 68 projects underway at this point—from last year’s UTRAC, previous UTRACs, and a few other sources. Over the past year, we’ve completed 20 projects from past years and currently have about 4.6 million dollars under contract for research. That’s down from about 5.8 million dollars the previous year, as we’ve taken care of some of our backlog and completed some of these projects. That total funding amount doesn’t include the experimental features, the pool fund projects where we’re not the lead state (twelve of those), and a number of the other research programs that we’re typically involved with.

Here is just a smattering of the other projects that we have underway in various areas inside of UDOT—some of the other 68.
You’re aware that we have a number of sources of funding. Our primary source is SP&R money—State Planning and Research money. That’s a federal allocation that comes to us as part of the overall Federal Highway Administration allocation to UDOT. It’s a fixed percentage of that. We also have some state research funds, we get involved in pooled funds, and we have some other sources where we have special programs like Innovative Bridge and Highways for Life. We have two university transportation centers that we cooperate with: one at Utah State and one that the U of U is involved with, which is the Mountain Plains Consortium. We get matching funds from them or provide matching funds to them, and that enhances our ability to do research.

Here, though this is more data than you’ll want, are the ten discipline areas that we have work in. This table shows the number of research projects that we have going in each of those areas and the amount of funding applied to those projects.

This slide has a pie chart on it that you can’t see. It’s an invisible pie chart; it’s meant to evoke your imagination. It was there last night. Tech savvy I’m not. I can send that to you if you want it, if you’re really interested.

When our projects are done we generally end up with a report out of the project. We publish those in hardcopy, and they’re found in the Lester Wire Library at the UDOT complex, in the research library on the fourth floor, and they’re distributed to a number of other state
libraries. The best way to find these reports is to go on the website where we post the PDF’s of all of these, or you can talk to Abdul Wakil who knows where all of these things are and can lead you to them if they’re not there.

Well, getting to today, we have 144 people registered here for our workshop today, and we have ten practice area groups. We’ve added a group this year, although we only have nine here because one group is meeting off-site for a variety of reasons. The first thing we’ll do in our groups this morning is get updates on a couple of ongoing projects, just to get you in the mindset and to give you an idea of where some of your specific projects in your topic area group are progressing. Then you’ll spend time discussing, evaluating, editing, and prioritizing the 68 problem statements that have been submitted this year.

The new group we’ve added this year is Engineering Technology. We’ve always struggled with feeling like we are not adequately serving some of the design functions that go on, so we’ve tried to capture that in Engineering Technology. The Traffic Management and Safety group is not meeting here today; they’re meeting elsewhere to go through a different process.

When I’m finished we’ll have a short break, then you’ll start talking about some of the problem statements that have been submitted.
During the lunch break we’ll have the Trailblazer award. Last year’s Trailblazer award winner was Chris Pantelides. The Trailblazer award is something we give which recognizes excellence and dedication in transportation research, and it’s been given for a dozen years or so. It’s a prestigious award, and we’re happy to award that again today.

Too often, when we do research projects that have great objectives, we get to the end and say, “Now what do we do with it?” We need to have in the beginning some anticipation of how we will use the research in the end. Granted, we may not understand what the results of the research will be, but we still need to spend some time anticipating what we’ll do with it when we’re finished, and if that is spelled out in the beginning we can direct the research toward a goal. It makes it more beneficial to us. We really shouldn’t be prioritizing projects when we have absolutely no clue what we would do with them when we’re done. So keep that in mind.

We also need to make sure, as we’re going through these projects, that we’ve got somebody in UDOT that is an advocate, a champion for this particular research that will help the research get done and will help the research get implemented. Sometimes we run into roadblocks as we try to do the research. We need somebody inside who can get some things happening, who can get us on construction sites to test certain things, and who can pull some strings to accomplish some of our objectives. Make sure you talk about that in your process.

And so you’ll refine the statements and the deliverables and then do a final vote.

Good luck today, and we’ll see you back at lunch.
The 15th UTRAC Trailblazer Award
for
Outstanding Contributions to Transportation Research

2009 Recipients:
Ralph Wadsworth
Kip Wadsworth
Guy Wadsworth

Trailblazer Presentation

Shana Lindsey, Director of Research and Bridge Operations:

It’s time to give out the Trailblazer award. I think most everyone knows what the Trailblazer award is, but I’m going to share a little background on why we do this. The Trailblazer award is an award that Research gives out to a person or to a group of people who have furthered along research. And we like to recognize those folks. We put their names on this traveling trophy that you see here. If you look closely, you’ll see a lot of names on there of people who have received this award. We want to recognize some of those people, and we know that all of you here today are helping us further along research. But there are always a few individuals that really do a lot to help research and we want to make sure we recognize those folks.
Earlier this morning, I talked about how last year we had a major success in Research in terms of transferring the technology of SPMT (Self-Propelled Modular Transports) and building our bridges with Accelerated Bridge Construction (ABC). I also talked about how we can’t do all that in Research by ourselves. We need all of you to help with the implementation of that, and the implementation of our research project is what makes it successful. That’s a key point. An important point of all the research that we do is to make sure it gets implemented. I talked about that also this morning. This year we want to recognize the individuals who have furthered along ABC—helped Research further along ABC by transferring that technology and making it successful. I’m not going to talk about everything they did because Jim’s going to talk about that, and I don’t want to steal his thunder.

We have the individuals here, and I’m going to call them up. Then I’ll have Jim present the award. Come on up Wadsworth Team! We’ve got Ralph Wadsworth, the dad. We’ve got Guy Wadsworth, the son. And we’ve got Kip Wadsworth, the other son. I know they have other sons that are great as well, so we appreciate you all being here and accepting this and helping Research progress. I don’t know how much I can say to thank you all for all that you have done. So, Jim, if you don’t mind presenting them with the award?

Jim McMinimee, Director of Project Development:

Thank you gentlemen for coming today. I appreciate it, and I appreciate you all being out there with us today.

This is a really unprecedented honor. We usually choose only one person to give this Trailblazer award to, but today and this last year have been so special in terms of what we have implemented in Research. UDOT has had the ability to do that, and we wanted to have the chance to recognize three individuals and two outstanding contractors—two really outstanding companies, if you will—that helped us in furthering SPMT’s and furthering Accelerated Bridge Construction.

I have the honor of being able to travel quite a bit for UDOT, and one of the things I always say when I’m out is that we have what I believe to be a world-class transportation industry here in Utah. And I think one of the advantages we have is that we have incredible, outstanding, world-class contractors here, and some of those gentlemen are right here with us today. This is really exciting for me to spend some time with these guys. I’m lucky enough that I get to do it fairly often, but I’m really lucky today to be here on this stage with them. Accelerated Bridge Construction was something that captured our industry over the last couple of years, and in fact it was so exciting that Ralph came out of retirement to help us implement the first SPMT move on 4500 South last year. Ralph I just want to thank you for doing that, and I know it was exciting for you. I met with Ralph on the grade a few times, and I can tell you it was like a kid being able to play with toys. They were big toys, but he was having a good time telling me about all the
design that they had done on the temporary abutments and telling me how they were going to do things. It was incredible to be close to someone who’d come out of retirement and was so excited about something like that. He reminded me of a kid during Christmas.

Shana Lindsey:

I have a little story I want to share about that. I was talking to Ralph one time, and his wife was with him. They had come to watch the bridge move down the street. If any of you have never seen that, it’s a pretty awesome scene. And his wife Peggy said, “Now why would someone come out of retirement to do this?” Guess what his answer was. “Because it’s fun!” That’s our theme for today right? We’re having fun.

Jim McMinimee:

Another thing that was really interesting as we started to do these projects was that we really had contractors—and this is something you won’t have anywhere but Utah—we had contractors lining up because they wanted to be the first people to do this. It just happened that Kip was the one who presented the winning proposal on 4500 South, but he just barely beat out other contractors. Kip’s company, Ralph Wadsworth Construction… I always get these mixed up, don’t I Kip? It’s Ralph’s company, but Kip’s the president. Their company was the one to get the scary honor to pioneer the first one, and they did a great job.

We had lots of people out watching us move that, and it’s a national sensation. I was talking with Professor Womack earlier today. He was telling me we made it into an ASCE publication, and we’ve gotten a lot of accolades for that first SPMT move. Following that, later in this last summer we had people lining up to move bridges on I-80, and Guy’s company, Wadsworth Brothers, made the winning proposal on that. They did something that has never been done before in the world, which was to move four bridges over the span of two weekends. That’s world-class and just an amazing engineering feat. I know many of you were there to see them do that, and it was just amazing. The whole process, I guess the whole effort, that these gentlemen and their companies went through to help us further SPMT’s, I think, is very worthy of this honor of being recognized with the Trailblazer award. To be honest, these guys represent great companies, and their names are great additions to this Trailblazer award. So please recognize them once again, and we’d like to give you gentlemen, if you’d like, an opportunity to speak. Let’s reward them first with our applause.

(applause)

Ralph Wadsworth, Founder, Ralph L. Wadsworth Construction Company:

Well, like Jim said being a structural engineer for thirty years—doing the same thing over and over and over, designing joists on buildings—to move into bridges, something different, was a challenge and a lot of fun. And he’s right: we had a great time doing it. We all had a fun time and enjoyed ourselves. I thank you for this.

(applause)
Kip Wadsworth, President and CEO, Ralph L. Wadsworth Construction Company:

I just want to give a quick thanks to UDOT and especially to Jim and Shana for allowing us the opportunity to participate in such a trailblazing program, to be able to do this kind of work when other people in the country aren’t as fortunate as we are to be on the cutting edge. We really appreciate it and love to do it and hope we can do some more in the future. So, thanks.

(applause)

Guy Wadsworth, President, Wadsworth Brothers Construction:

I appreciate the award. Like Dad said, it’s nice to do something different after you’ve been at it for thirty years. But I’d really like to take the chance right now to turn the tables around because the whole concept of the ABC has really served all of us in good stead, and I think that Research and Development and the leadership at UDOT really deserve accolades for this. It’s this renewed interest in our own infrastructure and rebuilding the roads that’s helping us get the money from our legislature, so you know this is self serving for us when we participate in this and help make it a success. We see that, through the confidence that UDOT has with all the guys on the hill, we’re able to get more jobs funded and a little more stuff. I’m happy to be a part of it.

(applause)

Jim McMinimee:

Who gets to keep the award?

Shana Lindsey:

One of them. Dad? Hold up your awards. Thanks you guys. You can go ahead and continue to eat your lunch. Michael what’s next? We’ll move on to the session right after lunch, and we’ll continue on the afternoon. Prioritizing your top research is a very important part of the process. Thank you.
RESEARCH PROBLEM STATEMENTS

Each issue considered during the UTRAC Workshop is described in a “UTRAC Problem Statement” form. The statements are prepared and submitted prior to the workshop. The form includes the objective of the proposed research, the steps anticipated to meet the objective, the approximate budget needed to perform these steps, the deliverables desired, the challenges and hurdles anticipated during the work, the key champion within UDOT who will monitor and use the results of the work, and other individuals and organizations who are interested in the research efforts.

The Problem Statements selected for funding are listed in the following section, including the full text of each Problem Statement. This is followed in the next section by a complete list of all Problem Statements considered at the workshop, and the full Problem Statements for each of those.

Problem Statements Prioritized For Funding

During the UTRAC Workshop, each discipline group discussed and prioritized the Problem Statements submitted to their group. The four to five highest priority Problem Statements, in order, were submitted to the Research Division for potential funding. After matching the anticipated available fiscal year 2010 research funding (from federal State Planning and Research [SPR] funds and state Construction funds) with the list of priorities, a list of thirteen Problem Statements resulted.

The thirteen Problem Statements ranked for funding are shown below, including the funding priority, the Problem Statement number and title, the discipline area each falls within, and the approximate budget anticipated. The research funding allocated to these projects is $607,800, not including the overhead costs needed to manage the work. Many of these projects will span more than one year, impacting research funding in subsequent years.

Following this list, the full text of each Problem Statement is given, in order of funding priority.
<table>
<thead>
<tr>
<th>Funding Priority</th>
<th>Prob No.</th>
<th>Problem Title</th>
<th>Discipline</th>
<th>Approx Budget</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>09.01-2</td>
<td>Project Earned Value</td>
<td>Construction</td>
<td>$47,000</td>
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<td>2</td>
<td>09.02-1</td>
<td>Using Unmanned Aircraft to Help Solve UDOT Problems</td>
<td>Maintenance</td>
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<td>3</td>
<td>09.03-1</td>
<td>Mechanistic Characterization of Soils and Aggregates</td>
<td>Materials and Pavements</td>
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<td>4</td>
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<td>Determining National Register Eligibility for Post-War Historic Bridges</td>
<td>Environmental</td>
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<td>5</td>
<td>09.05-1</td>
<td>Understanding the Economics of Transportation in Utah</td>
<td>Planning and Asset Management</td>
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<td>6</td>
<td>09.06-3</td>
<td>Evaluation of Utah Work Zone Practices</td>
<td>Traffic Management and Safety</td>
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<td>7</td>
<td>09.07-5</td>
<td>Lateral Pile Resistance Behind MSE Wall Abutments</td>
<td>Geotechnical</td>
<td>$50,000</td>
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<td>8</td>
<td>09.08-3</td>
<td>Evaluation of MATACRYL as a Waterproofing Membrane on Bridge Decks</td>
<td>Structural</td>
<td>$30,000</td>
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<td>9</td>
<td>09.09-3</td>
<td>Culvert Roughness Elements for Native Utah Fish Passage Phase I</td>
<td>Hydraulics</td>
<td>$79,200</td>
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<td>10</td>
<td>09.10-3</td>
<td>Lidar Technology for Bridges</td>
<td>Engineering Technology</td>
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<td>11</td>
<td>09.03-5</td>
<td>Improving Concrete Performance with Sustainable Long-Life Concrete Specifications</td>
<td>Materials and Pavements</td>
<td>$50,000</td>
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<td>12</td>
<td>09.07-3</td>
<td>Assessing Corrosion of MSE Wall Reinforcement</td>
<td>Geotechnical</td>
<td>$21,600</td>
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<td>13</td>
<td>09.10-2</td>
<td>Phases I &amp; II: CADD Platform Independent drawings</td>
<td>Engineering Technology</td>
<td>$30,000</td>
</tr>
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</table>
Problem Title: Project Earned Value

Submitted By: Lori Dabling

Project Champion: Craig Hancock

1. Briefly describe the problem to be addressed.

Earned Value Management (EVM) is a project management technique for measuring project progress in an objective manner. EVM has the unique ability to combine measurements of scope, schedule, and cost in a single integrated system. When properly applied, EVM provides an early warning of performance problems. Additionally, EVM promises to improve the definition of project scope, prevent scope creep, communicate objective progress to stakeholders, and keep the project team focused on achieving progress.

Project Tracking without EVM

It may be helpful to see an example of project tracking that does not include earned value performance management. Consider a project that has been planned in detail, including a time-phased spend plan for all elements of work. Figure 1 shows the cumulative budget for this project as a function of time (the blue line, labeled PV). It also shows the cumulative actual cost of the project (red line) through week 8. To those unfamiliar with EVM, it might appear that this project was over budget through week 4 and then under budget from week 6 through week 8. However, what is missing from this chart is any understanding of how much work has been accomplished during the project. If the project was actually completed at week 8, then the project would actually be well under budget and well ahead of schedule. If, on the other hand, the project is only 10% complete at week 8, the project is significantly over budget and behind schedule. A method is needed to measure technical performance objectively and quantitatively, and that is what EVM accomplishes.

Project Tracking with EVM

Consider the same project, except this time the project plan includes pre-defined methods of quantifying the accomplishment of work. At the end of each week, the project manager identifies every detailed element of work that has been completed, and sums the PV for each of these completed elements. Earned value may be accumulated monthly, weekly, or as progress is made.

Figure 2 above shows the EV curve (in green) along with the PV curve from Figure 1. The chart indicates that technical performance (i.e., progress) started more rapidly than planned, but slowed significantly and fell behind schedule at week 7 and 8. This chart illustrates the schedule performance aspect of EVM. It is complementary to critical path or critical chain schedule management.

Figure 3 on the next page shows the same EV curve (green) with the actual cost data from Figure 1 (in red). It can be seen that the project was actually under budget, relative to the amount of work accomplished, since the start of the project. This is a much better conclusion than might be derived from Figure 1.
Figure 4 shows all three curves together – which is a typical EVM line chart. The best way to read these three-line charts is to identify the EV curve first, then compare it to PV (for schedule performance) and AC (for cost performance). It can be seen from this illustration that a true understanding of cost performance and schedule performance relies first on measuring technical performance objectively. This is the foundational principle of EVM.

The intent of this proposed research problem statement is to use the concepts of EVM on UDOT’s project delivery processes, from design to construction. This will provide UDOT with an assessment of a project’s status and ultimate success.

EVM also recently received a ‘best practice’ citation from UDOT’s former Executive Director as the Report Facilitator on a recent national project delivery scanning tour of several state highway agencies.

2. **Strategic Goal:**
   - [ ] Preservation
   - [x] Operation
   - [ ] Capacity
   - [ ] Safety
   (check all that apply)

3A. **List the research objective(s) to be accomplished:**
1. Determine project work elements for design and construction projects (separately).
2. Identify applicable system resources in ePM and PDBS.
3. Propose a methodology for estimating work status.
4. Provide guidelines for addressing EV to PV discrepancies.

3B. **List the major tasks to accomplish the research objective(s):**

**Estimated person-hours:**

1. Determine project work elements for design and construction projects (separately).
2. Identify applicable system resources in ePM and PDBS.
3. Propose a methodology for estimating work status.
4. Provide guidelines for addressing EV to PV discrepancies.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000

5. **Indicate type of research and/or development project this is**
   - Large: [x] Research Project
   - [ ] Development Project
   - Small: [ ] Research Evaluation
   - [ ] Experimental Feature
   - [ ] New Product Evaluation
   - [ ] Tech Transfer Initiative
   - [ ] Other: ________________

   (A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   This is a 6 month project.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   Consultant, University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   1. Recommend Methods for implementation
   2. Identify which types of projects fit the Earned Value process
   3. What is the appropriate level of detail
   4. A plan for implementation as described in item 1.
   5. Cost/Benefit Analysis
   6. Manual of Practice

8B. Describe how this project will be implemented at UDOT.
   This will be supported by Project Development’s resources and used by Region Project Manager, Preconstruction Engineers and Resident Engineers.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   The goal of this research is to implement a tool to determine project standing and viability. It provides information to project-related engineers and management on the health of the delivery program and helps eliminate stagnant (project) investments.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The only aspect missing from this research is to identify quality of estimations. That will be resolved as UDOT implements EVM.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
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<tbody>
<tr>
<td>Jim McMinimee</td>
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<td>Craig Hancock</td>
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<td>Cameron Kergaye</td>
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<td>Lori Dabling</td>
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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
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2009 RESEARCH PROBLEM STATEMENT

Problem Title: Using Unmanned Aircraft to Help Solve UDOT Problems
No.: 09.02-1 & 09.09-1

Submitted By: Steven L. Barfuss and Mac McKee
Email: barfuss@engineering.usu.edu

Project Champion: Denis Stuhff or Michael Fazio
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   The goal of this study is to use high-resolution aerial photography obtained from Unmanned Aerial Vehicles (UAV) to improve UDOT’s understanding of State Roadways. Several specific benefits will be produced from the UAV photographic capabilities. These include improving and providing updates to UDOT GIS databases with photos of 1) new highway construction, 2) fish passage culvert locations, 3) wetlands in highway easements, 4) highway structures and 5) road maintenance issues. Because satellite imagery is normally only updated every few years, using geo-referenced UAV photographic images can provide high resolution aerial imagery to UDOT within hours instead of years in some cases. Not only will the turn-around time be decreased, but, it is also expected that using the UAV images will decrease imagery cost.

   It should be noted, that the technology and the accuracy of the geo-referenced images taken from the UAV systems continue to improve, and any improvements to the technology will be incorporated into the project as they are developed. The UAV’s are equipped with “smart” Global Positioning Systems (GPS) and are accurately referenced to ground reference points. This technology can potentially be used to locate, define and archive a multitude of highway structures with very high resolution photography. These imagery data sets will then become important tools within a larger UDOT GIS database for UDOT personnel. The speed that the images can be collected, the resolution of the images (a few centimeters), and the small relative cost of acquiring the images are all expected to be favorable to UDOT. Additionally, because images can be taken quickly and inexpensively, photos can also be taken at regular intervals to document important physical and environmental changes (that can only be seen from the air) on and near roadways with time.

   The UAV systems are pre-programmed to fly designated routes at defined altitudes. The plane is also commanded to take photographs so that the photos can later be uploaded, stitched together and geo-referenced. Much of the science behind this technology is in how the photos are handled after the plane lands so that they can be quickly utilized in the UDOT GIS database.

2. Strategic Goal:
   - Preservation
   - Operation
   - Safety
   (check all that apply)

3A. List the research objective(s) to be accomplished:
   The objectives for this project are to utilize unmanned Aerial Vehicles (UAV) to help UDOT better understand critical State highway and road issues using high resolution imagery.
   1. Continue improving the UAV technology as it applies to UDOT applications.
   2. Use UAV’s to locate, monitor, and inventory fish passage related culverts.
   3. Over a period of time, use UAV’s to monitor wetland areas that are located along known UDOT corridors.
   4. Use UAV’s to photograph recent highway construction projects carried out by UDOT.
   5. Where necessary, fly UAV’s to locate highway structures required for UDOT inventories. Possible structures to identify include: culverts, bridges, dividers, road stripes, street signs, etc.
   6. Use UAV’s to document UDOT highway maintenance issues, such as potholes, shoulder damage, striping and safety issues, etc.

3B. List the major tasks to accomplish the research objective(s):

   Estimated person-hours: 3000

   Task 1: Continue the development of the UAV technology in the direction of UDOT benefit.
   Task 2: Have regular meetings with UDOT to present imagery, advise on the incorporation of the imagery into UDOT GIS databases, and to determine specific future target zones for imagery that will benefit UDOT directly.
   Task 3: Utilize the UAV technology to extend and improve existing UDOT GIS inventory imagery data of pertinent highway structures.
   Task 4: Write report describing procedure and findings.
4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $139,000.00

5. Indicate type of research and/or development project this is
   - Large: [ ] Research Project [x] Development Project
   - Small: [ ] Research Evaluation [ ] Experimental Feature [ ] New Product Evaluation [ ] Tech Transfer Initiative
   - Other: [ ]
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   This project will last 12 months.
   Task 1: Months 1-12
   Task 2: Once every three months, a meeting will be held at the UDOT office for a total of four meetings.
   Task 3: Months 1-12
   Task 4: Months 11-12

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   This is a very appropriate project to have graduate students working under the direction of Steve Barfuss and Mac McKee. It is expected that one of the principal investigators will be at each meeting where data is presented and future flights are discussed.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   A final report will be organized by imagery topic, and will include an easy-to-read procedure and checklist of imagery collection. Actual image files will be provide on computer disc. It is expected that more than 30 flights (approximately two hours of flight time per flight) will be made over the course of 12 months.

8B. Describe how this project will be implemented at UDOT.
   The imagery made available will allow UDOT personnel to keep more complete, up to date, and accurate inventories of highway structures, monitor environmentally sensitive areas such as wetlands, and have complete aerial imagery of recent projects much sooner than is currently available.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   It is expected that having accurate and complete imagery data for highway structures will improve the current UDOT inventories. The UAV imagery will provide UDOT with a greater understanding of their highway systems as well as how the imagery changes over time.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   One of the obstacles that will need to be overcome during this project is handling the large amounts of imagery data associated with the high resolution photographs. The memory required to store the imagery will be very large. It is expected that several external hard drives will be purchased and used to store the data.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
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<tbody>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
1. Briefly describe the problem to be addressed.
As UDOT moves to implement the MEPDG, new information about the properties of individual pavement layers will be needed. Particular to soils and aggregates, the mechanistic-empirical pavement design process requires knowledge of Poisson’s ratio, coefficient of lateral earth pressure, and resilient modulus as strength properties. While resilient modulus can be estimated in the MEPDG software from CBR and selected other parameters, the application of the correlations to typical Utah materials warrants investigation. Therefore, research to establish resilient modulus values for typical Utah materials is needed, and existing correlations among these test results and those of more commonly performed tests need to be evaluated and new correlations developed as needed; for example, developing correlations between modulus and CBR for typical Utah materials would be very useful to UDOT pavement and materials engineers. In addition, understanding the effects of freezing on the strength properties of soils and aggregates would be useful in determining representative properties to use as inputs in the MEPDG software.

2. Strategic Goal:  
- Preservation
- Operation
- Capacity
- Safety

3A. List the research objective(s) to be accomplished:  
1. Conduct mechanistic characterizations of typical Utah soils and aggregates to support implementation of the new MEPDG.

3B. List the major tasks to accomplish the research objective(s):  
- Conduct a literature review and prepare a summary of available information related to mechanistic characterization of soils and aggregates for the MEPDG and correlations between modulus and other properties.
- Identify and obtain approximately 10 samples of soils and aggregates of greatest interest to UDOT.
- Design laboratory experimentation to measure resilient modulus (at normal and freezing temperatures), as well as other selected strength properties of each material.
- Perform analyses of test results, including evaluations of correlations used within the MEPDG software and calculations of representative modulus values for given climates within Utah.
- Develop an implementation plan.
- Prepare a research report documenting the full project.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $75,000

5. Indicate type of research and/or development project this is  
- Large: Research Project
- Small: Research Evaluation
- Other:  

6. Outline the proposed schedule (when do you need this done, and how will we get there):  
This would ideally be a two-year study. Tasks 1 and 2 would occupy the first 3 to 6 months, tasks 3 and 4 would require a full year, task 5 would require another 3 months, and the remaining time would be allotted to preparing the final report.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?  
University
8A. What deliverables would you like to receive at the end of this project? (e.g. usable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The primary deliverable would be the final research report, although an oral presentation would also be given to UDOT personnel interested in learning about the project findings and recommendations.

8B. Describe how this project will be implemented at UDOT.

The results of this research would be made available to UDOT pavement and materials engineers responsible for pavement design and implementation of the new MEPDG.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

The research would provide UDOT personnel with data on the strength properties of typical Utah soil and aggregate materials utilized in pavement construction. Knowledge of this data will facilitate implementation of the new MEPDG.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

No particular risks or obstacles are identified for this research.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
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<th>Email</th>
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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

Because the proposed research is Utah-specific, interest by outside agencies is probably limited.
**Problem Title:** Determining National Register Eligibility for Post-War Historic Bridges  
**No.:** 09.04-2

**Submitted By:** Elizabeth Giraud, AICP, UDOT Architectural Historian  
**Email:** egiraud@utah.gov

**Project Champion:** Rebecka Stromness  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**
   
   UDOT needs to determine the eligibility of approximately 450 bridges constructed between 1946 and 1965 for listing on the National Register of Historic Places. The eligibility determination is necessary to address the requirements for section 106 of the National Historic Preservation Act, section 4(f) of the Department of Transportation Act, and the National Environmental Policy Act (NEPA). Currently, no typology, overall history, or range or prevalence of use has been determined for the evaluation of Utah’s extant bridges that are at least 45 years old. Because of this lack of information, and knowledge of the “big picture,” UDOT ends up reviewing the eligibility of bridges on a case-by-case basis, determining more bridges than necessary as eligible and probably paying unnecessary money for mitigation. Ultimately, the goal of the research project is to negotiate a Programmatic Agreement with the Utah State Historic Preservation Office (SHPO) that will streamline the environmental reviews when UDOT undertakes work on bridge replacement or repair.

2. **Strategic Goal:**  
   - [ ] Preservation  
   - [ ] Operation  
   - [ ] Capacity  
   - [ ] Safety  
   (check all that apply)

3A. **List the research objective(s) to be accomplished:**

1. Provide a profile of each bridge type extant in Utah constructed between 1946 and 1965 and an understanding of each type within a national context.
2. Determine evaluation criteria for the state’s bridges constructed between 1946 and 1965 based on the physical appearance of the structure.
3. Determine character-defining features and aesthetic treatments by bridge type.
4. Determine common types of alterations found on the bridges.
5. Provide guidance on how to consider the common types of alterations when assessing adverse effects under section 106.

3B. **List the major tasks to accomplish the research objective(s):**  
**Estimated person-hours:** 910

A consultant would do the following:

1. Review the bridges in the UDOT internet-based bridge database, inspection files and electronic bridge images.
2. Create a new bridge survey form, with approval from SHPO, and complete the form using information entered into a Microsoft Access database created by the consultant.
3. Collect the bridge data found in the files located at the UDOT Complex.
4. Develop evaluation criteria for the state’s bridges constructed between 1946 and 1965. This task will include an outline of common types of alterations observed during data collection activities, and guidance on how to consider these alterations when assess adverse effects under section 106.
5. Compile, print and deliver three sets of completed bridge survey forms for the post-war bridges.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $85,000

5. **Indicate type of research and/or development project this is**

   - [ ] Research Project  
   - [ ] Development Project

   - [ ] Research Evaluation  
   - [ ] Experimental Feature  
   - [ ] New Product Evaluation  
   - [ ] Tech Transfer Initiative

   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**

   Funding is needed to begin July 1, 2009, and would extend for seven months, until January 31, 2010.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   A consulting team with a strong background in the study of historic bridges, particularly those constructed after WWII, would be
   the entity best suited to perform this project.

8A. What deliverables would you like to receive at the end of this project?  (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   1. Evaluation criteria for the state’s bridges construction between 1946 and 1965.
   2. Three copies of completed bridge survey forms.

8B. Describe how this project will be implemented at UDOT.
   Elizabeth Giraud, the UDOT Architectural Historian, will be the project manager.  UDOT will hire a consulting company with
   extensive experience in the documentation and assessment of historic bridges, and who understand the history of bridge design in
   a national context.  Ms. Giraud will coordinate the project with Structures employees, in order to provide the needed information
   to the consultant(s), and will keep the SHPO staff up to date on the project, in order to ensure that SHPO will accept the bridge
   survey when it is completed.  The involvement of SHPO throughout the process is essential, in order to ensure that the bridge
   survey will result in a programmatic agreement with SHPO to streamline the environmental process.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a
   discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   The UDOT Environmental staff intends to use the bridge survey to enter into an agreement with the SHPO to streamline the
   Section 106 process and ease the environmental review process regarding impacts to historic bridges.  The agreement would save
   time and money on upcoming structures projects for bridges built prior to 1965.  A streamlined review would aid UDOT, SHPO
   and the public.  Currently, the UDOT Environmental staff reviews each bridge for National Register eligibility as it is considered
   for replacement or repair, and this process is not very efficient.  Overall, UDOT probably spends unnecessary money on
   mitigation that does not need to be spent, if only we had a “big picture” of the true eligibility of pre-1965 bridges.  An agreement
   with SHPO that considers the statewide importance of bridge building and provides a basis of evaluation for the hundreds of
   bridges constructed in Utah from 1945-65 would ultimately save the Department time and money.  SHPO will not enter into an
   agreement with UDOT to streamline the process unless a bridge survey is undertaken.

   The UDOT divisions that will benefit from the research will be the Structures division at the Complex, and project managers and
   environmental staff in the regions.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Risks – the consultants will have a difficult time accessing the information they need if they are not in Utah.  To overcome the risk
   the UDOT staff will find a way to make it available to them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC)
   for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
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<tbody>
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<tr>
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<td>801-533-3563</td>
<td><a href="mailto:bmurphy@utah.gov">bmurphy@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
1. Briefly describe the problem to be addressed.
In order to provide decision makers with the tools necessary to prioritize improvements to the transportation system, UDOT Planning has implemented a decision support system as part of the Long Range Planning (LRP) effort. The decision support system is currently being improved upon with a series of performance measures for transportation. The performance measures include operations, safety, environment, and economics. Of the four performance measures, the economic analysis component is by far the least understood and most difficult to quantify. In a current research project (to be completed in the spring of 2009), four criteria have been developed to aid in the decision making process with respect to economic development impacts. Although these criteria have been developed and are expected to be implemented in the LRP process, there are still a number of questions to answer related to transportation and economics that will help to refine this process. The purpose of this research is to identify and provide a better understanding of the economics of transportation in Utah. For example, how does transportation affect a community in terms of economics? What is the correlation between traffic volume and the economy? How can economic factors be measured? This project will help to better quantify and understand the economics of transportation in Utah.

2. Strategic Goal:  
- Preservation  
- Operation  
- Capacity  
- Safety  
(check all that apply)

3A. List the research objective(s) to be accomplished:
1. Identify from the literature the tie between transportation and economics.
2. Evaluate and quantify the relationship between traffic volumes (or v/c ratio) and the economic strength of an area (as a function of retail sales or other metrics as determined through the literature review and overall research).
3. Evaluate the historic Travel Time Index (TTI) in Utah with relation to Gross Domestic Product (GDP) or other factors.
4. Compare retail sales to crash rates to relate traffic safety to economic indicators.

3B. List the major tasks to accomplish the research objective(s):  
Estimated person-hours: 2,000
1. Develop a project scope of work and detailed estimate.
2. Perform literature review to identify the economics of transportation from a national and international perspective.
3. Identify data sources available for traffic data and economic data (e.g., retail sales and GDP).
4. Model the relationships between traffic volume, travel time, and safety to economic strength of an area (based upon the data available in Task 3).
5. Provide conclusions and recommendations to the research.
6. Report results to UDOT in the form of a written report.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is
Large:  
- Research Project
- Development Project
Small:  
- Research Evaluation
- Experimental Feature
- New Product Evaluation
- Tech Transfer Initiative
Other:
(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
It is recommended that this project begin in Summer or Fall 2009 with the initial tasks of the project scope of work and detailed estimate, followed by the literature review. The work will continue with the identification of data sources and modeling of the relationships between transportation and economics. This will then be followed with the recommendations, and a written report. It is anticipated that the project would take 12-16 months.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University and UDOT Staff joint participation.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   The deliverable expected from this project would include an engineering report documenting the research results. The document would identify what has been reported in the literature, while presenting the results of the Utah analysis. The results of the deliverable would be utilized to update and improve the economic component of the decision support system.

8B. Describe how this project will be implemented at UDOT.
   This project would be implemented at UDOT through the Planning Division as part of the UPLAN effort. The result of this research will be helpful to further refine the performance measures and the decision support system.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from this project through a better understanding of the relationship between transportation and economics that can help to further refine the LRP process and the performance measures of the decision support system.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   No known risks or obstacles.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</thead>
<tbody>
<tr>
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<td>(801) 965-4175</td>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   TRB, NCHRP
2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Evaluation of Utah Work Zone Practices  
**No.:** 09.06-3

**Submitted By:** Kevin Heaslip, Ph.D., PE, Utah State University  
**Email:** kevin.heaslip@usu.edu

**Project Champion:** Robert Hull

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**
   
   Between 1997 and 2005, FHWA estimated a nearly 40% increase in work zone fatalities in the United States (USDOT, 2007). In 2005 alone, there were 1,074 work zone fatalities which represent about 2.5% of all roadway fatalities for the year. In a broader scope, an estimated 49,620 people were injured in more than 115,000 work zone crashes. Utah statistics suggest that work zone injuries and fatalities follow this compelling national problem. UDOT reported five fatalities and 870 injuries occurring in 830 crashes in Utah’s highway work zones in the years prior to 2005 (UDOT 2005). In 2005, the number of fatalities in Utah’s work zones rose to ten which accounted for 3.5% of Utah’s fatalities for the year (UDOT 2007). This percentage was above the national average.

   Frequently in freeway work zones, queues develop because of limited capacity and reduced speed in the work area. Work zone queues contribute to crashes because of the difficulty for approaching drivers to judge where the queue is in relation to their current position and the amount of time the driver has to stop before colliding with the queue, especially if the queue is rapidly propagating upstream. The American Traffic Safety Services Association (ATSSA) reported that as many as 37% of fatalities associated with work zones take place in secondary crashes in work zone queues. Non-recurring congestion accounts for 50 percent of congestion in the United States and work zone congestion accounts for 25 percent of non-recurring congestion (TTI, 2003).

   Several work zone safety measures have been well researched. Maze (2000) summarized a number of speed control measures which have been implemented by different agencies and conducted a survey of states to determine the state of the practice. The study found that flagging and police enforcement are effective in reducing work zone speeds, but these measures are expensive and sometimes impractical. Studies on the use of additional regulatory signs found the signs to be ineffective by themselves, but the use of regulatory signs with flashing beacons did have some traffic calming effect. The study also evaluated reduction in lane width and drone radar and found mixed results. Other studies on speed feedback signs (Texas Transportation Researcher 2006a) and the use of temporary transverse rumble strips indicated that these measures were effective. These studies are some of the many that have evaluated safety measures in work zones (Fitzsimmons et al., 2009).

2. **Strategic Goal:**  
   
   ☑ Preservation  ☑ Operation  ☑ Capacity  ☑ Safety (check all that apply)

3A. **List the research objective(s) to be accomplished:**
   
   1. Review of the current state of the art in work zone design and operations in work zones across the country. Synthesizing the information in a report of the state of the art.
   
   2. Gather the positions of members of the Associated General Contractors (AGC) of Utah and UDOT inspectors on work zone related issues and synthesize these positions.
   
   3. Conduct a field study of work zones in Utah to evaluate the measures being implemented in freeway and highway work zones.
   
   4. Provide recommendations for additions to UDOT standards for temporary traffic control that would increase safety and provide clear guidance to contractors for implementation.

3B. **List the major tasks to accomplish the research objective(s):**

   **Estimated person-hours:** 2,760

   1. Perform a comprehensive literature review of existing work zone design and operations techniques that promote safety. The literature search will include engineering, enforcement, and technology implementations.
   
   2. Evaluate the UDOT temporary traffic control guidelines and compare them to other state DOT guidelines.
   
   3. Distribute a questionnaire to all AGC-Utah members and to UDOT inspectors to gather opinions on work zone safety in Utah.
   
   4. Conduct two focus groups with selected members of the AGC-Utah and UDOT inspects to gather more detailed information.
   
   5. Conduct field evaluations of Utah freeway and highway work zones.
   
   6. Formulation of recommendations based upon the results of the research.
   
   7. Reporting of results to UDOT in a written final report.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000

   ($25,000 from UDOT and $25,000 from the Utah Transportation Center at Utah State University)
5. Indicate type of research and/or development project this is

Large: [ ] Research Project [ ] Development Project
Small: [ ] Research Evaluation [ ] Experimental Feature [ ] New Product Evaluation [ ] Tech Transfer Initiative
[ ] Other: ________________________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

The start date for the project is projected to be September 1, 2009.
The project is scheduled run for 15 months.
The project schedule is detailed below:

<table>
<thead>
<tr>
<th>Month</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td>Task</td>
<td>Sep</td>
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<tr>
<td>Final Report</td>
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The project schedule is designed to take advantage of the winter to conduct literature review, surveys, and focus groups and enabling the research team to conduct field evaluations during the summer construction season.

There will not be any need to purchase equipment for this project. Cameras and other equipment are available for use on the project.

Some funds from the project will be used for travel to focus groups and field evaluations.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

Utah State University is uniquely suited to carry out this project because of Dr. Heaslip’s standing as a member of the TRB Work Zone Traffic Control committee for 4 years. Dr. Heaslip’s membership on the committee provides contacts with other state DOTs and organizations like the American Road & Transportation Builders Association’s (ARTBA) work zone safety program.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The deliverables for this project will be the final report that will detail all activities of the project and the recommendations for the project. It is anticipated that the recommendations from this project would provide insight to UDOT staff in the design and operation of work zones on freeways. The recommendations from the project will be in a form where they could easily be implemented into the UDOT guidelines for work zone design.

8B. Describe how this project will be implemented at UDOT.

This project would be implemented by UDOT’s Traffic & Safety Division and Maintenance Divisions. It is also anticipated that each of the districts will be able to implement the results of the project. The results of this research would be used to effectively design and operate freeway work zones to maximize safety.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

UDOT will benefit from this research by increased knowledge of the factors that increase risk in freeway work zones. With this increased knowledge, UDOT will have insight to which design and operational improvements would provide the greatest improvements to safety. Because the members of the AGC-Utah will be consulted in the process of the project, it is anticipated that compliance with the recommendations should be high.
9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Potential risks and obstacles to the project include the unwillingness of AGC-Utah members to participate in the survey and the focus groups.

To overcome this, the research team will go in front of the Board of Directors of AGC-Utah to describe the project and explain that the results of the project will benefit the member contractors.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kevin Heaslip</td>
<td>Utah State University</td>
<td>435-797-8289</td>
<td><a href="mailto:kevin.heaslip@usu.edu">kevin.heaslip@usu.edu</a></td>
</tr>
<tr>
<td>Lisa Wilson</td>
<td>UDOT- Region 2 Traffic Ops Engineer</td>
<td>801-975-4827</td>
<td><a href="mailto:LWILSON@utah.gov">LWILSON@utah.gov</a></td>
</tr>
<tr>
<td>Tracy Conti</td>
<td>UDOT - Operations</td>
<td></td>
<td><a href="mailto:TCONTI@utah.gov">TCONTI@utah.gov</a></td>
</tr>
<tr>
<td>Robert Hull</td>
<td>UDOT – Traffic &amp; Safety</td>
<td></td>
<td><a href="mailto:RHULL@utah.gov">RHULL@utah.gov</a></td>
</tr>
<tr>
<td>Dave Kinnecom</td>
<td>UDOT – Traffic Management</td>
<td></td>
<td><a href="mailto:DKINNECOM@utah.gov">DKINNECOM@utah.gov</a></td>
</tr>
<tr>
<td>Darin Duersch</td>
<td>UDOT - Region 1 Traffic Engineer</td>
<td></td>
<td><a href="mailto:DDUERSCH@utah.gov">DDUERSCH@utah.gov</a></td>
</tr>
<tr>
<td>Roland Stanger</td>
<td>FHWA – Utah Division</td>
<td></td>
<td><a href="mailto:roland.stanger@dot.gov">roland.stanger@dot.gov</a></td>
</tr>
<tr>
<td>Kevin Womack</td>
<td>Utah State University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steven Schrock</td>
<td>University of Kansas</td>
<td>785-864-3418</td>
<td><a href="mailto:schrock@ku.edu">schrock@ku.edu</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
The Utah Transportation Center had pledged $25,000 to this effort.
## Problem Title:
Lateral Pile Resistance Behind MSE Wall Abutments

### No.: 09.07-5

### Submitted By: Kyle Rollins
### Email: rollinsk@byu.edu

### Project Champion: Jon Bischoff/Darin Sjoblom

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

---

### 1. Briefly describe the problem to be addressed.
Abutment piles are frequently surrounded by MSE walls rather than a soil slope. Limited testing indicates that piles close to MSE walls will provide significantly less lateral resistance. In addition, lateral pile loading can cause pullout of MSE reinforcement and distortion of the MSE wall facing. There are presently no methods available to predict the reduction in pile resistance or the increase in force on the walls for these conditions. In addition, little guidance is available regarding the spacing behind the wall necessary to eliminate these effects.

---

### 2. Strategic Goal:
- [ ] Preservation
- [x] Operation
- [ ] Capacity
- [x] Safety

### 3A. List the research objective(s) to be accomplished:
1. Determine reduced lateral pile resistance vs. distance behind MSE wall from full-scale testing.
2. Determine increase in wall force due to lateral load on the pile.
3. Develop p-multiplier vs. distance relationships to account for reduced pile resistance in LPILE.
4. Develop equations to predict increased force on MSE reinforcement due to lateral pile loading.

---

### 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Estimated person-hours:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conduct lateral load tests at one or two bridge sites with piles at variable spacings behind the MSE walls.</td>
<td></td>
</tr>
<tr>
<td>2. Develop relationships showing reduction in lateral resistance versus spacing behind wall.</td>
<td></td>
</tr>
<tr>
<td>3. Develop relationships showing increase in lateral force on MSE wall panel versus spacing behind wall.</td>
<td></td>
</tr>
<tr>
<td>4. Supplement field test results with calibrated results from FEM analysis.</td>
<td></td>
</tr>
<tr>
<td>5. Calibrate p-multipliers in LPILE to account for reduced resistance versus spacing.</td>
<td></td>
</tr>
<tr>
<td>6. Prepare final report</td>
<td></td>
</tr>
</tbody>
</table>

---

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $30-50k

### 5. Indicate type of research and/or development project this is
- [x] Research Project
- [ ] Development Project
- [ ] Research Evaluation
- [ ] Experimental Feature
- [ ] New Product Evaluation
- [ ] Tech Transfer Initiative
- [ ] Other: __________ (A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):
Instrumentation for lateral load testing of two piles at UDOT Bridge in Pleasant Grove is in place for testing in April/May. Additional bridge sites could be selected on Pioneer Crossing or other upcoming projects this summer. Analysis would take place in fall/winter semesters. Final report with recommendations could be available by May 2010.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University working in close collaboration with UDOT staff

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   - P-multipliers which can be used in LPILE to account for pile close to MSE walls.
   - Simple equations to predict force on the wall due to pile load
   - Normalized distance behind wall for which influence is negligible
   - Report which provides background on testing and development of equations

8B. Describe how this project will be implemented at UDOT.
   Investigators will present results to geotechnical and structural groups in seminar at UDOT offices. Recommendations should be included in UDOT Geotechnical manual

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT would benefit by developing a design approach for a widely used abutment geometry to that adequate seismic resistance can be obtained. In addition, a procedure for predicting increased pullout of reinforcing mats would allow the deformation of the mall to be limited. Poor seismic performance would have direct and indirect economic consequences to the state and disrupt traffic flow significantly.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Load testing of permanent structures could lead to cracking of some top panels. Instrumentation will be in placed to measure forces, but predicting when cracking may occur will be difficult. It may be necessary to replace a panel or two. This could conceivably be budgeted for to allow results to be obtained for large deflection. An alternative would be to build a wall dedicated to the testing program. This could conceivably be done at a site where piles are already in place

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loren Anderson</td>
<td>USU</td>
<td>(801) 661-7514</td>
<td><a href="mailto:loren@cc.usu.edu">loren@cc.usu.edu</a></td>
</tr>
<tr>
<td>Jerry Bishop</td>
<td>Geosystems, Inc.</td>
<td>(801) 633-0094</td>
<td><a href="mailto:jerry@geosystems-inc.com">jerry@geosystems-inc.com</a></td>
</tr>
<tr>
<td>Jon Bischoff</td>
<td>UDOT Geotechnical</td>
<td>(801) 222-3436</td>
<td><a href="mailto:jonbischoff@utah.gov">jonbischoff@utah.gov</a></td>
</tr>
<tr>
<td>Darin Sjoblom</td>
<td>UDOT Geotechnical</td>
<td></td>
<td><a href="mailto:dsjoblom@utah.gov">dsjoblom@utah.gov</a></td>
</tr>
<tr>
<td>Dan Avila</td>
<td>UDOT Region</td>
<td>801-367-2435</td>
<td><a href="mailto:davila@utah.gov">davila@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   Project could be expanded to a pooled-fund study as this is an issue that is of interest to a number of DOTs as well as the National Science Foundation.
2009 RESEARCH PROBLEM STATEMENT

<table>
<thead>
<tr>
<th>Problem Title:</th>
<th>Evaluation of MATACRYL as a Waterproofing Membrane on Bridge Decks</th>
<th>No.: 09.08-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitted By:</td>
<td>Zack Andrus, UDOT Structures</td>
<td>Email: <a href="mailto:zandrus@utah.gov">zandrus@utah.gov</a></td>
</tr>
<tr>
<td>Project Champion:</td>
<td>Fred Doehring</td>
<td>(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)</td>
</tr>
</tbody>
</table>

1. Briefly describe the problem to be addressed.
   In an effort to prolong the life of highway bridges, preservation projects specify a waterproof membrane be applied to bridge decks to prevent water penetration and corrosion. Several different kinds of materials are used to accomplish this, from treated fabric to spray applied membranes. MATACRYL is a spray-on waterproofing membrane that is manufactured in Belgium and has been tested and used in Europe as a water barrier under asphalt pavement and as a surface wearing course. It is proposed that research be conducted to determine if this material is suitable for use in Utah’s climate.
   Overlay systems for Pre-cast panels, SPMT moved bridges. Timing of overlays (before bridge is moved vs. after, etc.) Ability to accommodate movement between panels, span over grout pockets, etc.

2. Strategic Goal:  
   | Preservation | Operation | Capacity | Safety | (check all that apply) |

3A. List the research objective(s) to be accomplished:  
   1. Verify the waterproof qualities of MATACRYL and whether it meets current UDOT standards.  
   2. Consider including MATACRYL as a UDOT approved material.

3B. List the major tasks to accomplish the research objective(s):  
   Estimated person-hours:  
   1. Accumulating independent test data and comparing to current standards.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $ 

5. Indicate type of research and/or development project this is  
   Large: ☐ Research Project ☐ Development Project  
   Small: ☐ Research Evaluation ☐ Experimental Feature ☒ New Product Evaluation ☐ Tech Transfer Initiative  
   ☐ Other: ____________________________  
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):  
   Research and analysis should be completed in 6 months from start to finish.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University, UDOT Staff, Consultant, Product Supplier

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Approval or disapproval for use on UDOT projects.

8B. Describe how this project will be implemented at UDOT.
   This project will add another product to the list of available and approved materials.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from the implementation of this project by adding another resource for bridge preservation projects and waterproofing membrane material.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Locating an approved distributor and applicator.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

   Name           | Organization / Division / Region | Phone | Email

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   USDOT, FHWA, Neighboring States with similar climate and corrosion concerns, Local Governments
# 2009 Research Problem Statement

**Problem Title:** Culvert Roughness Elements for Native Utah Fish Passage Phase I  
**No.:** 09.09-3

**Submitted By:** Rollin H. Hotchkiss, Mark Belk, and Russell Rader  
**Email:** rhh@byu.edu

**Project Champion:** Denis Stuhff (co-champions Tim Ularich and Michael Fazio)  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

Completed and ongoing work for UDOT has provided information on the swimming abilities of native Utah fishes, assessment protocols to determine the ability for fish to successfully swim upstream through culverts, and analysis of culverts that may be sliplined as a rehabilitation alternative. Parallel work sponsored by BYU has shown how native Utah fishes use roughness elements in culverts to increase their upstream passage success rate. The proposed work extends these projects by testing near-prototype-scale roughness elements (rocks) in a flume with native Utah fishes (Phase I). Once work is completed the design elements will be tested in the field to assess real-world success (Phase II). The project will allow designers to retrofit many existing culverts and design new culverts based on the roughness element design and not on average velocities. The use of average velocities for barrel design results in oversized culvert barrels. The project will dovetail with the both the existing Phase I and Phase II testing of sliplined culverts, providing a lab-derived and field-tested procedure to improve native fish passage through Utah culverts.

## 2. Strategic Goal:

- ☒ Preservation  
- ☒ Operation  
- ☐ Capacity  
- ☐ Safety

## 3A. List the research objective(s) to be accomplished:

1. Finalize the design of roughness elements to improve native Utah fish passage through culverts (Phase I)
2. Field test the design (Phase II)
3. Provide a project report that documents design and placement procedures (Phases I and II)

## 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Extend previous literature review with a visit to Bureau of Reclamation laboratory</td>
<td>190 hours</td>
</tr>
<tr>
<td>2. Formulate two laboratory testing scenarios</td>
<td>260 hours</td>
</tr>
<tr>
<td>3. Collect wild native Utah fish and perform tests</td>
<td>270 hours</td>
</tr>
<tr>
<td>4. Collect ADV data using roughness elements from Task 3 to characterize velocity and turbulence</td>
<td>270 hours</td>
</tr>
<tr>
<td>5. Finalize design of roughness elements with stability, placement and maintenance considerations</td>
<td>190 hours</td>
</tr>
</tbody>
</table>

End of Phase I: provide interim project report  
$31,700 for Phase I

Phase II Tasks continue below

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Field test with before and after fish tagging procedures</td>
<td>590 hours</td>
</tr>
<tr>
<td>7. Prepare final report and report findings at a national conference</td>
<td>210 hours</td>
</tr>
</tbody>
</table>

End of Phase II  
$47,500 for Phase II

## 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):  
$31,700

Phase I only; total of $79,200 for Phases I and II

## 5. Indicate type of research and/or development project this is

- ☒ Research Project  
- ☐ Development Project  
- ☐ Research Evaluation  
- ☐ Experimental Feature  
- ☐ New Product Evaluation  
- ☐ Tech Transfer Initiative  
- ☐ Other:  

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):

This project will take two years and will be executed in two Phases due to the seasonality of fish movement in Utah streams. Proposed to begin in December 2009, Tasks 1 and 2, literature review and finalizing testing protocols, will require a total of five months. Fish will then be collected and tested during the Spring/Summer of 2010 (Task 3) including detailed video of fish holding and movement characteristics. Task 4, characterizing the flow fields where the fish were found to be holding, will require two months. Task 5, completing design procedures and checking for stability, will complete the first year of the project and Phase I and will require two months. An interim project report will be provided. The project will then be on hold until April 2011, when Phase II will begin and native Utah fish will be tagged up- and downstream from culverts selected for field testing. Design rocks will be installed in the culverts and fish will be collected again during the summer to assess passage success. These data will supplement earlier efforts to assess passage success in the field, with the earlier data representing the baseline, or ‘no improvement’ case. This will require seven months of work. The final report, estimated to require two months and beginning during the last month of field testing, will complete the 2-Phase, 24-month long project.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The project report will provide a laboratory-derived (Phase I) and field-tested design procedure (Phase II) for sizing and placing rocks in culverts that will allow more native Utah fishes to swim upstream than before.

8B. Describe how this project will be implemented at UDOT.

The design procedures from Phase II will be ready to use upon delivery of the project report. Engineers will be able to use the procedure to size and place rocks that have proven to improve fish passage both in the laboratory and in the field into either existing or new culverts. No special training should be required.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

UDOT will benefit from the results of this study because after Phase II they will be able to inexpensively retrofit many culverts to improve native Utah fish passage. By avoiding expensive culvert replacement, UDOT engineers will save design time and construction costs. The public will benefit by avoiding road detours during culvert replacement while knowing that UDOT is providing environmental benefits to all citizens of the State. For new culverts, this design alternative will provide designers an inexpensive alternative for improving fish passage that will not require the use of conservatively large culvert barrels.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

| Indeterminate laboratory results (Phase I) | Very careful consideration of experimental protocols |
| Inadequate fish capture in field (Phase II) | Repeat field visits as necessary |

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Mills</td>
<td>JSRIP Local Recovery Program Coordinator, Central Utah Water Conservancy District</td>
<td>801-226-7132</td>
<td><a href="mailto:mikem@cuwcd.com">mikem@cuwcd.com</a></td>
</tr>
<tr>
<td>Krissy Wilson</td>
<td>Utah Division Wildlife Resources</td>
<td>801-538-4756</td>
<td><a href="mailto:krissywilson@utah.gov">krissywilson@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

| Problem Title: | Lidar Technology for Bridges | No.: 09.10-3 |
| Submitted By: | Craig Hancock and Paul Wheeler | Email: chancock@utah.gov |

**Project Champion:** Craig Hancock

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**
   
   UDOT is interested in new Lidar technologies for use in scanning bridges in 3D. Current technology that UDOT uses does not allow for true 3D bridge data. The substructure such as beams, diaphragms, & items below the bridge deck is difficult for conventional surveying methods to collect.

2. **Strategic Goal:**

   [ ] Preservation  
   [x] Operation  
   [ ] Capacity  
   [ ] Safety  

3A. **List the research objective(s) to be accomplished:**

   1. Assess the ability to obtain more accurate data.
   2. Scanning bridges for preliminary Accelerated Bridge Construction.
   3. Scanning bridges for bridge inspection and for bridge widening.
   4. Define appropriate levels of modeling.
   5. Cost effectiveness on updated Lidar technology compared to conventional survey.
   6. Cost to implement & support
   7. Identify other applications.
   8. Training

3B. **List the major tasks to accomplish the research objective(s):**

   Estimated person-hours: 300

   1. Scan and create full 3D model of bridge
   2. Verify quality of data
   3. Print physical 3D composite model of bridge
   4. Prepare report
   5. Have presentation of results to interested parties.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000

5. **Indicate type of research and/or development project this is**

   Large: [x] Research Project  
   [ ] Development Project  
   Small: [ ] Research Evaluation  
   [ ] Experimental Feature  
   [x] New Product Evaluation  
   [ ] Tech Transfer Initiative  
   [ ] Other: ____________________

   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**

   The project is estimated at taking three months.
   Determine a project to use for a pilot project.
   Scan the bridge and do post processing of the data.
   Verify the data
   Print a 3D composite model of the data.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   UDOT Staff \ Consultant \ University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Final report with cost analysis & presentation
   3D composite model from 3D printer

8B. Describe how this project will be implemented at UDOT.
   Purchase or rental of Lidar software and hardware to use by surveyors to create deliverables for projects.
   Training of how to use the technology.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   By using Lidar technology and having full 3D data it would help in the concept and design processes to make more informed decisions by having more complete data of a bridge.
   This technology could also be used for inspections of bridges to determine the safety of bridges or in the use of a disaster.
   This will help in the creation of visualizations for projects with structures more efficient.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Supporting new technologies
   Training on new software and hardware.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Wheeler</td>
<td>UDOT \ETS \ Complex</td>
<td>801-965-4700</td>
<td><a href="mailto:pwheeler@utah.gov">pwheeler@utah.gov</a></td>
</tr>
<tr>
<td>Derek Peterson</td>
<td>UDOT \ Region 1 \ Right of Way</td>
<td>801-620-1642</td>
<td><a href="mailto:derekpetersen@utah.gov">derekpetersen@utah.gov</a></td>
</tr>
<tr>
<td>Scott McNeil?</td>
<td>McNeil Engineering</td>
<td>801-255-7700</td>
<td><a href="mailto:scott@mcneileng.com">scott@mcneileng.com</a></td>
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<td>ext 115</td>
<td></td>
</tr>
<tr>
<td>Frank Algaren?</td>
<td>Intelisum</td>
<td>801-558-7522</td>
<td><a href="mailto:falgarin@intelisum.com">falgarin@intelisum.com</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   Universities, State DOTS, FHWA
1. Briefly describe the problem to be addressed.
For the past three decades, transportation agencies have been increasing total cement contents to achieve more strength as a substitute for durability related properties. Optimizing the total cementitious materials content in concrete for transportation applications will improve the durability, economy, environmentally sustainability (lower CO$_2$ footprint and lower raw materials usage), corrosion resistance, and cracking resistance. The performance measures and mixture design techniques are developed sufficiently for Utah to be the first state to fully implement performance based mixtures for long-life and sustainable concrete.

2. Strategic Goal:
- Preservation
- Operation
- Capacity
- Safety

3A. List the research objective(s) to be accomplished:
1. Identify the performance characteristics that are required for long-lasting concrete in different Utah regions.
2. Define environmentally obtainable benchmarks that are consistent with UDOT organizational objectives
3. Remove organizational (specification) barriers to sustainable long-life concrete
4. Identify responsible incentives that encourage contractors to deliver long-lasting sustainable concrete with performance measures

3B. List the major tasks to accomplish the research objective(s):
1. Define the concrete performance levels that are needed for each class of concrete specified by UDOT
2. Review potential benchmarks from other organizations and conduct a roundtable of public agencies, contractors, suppliers, and experts to define environmentally obtainable benchmarks for the next five years.
3. Convene a series of working groups with the help of FHWA HPC Implementation Task Force to identify specific specification provisions that create barriers to long-life concrete.
4. Review the financial schedules, rewards and penalty structures that encourage quality construction
5. Implement the findings on 5 field projects with several different contractors and districts

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is
- Large: Research Project
- Small: Research Evaluation
- Other: ____________________________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
Task 1 through 4 is the first 9 months of the project
Task 5 in the 2010 construction season - 3 months
Complete a report with the evaluative data and recommendations in 3 months.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
University of Utah

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Draft Specifications and a final report.

8B. Describe how this project will be implemented at UDOT.
Task 5 is the initial implementation. Full implementation would require that UDOT consider the results of the project and decide to lead the nation in the implementation.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
UDOT and other highway agencies benefit from long life structures both financially and from a user impact. Using less natural resources, reducing the CO2 footprint of the public infrastructure and saving future capital expenditures and maintenance costs benefit the taxpayers of Utah and UDOT.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
The major risk in this project is a resistance to change. The approach engages agency and contractors to participate in moving toward major advances.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerry Hall</td>
<td>Geneva Rock</td>
<td>801-281-7900</td>
<td><a href="mailto:jhall@genevarock.com">jhall@genevarock.com</a></td>
</tr>
<tr>
<td>John Butterfield</td>
<td>UDOT</td>
<td></td>
<td><a href="mailto:Jbutterfield@utah.gov">Jbutterfield@utah.gov</a></td>
</tr>
<tr>
<td>Ben Blankenship</td>
<td>AshGrove Cement</td>
<td>(801) 263-3011</td>
<td><a href="mailto:ben.blankenship@ashgrove.com">ben.blankenship@ashgrove.com</a></td>
</tr>
<tr>
<td>Doug Beddingfield</td>
<td>Parsons</td>
<td>(801) 409-2575</td>
<td><a href="mailto:dbedingfield@jparson.com">dbedingfield@jparson.com</a></td>
</tr>
<tr>
<td>Brian Lee</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
This would be of interest to the FHWA and its HPC implementation task force. Lou Triandafliou heads up this effort out of the Maryland technology service center. States such as NH, NY, CA also work on this effort.
Problem Title: Assessing Corrosion of MSE Wall Reinforcement

Submitted By: Travis Gerber
Email: tgerber@byu.edu

Project Champion: Grant Gummow

1. Briefly describe the problem to be addressed.

MSE walls are now widespread in UDOT’s retaining wall inventory. Recent inspection work has documented current wall conditions. Unfortunately, one parameter that could not readily be assessed was the performance of the metallic reinforcement within the backfill, and in the case of 2-stage walls, the wire mesh at the wall face. Since corrosion significantly affects the long-term serviceability of MSE walls, it is important to quantify the extent to which corrosion may or may not be occurring. While coupons for corrosion testing have been installed, baseline information regarding essentially all of these installations which occurred during the I-15 corridor reconstruction project through Salt Lake City) is not available. By establishing a baseline now, future assessments of corrosion will be made much easier. This proposed project will establish a baseline by extracting and documenting the condition of select coupons. This project will also address resolution of potential challenges of coupon extraction on 2-stage walls.

2. Strategic Goal: ☑ Preservation ☐ Operation ☐ Capacity ☐ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Extract of buried reinforcement coupons from MSE walls site and document the sectional thicknesses and weights, thus providing a baseline against which to compare coupons extracted in the future.

2. Develop and assess technique(s) for removal of coupons on 2-stage MSE walls.

3B. List the major tasks to accomplish the research objective(s):

Estimated person-hours:

1. Review I-15 project files at UDOT, Terracon, and Woodward Clyde (now URS) for additional information regarding coupon installations.

2. Evaluate coupon sites for access and placement of coupon extraction equipment. Develop extraction procedure for 2-stage MSE walls where typical extraction technique using jacks reacting off of wall have potential of damaging or misalign wall panels. Do trial runs of extraction procedures.

3. Enter production mode, extracting coupons. Anticipate extracting approximately 20 coupons which are less than 8 feet above the ground (line thus avoiding need for lift equipment). This number represents about 11% of the approximately 174 known coupons; coupons are typically installed in groups of 6, with 1 or 2 groups of 6 located in a single wall segment.

4. Document sectional thicknesses and weights of the coupons; also estimate amount of corrosion using best estimates of initial conditions.

5. Prepare project report documenting results.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $21,600

5. Indicate type of research and/or development project this is

Large: ☐ Research Project ☑ Development Project
Small: ☑ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
Other: __________________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

Field work component of project should be accomplished during spring/summer. Remainder of work would follow. Project could be completed within a period of 6 months.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   The submitter of this project has both academic and industrial consulting expertise relating to MSE walls, and more particularly to the specific walls that will be worked for this project. Submitter recently conducted assessment of MSE wall performance and is thus familiar with general wall conditions.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   A report which documents the condition of the extracted reinforcing coupons.

8B. Describe how this project will be implemented at UDOT.
   The information in the report will constitute a baseline against which future assessments of MSE reinforcement corrosion will be performed.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   The information in the report will constitute a baseline against which future assessments of MSE reinforcement corrosion will be based. Since the long-term performance of MSE walls will be assessed using this information, the project contributes not only to future geotechnical design, but it affects the serviceability of adjacent structures such as bridges as well as public safety in general.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   It is assumed that the reinforcement coupons are typically installed as shown on the plans. If not, the work plan may need to be modified to extract the coupons. Also, it is assumed that the coupons are all galvanized wires and intended to be treated as buried coupons intended solely for extraction. If the coupons prove to be of varying materials (zinc, steel and galvanized) and/or are configured for remote electrochemical testing using potential and polarization resistance measurements, the work plan would need to be modified. Work also assumes coupons can successfully be extracted with a several-ton jack with a reasonable bracing scheme which reacts off the face of panels located near the ground surface without panel damage / misalignment.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</thead>
<tbody>
<tr>
<td>Ryan Cole</td>
<td>Gerhart and Cole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jerry Bishop</td>
<td>Geotechnical Design Services</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Phases I & II: CADD Platform Independent .dgn .dwg .dxf

Submitted By: Craig Hancock and Jim Buckley

Project Champion: Craig Hancock

1. Briefly describe the problem to be addressed.

UDOT currently requires all CADD digital file deliverables to be in native .dgn (MicroStation) file format. However during project deliverables various forms and formats of deliverable CADD data are submitted (i.e. .dwg, .dxf, and even .pdf files).

UDOT’s problem with receiving data as non-compliant to the native .dgn format causes internal UDOT staff to convert or redraw the digital drawings to UDOT standards which in turn causes unnecessary rework and unexpected workloads on internal UDOT staff. Additionally UDOT’s “enforcement” of native .dgn format makes it difficult to exchange CADD digital design data formats from AutoCAD .dwg format and various design software formats between UDOT and agencies such as Utah local government, Utah utility companies, and numerous engineering companies within the state of Utah.

2. Strategic Goal:

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

3A. List the research objective(s) to be accomplished:

1. Can UDOT accept and utilize various CADD digital design file formats along with the current .dgn file format and what are the impacts?

2. Determine the level of usage (%) of organizations doing work with UDOT (gov., utilities, contractors) that do not utilize Bentley software as their primary CADD software and therefore output .dwg file formats or others.

3. Research the impacts of the .dgn file format on the consultant and contractor communities when it comes to a contractor not bidding a project due to the .dgn file format requirement.

3B. List the major tasks to accomplish the research objective(s):

1. Interview key UDOT stakeholders to document the impacts of various file format deliverables .dgn, .dwg, etc. on design projects

2. Interview key UDOT staff members (CADD and Project Design staff) on the various companies that work for UDOT and what deliverable CADD file formats are received.

3. Organize, facilitate, and conduct conference calls and questionnaires to capture necessary information from identified Utah agencies, Utility organizations, and consultants

4. Research the technical aspect of commingling and sharing digital design data in a single UDOT environment, produced in .xml, .dgn, .dwg, and .dxf file formats.

5. Document all findings and research into a final deliverable document

6. Present all finding to UDOT Executive staff

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: _______________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

All deliverables and objectives of this research to be completed by December 31, 2009.

Proposed schedule to be approximately 6-12 months in duration.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

Consultant or university
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
1. Final Documentation report
2. Final Executive Staff presentation

8B. Describe how this project will be implemented at UDOT.
If the objective and research proves accomplishable and feasible, implementation at UDOT would consist of determining and defining CADD Consultant deliverable guidelines outlining various file format deliverables and how interoperability will be accomplished. Also implementation would consist of processes defined at UDOT to accept and verify quality control of digital design formats.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
UDOT would benefit from this project in research driven knowledge of how to utilize and accept multiple CADD file formats within the agency and therefore developing a plan of approach on the best method and practices to implementing these practices.

The beneficiaries of this project will consist of UDOT design staff and project managers, along with Consultants bidding on UDOT projects and or working on UDOT projects.

UDOT divisions such as UDOT regional offices would benefit by enabling the use of CADD independent file formats to be shared and used in a commingled digital file format environment vs. translating files to the “native .dgn format”. This digital design file independence would enable UTAH agencies outside of UDOT to benefit based on industry knowledge that .dwg file formats are widely used.

UDOT will benefit from smaller consulting firms wanting to do business with UDOT who have design and drafting staff versed in other CADD applications other than MicroStation and InRoads (Bentley software). These consultants tend to hire AutoCAD experienced users (who are more plentiful in the market) and therefore put them into a design/drafting role typically at a lower pay than MicroStation users. This in turn is potentially resultant in a more competitive bid when it comes to bidding on UDOT projects and opens up more opportunity for business that use other CADD applications than what UDOT currently requires (native .dgn).

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Expected risks would be that if research uncovered the ability to work in a CADD independent (non digital file format restriction), without processes in place to QA/QC the multi file format deliverables than quality control of the actual files would be compromised. It is imperative that all deliverable digital file formats be quality controlled for accuracy and usability. Archival process in place must also be retained as future use of this multi formatted files will be important to be able to be reused.

In order to overcome this QA/QC processes and standards must be not only developed but also practiced and adhered to. In order to do this a clear and concise plan must be developed and implemented.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Buckley</td>
<td>Utah DOT Headquarters</td>
<td>801-965-4662</td>
<td><a href="mailto:jbuckley@utah.gov">jbuckley@utah.gov</a></td>
</tr>
<tr>
<td>Craig Hancock</td>
<td>Utah DOT Headquarters</td>
<td>801-965-4865</td>
<td><a href="mailto:chancock@utah.gov">chancock@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Arizona Department of Transportation
Daryl Odom – CADD Project Manager (CMS)
(602) 712-7024
dodom@azdot.gov
Summary List Of All Problem Statements By Group

The following is a complete list of Problem Statements considered by the various discipline
groups at the workshop, organized by group. Within each group, the Problem Statements are
listed in sequential order, based on the number assigned before the workshop. On the left side is
shown the “Priority” determined by the group. Those Problem Statements that were selected for
funding are indicated with an “*” next to the Priority number. Some Problem Statements were
considered by multiple groups and have unique numbers in each group. Cross-reference numbers
are shown beneath the title for these Problem Statements. If the Problem Statement was selected
for funding under another number, that is noted.

Following this list, the full text of each non-funded Problem Statement is given, organized by
group and by number within the group. The full text of non-funded Problem Statements that
were considered by multiple groups is given only once. Those Problem Statements that were
listed for funding were presented in the previous section of this report and will not be repeated
here.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Prob No.</th>
<th>Problem Title</th>
<th>Approx Budget</th>
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<tbody>
<tr>
<td></td>
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<td><strong>GROUP 1:</strong> CONSTRUCTION</td>
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<tr>
<td>2</td>
<td>09.01-1</td>
<td>Professional Liability Insurance for Consultants (see also 09.05-3)</td>
<td>$50,000</td>
</tr>
<tr>
<td>1*</td>
<td>09.01-2</td>
<td>Project Earned Value</td>
<td>$50,000</td>
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<tr>
<td>3</td>
<td>09.01-3</td>
<td>Close-Out for Lump Sum Projects</td>
<td>$15,000</td>
</tr>
<tr>
<td>4</td>
<td>09.01-4</td>
<td>The Use of Hybrid Notepad/GIS/GPS Plan Sheets</td>
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<tr>
<td>Priority</td>
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<td>Approx Budget</td>
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</tbody>
</table>
| GROUP 2: MAINTENANCE | 09.02-1 | Using Unmanned Aircraft to Help Solve UDOT Problems  
(see also 09.09-1)                                                                                                                                                                                                                                                                                                      | $139,000      |
| 1*      | 09.02-2 | Crash Reduction Using Linear Fixed Anti-icing Spray System  
(see also 09.06-6)                                                                                                                                                                                                                                                                                                     | $300,000      |
| 4       | 09.02-3 | Pavement Markings Under Wet-Night Road Conditions                                                                                                                                                                                                                                                                                                                                  | $50,000       |
| 2       | 09.02-4 | Alternative Street Lighting Technology                                                                                                                                                                                                                                                                                                                                              | $60,000       |
|         | 09.02-5 | Development of a Solar Thermal Roadway/Bridge Deck Heating System for Deicing                                                                                                                                                                                                                                                                                                       | $75,000       |
| 5       | 09.02-6 | Determine Effectiveness of Salt Slurry for Roadway Deicing                                                                                                                                                                                                                                                                                                                         | $85,000       |
|         | 09.02-7 | Develop a Statewide Culvert Rehabilitation/Replacement Strategy and Program Life Cycle Cost Analysis (LCCA) Approach to Specifying Crash Cushions  
(see also 09.06-7) | $20,000       |
| 9.02-8  |         | Effectiveness of Urban Roadside Delineation  
(see also 09.06-8)                                                                                                                                                                                                                                                                                                           | $20,000       |
|         | 09.02-9 | Traffic Sign Retroreflectivity Restoration                                                                                                                                                                                                                                                                                                                                        | $15,000       |
| 09.02-10|         | Aerial GIS Feature Inventory Collection                                                                                                                                                                                                                                                                                                                                           | $15,000       |
| 09.02-11|         | LED Highway Lighting (Part II)  
(see also 09.06-9)                                                                                                                                                                                                                                                                                                               | $50,000       |
| 09.02-12|         | Utilizing Airborne LiDAR Technology for Estimating Snow Depth Distribution in Avalanche Start Zones above SR-210 and the Town of Alta, UT  
(see also 09.10-5) | $20,000       |
<p>| 3       | 09.02-13| Method for Improving Winter Pothole Patching                                                                                                                                                                                                                                                                                                                                       | $180,000      |
| 09.02-14|         | Timely Maintenance Operations to Reduce Accident Clusters                                                                                                                                                                                                                                                                                                                          | $60,000       |
|         | 09.02-15|                                                                                                                                                                                                                                                                                                                                                                                |               |</p>
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<td><strong>GROUP 3:</strong> MATERIALS &amp; PAVEMENTS</td>
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<td>Mechanistic Characterization of Soils and Aggregates</td>
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<td>09.03-2</td>
<td>Aging of Asphalt Mixtures</td>
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<tr>
<td>3</td>
<td>09.03-3</td>
<td>Analysis and Evaluation of Simple Performance Test Data</td>
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<td>4</td>
<td>09.03-4</td>
<td>Development of Hamburg WTD Standard for SGC Specimens</td>
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<td>Improving Concrete Performance with Sustainable Long-Life Concrete Specifications</td>
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<td>09.03-6</td>
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<td></td>
<td>09.03-7</td>
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<td>Determining National Register Eligibility for Post-War Historic Bridges</td>
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<td>Determining Wildlife Use of Wildlife Crossing Structures Under Different Scenarios Phase III, IV</td>
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<td>4</td>
<td>09.04-4</td>
<td>Use of UAVs</td>
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<tr>
<td>GROUP 5:</td>
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<td><strong>PLANNING &amp; ASSET MANAGEMENT</strong></td>
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<td>1*</td>
<td>09.05-1</td>
<td>Understanding the Economics of Transportation in Utah</td>
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<tr>
<td>4</td>
<td>09.05-2</td>
<td>Implementing Access Management Research and Performance Measures in Planning</td>
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<tr>
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<td>09.05-3</td>
<td>Professional Liability Insurance for Consultants (see also 09.01-1)</td>
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<td>09.05-4</td>
<td>GIS Planning Tools for Assessing Trip Pattern Changes and Land Use Impacts of Transportation Projects at Rural Areas</td>
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<td>Forecasting Network Traffic for Small Communities in Utah</td>
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<td>09.05-6</td>
<td>Developing Relationships Between Localized Truck Traffic Demand and Land Use</td>
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<td>GROUP 6:</td>
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<td><strong>TRAFFIC MANAGEMENT &amp; SAFETY</strong></td>
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<td>09.06-1</td>
<td>Safety Data and the Highway Safety Manual: Model Calibration</td>
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<td>3</td>
<td>09.06-2</td>
<td>Transportation Safety Data and Analysis</td>
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<td>09.06-4</td>
<td>Are Safe Routes to School Really Safe?: An Analysis of Parental Perceptions</td>
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<tr>
<td>09.06-6</td>
<td></td>
<td>Crash Reduction Using Linear Fixed Anti-icing Spray System</td>
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<td>Life Cycle Cost Analysis (LCCA) Approach to Specifying Crash Cushions</td>
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<td>Effectiveness of Urban Roadside Delineation</td>
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<td>Back-Calculation of Consolidation Parameters for 1st South Embankment Site</td>
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<td>Lateral Load Capacity of MSE Block Wall Abutment</td>
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<td>Stability and Consolidation Assessment of Embankments at South Layton Interchange</td>
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<td>Southern Utah (see also 09.03-7)</td>
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<td>Evaluation of Nano-Lithium Concrete Sealer for Structures</td>
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<td>Splice Sleeve Connection for Concrete Precast Bridge Piers</td>
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<td>Seismic Connection for Lightweight Concrete Precast Bridge Piers</td>
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<td>Steel Pipe Connections between Precast Bridge Decks and Precast Girders</td>
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<td>Life Cycle Performance and Cost Evaluation of Utah Bridges</td>
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<td>Culvert Roughness Elements for Native Utah Fish</td>
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<td>Update for Storm Drainage Chapter of Manual of Instruction</td>
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<td>Assessment of Precipitation Variability and Long-Term Trends Using Historical Precipitation Data for Use in Hydraulic Design</td>
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<td>Utilizing Airborne LiDAR Technology for Estimating Snow Depth Distribution in Avalanche Start Zones above SR-210 &amp; the Town of Alta, UT (see also 09.02-13)</td>
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Problem Title: Professional Liability Insurance for Consultants

Submitted By: Gaye Hettrick

Project Champion: Gaye Hettrick

1. Briefly describe the problem to be addressed.
   UDOT requires planning, environmental, and engineering consultants (consultants) to provide liability insurance coverage as part of our contracts with the consultants. UDOT needs to ensure adequate coverage to address the potential risk to UDOT on all dollar amounts of contracts.

   There have been concerns raised about the level of professional liability insurance coverage UDOT requires for small firms and/or firms providing work that has a low risk of liability such as environmental studies or public involvement services.

   Consultants include the cost for insurance in their indirect overhead which increases the cost of our projects. If the insurance requirements are above the level needed, it unnecessarily increases the cost to projects. However, consultants’ overhead rates are established by using indirect costs that is for all of their clients. Therefore, if another client of a consultant requires higher coverage limits, the consultant would have to purchase that coverage regardless of what UDOT’s limits are.

   Currently UDOT requires consultants provide minimum insurance coverage for Professional Liability at $1,000,000 per claim and $2,000,000 per aggregate. The contract values range anywhere from $5,000 to $60,000,000 and the duration ranges from a month to multiple years.

2. Strategic Goal:

   - Preservation
   - Operation
   - Capacity
   - Safety

3A. List the research objective(s) to be accomplished:

   1. Research the insurance industry for consultants to determine current industry standards for professional liability coverage requirements.
   2. Research other DOT’s processes for insurance requirements.
   3. Research claims history for consultants in the industry related to professional liability.
   4. Research the adequate level of coverage for UDOT’s protection; i.e., should we determine levels of coverage required by size of firm, size or duration of contract, risk potential for work provided, or some other mechanism not listed.
   5. Research the cost benefit ratio if low or no coverage is required.
   6. Research the risk if we require no professional liability insurance for consultants.

3B. List the major tasks to accomplish the research objective(s):

   - Estimated person-hours: 400-800

   1. Establish an easily administered process for determining the amount of professional liability insurance to require for consultants.
   2. Determine cost viability of various levels of insurance.
   3. Determine the risk liability for UDOT based on the mechanism recommended for determining coverage limits.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000 to 100,000

5. Indicate type of research and/or development project this is

   - Large: Research Project
   - Development Project
   - Small: Research Evaluation
   - Experimental Feature
   - New Product Evaluation
   - Tech Transfer Initiative
   - Other: ____________________________

   (A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
The proposed schedule is to have the initial research completed within 6 months to a year with the deliverables within an additional 6 months to a year.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
The type of entity best suited to perform this project is either a University or Consultant with assistance from UDOT Staff.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
The deliverables I would like to receive at the end of the project are:

- Standards
- Manual of Practice
- Report of:
  - Current industry standards for professional liability coverage requirements
  - Other DOT insurance requirements consultants
  - Claims history for consultants in the industry
  - Cost benefit ratio if low or no coverage is required
  - Risk if we require no professional liability insurance for consultants

8B. Describe how this project will be implemented at UDOT.
Consultant Services will incorporate the Manual of Practice into UDOT’s practices and Consultant Services Manual of Instructions, the contract boilerplate language, and requirements issued to consultants.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
If the research recommendations are to lower the professional liability requirements, there would be a cost benefit to some consultants and UDOT. UDOT savings would be in the reduction to the overhead rates of some consultants charged to each project. However, as noted above this would only take place if UDOT’s requirements meet or exceed consultants’ other clients requirements.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
- One risk/obstacle may be in obtaining factual data on cost savings to UDOT. A way to overcome this may be to utilize estimates.
- Results may recommend a higher insurance professional liability coverage requirement. The insurance cost might eliminate smaller consultants’ eligibility.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaye Hettrick</td>
<td>UDOT Consultant Services</td>
<td>801-965-4639</td>
<td><a href="mailto:ghettick@utah.gov">ghettick@utah.gov</a></td>
</tr>
<tr>
<td>Jim Horrocks</td>
<td>Horrocks Engineers</td>
<td>801-763-5132</td>
<td><a href="mailto:jim@horrocks.com">jim@horrocks.com</a></td>
</tr>
<tr>
<td>Lori Dabling</td>
<td>UDOT Project Development</td>
<td>801-964-4456</td>
<td><a href="mailto:ldabling@utah.gov">ldabling@utah.gov</a></td>
</tr>
<tr>
<td>Stan Burns</td>
<td>UDOT Engineering Services</td>
<td>801-965-4190</td>
<td><a href="mailto:sburns@utah.gov">sburns@utah.gov</a></td>
</tr>
<tr>
<td>Warren Grames</td>
<td>UDOT Risk Management</td>
<td>801-965-4272</td>
<td><a href="mailto:wgrames@utah.gov">wgrames@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Federal Highway Administration and ACEC-Utah Chapter
Problem Title: Close-Out for Lump Sum Projects
No.: 09.01-3
Submitted By: Kris Peterson
Email: krispeterson@utah.gov
Project Champion: Greg Searle

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Materials-Lump sum quantities, certifications, testing, contractor submits quantities
   Design Build projects are hard to track quantities

2. Strategic Goal:  
   - Preservation
   - Operation
   - Capacity
   - Safety

3A. List the research objective(s) to be accomplished:
   1. Contractor certify Lump sum items or projects
   2. Follow M & S Guide
   3. How do we make DB fit our normal UDOT process?
   4. 

3B. List the major tasks to accomplish the research objective(s):

   Estimated person-hours:
   1. 
   2. 
   3. 
   4. 
   5. 

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $15,000

5. Indicate type of research and/or development project this is
   - Large:  
   - Small:  
   - Other:

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

8B. Describe how this project will be implemented at UDOT.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
<th>Organization / Division / Region</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

Problem Title: The use of Hybrid Notepad/GIS/GPS plan sheets
No.: 09.01-4

Submitted By: Kris Peterson
Email: krispeterson@utah.gov

Project Champion: Craig Hancock

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
With the increasing use of GPS (survey) control on projects by contractors & the advent of fewer UDOT inspectors to document placement of items (quantities & location), we recommend a look at new technology in the form of Notepad/GIS/GPS plan sheets instruments for field inspectors.

2. Strategic Goal:
[ ] Preservation  [x] Operation  [ ] Capacity  [ ] Safety

(check all that apply)

3A. List the research objective(s) to be accomplished:
1. Cost & Time savings to projects including manpower
2. Documentation of benefits vs. shortfalls
3. Cost/Benefit study
4. What training would be necessary to use product

3B. List the major tasks to accomplish the research objective(s):
Estimated person-hours: 500
1. Review product capability
2. Review number of products on market
3. Cost of products
4. Buy a sample of product
5. What other technology would be required to be used with this product?

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $20,000

5. Indicate type of research and/or development project this is
Large: [ ] Research Project  [ ] Development Project
[ ] Other: __________________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

8B. Describe how this project will be implemented at UDOT.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
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<th>Email</th>
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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

<table>
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<tr>
<th>Problem Title: Crash Reduction Using Linear Fixed Anti-icing Spray System</th>
<th>No.: 09.02-2 &amp; 09.06-6</th>
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</thead>
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<tr>
<td>Submitted By: Lynn Bernhard</td>
<td>Email: <a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
</tr>
<tr>
<td>Project Champion: Lynn Bernhard</td>
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</table>

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   FAST technology has reduced accidents on the Provo River Bridge deck in Utah County. Portions of US-189 in Provo Canyon appear to have higher than normal crash levels due to pavement slickness caused by supercooled pavement, pavement transition, and abundant atmospheric moisture. Three locations in Provo Canyon would be identified for linear FAST system and localized accident data will be analyzed.

2. Strategic Goal:
   - Preservation
   - Operation
   - Safety
   - Capacity
   - (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Determine accident reduction due to use of FAST technology
   2. Determine effectiveness of integrated controllers
   3. Determine before-and-after crash rates
   4. Determine benefit/cost ratio of using FAST system for spot safety improvement

3B. List the major tasks to accomplish the research objective(s):
   - 1. Identify pavement sections for evaluation.
   - 2. Determine existing accident experience
   - 3. Install FAST systems in Provo Canyon
   - 4. Determine post-FAST system accident rates for the same locations
   - 5. Prepare cost/benefit analysis
   - 6. Prepare recommendations and reports
   Estimated person-hours: 400

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $300,000

5. Indicate type of research and/or development project this is
   - Large: Research Project
   - Development Project
   - Small: Research Evaluation
   - Experimental Feature
   - New Product Evaluation
   - Tech Transfer Initiative
   - Other: 
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   - 08/31/2009 Identify pavement sections
   - 04/30/2010 Complete plans and specifications package
   - 10/15/2010 Systems are fully functional
   - 4/30/2012 Complete field accident data collection
   - 9/30/2012 Submit recommendations and reports

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7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Consultant and/or FAST system provider

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Recommendations for Magnesium Chloride use on concrete pavements
- Final report containing accident analysis, cost benefit analysis, and findings
- Draft FAST system deployment warrant
- 30 minute PowerPoint presentation of the project and findings
- Presentation at UDOT Engineers Conference

8B. Describe how this project will be implemented at UDOT.
FAST systems would be programmed for spot safety projects where winter slipperiness is a contributing factor. Major construction and reconstruction projects would include FAST systems where past climate and accident indicate need for automated anti-icing.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Public – fewer crashes. UDOT – will benefit from reduce manpower to patrol historically slippery areas. Warrants for FAST system implementation will be available for designers.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Equipment startup issues may impact schedule.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>801-243-9624</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
</tr>
<tr>
<td>Tim Ularich</td>
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</tr>
<tr>
<td>Neil Lundell</td>
<td>Region 3 Maintenance</td>
<td>801-434-7470</td>
<td><a href="mailto:nlundell@utah.gov">nlundell@utah.gov</a></td>
</tr>
<tr>
<td>Ken Berg</td>
<td>Research</td>
<td>801-965-4321</td>
<td><a href="mailto:kenberg@utah.gov">kenberg@utah.gov</a></td>
</tr>
<tr>
<td>Rich Clarke</td>
<td>Central Maintenance</td>
<td>801-965-4120</td>
<td><a href="mailto:richardclarke@utah.gov">richardclarke@utah.gov</a></td>
</tr>
<tr>
<td>Brian Phillips</td>
<td>Region 3 Maintenance</td>
<td>801-227-8055</td>
<td><a href="mailto:bphillips@utah.gov">bphillips@utah.gov</a></td>
</tr>
<tr>
<td>Lloyd Neeley</td>
<td>Central Maintenance</td>
<td>801-244-4374</td>
<td><a href="mailto:lneeley@utah.gov">lneeley@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Clear Roads
1. Briefly describe the problem to be addressed.
   Pavement striping visibility in wet conditions has always been a problem for motorists. The problem is much worse at night, when water film on the pavement surface reflects light in random directions rather than back to the driver. In consideration of active winter maintenance activities in Utah, the thickness of pavement markings above the road surface is limited, because above-ground markers cannot be used. This creates a very difficult time for all motorists, and particularly older drivers, to see pavement markings under wet-night road conditions. Prior research project on concrete pavement showed paint stripping exhibited debonding. This project would determine the cause of paint debonding. This project would assess effectiveness of grooved-in paint lines in asphalt pavement.

2. Strategic Goal:
   - Preservation
   - Operation
   - Safety

3A. List the research objective(s) to be accomplished:
   1. Determine effectiveness of grooved-in paint markings on asphalt concrete roadway.
   2. Determine cause of paint debonding on previous grooved-in concrete paint stripping.

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 150
   1. Field test – to install grooved-in paint markings on AC pavement
   2. Inspect – to inspect pavement markings when roadway is wet; take retroreflectivity readings when roadway is both dry and wet; document, and take pictures.
   3. Study debonding; gather data
   4. Analyze data
   5. Make recommendations

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is
   - Large: ☐ Research Project ☑ Development Project
   - Small: ☑ Research Evaluation ☐ Experimental Feature ☑ New Product Evaluation ☐ Tech Transfer Initiative
   - ☐ Other: ____________________________
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   7/31/2009 complete literature search
   10/31/2009 complete installation of various marking methods
   4/30/2011 complete periodic retroreflectivity readings
   6/30/2011 complete project report

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   - UDOT
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Written recommended methods and products

8B. Describe how this project will be implemented at UDOT.
We could first implement to in-house maintenance use, then outsourcing if it is necessary

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Increase roadway safety under wet-night condition – Public and UDOT

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Snow removing operation is a concern

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vincent Liu</td>
<td>Central Maintenance</td>
<td>801-554-6334</td>
<td><a href="mailto:vliu@utah.gov">vliu@utah.gov</a></td>
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<tr>
<td>Dan Betts</td>
<td>Region Two</td>
<td>801-910-2430</td>
<td><a href="mailto:dbetts@utah.gov">dbetts@utah.gov</a></td>
</tr>
<tr>
<td>Ken Berg</td>
<td>Research</td>
<td>801-965-4321</td>
<td><a href="mailto:kenberg@utah.gov">kenberg@utah.gov</a></td>
</tr>
<tr>
<td>Rich Clarke</td>
<td>Central Maintenance</td>
<td>801-965-4120</td>
<td><a href="mailto:richardclarke@utah.gov">richardclarke@utah.gov</a></td>
</tr>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>801-243-9624</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Alternative Street Lighting Technology

**No.:** 09.02-4

**Submitted By:** Lynn Bernhard  
**Email:** lynnbernhard@utah.gov

**Project Champion:** Tim Ularich

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

Mast street lighting has traditionally used incandescent, fluorescent, and metal halide arc lamps for illuminating roadways and other maintenance areas. Budgets for power bills are under pressure to be reduced. The governor has mandated a reduction in energy consumption for all state agencies. Low energy lighting solutions may be functional and cost effective.

### 2. Strategic Goal:

- [x] Preservation  
- [ ] Operation  
- [ ] Capacity  
- [ ] Safety

(check all that apply)

### 3A. List the research objective(s) to be accomplished:

1. Search domestic and foreign literature for products, technologies, and economic studies
2. Identify lighting categories that may be converted to alternative lighting
3. Determine economic benefit for identified products or strategies.

### 3B. List the major tasks to accomplish the research objective(s):  

**Estimated person-hours:** 175

1. Conduct Literature search
2. National DOT Survey
3. Identify promising products.
4. Replacement of 40 foot cobra head lamps with LED technology
5. Evaluate lighting effectiveness by comparing field illumination results with published standards
6. Compare accident rates at test location before and after
7. Determine actual field power consumption under UDOT operating conditions
8. Determine method for evaluating LED replacements for HPS/Metal Hallide (HID)
9. Prepare life-cycle cost analysis for each system or product used
10. Prepare recommendations and reports

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):  

$60,000

### 5. Indicate type of research and/or development project this is

- [ ] Large: Research Project  
- [x] Development Project
- [ ] Small: Research Evaluation  
- [x] Experimental Feature  
- [ ] New Product Evaluation  
- [ ] Tech Transfer Initiative
- [ ] Other: ____________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
- 08/31/2009 Complete literature search
- 10/30/2009 Install lighting
- 06/30/2010 Gather field illumination data
- 06/30/2011 Inspect devices and confirm power use
- 09/30/2011 Submit recommendations and reports

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Consultant/University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Recommendations for alternative lighting systems
- Draft standard drawings and specifications for alternative lighting system
- Final report containing cost analysis, illumination studies, and recommendations

8B. Describe how this project will be implemented at UDOT.
Replacement of lighting on normal mortality cycle. Incorporate alternative energy lighting into UDOT standards

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Power costs will be reduced. UDOT budget savings can be reallocated to critical needs

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Products that do not work as intended; poor product performance in actual field conditions

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>801-243-9624</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
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<tr>
<td>Tim Ularich</td>
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<td>801-450-0177</td>
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<tr>
<td>Ken Berg</td>
<td>Research</td>
<td>801-965-4321</td>
<td><a href="mailto:kenberg@utah.gov">kenberg@utah.gov</a></td>
</tr>
<tr>
<td>Rich Clarke</td>
<td>Central Maintenance</td>
<td>801-965-4120</td>
<td><a href="mailto:richardclarke@utah.gov">richardclarke@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
# 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Development of a Solar Thermal Roadway/Bridge Deck Heating System for Deicing  
**No.:** 09.02-5

**Submitted By:** Lynn Bernhard  
**Email:** lynnbernhard@utah.gov

**Project Champion:** Tim Ularich  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**  
   Bridge decks ice over due to below freezing temperatures generally experienced at night. Icing results in reduced friction between tires and roadway causing a potentially hazardous condition. This project proposes development of a prototype Solar thermal Roadway/Bridge Deck Heating system.

2. **Strategic Goal:**  
   - [ ] Preservation  
   - [x] Operation  
   - [ ] Capacity  
   - [x] Safety  
   (check all that apply)

3A. **List the research objective(s) to be accomplished:**  
   1. Search domestic and foreign literature for products, technologies, and economic studies  
   2. Identify lighting categories that may be converted to alternative lighting  
   3. Determine economic benefit for identified products or strategies.

3B. **List the major tasks to accomplish the research objective(s):**  
   **Estimated person-hours:** 175  
   1. Conduct Literature search  
   2. Install linear radiant heat loop in traveled wheel path of bridge deck or dangerous curve area. Solar thermal panels will provide heat source and Solar PV pump to circulate  
   3. Gather field operating data, including temperatures and available solar radiation  
   4. Model deck heat flux and prepare system sizing curve for component sizing  
   5. Determine percentage of bare wheel track compared to test section  
   6. Prepare recommendations and reports

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):**  
   $75,000

5. **Indicate type of research and/or development project this is**  
   - [ ] Research Project  
   - [x] Development Project  
   - [ ] Research Evaluation  
   - [x] Experimental Feature  
   - [ ] New Product Evaluation  
   - [ ] Tech Transfer Initiative  
   - [ ] Other:  
   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**  
   08/31/2009 Complete literature search  
   6/30/2010 Install deck looping  
   9/30/2010 Install solar thermal collection system and pump system  
   6/30/2011 Gather data - air temperature, deck temperature at wheel paths  
   9/30/2011 Submit recommendations and reports
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   Consultant/University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Proof of concept for solar thermal wheel track heating system
   Final report containing studies, and recommendations

8B. Describe how this project will be implemented at UDOT.
   New bridge decks and pavements in historically shady locations would have wheel track system installed

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   Costs would be reduced due to lower maintenance time being spent tending bridge decks under black ice conditions
   Accidents due to slippery bridge decks would be reduced

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Resistance from bridge designers to having embedded tubing within the bridge deck cross-section

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>801-243-9624</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
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<td>801-450-0177</td>
<td><a href="mailto:Tularich@utah.gov">Tularich@utah.gov</a></td>
</tr>
<tr>
<td>Ken Berg</td>
<td>Research</td>
<td>801-965-4321</td>
<td><a href="mailto:kenberg@utah.gov">kenberg@utah.gov</a></td>
</tr>
<tr>
<td>Rich Clarke</td>
<td>Central Maintenance</td>
<td>801-965-4120</td>
<td><a href="mailto:richardclarke@utah.gov">richardclarke@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
**Problem Title:** Determine Effectiveness of Salt Slurry for Roadway Deicing

**No.:** 09.02-6

**Submitted By:** Lynn Bernhard

**Email:** lynnbernhard@utah.gov

**Project Champion:** Lynn Bernhard

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

Prewetting salt has been demonstrated to reduce scatter and to accelerate activation of granular salt. Studies at Michigan DOT determined that more than half of solids applied to roadways are scattered by bounce and traffic-induced turbulence. This project will determine the costs and effectiveness of applying a salt/liquid slurry for deicing.

### 2. Strategic Goal:

- [ ] Preservation
- [ ] Operation
- [ ] Capacity
- [x] Safety

### 3A. List the research objective(s) to be accomplished:

1. Determine best practices for using salt slurry.

2. Establish effectiveness relationship between dry application, prewetting, and salt slurry as deicing tools.

### 3B. List the major tasks to accomplish the research objective(s):

**Estimated person-hours:** 200

1. Conduct Literature search of domestic and foreign literature for prior experimentation

2. Conduct field tests or measurements comparing dry application, prewetting, and salt slurry at the same location

3. Measure salt use to obtain same level of service result

4. Gather field operating data

5. Prepare recommendations and reports

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):

$85,000

### 5. Indicate type of research and/or development project this is

- [ ] Large: Research Project
- [x] Large: Development Project
- [ ] Small: Research Evaluation
- [ ] Small: Experimental Feature
- [ ] Small: New Product Evaluation
- [ ] Small: Tech Transfer Initiative
- [ ] Other: ________________________________

(A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):

- 08/31/2009 Complete literature search
- 12/30/2010 Complete field testing
- 6/30/2011 Submit recommendations and reports
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Consultant/University/Western Transportation Institute at Montana State University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Proof of concept for salt slurry deicing system
- Recommended Application and Practice guidelines
- Presentation of findings at two national forums – TRB and one national snow and ice control conference
- 20 minute PowerPoint presentation showing tests, test methods, results, and conclusions
- Final report containing studies, and recommendations

8B. Describe how this project will be implemented at UDOT.
Salt Slurry will be implemented in the field using existing facilities and equipment. Slurry calibration method will be developed for spreaders. Slurry deicing will be taught as a recommended practice

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Costs would be reduced due to lower salt usage. Level of service would be improved early in storm cycle due to increase brine availability on the road surface

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Resistance from field personnel who have never seen salt slurry work

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>801-243-9624</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
</tr>
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<td>Tim Ularich</td>
<td>Central Maintenance</td>
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<td>Research</td>
<td>801-965-4321</td>
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<tr>
<td>Rich Clarke</td>
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<td>801-965-4120</td>
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<tr>
<td>Doug Anderson</td>
<td>Redmond Minerals</td>
<td>866-440-2529</td>
<td>doug@redмондminerals.com</td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Clear Roads
### 1. Briefly describe the problem to be addressed.
UDOT culverts are aging. No detailed physical and hydraulic inventory has been completed on the statewide system. A study by Utah State University of randomly selected culverts around the state found serious deterioration in some systems. One recommendation of that study was the need for a statewide strategy and rehabilitation program.

### 2. Strategic Goal:
- Preservation
- **Operation**
- Capacity
- Safety

### 3A. List the research objective(s) to be accomplished:
- 1. Develop statewide culvert rehabilitation/replacement strategy
- 2. Develop replacement/rehabilitation curves for various size culverts and cover conditions that can be used for program planning

### 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Estimated person-hours: 300</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conduct detailed inventory of culverts on one Utah Interstate Highway</td>
</tr>
<tr>
<td>2. Establish rating criteria based on condition, hydraulics, risk, and necessity</td>
</tr>
<tr>
<td>3. Prepare cost estimate curves for various repair/rehabilitation/replacement actions for culverts requiring attention</td>
</tr>
<tr>
<td>4. Prepare recommendations and reports</td>
</tr>
</tbody>
</table>

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):
$65,000

### 5. Indicate type of research and/or development project this is
- Large: [ ] Research Project  [ ] Development Project
- Small: [ ] Research Evaluation  [ ] Experimental Feature  [ ] New Product Evaluation  [ ] Tech Transfer Initiative
- **Other:** Planning Tool Preparation

(A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):
- 08/31/2010 Complete field inventory
- 6/30/2011 Submit recommendations and reports
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Consultant/University/UDOT Rotational Engineer

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Updated OMS culvert inventory for selected route
- Cost estimating curves
- Condition rating system
- 15 minute PowerPoint presentation showing results, and conclusions
- Final report containing studies, and recommendations

8B. Describe how this project will be implemented at UDOT.
Cost curves will be used by district engineers and central hydraulics to determine replacement program
Long-term Culvert Rehabilitation/Replacement/Abandonment Program will be prepared by regions and central hydraulics/maintenance

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Costs would be reduced due to having cost curves available to plan proactive culvert management rather than reactive breakdown culvert replacement

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
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<td>Denis Stuhff</td>
<td>Central Hydraulics</td>
<td>801-965-4225</td>
<td><a href="mailto:dstuhff@utah.gov">dstuhff@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Problem Title: Life Cycle Cost Analysis (LCCA) approach to specifying crash cushions

No.: 09.02-8 & 09.06-7

Submitted By: Lynn Bernhard
Email: lynnbernhard@utah.gov

Project Champion: Richard Clarke

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
Crash cushions are installed on projects based on initial installation cost, rather than a life-cycle best value approach. Crash cushion maintenance costs vary widely based on the system. Crash cushion repair is done by UDOT crews and by contract crews for recoverable accident repairs.

2. Strategic Goal: □ Preservation  □ Operation  □ Capacity  □ Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Identify life cycle cost of each approved UDOT crash cushion and end treatment
2. Develop a crash cushion best value bid selection process and specification

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 100
   1. Determine historical crash cushion repair costs from UDOT maintenance records
   2. Determine life expectancy of crash cushions based on AADT and location within the roadway corridor
   3. Prepare Life Cycle Cost Analysis toolkit for designers and maintenance use

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $20,000

5. Indicate type of research and/or development project this is
   Large: □ Research Project  □ Development Project
   Small: □ Research Evaluation  □ Experimental Feature  □ New Product Evaluation  □ Tech Transfer Initiative
   Other:

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   04/31/2010 Complete data mining
   9/30/2010 Deliver toolkit

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   Consultant/UDOT Rotational Engineer
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

- Historical Life Cycle Cost Data for each system currently approved by UDOT
- Computer web based LCCA and crash cushion/ end treatment selection toolkit

8B. Describe how this project will be implemented at UDOT.
Crash cushions will be selected based on life cycle cost rather than lowest purchase price

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Costs would be reduced due to using the least costly crash cushion system available

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
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<td><a href="mailto:Tularich@utah.gov">Tularich@utah.gov</a></td>
</tr>
<tr>
<td>Ken Berg</td>
<td>Research</td>
<td>801-965-4321</td>
<td><a href="mailto:kenberg@utah.gov">kenberg@utah.gov</a></td>
</tr>
<tr>
<td>Rich Clarke</td>
<td>Central Maintenance</td>
<td>801-965-4120</td>
<td><a href="mailto:richardclarke@utah.gov">richardclarke@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Problem Title: Effectiveness of Urban Roadside Delineation  
No.: 09.02-9 & 09.06-8

Submitted By: Lynn Bernhard  
Email: lynnbernhard@utah.gov

Project Champion: Lynn Bernhard
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   UDOT installs roadside delineation on all roadways without curb and gutter. Urban delineation is frequently damaged and appears to not add to hazard identification by motorists.

2. Strategic Goal:  
   - [ ] Preservation  
   - [x] Operation  
   - [ ] Capacity  
   - [x] Safety  
   (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Determine accident frequency change resulting from removing roadside delineation in urban and urbanized areas
   2. Develop new delineation standard for urban areas

3B. List the major tasks to accomplish the research objective(s):  
   Estimated person-hours: 100
   1. Determine pre-delineator removal accident rates at several locations in urban areas
   2. Remove delineators from a significant length of urban interstate highway
   3. Determine post-delineator removal accident rates at several locations in urban areas
   4. Prepare draft urban delineation policy

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $20,000

5. Indicate type of research and/or development project this is
   - [ ] Research Project  
   - [ ] Development Project  
   - [ ] Research Evaluation  
   - [x] Experimental Feature  
   - [ ] New Product Evaluation  
   - [ ] Tech Transfer Initiative  
   - [ ] Other:
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   09/30/2009 Select test sections and remove roadside delineation
   09/30/2011 Complete data gathering
   01/31/2012 Present draft urban delineation policy to Technical Committee
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   UDOT staff

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Accident rate compassion between delineated and non-delineated sections
   Draft urban delineation policy

8B. Describe how this project will be implemented at UDOT.
   Urban roadside delineation will be removed in most urban applications

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   Costs would be reduced due to less delineator maintenance

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Traffic Sign Retroreflectivity Restoration
No.: 09.02-10

Submitted By: Lynn Bernhard
Email: lynnbernhard@utah.gov

Project Champion: Vincent Liu
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Traffic signs become darkened with age. When retroreflectivity drops below standard the sign should be replaced.

2. Strategic Goal: ☑ Preservation ☑ Operation ☐ Capacity ☑ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Determine if a top coating of sign faces can restore retroreflectivity to higher levels

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 100
   1. Perform literature search
   2. Select new and deteriorated signs for
   3. Conduct study in light controlled area
   4. Compare retroreflectivity before and after treatment

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $15,000

5. Indicate type of research and/or development project this is
   Large: ☐ Research Project ☑ Development Project
   Small: ☐ Research Evaluation ☑ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
   ☐ Other: ____________________________
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   09/30/2009 Select test signs
   12/30/2009 Complete testing
   03/31/2010 Submit completed report
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   UDOT staff/ Region Sign Crew

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Summary of treatments and results
   Report of findings

8B. Describe how this project will be implemented at UDOT.
   UDOT field crews would utilize the treatments on low-retroreflectivity signs

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   Costs would be reduced due to less frequent sign replacement

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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</tr>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Aerial GIS Feature Inventory Collection  
**No.:** 09.02-11

**Submitted By:** Lynn Bernhard  
**Email:** lynnbernhard@utah.gov

**Project Champion:** Vincent Liu  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.
Field feature inventory data collection is labor intensive and exposes data collectors to roadside hazards. Remote sensing technologies exist which may be adapted to feature inventory data collection.

### 2. Strategic Goal:
- [ ] Preservation  
- [X] Operation  
- [ ] Capacity  
- [X] Safety  
(check all that apply)

### 3A. List the research objective(s) to be accomplished:
1. Evaluate mobile mapping, field collection and aerial data collection (USU) for best ROI levels

### 3B. List the major tasks to accomplish the research objective(s):
- Estimated person-hours: 100
  1. Collect aerial GIS data for one complete route corridor  
  2. Post-process data and normalize to UDOT geospatial data standard  
  3. Identify and tag features in database file  
  4. Upload data points and descriptors to OMS and verify compliance with OMS  
  5. Prepare written standard for aerial data collection

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):  
$15,000

### 5. Indicate type of research and/or development project this is
- Large: [ ] Research Project  
- [X] Development Project  
- Small: [X] Research Evaluation  
- [ ] Experimental Feature  
- [ ] New Product Evaluation  
- [ ] Tech Transfer Initiative  
- [ ] Other: ________________
(A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):
- 5/30/2010 Select test corridor  
- 7/31/2010 Complete field data gathering  
- 11/30/2010 Submit upload data
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Consultant/USU

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Copies of video files with embedded GIS data
- Feature inventory uploaded to OMS
- Copy or post-processing program or algorithm
- Report of findings

8B. Describe how this project will be implemented at UDOT.
UDOT field crews would utilize the data to identify physical feature locations

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Costs would be reduced due to less filed data collection time

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Problem Title: LED Highway Lighting (Part II)  
No.: 09.02-12 & 09.06-9  
Submitted By: Lynn Bernhard  
Email: lynnbernhard@utah.gov  
Project Champion: Tim Ularich  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Interchange and rural junction lighting uses electrical power from commercial sources. UDOT pays for such power year after year. UDOT is under a mandate to reduce energy use by 20%.

2. Strategic Goal:
   ☑️ Preservation  ☑️ Operation  ☐ Capacity  ☑️ Safety  
   (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Evaluate effectiveness of utilizing photovoltaic power array and wind turbine power production to supply net metered power for interchange or intersection lighting.
   2. Determine effectiveness and sustainability of using LED lumenaires for area lighting
   3. Determine net power use reduction

3B. List the major tasks to accomplish the research objective(s):  
   Estimated person-hours: 100
   1. Replace existing lumenaires with LED lumenaires
   2. Install PV and wind generation power field
   3. Monitor lighting levels and equipment robustness
   4. Maintain monthly power use records
   5. Prepare report of findings

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is
   ☐ Large: Research Project  ☐ Development Project  
   ☑️ Small: Research Evaluation  ☑️ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative  
   ☐ Other: 
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   5/30/2010 Select test location
   10/31/2010 Complete field installation
   06/30/2011 gather illumination data
   09/30/2012 Complete data gathering
   2/28/2013 Submit report
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   UDOT staff

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Illumination intensity contour maps as installed
   Report of findings

8B. Describe how this project will be implemented at UDOT.
   UDOT would install new PV facilities to reduce power consumption

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   Costs would be reduced due to less power being purchased

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Problem Title: Utilizing airborne LiDAR technology for estimating snow depth distribution in avalanche start zones above SR-210 and the Town of Alta, UT: An initial investigation of snow fencing as alternative mitigation method

No.: 09.02-13 & 09.10-5

Submitted By: Station 2449 - R2 UDOT
Email: sta2449@utah.gov

Project Champion: Chris Covington, Adam Naisbitt

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

During the winter months, avalanches threaten SR-210 within Little Cottonwood Canyon. UDOT currently uses military artillery to shoot an explosive charge into the avalanche starting zones in an attempt to initiate more numerous, smaller, and therefore less destructive, avalanches than could occur if no explosive charges were used. This method of avalanche control is known as “active control.” While effective, the use of artillery involves several inherent risks that UDOT would like to minimize. Because of the popularity of backcountry skiing, there is always a risk of someone being present in the avalanche starting zone when the artillery is used. The location of the avalanche paths requires that the artillery is fired over occupied buildings. Fundamentally, “active control” always relies on the judgments and decisions of the UDOT avalanche safety crew. One of the stated objectives of UDOT is to find alternatives to the use of military artillery for avalanche control. “Passive control” is the name given to constructing permanent structures in an effort to remove the avalanche risk. It is possible that constructing snow fences in the starting zones above the Town of Alta could obviate the need for artillery and improve the avalanche safety of SR-210 and the Town of Alta. In order to properly estimate snow fence dimensions it is necessary to have an accurate understanding of maximum snow depths within the area where the fences will be built. LiDAR (Light Detection and Ranging), an airborne remote sensing technology, has been shown as an effective and accurate tool for measuring terrain and spatial distribution of snow depths over large areas. The purpose of this study is to investigate the locations and costs associated to installing snow-fences in avalanche start zones on the north side of SR-210 above the Town of Alta. Once this research has been conducted, a better understanding of snow-fencing advantages/disadvantages, costs, and groundwork for installation may be obtained. Such work may introduce another option for both reducing avalanche risk along the highway and in the Town of Alta, as well as reducing the liability and costs associated to the use of artillery and explosives for “active control”.

2. Strategic Goal:

☐ Preservation  ☒ Operation  ☐ Capacity  ☒ Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Accurately identify the spatial distribution of snow depth in avalanche start zones above the Town of Alta.

2. Using snow-depth measurements and terrain analysis identify the height and extent of snow fencing required to mitigate the avalanche problem on south facing slopes above the Alta section of SR-210.

3. Estimate cost of implementing snow fencing in the described area.

4. Investigate land availability and permitting necessary for the construction of snow fences.

3B. List the major tasks to accomplish the research objective(s):

- LiDAR airborne data acquisition – 2 flights: one during fall months (Sept. – Oct.) without snow and one during the winter months in which snow depth is at its maximum and weather allows.

- Processing of LiDAR acquired snow depth measurements using GIS spatial analysis.

- Calculate height and extent of snow fencing required to mitigate the avalanche problem.

- Estimate snow fence implementation costs (labor, materials, transportation, etc.).

Estimated person-hours: 300

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $20,000

5. Indicate type of research and/or development project this is

Large: ☒ Research Project  ☐ Development Project

Small: ☐ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative

☐ Other: ____________________________________________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Summer 2009: Make arrangements for dry-ground and maximum snow-cover LiDAR data acquisition flights.
   September or October 2009: Dry-ground LiDAR data acquisition flight.
   March or April 2010: Maximum snow-cover LiDAR data acquisition flight.
   May 2010: Data analysis and estimation of snow fence dimensions and costs.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   UDOT staff and contracted private company.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, 
technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, 
equipment, training tool, etc.)
   Data and a report including maps.

8B. Describe how this project will be implemented at UDOT.
   UDOT will analyze the data and use it to understand the dimensions of snow fences necessary in the avalanche starting zones.
   Once the dimensions are known, cost estimates for construction can be obtained.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a 
discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from the implementation of this project by understanding the extent and costs of snow fences and will be able 
to better decide on an alternative for artillery avalanche control. If this study leads to the construction of snow fences, the benefits
   to UDOT include:
   - Decreased long term operational costs for org. 2449
   - Increased avalanche safety for SR-210
   - Decreased snow removal costs for SR-210 in org. 2433
   - Decreased liability for UDOT through the reduction of artillery use

   The benefits to the Town of Alta include:
   - Increased avalanche safety
   - Decreased amount of Interlodge Restrictions (time when all people are required to be in a building due to avalanche hazard)
   - Decreased operational costs

   The benefits to Alta Ski Lifts Company include:
   - Decreased operational costs

   The benefits to the U.S. Forest Service include:
   - Decreased liability through the reduction of artillery use
   - Decreased operational costs

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Two expected risks to this project are inclement weather preventing LiDAR data acquisition flights, and the possibility of a much-
   below average seasonal snow cover in the months of March and April of 2010. The risk of inclement weather can be overcome 
by continuous monitoring of weather forecasts and by rescheduling the flight. The risk of a below average snow cover can be 
mitigated by examining the historical record of snow study plot total snow depths and correlating the percentage of normal of the 
snow depth at the time of the flight to the percentage of snow in the avalanche starting zones.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) 
for this study:

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<td>801 742-2927</td>
<td><a href="mailto:Sta2449@utah.gov">Sta2449@utah.gov</a></td>
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<td>Rick Forster</td>
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<td>John Horel</td>
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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   Town of Alta, U.S. Forest Service, Alta Ski Lifts Company, Salt Lake County Watershed
**2009 RESEARCH PROBLEM STATEMENT**

**Problem Title:** Method for Improving Winter Pothole Patching  
**No.:** 09.02-14

**Submitted By:** Jack Mason  
**Email:** Jmmason@utah.gov

**Project Champion:** Jack Mason  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**  
During the winter months the roads develop potholes. These potholes are currently patched with cold mix asphalt. These patches do not last long so Maintenance has to return to refill them several times a winter. Ideally Maintenance would use Hot Mix Asphalt however; it is unavailable during the winter months. The solution would be to make our own HMA as needed to fill potholes and other patches.

2. **Strategic Goal:**  
[ ] Preservation  
[ ] Operation  
[ ] Capacity  
[ ] Safety  
(check all that apply)

3A. **List the research objective(s) to be accomplished:**  
1. Viability of new technology in small batch hot plants.  
2. Economy of making small batches of HMA using our own recycled materials compared to purchasing new HMA.  
3. Durability of recycled small batch asphalt.

3B. **List the major tasks to accomplish the research objective(s):**  
**Estimated person-hours:** 100

1. Purchase mobile hot plant.  
2. Strategically stockpiling rotomillings.  
4. Determine durability of hot patch material compared to traditional UDOT cold applied QPR

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $180,000

5. **Indicate type of research and/or development project this is**  
Large:  
[ ] Research Project  
[ ] Development Project  
Small:  
[ ] Research Evaluation  
[ ] Experimental Feature  
[ ] New Product Evaluation  
[ ] Tech Transfer Initiative  
[ ] Other:  

(A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**  
The equipment would need to be purchased by fall. The materials can be stockpiled during the construction season. This winter production would begin and the HMA would be used on the road. Spring would be the evaluation period of the equipment and resultant product on the roadway. This research would be completed in the fiscal year.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

    UDOT

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

    Equipment and Training.

8B. Describe how this project will be implemented at UDOT.

    This equipment and training, if successful, can be implemented at the region or district level.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

    UDOT will benefit with reduced winter maintenance costs. These benefits will be realized with less man hours devoted to pothole patching, reusing materials UDOT currently owns, fewer potholes equals safer roads, and less exposure to UDOT employees to high speed roadway work. This could translate to more areas if successful.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

    The biggest risk would be purchasing the equipment, it not working as expected and being stuck with the equipment. The equipment can be sold mitigating the risk. If the HMA product fails Cold Mix Asphalt can be used.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Todd Richins</td>
<td>R-2 Maintenance</td>
<td>801-910-2130</td>
<td></td>
</tr>
<tr>
<td>Kevon Ogden</td>
<td>R-2 Maintenance</td>
<td>801-910-2100</td>
<td></td>
</tr>
<tr>
<td>Rick Debban</td>
<td>R-2 Maintenance</td>
<td>801-910-2110</td>
<td></td>
</tr>
<tr>
<td>Lee Nitchman</td>
<td>R-2 Maintenance</td>
<td>801-910-2091</td>
<td></td>
</tr>
<tr>
<td>Barry Sharp</td>
<td>Central Research Division</td>
<td>801-965-4314</td>
<td><a href="mailto:rsharp@utah.gov">rsharp@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

    Any cool weather state that does not have HMA available during the winter or has isolated small paving locations.
# 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Timely Maintenance Operations to Reduce Accident Clusters  
**No.:** 09.02-15

**Submitted By:** Doug Anderson, ATC  
**Email:** Doug.ATC@Q.com

**Project Champion:** Lynn Bernhard

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

Many of the accidents that occur on Utah’s highways are preventable through focused and timely maintenance activities. Crashes that fit into this category are snow & ice related, slippery pavement problems, drainage related crashes, wild animal hits, domestic animal hits, edge drop-off problems, and work zone crashes.

Tools and data are available that can be used to identify a crash cluster, determine why the problem exists, select the best solution to reduce crashes, and measure over time to see if the problem has been reduced. Activities in the right place at the right time can greatly improve the safety of our highway system. These include timely improvement of skid numbers, enhanced snow removal and anti-icing, drainage improvements, new deer fence or existing fence maintenance, shoulder drop-off elimination, and improved work zone traffic control under certain conditions.

## 2. Strategic Goal:

|   | | | | | |
|---|---|---|---|---|
|   | Preservation | Operation | Capacity | Safety |

(check all that apply)

## 3A. List the research objective(s) to be accomplished:

1. Identify accident clusters that exist on our highway system for certain crash types.
2. Use timely maintenance activities in selected areas to reduce these crashes
3. Develop the program within UDOT at the Central and Region levels.
4. Establish a process to measure the effectiveness of the program over time and make improvements.

## 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th></th>
<th>Estimated person-hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,200</td>
</tr>
</tbody>
</table>

1. Modify existing safety data tools to focus on accidents that are related to maintenance activities.
2. Identify clusters for certain types of accidents that are related to these crash types.
3. Prioritize the clusters by numbers, rates, severity, and the likely reduction in the crashes.
4. Identify the best strategy to improve safety for each cluster.
5. Develop a program for these activities including the funding needed.
6. Work with each region to fit the program into its annual maintenance program.
8. Train UDOT personnel on how to complete the analysis on an annual basis and measure effectiveness.

## 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):

$60,000

## 5. Indicate type of research and/or development project this is

<table>
<thead>
<tr>
<th></th>
<th>Research Project</th>
<th>Development Project</th>
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<tbody>
<tr>
<td>Large:</td>
<td></td>
<td></td>
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<tr>
<td>Small:</td>
<td>Research Evaluation</td>
<td>Experimental Feature</td>
</tr>
<tr>
<td>Other:</td>
<td>New Product Evaluation</td>
<td>Tech Transfer Initiative</td>
</tr>
</tbody>
</table>

(A small project is usually less than $20,000 and shorter than 6 months)

## 6. Outline the proposed schedule (when do you need this done, and how will we get there):

This is an 18 month project.

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration</th>
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<tbody>
<tr>
<td>1</td>
<td>3 months</td>
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<tr>
<td>2 through 5</td>
<td>9 months</td>
</tr>
<tr>
<td>6</td>
<td>3 months</td>
</tr>
<tr>
<td>7 and 8</td>
<td>3 months</td>
</tr>
</tbody>
</table>
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University of Utah

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   - A first year plan to improve safety through maintenance activities.
   - The required system to analyze data.
   - Training for UDOT personnel.

8B. Describe how this project will be implemented at UDOT.
   - The results of the first year plan will be presented to the regions for adoption.
   - Each Region and selected Central personnel will be trained on how to use the tool and build a program.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   - Maintenance activities will be prioritized in a more effective way by including safety impacts.
   - Maintenance budgets can be dedicated in a more effective manner.
   - Fewer accidents will occur benefiting the traveling public.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   - The Department must realize and act on the fact that Maintenance activities have a very significant impact on safety. This is why we push snow, maintain deer fence, lay down surface seals, treat shoulders, and improve drainage.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynn Bernhard</td>
<td>Central Maintenance</td>
<td>964-4597</td>
<td><a href="mailto:lynnbernhard@utah.gov">lynnbernhard@utah.gov</a></td>
</tr>
<tr>
<td>Operations Engineers</td>
<td>Each region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement Mgt Engrs</td>
<td>Each region</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   City and County governments may wish to conduct similar studies on their highway systems.
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Aging of Asphalt Mixtures
No.: 09.03-2

Submitted By: Kevin VanFrank
Email: Kvanfrank@utah.gov

Project Champion: Kevin VanFrank
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Testing of asphalt mixtures is done on samples that have been conditioned to represent the material properties at an early age of pavement life. This means that the aging that occurs in the field is not considered during testing. Several studies have shown that aging results in critical changes of the asphalt mixture in terms of cracking resistance. Thus, a method to age asphalt mixtures is needed. A recent UDOT study has shown that small asphalt beams can be tested using the Bending Beam Rheometer to obtain low temperature properties of mixtures. A follow up study can look at aging asphalt mixtures using the Pressure Aging Vessel (PAV) and test them in the BBR. Comparisons between field samples and lab aging can then be performed so that proper material conditioning is used during testing.

2. Strategic Goal: ☒ Preservation ☒ Operation ☒ Capacity ☒ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Determine if mixture aging follows the same process that is predicted from binder aging
   2. Develop a mixture aging protocol
   3. Establish proper conditioning for asphalt mixtures so that the low temperature properties are measured based on the most critical field condition.

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 550
   1. Obtain field mixtures from the UDOT library and a core from the corresponding field project
   2. Determine protocols for aging asphalt mixtures using the PAV
   3. Test asphalt mixtures that have been aged in the PAV and compare results to tests from field samples
   4. Establish a protocol for aging mixtures using PAV

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $55,000

5. Indicate type of research and/or development project this is
   Large: ☒ Research Project ☐ Development Project
   Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
   ☐ Other: ____________________________
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Work is currently underway to develop protocols to determine low temperature properties of asphalt mixtures using the BBR. The study can be extended to incorporate the effect of aging, a factor that has been identified as critical to low temperature properties. UDOT has been collecting data from field project so material is already available for comparison. The next step will consists of preparing samples in the lab and aging them using the PAV before testing them. Comparisons can then be made with the results from field samples. Given the size of the sample in questions, one gyratory specimen or field core should provide enough samples for a valid test in the BBR.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University with knowledge of Superpave binder and mixture testing protocols along with the BBR needed for testing.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   A report with protocols for aging of asphalt mixtures and the relation to field aging for the determination of low temperature properties. This report will be part of the ongoing project to develop testing protocols for low temperature testing of asphalt mixtures.

8B. Describe how this project will be implemented at UDOT.
   A new protocol for testing low temperature properties of asphalt mixtures is being developed by the University of Utah in cooperation with the University of Minnesota and Dongre Labs. If the protocol includes the proper specimen conditioning, in terms of aging, it will be able to better predict the expected field performance. Both BBR and PAV equipment are available at the regional labs thus, once the project is completed and has been reviewed by the Agency, implementation should be easy since no new equipment is needed. This provides a significant advantage in terms of equipment and training.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   By being able to test asphalt mixtures in their most critical condition, millions of dollars can be saved from unnecessary repairs due to early pavement failures.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Aging of asphalt mixtures is a complex process that involves physical and chemical changes in the material. It is possible that the aging condition results in a complex relation between lab and field. However, even small changes will represent an improvement over the current non-aged protocols.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kevin VanFrank</td>
<td>UDOT Materials</td>
<td>801.965.4426</td>
<td><a href="mailto:kvanfrank@utah.gov">kvanfrank@utah.gov</a></td>
</tr>
<tr>
<td>Bin Shi</td>
<td>UDOT Materials</td>
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<td><a href="mailto:bshi@utah.gov">bshi@utah.gov</a></td>
</tr>
<tr>
<td>Pedro Romero</td>
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<td><a href="mailto:romero@civil.utah.edu">romero@civil.utah.edu</a></td>
</tr>
<tr>
<td>George Lukes</td>
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</tr>
<tr>
<td>Steven Anderson</td>
<td>UDOT Materials</td>
<td>801.965.4580</td>
<td><a href="mailto:stevenanderson@utah.gov">stevenanderson@utah.gov</a></td>
</tr>
<tr>
<td>Scott Nussbaum</td>
<td>UDOT/Region 1/Materials</td>
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<td><a href="mailto:snussbaum@utah.gov">snussbaum@utah.gov</a></td>
</tr>
<tr>
<td>Brent Gaschler</td>
<td>UDOT Materials</td>
<td>801.965.3816</td>
<td><a href="mailto:bgaschler@utah.gov">bgaschler@utah.gov</a></td>
</tr>
<tr>
<td>Mark White</td>
<td>UDOT Materials</td>
<td>801.965.4293</td>
<td><a href="mailto:markwhite@utah.gov">markwhite@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   FHWA, other State Highway Agencies.
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Analysis and Evaluation of Simple Performance Test Data

No.: 09.03-3

Submitted By: Kevin VanFrank

Email: kvanfrank@utah.gov

Project Champion: Kevin VanFrank

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
The Simple Performance Test (SPT) is used to determine the complex modulus that characterizes asphalt mixtures at intermediate and high in-service temperatures. The results from this test are used to control mixture properties and are important inputs to the MEPDG. UDOT is one of the few states in the country that has collected a significant amount of data in an effort to incorporate this relatively new test into the mixture design procedures as well as into the structural design of pavements. However, given that the test is still in a developmental stage, there are no established methods to analyze the data. For example, the complex modulus data is stored in separate data files for each temperature and frequency sweep. This arrangement makes it difficult to analyze and assess important issues like the repeatability of results, its ability to discern mixtures with different composition, and the relation between results and pavement performance. A research effort is needed to develop a procedure that incorporates the latest analysis and that can be used on a routine basis so that the existing data could be analyzed and the test be evaluated and eventually adopted as part of UDOT’s specification.

2. Strategic Goal:

Preservation  Operation  Capacity  Safety

3A. List the research objective(s) to be accomplished:

1. Perform a literature search to determine the most accepted procedure to characterize the dynamic data from the SPT device so that the results from different temperatures and frequencies can be combined into a single master curve.
2. Develop a procedure in the form of a computer program to analyze the data. This computer program should be able to collect and organize the data files from the different SPT devices currently being operated by the different UDOT laboratories and create time-temperature master curves using the most accepted procedures found in the literature.
3. Compare the data from previously tested mixtures and evaluate the test repeatability and its ability to discern different mixtures
4. Develop a manual for the data analysis procedure and report the repeatability of the test results.

3B. List the major tasks to accomplish the research objective(s):  Estimated person-hours: 500

1. Collect the data from all the SPT devices currently used in the state.
2. Develop a computer program that can be used to analyze the data, create a master curve, and provide direct inputs to the MEPDG program
3. Based on the tests performed to date, develop precision statement. How accurate is this test?
4. Characterize the mixtures that have been tested so far so that realistic ranges in data can be developed
5. Create a standard manual for analysis to be used in the analysis of SPT data

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is

Large:  Research Project  Development Project
Small:  Research Evaluation  Experimental Feature  New Product Evaluation  Tech Transfer Initiative

Other:  

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
The first step will consist in the development of a computer program to facilitate the analysis of data. One of such programs has been identified by the University of Utah. The program would need to be modified to allow evaluation of variability.

Once the computer program is in place, data from the different SPTs will be collected and analyzed to evaluate the variability in the results. Given that data has been collected by UDOT Central and Regional Laboratories, the within lab and the between lab variability in the results can be determined. Knowing the variability, the ability of the device to differentiate different mixtures can be documented.

Produce a document with the results as well as a standard procedure.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
University with knowledge of the latest developments in the implementation of the SPT.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
A software along with a manual of practice detailing the analysis of SPT data.
A document describing the significance of the results obtained from the SPT in terms of its ability to discern different mixtures and potential used in mixtures design.

8B. Describe how this project will be implemented at UDOT.
A standard of practice and eventually a specification with mixture requirements to meet desire characteristics.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
A significant amount of effort is already underway in all regional labs. While some are more familiar than other in the use of the SPT, the ability to analyze the data and interpret its significance will help in the eventual implementation of this technology. Furthermore, the data will be used in the MEPDG analysis.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
There have been several issues with the SPT mostly caused by the fact that this is a new piece of equipment. Even though data has been collected it has not been analyzed. The quality of the data is unknown.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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</thead>
<tbody>
<tr>
<td>Kevin VanFrank</td>
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<td>801.965.4426</td>
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<td><a href="mailto:stevenanderson@utah.gov">stevenanderson@utah.gov</a></td>
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<tr>
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<td>UDOT/Region 1/ Materials</td>
<td>801.620.1606</td>
<td><a href="mailto:snussbaum@utah.gov">snussbaum@utah.gov</a></td>
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<tr>
<td>Brent Gaschler</td>
<td>UDOT Materials</td>
<td>801.965.3816</td>
<td><a href="mailto:bgaschler@utah.gov">bgaschler@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
All the states involved in the implementation of the MEPDG will be very interested in the results
Federal Highway Administration
Superpave and Mixtures Expert Task Group
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Development of Hamburg WTD Standard for SGC Specimens

No.: 09.03-4

Submitted By: Kevin VanFrank

Email: Kvanfrank@utah.gov

Project Champion: Kevin VanFrank

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   The Hamburg Wheel Tracking Device (WTD) is used by UDOT to identify mixtures that are susceptible to premature failure caused by mix instability or moisture susceptibility. According to current MOI (Section 990.03.01), the test is run on either lab prepared or field compacted samples. For lab prepared specimens, Section 990.03.04 specifically requires that all laboratory compacted specimens shall be slabs specimens compacted using a Linear Kneading Compactor (LKC). Unfortunately, the LKC is an expensive device with limited availability. Furthermore, preparing the slabs requires more training, significant amount of material, and are more difficult to handle. Testing using the Hamburg WTD would be easier, and thus more accessible, if specimens prepared using the Superpave Gyratory Compactor (SGC) could be used. While such procedure is used by Texas DOT (TEX 242-F), it is not allowed by UDOT. Work by several researchers has shown that the mixture characteristics are different when compacted using the LKC and the SGC; thus a correlation is needed between the results obtained in the Hamburg WTD from slabs prepared using the LKC and samples prepared using the SGC. Such correlation would greatly simplify testing requirements.

2. Strategic Goal:
   - Preservation
   - Operation
   - Capacity
   - Safety

3A. List the research objective(s) to be accomplished:
   1. Review of the effects of laboratory compaction on HMA properties, including comparison of TEX 242-F specification to UDOT 990 specification.
   2. Determine the correlation between Hamburg WTD results obtained from specimens prepared using the LKC to specimens prepared using the SGC
   3. Develop a methodology to test SGC prepare samples in the Hamburg WTD including amendments to UDOT MOI 990

3B. List the major tasks to accomplish the research objective(s):

   1. Perform a literature review on the effects of compaction method on the mechanical properties of asphalt mixtures
   2. Select an asphalt mixture with a history of known performance when tested in the Hamburg WTD
   3. Test specimens prepared using the SGC and compare the results to specimens prepared using the LKC
   4. Develop a correlation between tests results from specimens prepared using both compaction methods
   5. Create a recommendation for possible specification limits for Hamburg WTD testing of asphalt mixture specimens prepared using the SGC

Estimated person-hours: 480

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $48,000

5. Indicate type of research and/or development project this is
   - Large: Research Project
   - Development Project
   - Small: Research Evaluation
   - Experimental Feature
   - New Product Evaluation
   - Tech Transfer Initiative
   - Other: 

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   A significant amount of work has already been done in characterizing asphalt mixtures using the Hamburg WTD. This includes the availability of mixtures with known performance. Thus, it is a logical progression to test the same mixtures using samples prepared with the SGC. Once the tests are repeated and the results analyzed, a correlation can be develop to allow for modifications to the MOI so that specimens prepared using the SGC are allowed.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
A University with knowledge of UDOT mixtures and a Hamburg WTD, a Linear Kneading Compactor, and a Superpave Gyratory Compactor that are compatible with UDOT’s equipment.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
A report along with suggested modifications or additions to MOI 990 to allow for testing of specimens prepared using the Superpave Gyratory Compactor

8B. Describe how this project will be implemented at UDOT.
This will most likely be a modification to existing specs. Implementation will be done once the results are review by the appropriate staff

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Currently there is a significant amount of effort required for the preparation of slabs using the LKC. The LKC is expensive and currently only available -and serviced- from one supplier; at the same time, the SGC is readily available in all UDOT materials lab and staff is more familiar with it. By allowing this small change, significant savings will be incurred in terms of equipment, sample preparation time, and staff training.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
It is possible that the correlation between the performance of slabs prepared using the LKC and samples prepared using the SGC is poor, thus requiring significant changes to the specs.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Hamburg WTD is used in the Intermountain West; those DOT’s currently requiring slabs prepared using the LKC would be interested.
FHWA
Contractors
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Methods to Stabilize Expansive Subgrade Soils in Southern Utah

No.: 09.03-7 & 09.07-9

Submitted By: Evert Lawton, Steve Bartlett, Pedro Romero, and Dave Black

Email: lawton@civil.utah.edu

Project Champion: Scott Goodwin

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
Expansive “blue clay” (Petrified Forest Member of the Chinle Formation) causes serious problems with roadways in Southern Utah, particularly heave of the base and surface courses, resulting in severe washboarding and damage. When problems appear, the typical practice is to re-pave the roads to cover the damaged area. However, many other states with expansive surficial soils typically identify the problem areas prior to construction and stabilize the expansive soil so that problems do not result. Stabilization methods are also used if problems develop after construction. Many different techniques have been successfully used in other states to stabilize their expansive soils. However, it is not known if any of these techniques will work successfully to stabilize expansive blue clay. An existing roadway in St. George that has been damaged by expansive blue clay has been identified as a potential site to study potential stabilization methods.

2. Strategic Goal:

• Safety

3A. List the research objective(s) to be accomplished:

1. Determine the effectiveness of various stabilization methods in controlling problematic expansive soils beneath roadways in Southern Utah.

2. Provide suggested guidelines for UDOT to use to control expansiveness of subgrade soils in Southern Utah, with the goal to reduce problems and damage to pavement systems.

3B. List the major tasks to accomplish the research objective(s):

1. Stabilize test sections of an existing roadway that has been damaged by expansive soil in St. George using various methods that have been successful in other states.

2. Monitor the test sections long-term.

3. Evaluate the results annually.

4. Conduct cost-benefit analyses of each method used.

5. Prepare a report to UDOT containing suggested guidelines for controlling expansive subgrade soils beneath roadways in Southern Utah.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $30,000

5. Indicate type of research and/or development project this is

• Research Project

• Development Project

• Research Evaluation

• Experimental Feature

• New Product Evaluation

• Tech Transfer Initiative

• Other: (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

Stabilization of existing roadway in test sections will occur this summer and fall. Monitoring will occur long-term. Evaluation will occur annually.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University/Consultant/UDOT/Local Agencies combined

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Manual of Practice

8B. Describe how this project will be implemented at UDOT.
   Research will produce a manual of practice that will guide Region 4 on how to deal with expansive soils in Southern Utah.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   Reduced costs related to repair of roadways damaged by expansive soils.
   Guidelines will be established to deal with expansive soil problems proactively rather than reactionary.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The risks are small, as a site in St. George has been identified where the roadway is going to be repaired anyway. This repair project presents an excellent opportunity to study various methods of stabilizing expansive blue clay in Southern Utah.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   City of St. George, Washington County
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Develop UDOT Community Impact Assessment Guidelines

Submitted By: Tom Twedt, BIO-WEST, Inc.  
Email: ttwedt@bio-west.com

Project Champion: Becky Stromness, UDOT Environmental

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

Assessing potential impacts to communities by UDOT projects is becoming ever more critical and important. At the same time, UDOT has recognized that there is inconsistency in the application and interpretation of community impact assessment (CIA) evaluations for project environmental documents. Among both UDOT personnel and consultants, there are also a variety of levels of training and experience regarding CIA methods. There is a lack of guidance available regarding preferred methods and criteria for determining the level of impact and appropriate avoidance and mitigation.

In addition, there is also a close but uncertain relationship between CIA, Environmental Justice assessments, and broader public involvement activities. It would be very valuable to have a UDOT-accepted guidance document that explains the relationship among these elements of project environmental assessments and to clarify where, when, and how CIA and EJ assessments need to go beyond routine public involvement activities. For the proposed project, UDOT CIA guidelines will be developed in close consultation with UDOT Environmental personnel and the Technical Advisory Committee for this project.

2. Strategic Goal:

☐ Preservation  ☑ Operation  ☐ Capacity  ☐ Safety  

(check all that apply)

3A. List the research objective(s) to be accomplished:

1. Complete a content analysis of existing CIA knowledge and practice. Review recent UDOT project environmental documents, summarize community impact assessment methods and criteria that are commonly used; determine areas of consistency and inconsistency. Also complete a review other States’ CIA methods and FHWA guidance, and determine methods that are most applicable to Utah’s demographic and social composition.

2. Draft CIA guidelines document. This will be similar in length to other existing UDOT Environmental guidance documents, though method of presentation could be updated as a decision-process model (web-based) to streamline application and link practitioners to the most current data sources and other on-line resources.

3. Review and revise the draft guidelines with UDOT Environmental personnel and the TAC.

4. Complete the final draft CIA guidelines in a decision-process format and facilitate implementation.

3B. List the major tasks to accomplish the research objective(s):

Estimated person-hours: 715

1. Coordinate UDOT Environmental and TAC involvement and support (40 person-hours)

2. Complete a comprehensive content analysis of CIA methods (160 person-hours)

3. Draft the CIA guidelines (270 person-hours)

4. Coordinate review and revision of guidelines with UDOT and the TAC (65 person-hours)

5. Finalize product and facilitate implementation (180 person-hours)

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is

Large:  ☑ Research Project  ☐ Development Project

Small:  ☐ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative

☐ Other:

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):

We anticipate at this time that the entire project can be completed within 12 months as shown below:

- Tasks 1 & 2 – 3 months
- Task 3 – 4 months
- Task 4 – 2 months
- Task 5 – 3 months

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

Among reasons why the consultant (BIO-WEST) is best suited are:

1) Accustomed to working closely with UDOT Environmental in meeting their needs for environmental impact evaluations; have available personnel for this project and are prepared to allocate necessary time to the identified tasks. BIO-WEST has three graduate-level sociologists on staff with experience implementing community impact assessment methods.

2) Familiar with UDOT’s Context-Sensitive Solutions strategy and can develop CIA guidelines that incorporate this approach and language.

3) Very familiar with all other resource areas in addition to CIA (e.g., wetlands, wildlife, vegetation, etc.); understand the broader NEPA criteria for determining issue relevance, significance of impacts, avoidance, and mitigation.

4) The consultant has an applied science and problem-solving approach vs. basic science/research orientation of University researchers.

5) The consultant is actively involved in implementing CIA methods for EIS and state environmental studies in Utah.

6) The consultant is also actively involved in developing CIA indicators for a new web-based planning and environmental linkages tool (PEL) for the UDOT Planning Division.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The product (CIA guidelines) will be appropriate for adoption as part of UDOT’s environmental assessment guidelines. Working with UDOT Environmental staff, we will determine how to facilitate implementation and ease-of-use. Likely this will be accomplished by providing a web-based decision tool, using a similar format to the developing PEL planning tool. The CIA method to be developed for UDOT can be coordinated with the PEL through a web-interface that will allow environmental planners access to data that will support the CIA and EIS processes.

8B. Describe how this project will be implemented at UDOT.

We will work closely with UDOT Environmental on the format and methods of dissemination. As mentioned above, the project could be implemented through a web-based decision tree that will allow users to access other web-based resources that support the CIA process. It is also possible to make the guidelines available in hard-copy format.

Coordination and involvement of CIA practitioners is the key to implementation. We recommend involvement of UDOT Environmental staff as part of the Technical Advisory Committee. We also recommend having the draft guidelines reviewed by external CIA experts in Utah and elsewhere. This can be completed as part of Task 4.
8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

While there are well-developed methods for other states (notable are California and Florida), it is difficult and labor intensive for Utah practitioners to determine most applicable methods for Utah. The UDOT CIA guidelines will focus on the most relevant social indicators for Utah’s communities and culture.

Environmental Justice is closely related to CIA and should be included in these guidelines. Because of Utah’s unique demographic, environmental justice issues are often overlooked. More broadly, CIA technical reports are often only pursued late in the environmental impact assessment process. The decision-tree format for the guidelines can help decision makers determine the level of detail needed for a CIA early in the process. Failure to pursue CIA or EJ early enough in the process can lead to larger conflicts with communities. Considering a community’s concerns early in the transportation planning process can prevent costly delays, negotiations, and redesigns, and will similarly benefit all UDOT Divisions by avoiding these problems. In addition, the methodology will continue to support improved long-range planning within the Planning Division.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

The main obstacle for this project will be implementation. Strategies for overcoming the obstacle are: involvement of key UDOT Environmental staff, review of the proposed guidelines by probable users, a web-based decision tree format, and integration with other UDOT environmental evaluation tools and the PEL.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</thead>
<tbody>
<tr>
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<td>801-963-0078</td>
<td><a href="mailto:Ed.woolford@dot.gov">Ed.woolford@dot.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

It is anticipated that both Wasatch Front Regional Council and the Mountainland Association of Governments (and likely other MPOs and COGs) would be supportive and would participate in this effort. Ongoing efforts in addressing aspects of community impacts and assessments for the Planning Division have brought considerable interest from these organizations.
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Determining Wildlife Use of Wildlife Crossing Structures Under Different Scenarios Phase III, IV  No.: 09.04-3

Submitted By: Patricia Cramer, PhD  Email: patricia.cramer@usu.edu

Project Champion: Becky Stromness

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
UDOT is sponsoring the current study of wildlife use of wildlife crossings to help determine mule deer and elk use of areas in and near wildlife crossings, culverts, and bridges under UDOT-maintained roads. The information learned from this study can help UDOT reduce wildlife-vehicle collisions and promote wildlife permeability by designing wildlife crossings that mule deer and elk will use. The funding for this project will be finished mid-year 2010, before many of the research’s questions can be fully addressed. Further funding is needed to determine if newly completed wildlife crossings are functioning for wildlife passage, and whether other mitigation treatments such as fences and soundproofing help to minimize animal-vehicle-collisions and promote wildlife permeability under the road.

2. Strategic Goal:
☐ Preservation  ☑ Operation  ☐ Capacity  ☑ Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Determine wildlife use of newly constructed wildlife crossings, particularly along US6
2. Determine if deer and elk will use box culverts after wildlife-proof fencing is constructed, particularly along I-15 and I-70
3. Determine if deer and possibly elk use of corrugated steel culverts at Wildcat on I-15 increases after sound-proof coating
4. Determine through experimentation, the minimum size a bridged passage needs to be before elk are repelled and will not use the structure (as of 2/09, a suitable bridge that elk are passing underneath for this future experiment has not been located).
5. Determine effectiveness of existing crossings of different materials (steel, concrete) and dimensions (length under road < 100 ft, >100ft), specifically along US 89/91 near Logan, and US 191 near Monticello, I-15 near Beaver, and new crossings on US6
6. A set of recommendations for designing future wildlife passages for deer and elk in Utah.

3B. List the major tasks to accomplish the research objective(s):

Estimated person-hours: 900

1. Monitor with remote cameras, the new wildlife crossings on US6: MP200.7 RxR bridge, Tucker bridge, Colton culvert, and Beaver Creek bridge.

2. Monitor I-70 MP 5.3 structures (planned for completion in 2010) for effectiveness and nearby existing box culverts after fence is constructed.


5. Monitor bridges in elk habitat to find a bridge to perform size experiments with.

6. Monitor steel culverts along US89/91 and along US 191 to determine how these work for mule deer and elk.

7. Create a report with recommendations on the mitigation approaches that best reduce wildlife-vehicle collisions and promote wildlife permeability through culverts and under bridges in Utah.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000
Phase III. Monitor new and existing crossings for wildlife use on US6, US89/91, I-70, and US 191 for 6 months $30,000
Phase IV. Monitor bridges and culverts on I-70 and I-15 for fencing and sound proof treatment efficacy in increasing wildlife use for 6 months $20,000

5. Indicate type of research and/or development project this is

Large: ☑ Research Project  ☐ Development Project
Small: ☐ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative
☐ Other: ____________________________________________________________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):

Funding is needed to begin July 1, 2010 to extend this work for 6 months, until December 31, 2010.
Phase III monies would be to monitor crossings listed above for those 6 months (July-Dec 2010)
Phase IV monies would be to monitor the culverts, bridges, and crossings described above for those 6 months (July-Dec 2010)

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University, such as Utah State University, which is currently home base for this research

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.

- Design methods that work for best promoting deer and possibly elk use of crossing culverts and bridges
- Technical information manual on the designs of crossings that work best for these species, and the road, human, and landscape factors that affect wildlife use of these structures
- Determine benefits from completed projects.

8B. Describe how this project will be implemented at UDOT.

- Patricia Cramer will continue to work with the panel.
- UDOT will continue construction and start future construction of wildlife crossings scheduled on US6 and I-70.
- When the experimental elk bridge is located, UDOT assistance would be needed to install the sliding gates-roll out doors that change the dimensions of the underpass.
- UDOT would install fencing along I-15 and I-70 in areas this project is monitoring culverts and bridges, and have sound proof coating applied to existing wildlife structures along I-15.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

- UDOT would benefit from the implementation of this project by learning of the minimum size criteria for mule deer, elk, and possibly moose passage under Utah roads. The smaller the size of the bridge necessary for wildlife to pass under the roadway, the greater cost savings to UDOT.
- UDOT could also learn of the effectiveness of placing wildlife fencing in areas where there are existing culverts and deer are accessing the highways, thus saving costs of wildlife-vehicle collisions and potential costs of constructing new wildlife crossings.
- UDOT could learn of the effectiveness of applying a sound proof coating to culvert underpasses, in promoting greater deer and possible elk use of those structures.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

Risks – camera theft. Strategy: we place cameras in utility boxes that are difficult to access. The cameras are locked to cables that are concreted in the ground. Stickers are placed on the boxes describing the study and that the equipment is theft protected.

Obstacles: Future funding and lack of elk use in areas under bridges. Strategy: keep applying for funds with non-profit groups, Federal Highways, and AASHTO-TRB process. Keep placing cameras at bridges with potential elk use for this experiment.
10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
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</tr>
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<td>John Bissonette</td>
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<td><a href="mailto:john.bissonette@usu.edu">john.bissonette@usu.edu</a></td>
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</tr>
<tr>
<td>Carmen Bailey</td>
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</tr>
<tr>
<td>Leroy Mead</td>
<td>Utah Division of Wildlife Resources</td>
<td>(435) 636-5359</td>
<td><a href="mailto:LEROYMEAD@utah.gov">LEROYMEAD@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

- Federal Highways – Office of Natural and Human Environment
- Utah Division of Wildlife Resources
- Utah State University, Utah Transportation Center, Dept. of Civil and Environmental Engineering
- US Fish and Wildlife Services
- Bureau of Land Management
- U.S. Forest Service
- Other State DOT’s and Wildlife Agencies
- Mule Deer Foundation
- Rocky Mountain Elk Foundation
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## 2009 Research Problem Statement

<table>
<thead>
<tr>
<th>Problem Title:</th>
<th>Use of UAVs</th>
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<tbody>
<tr>
<td>No.:</td>
<td>09.04-4</td>
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<tr>
<td>Submitted By:</td>
<td>Steven Barfuss, Mac McKee</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:barfuss@engineering.usu.edu">barfuss@engineering.usu.edu</a></td>
</tr>
</tbody>
</table>

### Project Champion:
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.
General introduction and discussion of Unmanned Aerial Vehicles (UAV) was held during the Environmental breakout session. The non-specific problem statement was included in the group’s prioritization voting.

### 2. Strategic Goal:
- [ ] Preservation
- [ ] Operation
- [ ] Capacity
- [ ] Safety

### 3A. List the research objective(s) to be accomplished:
1. 
2. 
3. 
4. 

### 3B. List the major tasks to accomplish the research objective(s):

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<tr>
<th>Estimated person-hours:</th>
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### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $ |

### 5. Indicate type of research and/or development project this is
- [ ] Research Project
- [ ] Development Project
- [ ] Research Evaluation
- [ ] Experimental Feature
- [ ] New Product Evaluation
- [ ] Tech Transfer Initiative
- [ ] Other: ____________________________

(A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

8B. Describe how this project will be implemented at UDOT.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Implementing Access Management Research and Performance Measures in Planning  
**No.:** 09.05-2

**Submitted By:** Tim Boschert (UDOT), Grant Schultz (BYU), Mitsu Saito (BYU)  
**Email:** tboschert@utah.gov, gschultz@byu.edu, msaito@byu.edu

**Project Champion:** Tim Boschert (UDOT Planning)

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**
   The Utah Department of Transportation (UDOT) is constantly striving to implement research in both current and future design and analysis of the roadway network. Over the past three years, UDOT and BYU have teamed together to determine the effectiveness of access management on the transportation network. These projects have included research to assess the safety benefits of access management techniques (UDOT Report UT-06.08), to prioritize access management implementation in Utah (UDOT Report No. UT-07.05), and to explore the relationships that exist between access and conflicts points in the vicinity of major crossroads (UDOT Report No. UT-08.25). Each of these individual research projects has generated useful data that can aid in the planning processes at UDOT. The projects, however, have been done separately and there is a need to be able to take the results of the individual research projects and apply the lessons learned to put this information into the hands of the planner so that they can go forward to the designer and the traffic engineer. In addition, there is a need to identify the performance measures utilized in each of these projects including consistent performance measures as well as those that may not have been included in these projects, but should be included in the future. With a better understanding of the performance measures, data collection procedures can be developed to aid in evaluating the benefit of access management on the planning and design of corridors. The purpose of this research project is to summarize the results of previous access management research projects, identify how this research can be applied in practice at UDOT planning, to identify performance measures for access management research, and to make recommendations on changes to current planning and design policy and practice to aid in research implementation.

2. **Strategic Goal:** ☑ Preservation ☑ Operation ☑ Capacity ☑ Safety (check all that apply)

3A. **List the research objective(s) to be accomplished:**
   1. Identify ways to implement transportation planning and safety research into the planning and design practices of UDOT.
   2. Develop relationships between research and implementation.
   3. Provide guidance for implementation of research and design.
   4. Identify performance measures common to all research projects as well as additional performance measures for future analyses.
   5. Put the results of past research projects into the hands of the UDOT engineers.

3B. **List the major tasks to accomplish the research objective(s):**

   Estimated person-hours: 2000
   1. Develop a project scope of work and detailed estimate.
   2. Summarize the results of past research, particularly the research completed over the past 3 years in this area.
   3. Identify how the research can be implemented and applied in practice to put the results of the research into the hands of the planner, the designer, and the traffic engineer.
   4. Identify performance measures common to existing research as well as additional performance measures for consideration.
   5. Make recommendations on changes to current planning and design practices to aid in this implementation.
   6. Report results to UDOT in the form of a written report.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000

5. **Indicate type of research and/or development project this is**

   Large: ☑ Research Project ☐ Development Project
   Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
   ☐ Other: ____________________________

   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**

   It is recommended that this project begin in Summer or Fall 2009 with the initial tasks of the project scope of work and detailed estimate, followed with the review of past research. The work will continue concurrently with the implementation efforts. This will then be followed with the recommendations, and a written report. It is anticipated that the project would take 12-16 months.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University and UDOT Staff joint participation.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   The deliverable expected from this project would include an engineering report documenting the research results. The document would identify how the research that has been conducted over the years can be implemented into current planning and design practice, while also identifying the performance measures used. This fills an important void in terms of application and implementation of research that has been ongoing.

8B. Describe how this project will be implemented at UDOT.
   This project would be implemented at UDOT through the Planning Division. The result of this research will be helpful to get the research results that have been done in the past into the hands of the Regions so that they can be more effective in their everyday tasks.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from this project through a better understanding of how the research that has been completed over the past several years can be implemented and applied in practice. UDOT will then be able to utilize the results of the research in getting information out to the Regions so that they can better plan for safe and efficient access in their projects.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   No known risks or obstacles.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
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<tr>
<td></td>
<td>UDOT Region Traffic Engineers</td>
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<td></td>
<td>UDOT Design Engineers</td>
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<td></td>
<td>UDOT Project Managers</td>
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</tr>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   TRB, NCHRP
### 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** GIS Planning Tools for Assessing Trip Pattern Changes and Land Use Impacts of Transportation Projects at Rural Areas

**No.:** 09.05-4

**Submitted By:** Xuesong Zhou (University of Utah)  
**Email:** zhou@eng.utah.edu

**Project Champion:**  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

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1. **Briefly describe the problem to be addressed.**  
   Utah is among the nation’s fastest-growing states in recent years, as its population climbed 2.5 percent to 2.7 million merely between July 1, 2007, and July 1, 2008, according to estimates released by the U.S. Census Bureau. In response to such rapid population growth and the resulting urban sprawl, many transportation projects need to be evaluated and further programmed by UDOT. The evolving transportation capacity supply could further change land use and trip generation/distribution patterns. In addition, the Obama-Biden comprehensive New Energy for America plan potentially contributes to dramatic changes in the freight flow generation and distribution patterns in Utah. To better keep track of the changing passenger and freight transportation demands, and to investigate into the impact of transportation projects on trip generation and land use, there is a great need to analyze, select and calibrate appropriate trip generation/distribution estimation models at the state-wide level, especially for the rural areas in Utah. Transportation planners at MPOs, UDOT and the state planning office also need a system of analysis tools to predict passenger and commodity flows at potential growth points, to evaluate and prioritize various projects in UDOT, and to improve major travel corridor in the State of Utah.

2. **Strategic Goal:**  
   (check all that apply)
   - Preservation
   - Operation
   - Capacity
   - Safety

3A. **List the research objective(s) to be accomplished:**
   1. Evaluate various land use modeling software packages using data available from the regional and state-wide passenger and freight planning process.
   2. Enhance a web-based GIS system to visualize existing spatial and temporal data with additional tabular analytical data query interface
   3. Calibrate land use/trip generation packages to assess cumulative traffic change patterns at rural areas, and evaluate alternative transportation improvement scenarios at corridor and systems levels
   4. Visualize multiple growth forecasts and identify additional data and modeling needs to reduce the error and uncertainty in land use models.

3B. **List the major tasks to accomplish the research objective(s):**  
   **Estimated person-hours:** 1360
   1. Review literature for national and other states’ practices and review modeling approaches taken by other state DOTs; Meet with UDOT personal and MPO planners to specify detailed functional requirements for GIS tools.
   2. Collect datasets for calibrating state-wide rural area passenger and freight trip generation and distribution models in the regional planning process.
   3. Setup, configure and calibrate the existing major trip generation and distribution models using the collected datasets for both metropolitan and rural areas.
   4. Develop a web-based GIS system to visualize existing spatial and temporal data with additional tabular analytical data query interface.
   5. Conduct validation tests to assess the applicability of the existing models at state-wide level. If necessary, develop new trip generation and distribution models with practical and operational factors such as data availability taken into account.
   6. Use the calibrated and validated models to evaluate land use impacts for several representative transportation projects, forecast possible changes in passenger and freight trip generation and distribution for potential growth points.
   7. Write a draft report and final report.

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $60,000
5. Indicate type of research and/or development project this is

- Large:  ☑ Research Project  ☐ Development Project
- Small:  ☐ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative
- Other:  ____________________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

This project will span over 18 months, expected to begin in July as soon as funds are available.

Phase I (6 months): Tasks 1-3, literature review, meeting planners, data collection
Phase II (6 months): Tasks 4-5, model setup and calibration
Phase III (6 months): Tasks 6-7, additional development and final report production

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University, Regional Metropolitan Planning Organization

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

- Literature review
- Web-based GIS platform that visualizes major input/output and analysis results of land use models
- Model calibration results using MPO data sets and representative transportation projects
- Final report with model recommendations

8B. Describe how this project will be implemented at UDOT.

For rural areas with signal traffic growth, UDOT planners and regional MPO can use the recommended model and additional GIS tools to rapidly visualize and evaluate the new trip generation/distribution patterns and land use impact of a transportation project with better confidence and accuracy.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

The evaluation and calibration report will recommend appropriate models with easy data entry and reliable analysis. The GIS tool will provide better mapping of the input data, calibration results, and forecast results. The UDOT and MPO planners can better understand and assess the future impact of transportation projects on employment and residential activities based on transportation accessibility and underlying economic factors.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

- Comprehensive freight data could be difficult to collect. The study aims to utilize the following data to generate the best-effort estimates.
  - Federal and state freight flow database
    - Vehicle Inventory and Use Survey (VIUS)
    - Global Insight Transearch (Reebie) commodity flow data
  - Truck survey data
    - Sub-regional studies
    - Roadside and origin/destination survey data
  - Truck weight measurement data
    - Vehicle Travel Information System (VTRIS)
    - Truck weight distribution from other static and WIM stations

No additional cost is needed for developing the proposed open-source web-based system. The in-house GIS tool will be developed to address specific needs and incorporate additional data available in the local planning process.
### 10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<thead>
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<td>965-4175</td>
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<td><a href="mailto:andyli@wfrc.org">andyli@wfrc.org</a></td>
</tr>
</tbody>
</table>

### 10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

Brian Gardner, Planner from the Travel Analysis & Forecasting team at FHWA Office of Planning, could provide possible support for open-source web-based GIS development for transportation planning applications.
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Forecasting Network Traffic for Small Communities in Utah  
**No.:** 09.05-5

**Submitted By:** Anthony Chen (USU), Jeff Gilbert (CMPO), and Tim Boschert (UDOT)  
**Email:** achen@engineering.usu.edu, Jeff.Gilbert@cachecounty.org, tboschert@utah.gov

**Project Champion:** Tim Boschert (UDOT Planning)  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

Current practice in modeling network traffic for planning applications is through a four-step travel demand model that requires travel surveys and a team of specialized technical staffs to operate. Although such a modeling approach has been used in practice in major urban areas, small- and medium-sized communities usually do not have sufficient resources to conduct travel surveys nor to house technical staffs for model development and maintenance. In order for these communities to meet the planning requirements mandated by the federal government, development of innovative methodologies is urgent and necessary. This study proposes to develop simplified planning tools to help small and medium-sized communities in Utah with limited resources to develop travel demand model that meets the requirements in order to receive federal transportation funding. A case study will be conducted using the Cache Metropolitan Planning Organization (CMPO) network. The results obtained from the simplified planning tools will be compared with those produced from the CMPO model (a four-step travel demand model) and the Utah statewide travel forecasting model.

In addition to the objective of developing alternative planning tools for modeling and forecasting network traffic flows for small- and medium-sized planning communities with limited resources, the proposed research project is intended to help state and local agencies through the provision of technical assistance and training, thereby, strengthening links between the university and the agencies responsible for local transportation planning. Hence, the project team will work with CMPO in Logan, Utah, to address their transportation needs in the travel demand forecasting process. We will also initiate discussions with CMPO and the planning division in UDOT to explore the possibility of providing technical support to maintain and update the model on a regular basis and identifying projects to be undertaken by our USU students to obtain hands-on experience and thereby prepare them for a career in transportation. This would involve faculty and students from USU and staffs from the Utah Technology Transfer (T³) Center at USU. The goal of this partnership is to provide services (e.g., traffic count and freight movement data collection, maintenance and update of the travel demand model, and training of the simplified planning tools) to CMPO to address their transportation needs.

### 2. Strategic Goal:  

- Preservation  
- Operation  
- Capacity  
- Safety  

(check all that apply)

### 3A. List the research objective(s) to be accomplished:

1. Develop simplified planning tools to model network traffic for planning applications in small and medium-sized communities.
2. Conduct a case study using the Cache MPO network.
3. Compare the results with those produced from the CMPO model.
4. Compare the results with those produced from the Utah statewide travel forecasting model.

### 3B. List the major tasks to accomplish the research objective(s):  

**Estimated person-hours:** $60,000  
Note: Matching fund will be sought from the University Transportation Center at USU.

2. Collect data and build the CMPO network.
3. Develop simplified planning tools via the concept of path flow estimator using existing available data (e.g., traffic counts, land use data converted to zonal production and attraction via ITE trip rates, seed OD table if available, etc.).
4. Conduct a case study using data collected from CMPO in Utah.
5. Compare and analyze the results from the simplified planning tools with those produced from a four-step travel demand forecasting model (i.e., the current 2030 regional transportation plan of CMPO).
6. Compare and analyze the results from the simplified planning tools with those produced from a statewide travel forecasting model.
7. Document findings and prepare final report.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $60,000
5. Indicate type of research and/or development project this is

Large: ☒ Research Project ☒ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: ____________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
The project duration is anticipated to be approximately 12 months. The schedule of tasks is as follows.

Task 1 = 1 month
Task 2 = 1 month
Task 3 = 3 months
Task 4 = 2 months
Task 5 = 2 months
Task 6 = 2 months
Task 7 = 1 month

Anticipated starting time is September 2009.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University, CMPO, and planning division of UDOT

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

Simplified planning tools for small and medium-sized communities.
A final report documenting the research findings.

8B. Describe how this project will be implemented at UDOT.
This project will be implemented using the CMPO network as a case study. Both CMPO and the planning division of UDOT would be involved in the implementation.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

Results from this proposed research are expected to help small and medium-sized communities that do not have sufficient resources to conduct travel surveys nor to house technical staffs for model development and maintenance. According to the U.S. Census, over 40 percent of all U.S. communities have populations less than 50,000. In Utah, there are 261 municipalities out of 272 municipalities (or 22 counties out of 29 counties) that have a population less than 50,000 (U.S. Census Bureau). We believe that the end products will be useful to the small and medium-sized communities in Utah, the planning division at UDOT, and MPOs in Utah (especially CMPO that does not have the sufficient resource to conduct and maintain a comprehensive four-step travel demand model). It is expected that large savings will result if the small and medium-sized communities in Utah use the simplified planning tools proposed in this study.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
In order to have accurate and reliable results, reliable input data are crucial. At a minimum, CMPO and UDOT must have sufficient and reliable traffic counts in order to estimate a reliable origin-destination trip table for the base year before it can be used for forecasting future network flows.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<thead>
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<tbody>
<tr>
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<td>Cache Metropolitan Planning</td>
<td>435-755-1634</td>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
**Problem Title:** Developing Relationships between Localized Truck Traffic Demand and Land Use

**Submitted By:** Walter Steinvorth, Mitsuru Saito (BYU), Grant G. Schultz (BYU)  
**Email:** msteinvorth@utah.gov, msaito@byu.edu, gschultz@byu.edu

**Project Champion:** Walter Steinvorth

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**

   The increase in truck traffic on highways has brought many problems and challenges to transportation planning and traffic operation, including traffic congestion, transportation system deficiency (insufficient truck parking, etc), safety, infrastructure deterioration, environmental impacts (air quality and noise), economic development, and so forth. In response to these issues, the Utah Department of Transportation (UDOT) has developed a statewide travel demand and truck forecasting model, and has also purchased commodity flow forecast data based on the Global Insight international forecasting model. These data are encapsulated in a TRANSEARCH database forecasting commodity flows by commodity type, mode, value and origin-destination pair. However, a weakness of utilizing results of a high-level commodity flow model like the Global Insight model is a lack of feedback and responsiveness to different economic scenarios or forecasts that may be provided within the state of Utah. For example, changing forecasts and assumptions from the Utah Governor’s office of Planning and Budget (GOPB) cannot readily be tied to commodity flow estimates that are currently available in UDOT’s TRANSEARCH database. For this reason there is research value in seeking methods to adapt a localized or regional commodity flow modeling methodology consistent with both TRANSEARCH national an international data as well as Utah’s way of economic forecasting through GOPB. Localized truck movements are an example of a level of forecasting far beyond the level of resolution of commodity flow information available through the international TRANSEARCH database currently used by federal and state transportation planning agencies. Thus, lately, the integration of the freight flow modeling and land use modeling has emerged as an alternate and better tool to estimate freight movements. Obtaining valid truck freight data has been a major challenge for states and metropolitan areas seeking to develop higher resolution statewide truck freight flow models for local planning applications. Truck freight data from the US Census Bureau’s Commodity Flow Surveys (CFS), the Federal Highway Administration’s Freight Analysis Framework (FAF), county level commodity flow forecasts from Global Insight are some sources available for developing commodity flows, in addition to the trip tables, external station data and other assumptions available in Utah’s existing statewide traffic and truck forecasting model. Also, results of the study on truck traffic data accuracy conducted by Saito and Jin (BYU) can help calibrate localized truck analysis of commodity flows.

2. **Strategic Goal:**

   - Preservation
   - Operation
   - Capacity
   - Safety (check all that apply)

3A. **List the research objective(s) to be accomplished:**

   1. Develop commodity and freight forecasting techniques that complement statewide modeling efforts and data sources.
   2. Identify methods and data sources for refined localized truck traffic forecasting and analysis based on Utah’s existing statewide model, GOPB methods, TRANSEARCH data and local land use planning.
   3. Test and compare different localized commodity flow estimation techniques for different land use and economic scenarios in Utah communities.
   4. Recommend procedures for estimating shifts in localized truck and commodity flow demand based on (1) and (2) above.

3B. **List the major tasks to accomplish the research objective(s):**

   Estimated person-hours: 2000

   1. Coordinate with UDOT’s statewide modeling team to scope and develop potential new methods for localized commodity demand analysis.
   2. Conduct a literature review – Focus on methodologies for refining high-level state and international commodity flow model results in to forecasts and other actionable analyses for specific sub-areas within communities or emerging areas.
   3. Define key applications for refined/localized truck modeling where detailed economic and commodity flow assumptions (beyond the level of FAF, TRANSEARCH or Utah Statewide Model) may be integral to transportation improvement scenarios.
   4. Develop the quantifiable relationships between localized truck demand at a particular place (small community or sub-area) and larger commodity flow patterns observable in UDOT’s existing models and data sources.
   5. Prepare a final report

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000
5. Indicate type of research and/or development project this is

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: ____________________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

It is expected that the work will begin in summer as soon as the contract is signed. The study will be completed in 12 to 16 months.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University research teams are best suited for this type of modeling work, together with model calibration work. The study will require participation and guidance of freight model specialists and traffic count experts at UDOT and Utah Trucking Association.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The anticipated deliverables include a final report that presents methods to quantify relationships between localized truck demand at a particular place (small community or sub-area) and larger commodity flow patterns observed in UDOT’s existing models and data sources and a GIS application of the concepts developed in the study.

8B. Describe how this project will be implemented at UDOT.

Truck traffic counts are not accurate at present. Vehicle classification algorithms that come with the vehicle sensors still require improvements. Until they are improved, truck traffic counts from ATRs would not be very reliable. Hence, UDOT needs a procedure that will supplement truck traffic count data obtained by ATRs. The deliverables from this study will provide a procedure to adjust truck traffic data provided by ATRs for Utah’s truck routes with truck traffic estimated by a truck freight flow model based on the concept of commodity flow modeling.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

The deliverables from this study will improve DOT’s activities that involve truck traffic data such as system planning (that involves truck data), project programming, pavement design (including contributions to M-EPDG), operation, management, and maintenance of truck routes.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

There is no risk associated with this study.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
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<td><a href="mailto:gschultz@byu.edu">gschultz@byu.edu</a></td>
</tr>
<tr>
<td>Region Traffic Engineers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

MPOs, Utah Trucking Association, FHWA, Cities
# 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Safety Data and the Highway Safety Manual: Model Calibration  
**No.:** 09.06-1

**Submitted By:** Robert Hull, Mitsuru Saito (BYU), Grant Schultz (BYU)  
**Email:** RHULL@utah.gov, msaito@byu.edu, gschultz@byu.edu

**Project Champion:** Robert Hull  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

Transportation safety data are a critical component for any state Department of Transportation (DOT). The analysis of these data is also a critical component and one that needs to be addressed in state DOTs throughout the nation. The much anticipated Highway Safety Manual (HSM) is expected to be published in late 2009 or early 2010 by AASHTO to help in the analysis of transportation safety data. The purpose of the HSM is to provide practitioners with the best factual information and tools to facilitate roadway design and operation decisions based on explicit consideration of their safety consequences. HSM was developed to incorporate the explicit role of highway safety in making decisions on roadway planning, design, maintenance, construction, and operations. Currently, there are no such widely accepted tools available for agencies responsible for managing the safety of our roadways and as a result, safety considerations often carry little weight in these processes (paraphrased from the HSM website, 2008). Two software programs, IHSDM and Safety Analysis (SA), that will accompany the HSM, have also been developed. The use of IHSDM in safety audits has been studied by Dr. Saito and its utility in safety audits has been demonstrated. The relationship among HSM, IHSDM and SA is like that of the Highway Capacity Manual (HCM) and the Highway Capacity Software (HCS). Just as HCM contains numerous mathematical and empirical models, HSM contains a large number of crash prediction models and the TRB Task Force for the HSM strongly recommends calibration of such models to reflect each state’s special highway conditions. The purpose of this proposed research is to clarify data requirements, availability and needs for model calibration and develop a procedure for performing model calibration that can be followed in the future to continually improving HSM models.

## 2. Strategic Goal:

- Preservation  
- Operation  
- Safety  
- Capacity

## 3A. List the research objective(s) to be accomplished:

1. Determine data requirements for crash prediction model calibration recommended by the HSM Task Force
2. Determine data availability and data needs at UDOT for conducting recommended crash prediction model calibrations
3. Calibrate selected crash prediction models included in HSM
4. Develop a procedure for future model calibration work

## 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conduct literature search with focus on data requirements to implement HSM based safety analysis, the history on the development of crash prediction models included in HSM</td>
<td>750</td>
</tr>
<tr>
<td>2. Select sample crash prediction models, upon consultation with the TAC members, that can be used as examples to develop a procedure to conduct crash prediction model calibration in the future</td>
<td>750</td>
</tr>
<tr>
<td>3. Determine data requirements, data availability and data needs to conduct calibration on selected crash prediction models</td>
<td>750</td>
</tr>
<tr>
<td>4. Calibrate the selected crash prediction models, conduct necessary statistical analyses, and develop models that reflect Utah’s highway and driver conditions</td>
<td>750</td>
</tr>
<tr>
<td>5. Develop a procedure for calibrating crash prediction models that will take place as the HSM become integrated into UDOT’s decision making process</td>
<td>750</td>
</tr>
<tr>
<td>6. Prepare a final report and recommend how HSM is integrated in UDOT’s various decision making tasks.</td>
<td>750</td>
</tr>
</tbody>
</table>

## 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $35,000 ($25,000 from UDOT and $10,000 from BYU); scope may need to be reduced to match this cost.
5. Indicate type of research and/or development project this is

Large: ☑ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: ______________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

It is expected that the work will begin in the Summer or Fall of 2009. The study will be completed in 12-16 months.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University research team is best suited for this type of work, that is, calibration of the crash prediction models that require significant amount of statistical analyses. The study strongly recommends participation of traffic safety engineers of UDOT in model calibration process so that they become familiar how crash prediction models are developed.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The anticipated deliverables are the answers to the four objectives of the study that are listed in the objective section of this research proposal statement in a final report format. This study emphasizes the development of a procedure for crash prediction model calibration that can be followed as UDOT actively begins to incorporate HSM in their decision making process in the future.

8B. Describe how this project will be implemented at UDOT.

It is expected that HSM will evolve as HCM has evolved. In the process crash prediction models will need to be revisited and evaluated. The model calibration procedure that will be developed in this proposed study will standardize model calibration and development procedure at UDOT.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

HSM is bound to be incorporated into UDOT’s decision making process. As such changes take place, model calibration will become a necessary task for UDOT so that such decision making outcomes become valid and relied upon. This standardization of model calibration procedure will significantly benefit traffic engineers and decision makers because it makes the comparison of projects objective.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

There is no risk associated with this study. The Highway Safety Manual has been spearheaded by the Task Force organized by the Transportation Research Board and HSM will be published by AASHTO.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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<th>Phone</th>
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<tbody>
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<tr>
<td></td>
<td>Region Traffic Engineers</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Traffic &amp; Safety Policy Committee</td>
<td></td>
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</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

FHWA, TRB
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Transportation Safety Data and Analysis

Submitted By: Robert Hull, Grant Schultz (BYU), and Mitsuru Saito (BYU)  
Email: rhull@utah.gov, gschultz@byu.edu, msaigo@byu.edu

Project Champion: Traffic & Safety Policy Committee

(U DOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

The purpose of this problem statement is to address transportation safety in the state of Utah in a way that it has not been addressed in the past, from a system wide basis. Transportation safety has been, and continues to be, a critical component emphasized by the United States Department of Transportation (USDOT). The number of deaths on highways in the United States has remained steady over the past 15 years at approximately 40,000 fatalities per year. Although the total number of fatalities is relatively constant, the fatality rate is dropping due to an increase in the total number of vehicle miles traveled (VMT) in the nation. The Utah Department of Transportation (UDOT) has placed transportation safety at the forefront of their priorities over the past several years. One of the more active programs in the state is the “Zero Fatalities: A Goal We Can All Live With” campaign. Since the inception of the campaign, awareness of traffic safety has increased, while traffic fatalities in the state have dropped 24 percent since 2000. While great strides have been made in transportation and traffic safety, there are continual improvements to be made. One of the factors that can help to aid in these improvements is an increase in focused transportation safety research in the state with an emphasis in the improvement of transportation safety data collection and analysis. The purpose of this proposal is to establish a program that would provide UDOT with transportation safety research that goes beyond today and addresses the future of the system. Such a program would emphasize transportation safety data and the statistical analysis of that data in five primary areas: 1) development of analytical tools for safety analysis, 2) establishment and calibration of the Highway Safety Manual (HSM) for the state, 3) systematic mitigation of safety issues, 4) prioritization of low-cost safety improvements (e.g., rumble strips and cable barrier), and 5) workforce development (training transportation safety engineers of the future). Although all of this research cannot be accomplished in one year, the purpose of this proposal is to establish the framework for focused safety research in the state that includes all five areas outlined and addresses items 1 and 2 in more detail.

2. Strategic Goal:  ☒ Preservation  ☒ Operation  ☐ Capacity  ☒ Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Develop and/or implement existing analytical tools for safety analysis in the state.
2. Establish procedures for HSM model development and calibration.
3. Lay framework to establish a systematic procedure for the mitigation of safety issues.
4. Develop the basis for a methodology wherein low-cost safety improvements (e.g., rumble strips and cable median barrier) could be prioritized, including the establishment of priorities for long-term systematic prioritization.
5. Lay the background for training and workforce development to train the transportation safety engineers of the future.

It is important to note that objectives 3 through 5 in this problem statement are preliminary in nature. Future research will be needed to build upon these objectives and to establish a long-term program for effective data analysis and safety research.

3B. List the major tasks to accomplish the research objective(s):

Estimated person-hours: 3,500

1. Develop a project scope of work and detailed cost estimate and schedule.
2. Perform literature review on the state of the practice for transportation safety data analysis with focus on analytical tools for safety analysis, HSM safety analysis implementation, crash prediction models, safety mitigation, prioritization processes, and workforce development and training for transportation safety.
3. Develop procedure to utilize existing traffic safety data and analyze this data for more robust data collection and analysis.
4. Develop HSM model calibration procedure including subtasks such as determination of data requirements and data availability, calibration of crash prediction models, and overall calibration procedure for HSM.
5. Develop the framework to establish a systematic procedure for the mitigation of safety issues.
6. Develop the basis of a prioritization process for low-cost safety improvements.
7. Establish a background for workforce development training in transportation safety.
8. Make limited recommendations on transportation safety data analysis, HSM calibration and integration to UDOT’s decision making procedures, along with a framework for analysis on a systematic procedure for the mitigation of safety issues, prioritization of low-cost safety improvements, and workforce development.
9. Report results to UDOT in the form of a written report, including future steps to follow to further develop a systematic transportation safety analysis in the state.
4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $100,000

5. Indicate type of research and/or development project this is

Large: Research Project
Small: Research Evaluation

A small project is usually less than $20,000 and shorter than 6 months

6. Outline the proposed schedule (when do you need this done, and how will we get there):

It is recommended that this project begin in the Summer or Fall of 2009 with the initial tasks of the project scope of work and detailed estimate, followed by the other tasks identified. It is anticipated that the project would take 12-16 months, with an outline of the next steps to consider in order to meet the ultimate goal of establishing a transportation safety laboratory in the state that would look long-term at safety goals for the state.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

A University research team is best suited for this type of work with close coordination by UDOT Traffic & Safety such that the program established will be of greatest benefit to the state.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The deliverables expected from this project would include an engineering report documenting the research results. The document would provide the background on state of the practice for transportation safety data analysis with focus on analytical tools for safety analysis, HSM safety analysis implementation, crash prediction models, safety mitigation, prioritization processes, and workforce development and training for transportation safety. Further, the document would provide research results to meet the objectives of the research, along with steps to follow to further develop transportation safety in the state.

8B. Describe how this project will be implemented at UDOT.

It is anticipated that UDOT Traffic & Safety will work very closely with the research team on this project. The outcomes of the project will be implemented through Traffic & Safety with the utilization of the analytical tools, the HSM, and the background for systematic mitigation, prioritization of low-cost safety improvements, and workforce development. This project has been established to help UDOT meet their goals with respect to transportation safety.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

UDOT will benefit not only through Traffic & Safety, but through the Planning Division as they utilize the prioritization tools, the analytical analysis tools, and the future workforce development. WFRC and MAG will also be able to benefit from the safety analysis, while all citizens of the state will benefit through the safety improvements and will move closer to ZERO FATALITIES.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

No known risks.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
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<td><a href="mailto:gschultz@byu.edu">gschultz@byu.edu</a></td>
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<td>801-422-6326</td>
<td><a href="mailto:msaito@byu.edu">msaito@byu.edu</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

TRB, FHWA
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Are Safe Routes to School Really Safe?: An analysis of parental perceptions

No.: 09.06-4

Submitted By: Shaunna K. Burbidge, PhD
Email: burbridge@byu.edu

Project Champion:
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Between 1970 and 2001 the number of children who walked to and from school decreased by 27.8%. Existing research has shown that perceptions of the built environment significantly impact an individual’s decision regarding travel mode and route choice; or in the case of school children, their parents’ perceptions. If parents do not feel that the route from home to school is safe, children will typically not utilize an active mode. Using a sample population of elementary schools in the Salt Lake Valley this research seeks to identify existing perceptions of route safety from home to school and to identify characteristics of the built environment which are seen as both “safe” and “unsafe”. These data will then be used to both enhance the existing Safe Neighborhood Access Program (SNAP) maps, as well as identify general problem areas for future infrastructure improvement.

2. Strategic Goal:
   [ ] Preservation  [x] Operation  [ ] Capacity  [x] Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Identify existing parental perceptions regarding the safety of routes between a child’s home and school.
2. Statistically identify characteristics of the built environment which are seen as “safe” versus “unsafe”.
3. Compare survey route characterizations to the existing SNAP maps for the area.
4. Establish recommendations for infrastructure improvements which would enhance the built environment and promote safe active travel for children.
5. Amend existing SNAP Inventory protocol to provide more appropriate guidance for individual schools and districts.

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 650
1. Data collection of perception and route characterization using a survey to be completed by parents of students from a sample of Elementary Schools on Salt Lake County’s west side. (150 hours)
2. GIS coding and analysis of route characterization as identified by parental surveys. (100 hours)
3. Qualitative and quantitative analysis of perceptions with regard to safety concerns. (70 hours)
4. Statistical comparison between perceived route safety and existing SNAP maps. (80 hours)
5. Development of recommendations for improvements to SNAP map Inventory protocol, as well as providing recommendations for general infrastructure improvements. (250 hours)

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $20,000-$35,000

5. Indicate type of research and/or development project this is
   Large: [ ] Research Project  [ ] Development Project
   Small: [ ] Research Evaluation  [ ] Experimental Feature  [ ] New Product Evaluation  [ ] Tech Transfer Initiative
   [x] Other: This project could be either a research evaluation (obj. 1-4 only) or a research project (if obj. 5 is included)*
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Objective 1: September 2009-October 2009
   Objective 2: November 2009-January 2010
   Objective 3: December 2009-January 2010
   Objective 4: February 2010-March 2010
   *Objective 5: March 2010-June 2010

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7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)? University in cooperation with DOT staff and school/district representatives

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Technical report outlining the process and the findings of the research (objectives 1-4)
- Technical report outlining recommendations for: improvements to SNAP inventory protocol including measurement tools, and generalized recommendations for infrastructure improvements (by type rather than specific location).
- Trainings or workshops assisting individual schools and districts in improving their SNAP maps.
- Trainings or workshops assisting local planners with enhancing the built environment around schools for active mode choice.

8B. Describe how this project will be implemented at UDOT.
UDOT’s Safe Routes to School Coordinator and Traffic and Safety Division (with possible assistance from the Bicycle/Pedestrian Coordinator) will be responsible for taking the data provided in the technical report(s) and using it to create appropriate training/workshop opportunities for local Utah planners, schools, communities, and even consultants.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
This project will identify key ways to improve the SNAP inventory protocol which will increase map accuracy by making them more consistent with parental perceptions. Additionally, crafting a plan for strategic investment in infrastructure improvements will promote active mode choice to and from school for children increasing overall physical activity. This creates additional benefit not just for students, but for all active travelers in the community. Additionally, higher utilization of active modes will improve the overall perception of safety in and around local neighborhoods.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Potential Obstacles: Recruitment difficulty for initial survey, issues with existence, accuracy, and validity of existing SNAP maps and resources, potential conflict with local school administrators/community members, implementation of recommendations.
Strategies: The research team will take great care sampling parents of students in the selected schools providing incentives and sing proven methods to avoid sample attrition or non-response rates. The research team will additionally work with the UDOT Safe Routes to School coordinator and the schools to acquire accurate and current maps and resources. Exceptional effort will be made to select schools with supportive administrations and community members. Lastly, the research team will work rigorously with UDOT to promote the final recommendations and create a long term plan for implementation and follow-up.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Active Living Research (Robert Wood Johnson Foundation- Grant pending Summer 2009 approval), Brigham Young University Office of Research (Grant pending Fall 2009 approval), and the National Institute of Health (NIH)
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Snow-melt infiltration and slow-moving landslide movement triggering mechanism  No.: 09.07-1

Submitted By: John Rice, Utah State University  Email: jdrice@engineering.usu.edu

Project Champion: Jon Bischoff
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
Slow moving landslides pose a risk to the integrity of highways across Utah. While it is understood that movement of these slides initiates during the spring snow melt, details of the mechanism are not well understood. Monitoring of landslide movement has often resulted in counterintuitive observations where the magnitude of movement has not always correlated with the amount of precipitation experienced during the year. A better understanding of the interaction of snow melt, groundwater infiltration, and the buildup of water pressure above and/or below the failure plane will provide insight into the triggering mechanism for movement on these landslides.

There are two scenarios for relating the effects of snow melt infiltration to the initiation of the landslide: 1) snow melt infiltrates through the slide mass and accumulates above the failure plane and increases the pore pressure along the upper boundary of the slide plane, and 2) snow melt infiltrates in areas upslope from the landslide and percolates down slope beneath the landslide increasing the pore pressure below the failure plane. This project will install an automated monitoring system to continuously measure groundwater conditions within and around a landslide mass and to correlate changes in the groundwater conditions with landslide movement. The instrumentation will be designed to 1) monitor the downward propagation of the surface water infiltration (unsaturated) within the landslide mass during the seasonal snow melt, 2) monitor the buildup of water pressure above and below the slide plane, 3) monitor movements of the landslide. The data will be continuously collected and transmitted back to Utah State University via cell phone.

2. Strategic Goal:
[ ] Preservation  [x] Operation  [ ] Capacity  [x] Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Measure infiltration of snow melt water and the progression of the wetting front into the landslide mass and compare observed infiltration with existing published numerical models.
2. Measure pore pressure buildup above and below the failure plane in two locations.
3. Correlate water infiltration and pore pressure buildup with measured landslide movement.
4. Based on collected data, develop theory on mechanism responsible for landslide movement initiation.

3B. List the major tasks to accomplish the research objective(s):
1. Installation of landslide monitoring system in a landslide that has exhibited movement over the past several years.
2. Collection of data throughout winter, spring and early summer.
3. Correlate snow melt with moisture content increase and depth within the slide mass. Compare to published numerical infiltration models.
4. Correlate infiltration to the buildup of pore pressure above and below the failure plane.
5. Correlate pore pressure buildup with measured landslide movement.
6. Prepare written research report.

Estimated person-hours: 1080

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $15K UDOT, 15K UTC, 25K other USU sources: Total of $55,000

5. Indicate type of research and/or development project this is
[ ] Research Project  [ ] Development Project
[ ] Research Evaluation  [ ] Experimental Feature  [ ] New Product Evaluation  [ ] Tech Transfer Initiative  [ ] Other:

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   1. Install instrumentation system during the summer of 2009.
   2. Collect data during fall, winter, spring, and early summer 2009 to 2010.
   3. Evaluate data starting in spring 2010 and continuing as data is collected through summer 2010.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University with consultation from Utah Geological Society and UDOT personnel.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

   A report will be prepared describing installation of the instrumentation, data collection, data correlation, and conclusions on landslide initiation mechanism. Although a small amount of additional funding may be needed to maintain the monitoring equipment beyond the first year, it is planned to continue the collection of data for several years. Data from this data collection will be provided to UDOT.

8B. Describe how this project will be implemented at UDOT.

   The information gained from this project will provide insight into the movement triggering mechanism of slow moving landslides in Northern Utah. While the information is only site specific for one landslide, the insights gained on the triggering mechanism will be applicable to varying degrees to other Northern Utah landslides that pose a risk to UDOT facilities. It should be noted that while we have selected a primary candidate landslide and several backup alternatives, this project is not locked into any one specific landslide and we are willing to perform this monitoring program on a landslide that is of importance to UDOT provided it meets the criteria needed to perform our study (drill rig access, clearly definable slide planes, etc.).

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

   An improved understanding of the mechanism responsible for the initiation of movement on slow moving landslides will assist UDOT in two ways. First, the information will assist UDOT in assessing the risk and estimating annual maintenance costs for slow moving landslides affecting state highways. Secondly, understanding the mechanism will help to designing effective mitigation measures for landslides (such as horizontal drains versus surface drains depending on the source of triggering pore pressure buildup).

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

   1. Permission from land owners is needed to install monitoring instruments. We have already identified several candidate landslides that are suitable for the study and have started the process of obtaining permission. In the event that access is denied we have several backup candidates.
   2. Drilling to install instrumentation may be problematic due to the inclusion of boulders in the landslide mass. We have allocated significant time during the summer to the installation of the instrumentation and will have the ability to abandon a boring blocked by boulders and drill other borings within the allocated time frame.
   3. Costs of the study are high. We have obtained a commitment from a local geotechnical firm to provide a drill rig to help with the instrumentation installation free of charge. Utah State University also owns portable drilling equipment that can be used for drilling in hard to access regions of the landslides. The student at Utah State University working on the project will be funded by Utah State University (scholarship or assistantship from USU funds). The requested funds from UDOT will be used to cover the cost of instrumentation and incidental costs. The Utah Transportation Center at Utah State will provide matching funds to cover overhead expenses.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
<th>Organization / Division / Region</th>
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<th>Email</th>
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</thead>
<tbody>
<tr>
<td>Jon Bischoff</td>
<td>UDOT/Geotechnical/</td>
<td>801-965-4326</td>
<td><a href="mailto:jonbischoff@utah.gov">jonbischoff@utah.gov</a></td>
</tr>
<tr>
<td>Francis Ashland</td>
<td>UGS/Geologic Hazards</td>
<td>801-537-3380</td>
<td><a href="mailto:francisashland@utah.gov">francisashland@utah.gov</a></td>
</tr>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

   Utah Geologic Survey – Geologic Hazards Group
## Problem Title: LiDAR Derived Landslide Inventory Maps along Selected Utah Highways

### No.: 09.07-4

### Submitted By: Steve Bowman & Francis Ashland, Utah Geological Survey (UGS)  
**Email:** stevebowman@utah.gov, francisashland@utah.gov

### Project Champion:
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

Many highway corridors within mountainous regions of Utah are subject to landslide hazards. Detailed landslide mapping has typically not been performed for these corridors, resulting in an unknown level of risk to highways. Due to dense vegetation in many of these corridors within steep canyons, traditional landslide mapping using aerial photography is of limited use. Recently acquired 2-meter LiDAR data from along the Wasatch Front includes portions of the I-80, I-84, SR-39, and SR-65 highway corridors within the Wasatch Range. Using the existing LiDAR data, we will generate various hillshade angle images for use in mapping landslides along the I-80 and I-84 corridors, including drainages above. If time allows, we will also include the SR-65 and SR-39 corridors. The mapped landslides will be used to generate a landslide inventory map along the selected corridors, along with an accompanying summary report that will be suitable for future highway maintenance, planning, and design activities.

### 2. Strategic Goal:

- Preservation
- Operation
- Safety

### 3A. List the research objective(s) to be accomplished:

1. Develop landslide inventory maps along selected Utah highway corridors (I-80 and I-84) for use in determining landslide risk and future highway maintenance, planning, and design activities.

### 3B. List the major tasks to accomplish the research objective(s):  

**Estimated person-hours:** 420

1. Process existing LiDAR data with several hillshade angles to generate images along selected Utah highway corridors.
2. Map landslides along selected highway corridors using LiDAR hillshade images.
3. Create landslide inventory maps.
4. Write report.

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $24,950 ($19,960 UDOT, $4,990 with a 20% UGS cost share)

### 5. Indicate type of research and/or development project this is

- Large: ☐ Research Project  ☐ Development Project
- Small: ☑ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative  ☐ Other: ________________

(A small project is usually less than $20,000 and shorter than 6 months)

### 6. Outline the proposed schedule (when do you need this done, and how will we get there):

- Data processing and analysis / landslide inventory: October to December 2009
- Report: January 2010

### 7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

Utah Geological Survey (UGS)
8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Landslide inventory maps along selected Utah highway corridors and an explanatory summary report. Maps will be provided in hard copy, Adobe PDF, and as ArcGIS data files. The ArcGIS data files can be used in GIS software or exported into highway design software (such as Microstation, AutoCAD, etc.). The report will be provided in hard copy and an Adobe PDF file.

8B. Describe how this project will be implemented at UDOT.
Landslide inventory maps would be used for highway risk assessments, during project planning and design activities, and in response to maintenance from landslide events.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
These landslide inventory maps will give UDOT spatial information on the location of mapped landslides along the selected highway corridors. These locations will be crucial in planning for modified or new structures (such as signs, traffic cameras, communication cables, etc.), future highway expansion, and in maintenance and mitigation of landslide hazards along the corridors (Project Development and Regions 1 and 2).

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Involuntary commitments of UGS Geologic Hazard Program (GHP) staff to geologic emergencies during the approximate project time frame may require rescheduling of project tasks.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Email</th>
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10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Uinta-Wasatch-Cache National Forest (USFS)
Salt Lake City Utilities
Weber County (Planning Division, Emergency Management/Homeland Security)
Morgan County (Planning & Development Services, Emergency Services)
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Back-Calculation of Consolidation Parameters for 1st South Embankment Site
No.: 09.07-6

Submitted By: Clifton Farnsworth
Email: Clifton_Farnsworth@uttyler.edu

Project Champion: Jon Bischoff, Darin Sjoblom, Grant Gummow

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

When the I-15 embankment monitoring program was initiated in 1999, it was anticipated that numerical modeling would be performed for the Lime Cement Column and MSE Wall sites, as these sites were expected to experience primary consolidation settlement of the foundation soils. However, it was not anticipated that the EPS Geofoam sites would need to include numerical modeling of the foundation soils, as foundation settlement at these locations was not expected to occur. Over the last 10 years the I-15 embankment monitoring program has been ongoing, with foundation performance data being collected, analyzed, interpreted, and reported. These results have indicated that there has indeed been foundation settlement at several of the geofoam sites, with the 1st South Geofoam Array specifically approaching 200-mm of total foundation movement, with about half of that value representing post-construction movement. Numerical modeling of this location, fit with actual site geometry, subsurface strata, and foundation movement from the monitoring program, would allow back-calculation of the of the foundation parameters that exhibited this movement. This project is therefore an appendage to the current monitoring project, providing some closure to issue of foundation beneath the 1st South Geofoam site. Furthermore, this project addresses an issue that was not originally anticipated for geofoam sites, and will therefore provide benefit to future geofoam applications.

2. Strategic Goal: [ ] Preservation [x] Operation [ ] Capacity [ ] Safety (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Back-calculate the foundation strength parameters at the 1st South Geofoam site, by fitting actual performance behavior with numerical modeling
2. Provide recommendations to avoid foundation movement for Geofoam applications, to be included in final summary report for I-15 embankment monitoring program report.

3B. List the major tasks to accomplish the research objective(s):
1. Obtain current foundation settlement data for 1st South Geofoam site
2. Establish a numerical model for the 1st South Geofoam site, based on soil stratigraphy and embankment geometry
3. Fit the numerical model to the actual foundation settlement data
4. Report findings and provide recommendations

Estimated person-hours: 1,148

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $39,023

5. Indicate type of research and/or development project this is

Large: [x] Research Project [ ] Development Project
Small: [ ] Research Evaluation [ ] Experimental Feature [ ] New Product Evaluation [ ] Tech Transfer Initiative
[ ] Other:

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

The I-15 embankment monitoring program is due to complete its 10-year post-construction evaluation in 2010. The timely completion of this project would compliment the conclusion of the 10-year embankment monitoring evaluation, and provide some closure to the issue surrounding the foundation settlement of the 1st South Geofoam site. To ensure that the results of this project can be summarized in the final 10-year embankment monitoring report, this project would need to be completed during the 2010 fiscal year. It is estimated that the establishment of the numerical model and fitting of the actual foundation settlement data will take most of the project time.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   A university is the type of entity best suited to perform this research. Because this project is an extension of the current I-15 embankment monitoring project, the personnel that have been performing that research would be a natural fit to continue with this additional piece of work.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   The primary deliverable to UDOT would be a Research Report detailing the numerical modeling, the current monitoring data, and the back-calculated foundation strength and consolidation properties.

8B. Describe how this project will be implemented at UDOT.
   The results of this project may be used by UDOT consultants and UDOT personnel alike, to provide guidance for avoiding foundation settlement for future Geofoam applications.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   EPS Geofoam is typically used for locations where foundation settlement must be kept very minimal. The information gained by better understanding the foundation movement that has occurred at the 1st South Geofoam Site, will help to prevent this issue from occurring again.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The settlement data for the 1st South Geofoam site has been collected on an ongoing basis since the summer of 2000. The data collected thus far is valuable in demonstrating the construction and post-construction foundation behavior of this site. However, slowly over time some of the instrumentation originally installed has become lost due to deformation, natural wear and tear, vandalism, weathering, etc. It is expected that at some point in time, most (if not all) of the field instrumentation will have transpired through its usable life. The proposed project provides some closure to the gathering of this data. Subsurface data for the 1st South Geofoam site is available through the I-15 reconstruction data. Constructed geometry of the 1st South Geofoam embankment and design documentation can be used to hypothesize what design calculations were made.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon Bischoff</td>
<td>UDOT Geotechnical Division</td>
<td>801-965-4326</td>
<td><a href="mailto:jonbischoff@utah.gov">jonbischoff@utah.gov</a></td>
</tr>
<tr>
<td>Grant Gummow</td>
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<td>801-965-4307</td>
<td><a href="mailto:ggummow@utah.gov">ggummow@utah.gov</a></td>
</tr>
<tr>
<td>Darin Sjoblom</td>
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<td>801-964-4474</td>
<td><a href="mailto:dsjoblom@utah.gov">dsjoblom@utah.gov</a></td>
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<tr>
<td>Steve Bartlett</td>
<td>University of Utah, Civil Engineering</td>
<td>801-587-7726</td>
<td><a href="mailto:bartlett@civil.utah.edu">bartlett@civil.utah.edu</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Lateral Load Capacity of MSE Block Wall Abutment  
**No.:** 09.07-7

**Submitted By:** Travis Gerber  
**Email:** tgerber@byu.edu

**Project Champion:** Jon Bischoff  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   MSE block-type walls are increasingly being used at bridge abutments. While previous studies have been undertaken to better understand the lateral load-displacement response of variously backfilled abutments and pilecaps, including one full-scale test with MSE panel walls, full-scale tests involving MSE block walls are lacking. The MSE block-type of wall presents conditions different from common bridge abutments, most particularly the truncation of the backfill width and the effect of internal reinforcement. The MSE block-type of wall presents conditions different from typical MSE panel walls in that the reinforcement is typically extensible geosynthetic material rather than inextensible steel mesh (likely behaving differently for loadings occurring in the transverse direction) and the wall face is much more flexible.

2. Strategic Goal:  
   - Preservation  
   - Operation  
   - ☑️ Capacity  
   - Safety  
   (check all that apply)

3A. List the research objective(s) to be accomplished:  
   1. Quantify the performance of a full-scale MSE block-type of wall relative to a regular, full-width backfill without walls and MSE panel-walls.

3B. List the major tasks to accomplish the research objective(s):  
   **Estimated person-hours:**
   1. Prepare instrumentation and testing plan, including mounting strain gauges on reinforcement
   2. Conduct load test without backfill present to confirm baseline response of pilecap without backfill present
   3. Construct MSE block wall and backfill
   4. Conduct load test on MSE block-walled backfill
   5. Analyze and interpret data; compare to previous results from tests with full-width backfill and MSE panel-walled backfill; develop design recommendations
   6. Prepare report documenting results

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $~50,000

5. Indicate type of research and/or development project this is  
   - Large: ☑️ Research Project  
   - ☐ Development Project  
   - Small: ☐ Research Evaluation  
   - ☐ Experimental Feature  
   - ☐ New Product Evaluation  
   - ☐ Tech Transfer Initiative  
   - ☐ Other: 
   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):  
   Field work component of project should be accomplished during summer 2009 (or 2010). Remainder of analysis and interpretation would follow. Project would be completed within a period of 1 year. Testing will be performed at the SLC International Airport site in conjunction with other testing in order to help reduce overall costs.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
The submitter of this project has both academic and industrial consulting expertise relating to MSE walls, and has conducted several full-scale load tests of the type proposed.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
A report which documents the results of the field testing, provides analysis and interpretation of the results, and provides recommendations for design involving this type of wall at bridge abutments.

8B. Describe how this project will be implemented at UDOT.
Recommendations developed as part of this work can be used by UDOT personnel and consultants in their designs.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
MSE block-walled abutments will have more reliable performance during extreme loading events in which passive soil pressures are mobilized at bridge abutments.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Work is planned to be performed in conjunction with other testing at SLC international airport site.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
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<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Stability and Consolidation Assessment of Embankments at South Layton Interchange   No.: 09.07-8

Submitted By: Evert Lawton and Steve Bartlett   Email: lawton@civil.utah.edu

Project Champion: Jim Higbee

1. Briefly describe the problem to be addressed.
   The current method of assessing embankment and foundation stability used by UDOT and its designers is based on total stress concepts and undrained shear strength theory. For rapid construction on soft soils, it is important to estimate and account for the initial excess pore pressure generation from the embankment loading(s), the rate at which excess pore water pressure dissipates and the subsequent degree of consolidation and the associated gain in shear strength. Such an approach requires a fully-coupled effective stress soil model that inherently accounts for consolidation and shear-induced pore pressures and their affect on stability. The proposed research at the South Layton Interchange will tie in with ongoing tasks at SR-77 in Springville. The cost of the instruments for the monitoring arrays at South Layton, including installation, has been included in the bid documents and will be borne by the project. However, additional funding is needed for personnel to read the instruments; interpret and analyze the results; conduct laboratory tests; and perform complementary field testing such as vane shear and borehole shear tests.

2. Strategic Goal: □ Preservation   □ Operation   ☒ Capacity   ☒ Safety   (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Recommend appropriate full-coupled soil models to UDOT for fully-coupled effective stress analyses.
   2. Develop triaxial test program and procedures to obtain the required soil parameters.
   3. Develop correlations with required soil parameters so that in situ tests can also be used to estimate model parameters.
   4. Validation of approach with field observations at South Layton Interchange
   5. Develop methods/recommendations for safe rates of embankment placement.
   6. Develop standard instrumentation guidelines (types, amounts, and locations of instruments) that should be used to monitor embankment construction.

3B. List the major tasks to accomplish the research objective(s):

   - Perform field investigations, including in situ testing. Supervise obtaining undisturbed soil samples and installation of instrument arrays.
   - Perform laboratory testing to obtain soil parameters for selected soil model.
   - Develop correlation of laboratory-obtained soil properties with in situ tests
   - Conduct modeling of construction performance data to help validate approach.
   - Develop methods to determine and monitor safe rate of embankment construction
   - Report findings, recommendations, procedures and technical specifications to UDOT

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $25,000

5. Indicate type of research and/or development project this is
   Large: ☒ Research Project   ☐ Development Project
   Small: ☐ Research Evaluation   ☐ Experimental Feature   ☐ New Product Evaluation   ☐ Tech Transfer Initiative
   ☐ Other:

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   The timing of this project depends on when actual construction at the South Layton Interchange occurs. Performance of tasks must be coordinated with the design-build construction project.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   - Laboratory test procedures
   - Software for modeling
   - Modeling Report and Validation of Approach (Report)

8B. Describe how this project will be implemented at UDOT.
   This research and its deliverables will be used by UDOT geotechnical division or its design consultants to evaluate embankment performance and stability for rapid construction on soft soil sites.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   - Reduced construction time and cost
   - Improved methods of analysis, design and construction performance monitoring with higher reliability
   - Less construction, settlement/instability risks to stakeholders, adjacent landowners and facilities

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Since the cost of purchasing instruments and installing them will be borne by the design-build project, the only risk is if the South Layton Interchange project does not actually get built.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   The costs associated with purchasing and installing the instrumentation, as well as the Cone Penetration Tests needed at each instrumentation array to verify the soil profiles at each site, will be borne by the design-build project.
Problem Title: Field Behavior of Deep Soil Mixed Improved Ground

Submitted By: Steven Bartlett, Evert Lawton, Armin Stuedlein

Email: bartlett@civil.utah.edu

Project Champion: Grant Gummow

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   The field behavior of Deep Soil Mixed (DSM) improved ground for supporting embankments and bridge approaches on soft and potentially liquefiable foundation soils warrants further study. The technology needs to be evaluated regarding its capability to handle multiple design challenges in a fast-paced construction environment. Current design issues include (1) the ability to penetrate locally dense or hard zones with the mixing tools, (2) amount of stress concentration that may develop over the “hard points” presented by the DSM, (3) the in-situ strength and modulus of the improved ground, (4) the rate at which DSM improved ground gains strength, (5) the rate at which the DSM improved ground gains strength in-situ compared to in laboratory conditions, (6) the potential for settlement in deeper compressible layers, (7) reduction of liquefaction potential, (8) change in seismic ground response in DSM improved areas.

2. Strategic Goal:
   - [ ] Preservation
   - [x] Operation
   - [ ] Capacity
   - [x] Safety

3A. List the research objective(s) to be accomplished:
   1. Obtain settlement, stress, and strain data in DSM area to assess design and construction and long-term performance
   2. Analyze the load transfer mechanism and embankment stability using DSM
   3. Make recommendations regarding improvements to design

3B. List the major tasks to accomplish the research objective(s):

   Estimated person-hours: 1500
   1. Instrument installation
   2. Data gathering, reduction and interpretation
   3. Assessment of strength and stress-strain modulus and comparison with Contractors’ QC tests
   4. Evaluate existing methods of predicting load transfer
   5. Perform probabilistic global stability analyses using measured DSM strengths at end-of-construction, long-term static and under seismic conditions.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $40,000

5. Indicate type of research and/or development project this is
   - Large: [x] Research Project
   - Development Project
   - Small: [ ] Research Evaluation
   - Experimental Feature
   - New Product Evaluation
   - Tech Transfer Initiative
   - Other: ________________________________

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   The instrumentation array is planned at 1100 N. as part of the Beck St. Project. It will be done in conjunction with the DB contractor.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
DB contractor / University partnership

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Data report
Technical report discussing design and performance

8B. Describe how this project will be implemented at UDOT.
As part of future DB projects where this technology is implemented

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
This study is needed to better develop and assess this technology for rapid construction. It is currently being used in Salt Lake and Utah Counties on UDOT projects.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
none

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant Gummow</td>
<td>UDOT Geotech Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steven Bartlett</td>
<td>U of U</td>
<td>801-587-7726</td>
<td><a href="mailto:bartlett@civil.utah.edu">bartlett@civil.utah.edu</a></td>
</tr>
<tr>
<td>Evert Lawton</td>
<td>U of U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armin Stuedlein</td>
<td>Shannon-Wilson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steven Saye</td>
<td>Kiewit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

Note: This is a joint proposal that is being championed by Parson-Kiewit. They will participate in the study and match UDOT funding at a 50 – 50 percent match. It is expected that Parson-Kiewit will contribute $20 k of funding to this study.
1. Briefly describe the problem to be addressed.
As UDOT gains more experience with Accelerated Bridge Construction practices and procedures, flaws and problems arise and “a better way” is needed. As bridge deck panels are cast and cured prior to construction the parapet walls are cast as part of the panel, issues have arisen. These walls were previously installed as a cast in place element providing continuous support throughout the parapet wall. As part of ABC, these walls are now designed individually as concrete barrier end sections, assuming maximum survivability in the case of a collision. This design makes certain assumptions regarding its ability to withstand multiple collisions before repair resulting from the first hit is completed. This weakness is overcome with a reinforced connection between the wall portions of the pre-cast deck panel, adding time and cost to the construction process. It is proposed that research be conducted to determine the necessity of the parapet wall connection.

What is the effect of lightweight concrete on parapet to deck connection, etc.

2. Strategic Goal:
- [ ] Preservation
- [x] Operation
- [ ] Capacity
- [x] Safety
(check all that apply)

3A. List the research objective(s) to be accomplished:
1. Can a parapet wall under current design requirements survive 2 collisions?
2. Is the connection requirement excessive?
3. Is there an easier way to construct the parapet wall with or without connections (slip form cast in place, link form pre-cast)?

3B. List the major tasks to accomplish the research objective(s):
1. Crash testing parapet wall elements and analyzing the data.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $

5. Indicate type of research and/or development project this is
- [x] Research Project
- [ ] Development Project
- [ ] Research Evaluation
- [ ] Experimental Feature
- [ ] New Product Evaluation
- [ ] Tech Transfer Initiative
- [ ] Other: ____________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
Research and analysis could be completed within one year beginning to end,
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University, American Association of State Highway and Transportation Officials, American Concrete Institute, Insurance
   Institute for Highway Safety

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method,
   technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware,
   equipment, training tool, etc.)
   Design Method, Standard Specification

8B. Describe how this project will be implemented at UDOT.
   This project will be implemented at UDOT as another facet of Accelerated Bridge Construction.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a
   discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from the implementation of this project by having a clear understanding of what method best meets the
   AASHTO design requirements.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The expected risk is funding for crash testing of the parapet wall, this can be overcome by a research grant.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC)
     for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
     All transportation departments interested in Accelerated Bridge Construction.
Problem Title: Seismic Loading of Abutment Connections for ABC Structures

Submitted By: Zack Andrus, UDOT Structures

Project Champion: Fred Doehring

1. Briefly describe the problem to be addressed.
   In the construction of an ABC Structure when pre-cast concrete elements are used certain joints are created. It is feared that the bond at some of these joints would be inadequate under seismic forces. The specific element in question is the bridge abutment stem. Because of size and weight, the abutment cannot be pre-cast as one piece. When installed over driven piles it must be done in several segments, the joint created is filled with concrete. The pre-cast back wall is joined to the top of the abutment with mechanical rebar splices. This design accounts for all vertical loads, but pays little consideration to horizontal movement. It is proposed that research be conducted to learn the seismic behavior of the current design specifications for pre-cast abutment construction.

2. Strategic Goal: ☑️ Operation 

3A. List the research objective(s) to be accomplished:
   1. Will the current abutment stem joint closure withstand lateral and longitudinal seismic loading?
   2. Will the current back wall connection provide sufficient stabilization to the abutment in a seismic event?
   3. 
   4. 

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours:
   1. Apply horizontal forces to a constructed abutment element laterally and longitudinally.
   2. 
   3. 
   4. 
   5. 

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $

5. Indicate type of research and/or development project this is
   Large: ☑️ Research Project ☐ Development Project
   Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
   ☐ Other: ______

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Research and analysis should be completed within one year start to finish.
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University, American Association of State Highway and Transportation Officials, American Concrete Institute

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Design Criteria

8B. Describe how this project will be implemented at UDOT.
   This project will be implemented at UDOT as a change in ABC procedure for bridge construction and installation.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit from the implementation of this project by applying what is learned to seismic ABC design, with the traveling public being the primary beneficiaries. Several UDOT Divisions will directly benefit from the outcome of this project by having clear standards and specifications requirements. These divisions include Roadway Design, Project Management, Operations, Traffic and Safety, and Maintenance.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The expected risks are devising a system which will allow for adequate testing of the abutment element, applying the axial forces required for a comprehensive test and reliable data.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
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<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   USDOT, FHWA, AASHTO, ACI, other State Transportation Departments interested in ABC
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Rocking Foundations for Accelerated Bridge Construction

No.: 09.08-4

Submitted By: Keri Ryan, James Bay

Email: kryan@engineering.usu.edu

Project Champion: Fred Doehring, Jon Bischoff

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

Application of rocking foundations for bridge piers may provide a number of benefits for accelerated bridge construction and earthquake performance. In a “rocking foundation”, a shallow spread footing or “loosely” connected pile cap is allowed to rock back and forth on the soil in an earthquake, whereby energy is dissipated through the rocking action rather than plastic hinge formation in the bridge columns or piers. The rocking system is naturally self-centering, thereby minimizing residual displacements. The footing dimensions for a rocking foundation are smaller than for a conventional foundation, and the pile tensile capacity can be minimized, thereby allowing cost savings in the overall construction. Furthermore, the footing and column/pier can be cast together as a single unit offsite, and thereafter placed on top of the soil foundation.

There is a significant amount of information in the literature about the concept of rocking foundations, including theoretical studies, experimental studies, and design guidance (e.g. Priestly et. al, 1996). However, practical application seems to be somewhat limited. The concept of rocking foundations is being pursued aggressively by Caltrans through research at the Pacific Earthquake Engineering Research (PEER) Center, including large scale testing of rocking bridge piers and geotechnical centrifuge testing of soil-structure interaction.

Some of the questions to be answered for UDOT include:
(1) How are the rocking displacements accommodated in the superstructure, and what kind of special superstructure-substructure connection joint is needed?
(2) How should the footing or pile cap be connected to the piles?
(3) How much lateral load can be accommodated by the foundation? Is it necessary to transfer a larger portion of the lateral load to the abutments?
(4) What techniques are used to inspect and repair the foundation after a large earthquake?
(5) Can the technique be applied effectively to bridges with multi-column piers?
(6) How is soil retained from falling into the gap while the foundation is rocking?

2. Strategic Goal: Preservation  ☑ Operation  ☐ Capacity  ☐ Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Determine the feasibility of the rocking foundation approach applied to typical Utah highway bridges.
2. Develop representative design details for rocking foundations.
3. Perform a seismic response comparison study of a typical Utah highway bridge designed conventionally and designed with rocking foundations.

3B. List the major tasks to accomplish the research objective(s):

1. Perform a literature search on rocking foundations, with emphasis on practical applications. A report should focus on practical design issues.
2. Select a pilot bridge that represents the typical characteristics of bridges that could utilize rocking foundations. Preferably, a Utah state bridge that has already been designed with conventional foundations should be selected.
3. In consultation with consultants, develop modified design details for the pilot bridge including:
   a. Spread footing/pile cap and connection details
   b. Modified pile design if needed
   c. Design of superstructure to substructure (pier or bent cap) connection to accommodate the rocking motion.
   d. Modified design of the column or pier to allow seismic capacity to be controlled by rocking.

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4. Develop analytical models of the pilot bridge both conventionally designed and designed with rocking foundations. The analytical bridge models should include appropriate models to assess soil-structure interaction.

5. Perform a comparative seismic assessment of both pilot bridge models, using both static and dynamic analysis as appropriate.

6. Write a report documenting the literature search, conceptual design details, and results of the seismic assessment.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is

- Large: [ ] Research Project [ ] Development Project
- Small: [ ] Research Evaluation [ ] Experimental Feature [ ] New Product Evaluation [ ] Tech Transfer Initiative
- Other:

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

18 month project

- Task 1: 3 months
- Task 2: 1 month
- Task 3: 2 months
- Task 4: 4 months
- Task 5: 5 months
- Task 6: 3 months

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University and Consultant

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The deliverable is a report documenting the literature review, conceptual solutions to design issues, and the pilot bridge design details and analytical study.

8B. Describe how this project will be implemented at UDOT.

The information generated in this study will be used to evaluate whether the rocking foundation approach can be utilized by UDOT as an advantageous technique for accelerated bridge construction and enhanced seismic performance. If the idea proves to be promising, a follow-up project may be needed to develop standard details for rocking foundations.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

Adoption of rocking foundation for typical highway bridges will lead to reduced costs and better seismic performance. Furthermore, they are conducive to accelerated construction techniques, and therefore aligned with UDOT’s strategic vision. Both structures and geotech group will benefit by being able to apply the techniques to bridge design. The entire organization will benefit from decreased construction costs.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

One risk is that rocking foundation approach will turn out to be infeasible or non-beneficial for typical highway bridges in the state of Utah. However, the potential benefits outweigh the risks, and this feasibility study requires a relatively small investment, which makes the risk worthwhile. Another risk, which is based on initial brainstorming about the concept, is that it will be difficult to develop the design details for the rocking foundations. This can be minimized by involving consultants that may have relevant experience.
10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

While the PEER Center will not provide funds for this project, the center can contribute resources toward the project in terms of tools and staff expertise. The PEER Center is currently performing related research for Caltrans, and we can benefit from the recent results as well as collaborate with PEER Center researchers on an ongoing basis. The PEER Center may be able to supplement travel costs for Utah researchers wishing to participate in PEER workshops or face-to-face collaborations with PEER researchers.
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Evaluation of Nano-Lithium Concrete Sealer for Structures

No.: 09.08-5

Submitted By: W. Spencer Guthrie, BYU

Email: guthrie@byu.edu

Project Champion: Chris Potter, UDOT

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Corrosion of reinforcing steel in concrete structures is a prominent mechanism leading to physical deterioration of affected structures. A primary cause of corrosion is elevated chloride concentrations in the vicinity of reinforcing steel within concrete. Because safety considerations will continue to drive the application of deicing salts along highway corridors for the foreseeable future, bridge elements such as decks and parapet walls, concrete facings on retaining walls, and concrete barriers need protection against salt ingress. While epoxy systems have proven successful for protecting bridge decks and providing enhanced surface friction when applied properly, protection of other elements is often neglected. Nano-lithium technology offers a permanent, relatively inexpensive sealer/hardener for concrete that can be very easily applied during or after construction.

2. Strategic Goal:
   ☒ Preservation  ☐ Operation  ☐ Capacity  ☒ Safety  
   (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Investigate the efficacy of different application rates of different lithium-based concrete sealers for achieving desirable reductions in permeability of concrete having different surface finishes.

3B. List the major tasks to accomplish the research objective(s):
   
   Estimated person-hours: 1300
   1. Conduct a literature review and prepare a summary of available information related to composition, characteristics, application, and performance of lithium-based sealers.
   2. Identify and obtain samples of products of greatest interest for applications to transportation infrastructure. (At least one manufacturer is located in Utah.)
   3. Using principles of statistics, design laboratory experimentation to investigate different application rates of different products for different concrete surface finishes.
   4. Perform analyses of test results and derive recommendations.
   5. Develop an implementation plan and provide initial field demonstrations.
   6. Prepare a research report documenting the full project.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $40,000

5. Indicate type of research and/or development project this is
   Large: ☒ Research Project  ☐ Development Project
   Small: ☐ Research Evaluation  ☐ Experimental Feature  ☐ New Product Evaluation  ☐ Tech Transfer Initiative
   ☐ Other:

   (A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):
   This would ideally be a two-year study. Tasks 1 and 2 would occupy the first 3 to 6 months, tasks 3 and 4 would require a full year, task 5 would require another 3 months, and the remaining time would be allotted to preparing the final report.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University

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8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

The primary deliverable would be the final research report, although an oral presentation would also be given to UDOT personnel interested in learning about the project findings and recommendations.

8B. Describe how this project will be implemented at UDOT.

Construction specifications could simply require application of the sealer as part of projects involving reinforced concrete members.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

The research will provide UDOT personnel with data on the application rates needed to achieve desirable reductions in permeability for typical UDOT concrete mixes. Implementation of the anticipated research recommendations should greatly increase the service life of treated transportation infrastructure elements with minimal extra expense.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

No particular risks or obstacles are identified for this research.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

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<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

The individual product manufacturers will certainly have an interest in supporting this study, and other agencies that manage transportation infrastructure in cold regions should be interested in the research.
# 2009 RESEARCH PROBLEM STATEMENT

<table>
<thead>
<tr>
<th>Problem Title:</th>
<th>Splice Sleeve Connection for Concrete Precast Bridge Piers</th>
<th>No.: 09.08-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitted By:</td>
<td>Chris Pantelides and Larry Reaveley, UofU</td>
<td>Email: <a href="mailto:chris@civil.utah.edu">chris@civil.utah.edu</a></td>
</tr>
<tr>
<td>Project Champion:</td>
<td>Fred Doehring</td>
<td></td>
</tr>
</tbody>
</table>

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
   Connections between precast columns and precast footings or precast columns and precast cap beams must be able to withstand significant shears and rotations in large earthquakes. Currently, the splice sleeve connection is being considered as the method of choice for connecting such elements. Although the connection has been used in buildings there is currently no data for use of this connection in bridges located in high seismic regions. The present proposal aims at performing cyclic tests to verify the capacity of the splice sleeve connection in high seismic regions for connecting precast elements such as footings and columns.

2. Strategic Goal: ☒ Preservation ☐ Operation ☒ Capacity ☒ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:
   1. Design of lightweight precast concrete columns, footings and cap beams with the option of using a splice sleeve connection to connect the column to the cap beam or footing.
   2. Evaluate the performance of the splice sleeve connection in a seismic setting using experiments described in section 3B.
   3. Develop ABC Standard Drawings for lightweight precast concrete bridge elements connected using the proposed splice sleeve connection in a seismic application.

3B. List the major tasks to accomplish the research objective(s):
   Estimated person-hours: 1,000
   1. Design and construct three column to footing connections using lightweight precast concrete; column is to be 24 in. square and the footing is to be 60 in. square 400
   2. Perform cyclic load tests simulating earthquake damage for the three specimens and after being damaged test axially up to failure 400
   3. Develop ABC Standard Drawings for lightweight precast concrete elements with the splice sleeve connection 200

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $65,000

5. Indicate type of research and/or development project this is
   Large: ☒ Research Project ☐ Development Project
   Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
6. Outline the proposed schedule (when do you need this done, and how will we get there):

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Design and construct columns and footings</td>
<td>4 months</td>
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<tr>
<td>Cyclic tests</td>
<td>4 months</td>
</tr>
<tr>
<td>Develop Design Guidelines for ABC</td>
<td>4 months</td>
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</tbody>
</table>

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

- Design Guide for Precast Concrete Connections for RC Bridge Piers in ABC
- Report on Test Findings & Constructability of Precast Concrete Connections for Bridge Piers in ABC
- Standard Drawings for Precast Concrete Connections for Bridge Piers in ABC
- Training of UDOT Personnel and Others for Design of Precast Concrete Connections for Bridge Piers in ABC

8B. Describe how this project will be implemented at UDOT.

- UDOT is considering implementation of Precast Concrete Connections for Bridge Piers in ABC
- The results of this study can be used immediately in the construction of Precast Concrete Bridge Piers in ABC in the State of Utah

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

- The Bridge Design Division will benefit from the obvious benefits of light weight, and longer lasting bridge piers. The light weight is especially important because of Accelerated Bridge Construction.
- The Construction Division will benefit from the fact that lighter weight will speed up further and reduce the cost of ABC

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

There is no standard connection for seismic regions between bridge columns and footings. This connection has been used before but not for seismic design of bridge elements.
10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
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<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
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<th>Email</th>
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<tbody>
<tr>
<td>Fred Doehring</td>
<td>UDOT</td>
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<tr>
<td>Daniel Hsiao</td>
<td>Research, UDOT</td>
<td>965-4638</td>
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<tr>
<td>Carmen Swanwick</td>
<td>HDR</td>
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<tr>
<td>Ray Cook</td>
<td>Senior Bridge Engineer, UDOT</td>
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<tr>
<td>Rebecca Nix</td>
<td>UDOT</td>
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</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
**Problem Title:** Seismic Connection for Lightweight Concrete Precast Bridge Piers  
**No.:** 09.08-7

**Submitted By:** Larry Reaveley and Chris Pantelides, UofU  
**Email:** chris@civil.utah.edu

**Project Champion:** Fred Doehring

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**

   Connections between precast columns and precast footings or precast columns and precast cap beams must be able to withstand significant shears and rotations in large earthquakes. Currently, the splice sleeve connection is being considered as the method of choice for connecting such elements. A new method for connecting precast elements is proposed which utilizes a newly developed mechanical anchorage device to connect column bars to the pile cap bars and then finishing the connection with a grouted pour back section.

2. **Strategic Goal:**

   - Preserves
   - Operation
   - Capacity
   - Safety

3A. **List the research objective(s) to be accomplished:**

   1. Design of lightweight precast concrete columns, footings and cap beams with the option of installing the mechanical anchor to connect the column to the cap beam or footing.
   2. Evaluate the performance of the mechanical anchor in a seismic connection using experiments described in section 3B.
   3. Develop design guidelines for the seismic connection and specify tolerances.
   4. Develop ABC Standard Drawings for lightweight precast concrete bridge elements connected using the proposed seismic connection.

3B. **List the major tasks to accomplish the research objective(s):**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and construct three column to footing connections using lightweight precast concrete; column is to be 24 in. square and the footing is to be 60 in. square</td>
<td>400</td>
</tr>
<tr>
<td>Perform cyclic load tests simulating earthquake damage for the three specimens and after being damaged test axially up to failure</td>
<td>400</td>
</tr>
<tr>
<td>Develop Design Guidelines for lightweight precast concrete elements with the new mechanical anchor and develop ABC Standard Drawings</td>
<td>200</td>
</tr>
</tbody>
</table>

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $65,000

5. **Indicate type of research and/or development project this is**

   - Large: Research Project
   - Small: Research Evaluation
6. Outline the proposed schedule (when do you need this done, and how will we get there):

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 months (Report)</td>
<td></td>
</tr>
<tr>
<td>Design and construct columns and footings</td>
<td>4 months</td>
</tr>
<tr>
<td>Cyclic tests</td>
<td>4 months</td>
</tr>
<tr>
<td>Develop Design Guidelines for ABC</td>
<td>4 months</td>
</tr>
</tbody>
</table>

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

- Design Guide for Precast Concrete Connections for RC Bridge Piers in ABC
- Report on Test Findings & Constructability of Precast Concrete Connections for Bridge Piers in ABC
- Standard Drawings for Precast Concrete Connections for Bridge Piers in ABC
- Training of UDOT Personnel and Others for Design of Precast Concrete Connections for Bridge Piers in ABC

8B. Describe how this project will be implemented at UDOT.

- UDOT is considering implementation of Precast Concrete Connections for Bridge Piers in ABC
- The results of this study can be used immediately in the construction of Precast Concrete Bridge Piers in ABC in the State of Utah

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

- The Bridge Design Division will benefit from the obvious benefits of light weight, and longer lasting bridge piers. The light weight is especially important because of Accelerated Bridge Construction.
- The Construction Division will benefit from the fact that lighter weight will speed up further and reduce the cost of ABC

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

There is no standard connection for seismic regions between bridge columns and footings. This connection has not been tested before.
10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred Doehring</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daniel Hsiao</td>
<td>Research, UDOT</td>
<td>965-4638</td>
<td></td>
</tr>
<tr>
<td>Carmen Swanwick</td>
<td>HDR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ray Cook</td>
<td>Senior Bridge Engineer, UDOT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
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### Problem Statement:

**Problem Title:** Steel Pipe Connections between Precast Bridge Decks and Precast Girders  
**No.:** 09.08-8

**Submitted By:** Larry Reaveley and Chris Pantelides, UofU  
**Email:** chris@civil.utah.edu

**Project Champion:** Fred Doehring  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**
   
   Connections between precast girders and precast decks are now done with shear studs. There are issues with this approach and this proposal is targeted at simplifying the construction of girder to deck connections. It is proposed to study a very simple method for connecting the precast bridge decks to girders using a 3 in. diameter pipe at selected locations in the field by coring in-place both the deck and the girder.

2. **Strategic Goal:**
   - Preservation
   - Operation
   - Capacity
   - Safety

3A. **List the research objective(s) to be accomplished:**
   1. Evaluate the performance of a method of connecting precast bridge decks to concrete girders. It is envisioned that several girder pieces will be constructed. In addition four types of decks will be constructed based on normal weight concrete, lightweight concrete, steel bars and glass fiber reinforced polymer (GFRP) bars.
   2. Develop design guidelines for such steel pipe connections between girders and decks.
   3. Develop ABC Standard Drawings for such steel pipe connections.

3B. **List the major tasks to accomplish the research objective(s):**  
**Estimated person-hours:** 1,600

   1. Design and construct five specimens for each of the following combinations:  
      - Concrete girder + normal weight deck with steel bars  
      - Concrete girder + normal weight deck with GFRP bars  
      - Concrete girder + light weight deck with steel bars  
      - Concrete girder + light weight deck with GFRP bars  
      - Concrete girder + normal weight deck with GFRP bars
   2. Perform 12 pushoff tests to test the connections in single shear
   3. Develop Design Guidelines for such steel pipe connections between girders and decks and develop ABC Standard Drawings

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000
5. Indicate type of research and/or development project this is
Large: ⊗ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: _______________________

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

- 12 months (Report)
- Design and construct specimens 4 months
- Pushoff shear 4 months
- Develop Design Guidelines for ABC 4 months

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
- Design Guide for Steel Pipe Connections between Precast Bridge Decks and Precast Girders in ABC
- Report on Test Findings & Constructability
- Standard Drawings for ABC
- Training of UDOT Personnel and Others for Design

8B. Describe how this project will be implemented at UDOT.
- UDOT is implementing Precast Deck panels in ABC
- The results of this study can be used immediately in the construction of Bridges using ABC in the State of Utah

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
- The Bridge Design and Construction Division will benefit from the obvious benefits fast construction and tolerances

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

There is no standard Steel Pipe Connection between Precast Bridge Decks and Precast Girders. This connection has not been tested before.
### 10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred Doehring</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daniel Hsiao</td>
<td>Research, UDOT</td>
<td>965-4638</td>
<td></td>
</tr>
<tr>
<td>Carmen Swanwick</td>
<td>HDR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ray Cook</td>
<td>Senior Bridge Engineer, UDOT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
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Problem Title: Life Cycle Performance and Cost Evaluation of Utah Bridges

Submitted By: Keri Ryan
Email: kryan@engineering.usu.edu

Project Champion: Fred Doehring

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

Often, policy decisions about seismic design criteria and/or preferred seismic systems are made without good information to evaluate the economic consequences. In recognition that traditional life safety goals of design codes may not lead to acceptable post-earthquake operability of transportation networks, performance-based earthquake engineering (PBEE) design and evaluation procedures have been under development by the structural engineering community. Over the past 10 years, the Pacific Earthquake Engineering Research (PEER) Center has been a leader in the development of PBEE, and is on the cusp of applying the techniques in a practical context. A key development has been a methodology for life cycle cost evaluation of bridges that integrates probabilistic hazard assessment, response assessment, damage assessment, and repair assessment. Current projects underway at the PEER Center include a pilot study to compare life cycle performance of next generation bridges, and a research to practice project to apply loss estimation techniques to an existing bridge.

In this project, researchers from Utah will collaborate with researchers from the PEER Center to perform a life cycle evaluation of one or more hypothetical or real Utah bridges. The study can be designed to address one or more of the following questions as prioritized by UDOT:

1. Do current or proposed design criteria lead to expected or acceptable performance of Utah bridges in terms of probabilistic repair costs over the life of the bridge? Is it economical to design to a 1000 year or 2500 year return period earthquake?
2. Do current or proposed accelerated bridge construction standards lead to expected or acceptable performance of Utah state bridges in terms of probabilistic repair costs over the life of the bridge? Are some construction techniques more reliable than others?
3. What is the overall cost-benefit for seismically-isolated bridges based on their life cycle analysis?

2. Strategic Goal:

Preservation  Operation  Capacity  Safety  (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Using life cycle analysis techniques, perform a comparative cost-benefit study of 2 or more bridges strategically selected to address pertinent policy issues.

3B. List the major tasks to accomplish the research objective(s):

1. Select bridges to be evaluated and obtain design drawings.
2. Estimate total project costs. May be obtained by project records or through the help of a cost consultant.
3. Develop and test computer models of the bridges suitable for response history analysis.
4. Select ground motions for response history analysis based on location, seismic hazard, site effects. Use PEER Center guidelines and previously developed bins of motions where applicable.
6. Damage and loss assessment of bridges using tools developed by the PEER Center.
7. Write report.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is

Large: Research Project  Development Project
Small: Research Evaluation  Experimental Feature  New Product Evaluation  Tech Transfer Initiative
Other:__________________________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   18 month project
   
   Task 1: 1 month  
   Task 2: 3 months  
   Task 3: 6 months  
   Task 4: 1 month  
   Task 5: 3 months  
   Task 6: 2 months  
   Task 7: 3 months

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   The deliverable is a report describing the methodology and results of the loss estimation study for each bridge that is considered.

8B. Describe how this project will be implemented at UDOT.
   The information generated in this study may be used to make/evaluate policy decisions at UDOT pertaining to seismic design criteria, seismic performance of standard accelerated construction techniques, and adoption of innovative or alternative bridge systems that may be conducive to accelerated construction techniques.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT will benefit by having better information to make important policy decisions.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   One of the risks is that it will be difficult to gather the damage and cost data needed to complete the study; however, similar projects at the PEER center means that a lot of data will be available.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

While the PEER Center will not provide funds for this project, the center can contribute a wealth of resources toward the project in terms of tools and staff expertise. Since the PEER Center is currently performing a similar study for the state of California, intense collaborations between PEER Center and Utah researchers are envisioned. PEER Center may be able to supplement travel costs for Utah researchers wishing to participate in PEER workshops or face-to-face collaborations with PEER researchers.
**Problem Title:** Bridge Monitoring for ABC Bridge Construction  
**No.:** 09.08-10  
**Submitted By:** Marv Halling, Paul Barr  
**Email:** marv.halling@usu.edu  
**Project Champion:** Fred Doehring

1. **Briefly describe the problem to be addressed.**
   ABC Bridge construction has become the primary construction method in the state of Utah. With the inclusion of user costs, the total cost of a project has become lower than other construction methods that are longer in duration. While economically ABC bridge construction makes sense, the long-term bridge performance is virtually undocumented. Accordingly, this project focuses on the long-term instrumentation of a bridge that is constructed with ABC technology. The data gathered from this instrumentation will be used to quantify the long-term performance of these bridges. This data will also be used to develop improvements in construction techniques to make UDOTs bridges last longer which will further enhance the benefits of ABC construction.

2. **Strategic Goal:**
   - Preservation
   - Operation
   - Capacity
   - Safety

3A. **List the research objective(s) to be accomplished:**
   1. Quantify the long term performance of ABC Bridges
   2. Compare durability of ABC Construction with conventional construction
   3. Provide recommendations that will improve the long-term performance of these bridges.

3B. **List the major tasks to accomplish the research objective(s):**
<table>
<thead>
<tr>
<th>Estimated person-hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Literature review</td>
</tr>
<tr>
<td>2. Design of experiment (based on UDOT input)</td>
</tr>
<tr>
<td>3. Instrumentation for collection of data</td>
</tr>
<tr>
<td>4. Collection and analysis of data</td>
</tr>
<tr>
<td>5. Compare results with other bridge construction types, including bridges from LTBP Program</td>
</tr>
</tbody>
</table>

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $ 

5. **Indicate type of research and/or development project this is**
   - Large: Research Project 
   - Small: Research Evaluation 
   - Other: 

   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**
   Tasks 1 and 2 would proceed within 3 months of project award. Task 3 would begin this summer on the selected ABC Bridge. Tasks 4 and 5 would be a four year effort. (4 years total)
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   A report would be provided that would feed into the ongoing process of design specs and procedures for UDOT’s Nation Leading effort in ABC construction and development.

8B. Describe how this project will be implemented at UDOT.
   The construction stresses as well as long-term behavior regarding this type of construction will be invaluable for UDOT to incorporate ABC into the vast majority of their construction projects. The long-term performance will be quantified and compared with conventional construction techniques.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT structures will benefit for design, and UDOT maintenance will benefit in the long-term maintenance of these bridges.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The obstacle is that this project is relatively long term in nature and therefore will require a minimal, but sustained effort over at least 4 years.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred Doehring</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jason Richins</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jim McMinimee</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shana Lindsey</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larry Reasch</td>
<td>Horrocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hugh Boyle</td>
<td>Baker</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   The Utah Transportation Center, USU
Problem Title: Investigate the life cycle savings of stainless clad or FRP reinforcement in accelerated construction No.: 09.08-11

Submitted By: Paul J. Tikalsky, University of Utah
Email: Tikalsky@civil.utah.edu
Project Champion: George Lukes
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.
The availability of corrosion resistant reinforcement has become economical in light of greater emphasis on life cycle analysis and the consideration of user costs in reconstructing, maintaining and repairing bridge decks and substructures. The use of fiber reinforced polymer bars and stainless or dual phase steels in bridge decks, bridge substructures and other corrosion susceptible structural elements could greatly enhance the life expectancy of these structures. These reinforcement materials need different design considerations since they have different ductility behavior and strength than conventional black steel covered by AASHTO guides.

2. Strategic Goal: [ ] Preservation [ ] Operation [ ] Capacity [ ] Safety (check all that apply)

3A. List the research objective(s) to be accomplished:
1. Define corrosion susceptible elements in the transportation infrastructure and determine the effect of corrosion on these elements.
2. Provide alternative designs for each standard element using FRP and stainless steel or dual phase steels.
3. Evaluate the value of using alternative reinforcement vs. conventional reinforcement in each standard element.
4. Determine a standard method of evaluation to assist in the selection of reinforcing material.

3B. List the major tasks to accomplish the research objective(s):
Estimated person-hours: 2000
1. Define the concrete performance levels that are needed for each structural element specified by UDOT
2. Review existing design guidelines and life-cycle considerations for each alternative reinforcement system.
3. Implement the findings on 5 field projects with several different contractors and districts.
4. Summarize and submit a report and recommendations.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $50,000

5. Indicate type of research and/or development project this is
   Large: [ ] Research Project [ ] Development Project
   Small: [ ] Research Evaluation [ ] Experimental Feature [ ] New Product Evaluation [ ] Tech Transfer Initiative
   [ ] Other: _____________________________
   (A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Task 1 and 2 is the first 6 months of the project
   Task3 in the 2010 construction season - 3 months
   Complete a report with the evaluative data and recommendations in 3 months.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University of Utah

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Draft design guidelines and a final report.

8B. Describe how this project will be implemented at UDOT.
   Task 3 is the initial implementation. Full implementation would require that UDOT consider the results of the project and decide to lead the nation in the implementation.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   UDOT and other highway agencies benefit from long life structures both financially and from a user impact. Reducing the need to replace the public infrastructure saves future capital expenditures and maintenance costs and benefits the taxpayers of Utah and UDOT.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   The major risk in this project is a resistance to change. The approach engages agency and contractors to participate in moving toward major advances.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Butterfield</td>
<td>UDOT</td>
<td></td>
<td><a href="mailto:Jbutterfield@utah.gov">Jbutterfield@utah.gov</a></td>
</tr>
<tr>
<td>Stan Burns?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
   This would be of interest to the FHWA and its HPC implementation task force. Lou Triandafilou heads up this effort out of the Maryland technology service center. States such as NH, NY, CA also work on this effort.
**Problem Title:** Next Generation Bridge Deck Strengthening System Using Advanced Composites  
**No.:** 09.08-12

**Submitted By:** Ayman Mosallam & Mahmoud Taha, UCI -UNM - Linford  
**Email:** mosallam@uci.edu, mrtaha@unm.edu

**Project Champion:**  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**  
There is a significant need for externally bonded strengthening system for increasing load bearing capacity of horizontally extended concrete structures such as slabs and bridge decks, as well as vertical structures. In this case with the reinforcement being performed on the compression side with respect to the positive load. Using advanced composite strengthening system that combines both the FRP tensile strength capabilities along with very high strength concrete can enable system capabilities that are beyond classical strengthening system. We suggest using this system for strengthening of bridges. The proposed system includes two subsystems: a tension layer and a compression layer. The tension layer is a system with high tensile strength, and the compression layer possesses very high compressive strength (above 14000 psi) and relatively high tensile strength. The tension layer is sandwiched between, and bonded to, the compression side of existing substrate and the compression layer. The high strength-to-weight and strength-to-volume characteristics inherent in of the advanced composite strengthening system. The system thus allows a strengthening that is orders of magnitude lighter and smaller in profile than other reinforcement systems with similar strength characteristics within reasonable costs.

2. **Strategic Goal:**  
☐ Preservation  
☐ Operation  
☒ Capacity  
☒ Safety  
(check all that apply)

3A. **List the research objective(s) to be accomplished:**  
1. Experimentally examine the strengthening system ability to enhance the structural capacity of RC bridge deck slabs  
2. Develop a numerical model for the strengthening approach for verification of the system  
3. Field application and monitoring of the system  
4. Examine the ability of the enhanced polymer concrete layer for rehabilitation of corroded RC bridge columns and girders

3B. **List the major tasks to accomplish the research objective(s):**  
1. Examine bridge deck slabs strength and deformation capacity with and without the proposed strengthening system  
2. Develop a numerical model to explain the mechanics of the system and to be able to predict the system capacity  
3. Verify the numerical model using the experimental data  
4. Develop design guidelines for the new strengthening system

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $

5. **Indicate type of research and/or development project this is**  
☐ Large: Research Project  
☐ Development Project  
☐ Small: Research Evaluation  
☐ Experimental Feature  
☐ New Product Evaluation  
☐ Tech Transfer Initiative  
☐ Other: ____________________________  
(A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**  
12 to 18 months
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University of California, Irvine
   University of New Mexico
   LinFord

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Experimental evaluation of proposed system and development of numerical verification
   Observation of field system if possible

8B. Describe how this project will be implemented at UDOT.
   If successful, the system will present an excellent alternative for strengthening of bridge deck slabs

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:
   Name | Organization / Division / Region | Phone | Email

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
# 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Debris and Sediment Sampling in Storm Drain Catch Basins  
**No.:** 09.09-2  
**Submitted By:** Steven L. Barfuss and Blake P. Tullis  
**Email:** Barfuss@cc.usu.edu  
**Project Champion:** Denis D. Stuhff of UDOT's Central Hydraulics Section

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

Dealing with pollutants in storm water systems in an effective and economical manner is an ongoing challenge for UDOT as well as for DOT’s nationally. Sediment and debris that finds its way into storm water systems can cause loss of capacity in the system and can pollute the water in the system. Spills due to accidents as well as thoughtless people who dispose of chemicals or urban wastes (leaves, soil litter, fertilizers, pesticides, street residuals) can also occur. Such upsets can cause significant localized increases of these pollutants and degrade water quality. Traction sands, chip sealing and tracked soil materials from raw construction sites and even wind born materials find their way into storm water systems. Minimizing the pollution associated with storm water can be costly or worse it can be both costly and ineffectual.

There exists a clear need to better define the fate of the oil and grease materials deposited on roadways by vehicular traffic. The forms and distribution of hydrocarbons and their byproducts within a functioning storm drainage system is not well defined. This is not surprising since the subject is manifestly a complex one. However what is surprising is how little data of a practical nature exists to aid the designers of common BMPs for highway pollutants. For example it is known that fuels and oils discharged onto roadways exist in several forms eg. (1) as free oil (seen rising to the surface of any standing water), (2) as mechanically emulsified oil (sometimes observed during the first portion of a rain event due to tire wash), (3) as chemically emulsified or dissolved oil, and significantly (4) as Oil-wet solids (where oil adheres to soil sediments and grit on the highway. It is believed that 60% or more of the total hydrocarbons deposited are taken up by the TSS in urban stormwater. Heavy metals are also associated with TSS loadings. The efficient removal of TSS in an appropriately designed treatment drain will clearly improve water quality in multiple ways. However there exists little data on the actual distribution of TSS in urban stormwaters, both locally and nationally. This project would create a database about the types of debris and pollutants found in catch basins in representative locations along the Wasatch Front, documenting the nature and order of magnitudes of typical pollutants and sediment size fractions and investigate the influence of the parent soils of the source catchments have a significant influence on the sediment size distributions in storm water systems in the State of Utah.

With this information, UDOT and others will be able to make better decisions about the management of pollutants and sediments in stormwater and the general public can be better educated about the problem.

## 2. Strategic Goal:

- Preservation
- Operation
- Safety

## 3A. List the research objective(s) to be accomplished:

1. For a 12 month period monitor the contents of storm drain catch basins at approximately 50 sites along the I-15 corridor. Each site would be visited once a month and the nature of the pollutants and the associated sediments would be recorded.

2. Associated with each site would be an overview of the contribution drainage area (industrial, residential, etc.) and dominant soil type(s) with details regarding activity at the site.

3. Most of the debris would be replaced into the catch basin after each visit, so that normal process would occur.

## 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate sites that provide diverse conditions for debris and other pollutant loading</td>
<td>200</td>
</tr>
<tr>
<td>Site visits over 12-month period</td>
<td>1200</td>
</tr>
<tr>
<td>Final report and summary tables</td>
<td>120</td>
</tr>
</tbody>
</table>

## 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $46,000, although if the time period for sampling were cut in half, the cost would be reduced to $34,000.

## 5. Indicate type of research and/or development project this is

- Research Project
- Development Project
- Research Evaluation
- Experimental Feature
- New Product Evaluation
- Tech Transfer Initiative

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
The project will take 15 months to complete. This will include a preliminary phase in available information concerning pollutants of interest and associated sediments are investigated in the State of Utah and appropriate sampling points for storm drain catchment basins are located. The second phase will be the sampling and analysis phase during which each of approximately 50 sites is visited. The final phase will include summarizing the results of the sampling program in report form. The preliminary phase will take 2 months to complete, the sampling and analysis phase will take 12 months to complete and the report phase will take 1 month to complete.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
University. Graduate students will be utilized for much of the sampling work.

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Deliverables would include a final report, and a still photograph of each site and of typical debris that was found. The final report will provide valuable and currently lacking information about the magnitude and nature of pollutants and sediments found in storm drain systems in Utah.

8B. Describe how this project will be implemented at UDOT.
The results of these studies would be incorporated into UDOT’s Hydraulic Manual for the use of the Departments Engineers and consultants when designing appropriate optimal storm water BMP’s.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
This study will allow the optimal design of BMP’s which will save dollars. It will insure that the best water quality values are achieved at the most economical costs. The collection of this data will establish the Department as one of the public agencies that is exhibiting a leadership role in the important area of water quality. The information could also be used to identify locations where inappropriate dumping of materials is occurring and provide opportunities for educating the public. Other beneficiaries will be sister agencies such as the DWQ which will be able to use the results.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
One of the obstacles with this project will be getting permission to make monthly site visits. This could take time and considerable effort. Help from UDOT maintenance folks in identifying safe and representative access to sampling points may be needed. If non-UDOT drains are being sampled the owner would need to be notified and permission to sample be secured. If such permission is not given help from UDOT in identifying alternative sample locations would be requested.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steven L. Barfuss</td>
<td>Utah State University</td>
<td>435-797-3214</td>
<td><a href="mailto:barfuss@cc.usu.edu">barfuss@cc.usu.edu</a></td>
</tr>
<tr>
<td>Blake P. Tullis</td>
<td>Utah State University</td>
<td>435-797-3194</td>
<td><a href="mailto:btullis@engineering.usu.edu">btullis@engineering.usu.edu</a></td>
</tr>
<tr>
<td>Jerry Chaney</td>
<td>UDOT Environmental Division</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tim Ularich</td>
<td>UDOT Central Maintenance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
The FHWA and the Utah Division of Water Quality
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Calibration of time parameters and synthetic unit hydrograph coefficients for Utah watersheds  
**No.:** 09.09-4

**Submitted By:** Christine Pomeroy, University of Utah  
**Email:** Christine.Pomeroy@utah.edu

**Project Champion:** Denis Stuhff  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

Because of the importance of runoff timing, most hydrologic models require a watershed characteristic that reflects the runoff travel time. The most frequently used time parameters in hydrologic models are the time of concentration and the lag time. Time parameters for hydrographs for ungauged watersheds are usually estimated using empirical formulas. For example, a lag time is defined in terms of the physical characteristics of the watershed, such as drainage area, channel length and channel slope. However, most of these formulas have been based on very limited data and should be used with considerable caution for watersheds in which physical characteristics are different from those of the watersheds used to calibrate the formula and that are outside the geographic region for which the formula was developed. For example, the widely used Kirpich’s formula for lag time was developed based on a study of small agricultural watersheds in Tennessee. The hydrographs developed using the commonly used NFF Regression Equations default to parameters developed for Georgia. No studies are available for semi-arid Utah watersheds. It is no surprise that when tested on a watershed in Utah (Red Butte Canyon, 7.2 mi²), lag time estimates for the watershed varied from 12 minutes to 7 hours, depending on the formula used.

### 2. Strategic Goal:

- [ ] Preservation  
- [ ] Operation  
- [ ] Capacity  
- [x] Safety  

### 3A. List the research objective(s) to be accomplished:

1. To develop reliable estimates of lag time and time of concentration parameters for typical Utah watersheds.
2. To provide regional estimates of empirical coefficients used in most accepted synthetic unit hydrograph methods; such as a peaking coefficient needed for Snyder’s synthetic unit hydrograph method and a storage coefficient used in Clark’s method.
3. To create a regional synthetic unit hydrograph to be used in hydrologic models, such as HEC-HMS, for rainfall-runoff transformation.

### 3B. List the major tasks to accomplish the research objective(s):

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated person-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a database of short-interval (5-, 10-, 15-min) rainfall and runoff data for as many rural watersheds in Utah as possible.</td>
<td>1700</td>
</tr>
<tr>
<td>2. Use watershed modeling system (WMS) software to estimate a number of physiographic characteristics of each watershed that will be explored as possible predictors of time parameters.</td>
<td></td>
</tr>
<tr>
<td>3. Estimate lag time and time of concentration parameters based on collected rainfall-runoff events.</td>
<td></td>
</tr>
<tr>
<td>4. Develop empirical equations that will relate lag time parameter to selected watershed characteristics.</td>
<td></td>
</tr>
<tr>
<td>5. Use HEC-HMS program to calibrate empirical coefficients of two existing and widely used synthetic unit hydrograph methods, or, if feasible, develop a new synthetic unit hydrograph for the region.</td>
<td></td>
</tr>
<tr>
<td>6. Depending on the number of watersheds that will be available for analysis, a regional analysis, or separation of watersheds based on land uses, may be attempted.</td>
<td></td>
</tr>
</tbody>
</table>

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $51,160

### 5. Indicate type of research and/or development project this is

<table>
<thead>
<tr>
<th>Type</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large:</td>
<td>Research Project</td>
</tr>
<tr>
<td>Small:</td>
<td>Research Evaluation</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):
   Approximately 18 months will be required to complete this project.
   6 months for data collection, quality control, and database development.
   6 months for HEC-HMS and WMS runs.
   6 months for analysis of results and report development.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
   University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
   Short manual containing practical examples, demonstrating how to apply these coefficients to common problems. This will be incorporated into the next version of the UDOT Drainage Manual of Instruction.

8B. Describe how this project will be implemented at UDOT.
   The manual will be distributed to region roadway designers and hydraulic engineers and incorporated into the UDOT Drainage Manual of Instruction for the use of consultants and others doing drainage designs for the department.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
   The methods will be used by region roadway designers, hydraulic engineers, consultants, and others doing drainage designs for the department.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
   Selection of appropriate regionally representative gauged drainage basins. Using the knowledge of statewide conditions, which have been acquired by previous work within Utah and bordering states will facilitate this problem.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christine Pomeroy</td>
<td>University of Utah</td>
<td>801.585.7300</td>
<td><a href="mailto:Christine.Pomeroy@utah.edu">Christine.Pomeroy@utah.edu</a></td>
</tr>
<tr>
<td>Denis Stuhff</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jim Baird</td>
<td>UDOT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
## 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Update for Storm Drainage Chapter of Manual of Instruction  
**No.:** 09.09-5

**Submitted By:** Christine Pomeroy, University of Utah  
**Email:** Christine.Pomeroy@utah.edu

**Project Champion:** Denis Stuhff  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

### 1. Briefly describe the problem to be addressed.

The UDOT Drainage Manual of Instruction is in need of significant revision present material in a format that include local practices and guidelines for roadway designers, hydraulic engineers, consultants, and others doing drainage designs for the department. Existing publications and publications currently under development under other UDOT research projects need to be incorporated into the manual. Especially needed is a prescriptive methodology chapter for stormwater management practice design, especially focusing on retention/detention.

The revision will be a large undertaking. As first steps towards the goal of a new UDOT Drainage Manual of Instruction it is proposed to develop modification recommendations, additional content that is required, and an outline for full reorganization of the Manual. A retention/detention design chapter will be written in a way that it will easily fold into the full revision when it is written.

### 2. Strategic Goal:

- [ ] Preservation  
- [ ] Operation  
- [ ] Capacity  
- [x] Safety  

(check all that apply)

### 3A. List the research objective(s) to be accomplished:

1. A new chapter on design of retention/detention facilities will be written for incorporation into the UDOT Drainage Manual of Instruction.

2. Recommendations and outline for full reorganization of the UDOT Drainage Manual of Instruction, including scope of work and anticipated level of effort for full revision.

3. Links for each section to tutorials online.

### 3B. List the major tasks to accomplish the research objective(s):

- **Estimated person-hours:** 950

1. Research existing manuals available in both the United States and internationally to identify recommended approaches for the UDOT Drainage Manual of Instruction.

2. Prepare a draft chapter for TAC review.

3. Prepare final chapter for addition to the UDOT Drainage Manual of Instruction.

4. Develop empirical equations that will relate lag time parameter to selected watershed characteristics.

5. Develop recommendation and outline for full reorganization of the UDOT Drainage Manual of Instruction, including scope of work and anticipated level of effort for full revision.

### 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):

- **$33,010**

### 5. Indicate type of research and/or development project this is

- [x] Research Project  
- [ ] Development Project  
- [ ] New Product Evaluation  
- [ ] Tech Transfer Initiative

- [ ] Research Evaluation  
- [ ] Experimental Feature  
- [ ] Other: ____________________

(A small project is usually less than $20,000 and shorter than 6 months)
6. Outline the proposed schedule (when do you need this done, and how will we get there):

   3 months to research existing manuals available in both the United States and internationally to identify recommended approaches for the UDOT Drainage Manual of Instruction. During this time the outline for full reorganization of the UDOT Drainage Manual of Instruction, including scope of work and anticipated level of effort for full revision will be developed. The retention/detention design chapter will be written in a way that it will easily fold into the full revision when it is written.

   6 months to prepare a draft chapter for TAC review.

   3 months for review and revision of final chapter and development of recommendations.

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

   University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

   A new chapter in the UDOT Drainage Manual of Instruction that provides step-by-step instruction on detention/retention basin design.

8B. Describe how this project will be implemented at UDOT.

   The new chapter will be distributed to region roadway designers and hydraulic engineers and incorporated into the UDOT Drainage Manual of Instruction for the use of consultants and others doing drainage designs for the department. Recommendations on how to proceed with the remainder of the manual will be used to shape development of a full document.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

   The methods will be used by region roadway designers, hydraulic engineers, consultants, and others doing drainage designs for the department.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

   The risk is low. One potential obstacle is that there are many methodologies for detention/retention design. Reviewers may not be in agreement with appropriate methods. A strategy to overcome this is to have agreement within the technical advisory committee pertaining to the recommended approaches.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
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</tr>
<tr>
<td>Jim Baird</td>
<td>UDOT</td>
<td></td>
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</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
**2009 RESEARCH PROBLEM STATEMENT**

**Problem Title:** Guidance Report and GIS Tool for Computing Benefits of Tamarisk Removal as a Mitigation Measure  
**No.:** 09.09-6

**Submitted By:** Christine Pomeroy, Steve Burian, Kevin Hultine  
**Email:** Christine.Pomeroy@utah.edu

**Project Champion:** Denis Stuhff and Environmental Staff  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**  
The presence of Tamarisk (or Saltcedar) in western North America has had considerable consequences on the environment, and in particular water resources. First, the introduction of Tamarisk in the western U.S. has caused dramatic decreases in native riparian cottonwood/willow communities, which support some of the highest numbers of bird breeding species found in any vegetative community type in the U.S. leading to an overall reduction in biodiversity and ecosystem health of waterways. One large Tamarisk can absorb more than 200 gallons of water per day, and the cumulative effects of riparian area invasion is reduction in streamflow and decreased downstream water availability. There is potential for significant environmental benefits to be realized by performing Tamarisk removal as part of a mitigation program for other riparian impacts from highway and roadway construction.

2. **Strategic Goal:**  
- Preservation  
- Operation  
- Capacity  
- Safety  
(check all that apply)

3A. **List the research objective(s) to be accomplished:**  
1. Compile a brief report quantifying the environmental and water resources impacts of the Tamarisk in Utah  
2. Develop GIS maps of Tamarisk stands and associated impacts in Utah  
3. Create clear guidance on Tamarisk removal and expected benefits  
4. Develop a GIS tool to identify locations and quantify mitigation opportunities

3B. **List the major tasks to accomplish the research objective(s):**  
1. Literature review and survey of western U.S. State DOTs  
2. Data acquisition, remote sensing image processing, geospatial data analysis, and map making  
3. Calculate benefits of Tamarisk removal  
4. Write computer code to create GIS tool

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $70,000

5. **Indicate type of research and/or development project this is**  
- Large: ☒ Research Project  
- Small: ☐ Research Evaluation  
- Development Project  
- Experimental Feature  
- New Product Evaluation  
- Tech Transfer Initiative  
☐ Other:  

(A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**  
- Month 3 complete lit review and background report  
- Month 4 review meeting with UDOT and project advisors – feedback on methods and needs  
- Month 6 complete GIS database compilation and image processing  
- Month 7 review meeting with UDOT and project advisors  
- Month 9 complete Calculations of Tamarisk water loss  
- Month 10 review meeting with UDOT and project advisors  
- Month 11 Demonstrate GIS tool and procedures to UDOT and project advisors  
- Month 12 Submit completed report

199
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University combined with UDOT staff

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

Report, maps, guidance document, GIS tool.

8B. Describe how this project will be implemented at UDOT.

This tool and guidance can be used for developing mitigation plans for UDOT projects. This tool would permit the benefits of the mitigation measure to be quickly calculated.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.

Hydraulics and Environmental will benefit. All UDOT will be able to quickly call upon a potential mitigation measure and measure the benefits anywhere in the state.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

The risk is low. Obstacles are data and programming the GIS tool. Pitfalls are likely, but debugging time is factored into the tool development.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ira Bickford</td>
<td>UDOT Central Maintenance</td>
<td>801-580-6637</td>
<td><a href="mailto:IBickford@utah.gov">IBickford@utah.gov</a></td>
</tr>
<tr>
<td>Terry Johnson</td>
<td>UDOT Environmental</td>
<td>801-965-4598</td>
<td><a href="mailto:TerryJohnson@utah.gov">TerryJohnson@utah.gov</a></td>
</tr>
<tr>
<td>Jerry Chaney</td>
<td>UDOT Environmental</td>
<td>801-633-6218</td>
<td><a href="mailto:JChaney@utah.gov">JChaney@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:

Any western U.S. DOT (e.g., Colorado)

Most western U.S. DOT’s should be interested in the idea of Tamarisk removal as a mitigation measure. This guidance report will definitely be useful to them, and the tool concept can be adopted with data for other states fairly easily.
2009 RESEARCH PROBLEM STATEMENT

Problem Title: Assessment of precipitation variability and long-term trends using historical precipitation data for use in hydraulic design

Submitted By: Francis Ashland, Utah Geological Survey

Project Champion:

Email: francisashland@utah.gov

1. Briefly describe the problem to be addressed.
The October 6-8, 2006 storm at Hanksville, Utah is an example of an extreme precipitation/flood event that caused considerable damage to infrastructure. Precipitation during the three-day storm exceeded that for the historical wettest month on record. Assessment of historical precipitation data by the UGS at selected weather station sites identified two trends in the past four decades relative to the earlier part of the historical precipitation record: 1) long-term wetter-than-normal conditions (cumulative surplus precipitation) and 2) increased variability. However, assessment of these data statewide has yet to be completed. Analysis and assessment of precipitation trends and variability in each UDOT region may provide insight into the need to modify hydraulic design to accommodate flood flows from extreme precipitation events or assess the limitations of existing infrastructure.

2. Strategic Goal:

3A. List the research objective(s) to be accomplished:
1. Assess changes in precipitation variability and long-term trends
2. Evaluate recent extreme weather events in relation to variability and long-term trends
3. Develop dataset for use by UDOT hydraulic engineers

3B. List the major tasks to accomplish the research objective(s):
1. Analyze variability and long-term trend in precipitation at National Weather Service stations containing a minimum 50-year record in each UDOT region
2. Plot and assess (statistics) data
3. Evaluate selected extreme precipitation/flood events
4. Write data report

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $15,400 ($7,700 UDOT, $7,700 UGS with a 50% UGS cost share)

5. Indicate type of research and/or development project this is

6. Outline the proposed schedule (when do you need this done, and how will we get there):
Data analysis and plots: October 2009
Report: November 2009

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
Utah Geological Survey Geologic Hazards Program
8A. What deliverables would you like to receive at the end of this project? (e.g. usable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Final report including precipitation variability and long-term trend datasets that could be incorporated into hydraulic design of drainage structures, etc.

8B. Describe how this project will be implemented at UDOT.
Datasets could be used to develop a future hydraulic design document and useful for infrastructure risk assessment.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
Reduction in damage, loss of service, and repair costs of roads caused by weather events. UDOT maintenance personnel and general public would benefit.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Involuntary commitments of UGS GHP staff to geologic emergencies in 2009 may require rescheduling of project tasks.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
State Hazard Mitigation Team
National Weather Service
Utah Geological Survey
# 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Phase I: CADD Platform Independent .dgn .dwg .dxf  
**No.:** 09.10-1

**Submitted By:** Craig Hancock and Jim Buckley  
**Email:** chancock@utah.gov

**Project Champion:** Craig Hancock

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

UDOT currently requires all CADD digital file deliverables to be in native .dgn (MicroStation) file format. However during project deliverables various forms and formats of deliverable CADD data is submitted (i.e. .dwg, .dxf, and even .pdf files).

UDOT’s problem with receiving data as non-compliant to the native .dgn format causes internal UDOT staff to convert or redraw the digital drawings to UDOT standards which in turn causes unnecessary rework and unsuspected workloads on internal UDOT staff. Additionally UDOT’s “enforcement” of native .dgn format makes it difficult to exchange CADD digital design data formats from AutoCAD .dwg format and various design software formats between UDOT and agencies such as Utah local government, Utah utility companies, and numerous engineering companies within the state of Utah.

## 2. Strategic Goal:

- [] Preservation  
- ✔ Operation  
- ✔ Capacity  
- [ ] Safety  

(check all that apply)

## 3A. List the research objective(s) to be accomplished:

Can UDOT accept and utilize various CADD digital design file formats along with the current .dgn file format and what are the impacts?

## 3B. List the major tasks to accomplish the research objective(s):  

**Estimated person-hours:** 280

1. Research the technical aspect of commingling and sharing digital design data in a single UDOT environment, produced in .dgn, .dwg, and .dxf file formats.

2. Document findings and research into a final deliverable.

## 4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $25,000

## 5. Indicate type of research and/or development project this is

- ✔ Large: Research Project  
- [ ] Development Project  
- [ ] Small: Research Evaluation  
- [ ] Experimental Feature  
- [ ] New Product Evaluation  
- [ ] Tech Transfer Initiative  
- [ ] Other: 

(A small project is usually less than $20,000 and shorter than 6 months)

## 6. Outline the proposed schedule (when do you need this done, and how will we get there):

All deliverables and objectives of this research to be completed by December 31, 2009.

Proposed schedule to be approximately 6 months in duration

## 7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

Consultant and university

---

203
8A. **What deliverables would you like to receive at the end of this project?** (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

1. Final Documentation report approx 30 pages

8B. **Describe how this project will be implemented at UDOT.**

If the objective and research proves accomplishable and feasible, implementation at UDOT would consist of determining and defining CADD Consultant deliverable guidelines outlining various file format deliverables and how interoperability will be accomplished. Also implementation would consist of processes defined at UDOT to accept and verify quality control of digital design formats.

8C. **Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.**

The beneficiaries of this project will consist of UDOT design staff and project managers, along with Consultants bidding on UDOT projects or working on UDOT projects.

UDOT divisions such as UDOT regional offices would benefit by enabling the use of CADD independent file formats to be shared and used in a commingled digital file format environment vs. translating files to the “native .dgn format”. This digital design file independence would enable UTAH agencies outside of UDOT to benefit based on industry knowledge that .dwg file formats are widely used.

UDOT will benefit from smaller consulting firms wanting to do business with UDOT who have design and drafting staff versed in other CADD applications other than MicroStation and InRoads (Bentley software). These consultants tend to hire AutoCAD experienced users (who are more plentiful in the market) and therefore put them into a design/drafting role typically at a lower pay than MicroStation users. This in turn potentially results in a more competitive bid when it comes to bidding on UDOT projects and opens up more opportunity for business that use other CADD applications than what UDOT currently requires (native .dgn).

9. **Describe the expected risks and obstacles as well as the strategies to overcome them.**

Expected risks would be that if research uncovered the ability to work in a CADD independent (non digital file format restriction), without processes in place to QA/QC the multi file format deliverables than quality control of the actual files would be compromised. It is imperative that all deliverable digital file formats be quality controlled for accuracy and usability. Archival process in place must also be retained as future use of this multi formatted files will be important to be able to be reused.

In order to overcome this QA/QC processes and standards must be not only developed but also practiced and adhered to. In order to do this a clear and concise plan must be developed and implemented.

10A. **List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Buckley</td>
<td>Utah DOT Headquarters</td>
<td>801-965-4662</td>
<td><a href="mailto:jbuckley@utah.gov">jbuckley@utah.gov</a></td>
</tr>
<tr>
<td>Craig Hancock</td>
<td>Utah DOT Headquarters</td>
<td>801-965-4865</td>
<td><a href="mailto:chancock@utah.gov">chancock@utah.gov</a></td>
</tr>
</tbody>
</table>

10B. **Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:**

- Arizona Department of Transportation
  - Daryl Odom – CADD Project Manager (CMS)
  - (602) 712-7024
  - dodom@azdot.gov
### 2009 RESEARCH PROBLEM STATEMENT

**Problem Title:** Augmented Reality  
**No.:** 09.10-4  
**Submitted By:** Craig Hancock and Paul Wheeler  
**Email:** chancock@utah.gov  

**Project Champion:** Craig Hancock  
(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. **Briefly describe the problem to be addressed.**  
   Augmented Reality is a new technology that combines computer generated data and live footage in real time. The use of live video imagery is augmented by computer generated graphics. This technology will change the way we view the world. This technology could benefit many applications within the department. Augmented reality could be used to see what a project would look like before it is built in “real time” while standing on location. This technology could also be used to create 3D models that are displayed as a virtual hologram in meetings to help convey complex information easily. This would help difficult concepts to be understood by key members in a more efficient manner.

2. **Strategic Goal:**  
   - [ ] Preservation  
   - [x] Operation  
   - [ ] Capacity  
   - [ ] Safety  

3A. **List the research objective(s) to be accomplished:**  
   1. Create a workable Augmented Reality model  
   2. Create hardware and software to utilize the Augmented Reality technology  
   3. Cost to implement and support  
   4. Training

3B. **List the major tasks to accomplish the research objective(s):**  
   Estimated person-hours: 400  
   1. Purchase Hardware (Head Mounted Display Device, GPS, Tracking device, etc.)  
   2. Create software to utilize the Augmented Reality technology  
   3. Demonstrate the practical uses of Augmented Reality

4. **Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** $50,000

5. **Indicate type of research and/or development project this is**  
   - [x] Research Project  
   - [ ] Development Project  
   - [ ] Research Evaluation  
   - [x] Experimental Feature  
   - [x] New Product Evaluation  
   - [ ] Tech Transfer Initiative  
   - [ ] Other: ____________  

   (A small project is usually less than $20,000 and shorter than 6 months)

6. **Outline the proposed schedule (when do you need this done, and how will we get there):**  
   This project should take approximately 4 months.  
   - Select personnel to work on programming of software  
   - Purchase hardware  
   - Collect Data  
   - Build 3D model for use in the augmented reality system  
   - Demonstrate results
7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
UDOT Staff \ TRB Visualization Committee \ University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Augmented Reality hardware, software, and workable model to be utilized by the Department.

8B. Describe how this project will be implemented at UDOT.
Implement this technology first in the ETS Visualization group.
Implement the technology for use in design and construction.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be. Include a discussion of how UDOT Divisions other than that of the problem submitter will benefit, and how.
UDOT will lead the country with the utilization of this technology. The interest in Augmented Reality is growing throughout the world. All divisions of UDOT could utilize this technology; it could be used in concept, safety, design, construction phases of projects, and public involvement. It could limit the number of necessary trips to the project by being able to see virtually what the project would look like. The impacts of a design change or decision could easily be understood without costly change orders. Construction personnel could see the design in 3D to use for inspection purposes while on site. Safety impacts could be assessed more easily.

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
Creating the software to utilize the Augmented Reality system. By finding individuals with programming skills we should be able to overcome this obstacle.

Being able to track location correctly within the augmented reality system. By using a GPS system we should be able to better track location in space.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization / Division / Region</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Wheeler</td>
<td>UDOT/ETS/Complex</td>
<td>801-965-4700</td>
<td><a href="mailto:pwheeler@utah.gov">pwheeler@utah.gov</a></td>
</tr>
<tr>
<td>Michael Manore, P.E.</td>
<td>Independent Consultant / Chair TRB</td>
<td>651-343-1444</td>
<td><a href="mailto:michael.manore@gmail.com">michael.manore@gmail.com</a></td>
</tr>
<tr>
<td>Dr. Harvey Miller</td>
<td>Visualization Committee (ABJ95)</td>
<td>801-585-3972</td>
<td><a href="mailto:harvey.miller@geog.utah.edu">harvey.miller@geog.utah.edu</a></td>
</tr>
</tbody>
</table>

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
TRB Visualization Committee, Universities, State Dots.
APPENDIX A

WORKSHOP AGENDA
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AGENDA

UTRAC WORKSHOP 2009

INNOVATIONS IN TRANSPORTATION

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

Tuesday, April 7, 2009

Registration: Karen G. Miller Conference Center (KGMC)
7:30 am - Noon Workshop Registration

Introductory Plenary Session: KGMC
8:30 – 9:45 am Welcome – Rukhsana Lindsey, Director, Research and Bridge Operations
Keynote Address – Rollin Hotchkiss, Professor, Civil and Environmental Engineering, Brigham Young University
Research Program Status – Blaine Leonard, Research Program Manager
Workshop Instructions – Blaine Leonard, Research Program Manager

Morning Break: KGMC-Main Foyer
9:45 – 10:00 am Workshop-sponsored break

First Breakout Session: Miller Professional Development Center (MPDC)
10:00 am – 12:00 pm Presentation of existing research projects, Problem Statement presentations and discussion
First prioritization voting
(See map for room assignments and separate agenda for project presentations)

Workshop sponsored lunch: KGMC
12:00 – 1:00 pm Lunch
Presentation of Trailblazer Award – Jim McMinimee, Director, Project Development and Rukhsana Lindsey, Director, Research and Bridge Operations

Second Breakout Session: MPDC
1:00 – 3:00 pm Problem Statement refinement: Deliverables, tasks & budget
Final prioritization voting, Workshop feedback

Adjourn Workshop: 3:00 pm
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APPENDIX B

WORKSHOP ATTENDEES
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## UTRAC 2009 Attendees

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Group</th>
<th>Role/Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Seyed Abbasi</td>
<td>LINFORD LLC</td>
<td>Group 10</td>
</tr>
<tr>
<td>Mr. Douglas Anderson</td>
<td>ATC LLC</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. Howard Anderson</td>
<td>UDOT MATERIALS</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. Steven Anderson</td>
<td>UDOT MATERIALS</td>
<td>Group 3</td>
</tr>
<tr>
<td>Ms. Jessica Andrews</td>
<td>UDOT MAINTENANCE</td>
<td>Group 2</td>
</tr>
<tr>
<td>Mr. Francis Ashland</td>
<td>UTAH GEOLOGICAL SURVEY</td>
<td>Group 7</td>
</tr>
<tr>
<td>Mr. Doug Atkin</td>
<td>FHWA</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. James Baird</td>
<td>UDOT HYDRAULICS</td>
<td>Group 9</td>
</tr>
<tr>
<td>Dr. Steven Barfuss</td>
<td>UTAH STATE UNIVERSITY</td>
<td>Group 2</td>
</tr>
<tr>
<td>Dr. Paul Barr</td>
<td>UTAH STATE UNIVERSITY</td>
<td>Group 8</td>
</tr>
<tr>
<td>Dr. Steve Bartlett</td>
<td>UNIVERSITY OF UTAH</td>
<td>Group 7</td>
</tr>
<tr>
<td>Mr. Austin Baysinger</td>
<td>UDOT ASSET MANAGEMENT</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. Jared Beard</td>
<td>UDOT REGION 4</td>
<td>Group 9</td>
</tr>
<tr>
<td>Mr. Ken Berg</td>
<td>UDOT RESEARCH</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. Lynn Bernhard</td>
<td>UDOT MAINTENANCE</td>
<td>Group 2</td>
</tr>
<tr>
<td>Mr. Jon Bischoff</td>
<td>UDOT GEOTECHNICAL</td>
<td>Group 7</td>
</tr>
<tr>
<td>Mr. Ben Blankenship</td>
<td>ASH GROVE CEMENT</td>
<td>Group 3</td>
</tr>
<tr>
<td>Mr. Bruce Bonebrake</td>
<td>UTAH DWR</td>
<td>Group 4</td>
</tr>
<tr>
<td>Mr. Tim Boschert</td>
<td>UDOT SYSTEMS PLANNING</td>
<td>Group 5</td>
</tr>
<tr>
<td>Mr. Brook Bowen</td>
<td>BOWEN DESIGN WORKS</td>
<td>Administrative</td>
</tr>
<tr>
<td>Mr. Steve Bowman</td>
<td>UTAH GEOLOGICAL SURVEY</td>
<td>Group 7</td>
</tr>
<tr>
<td>Mr. Keith Brown</td>
<td>UDOT GEOTECHNICAL</td>
<td>Group 7</td>
</tr>
<tr>
<td>Ms. Kelly Burns</td>
<td>UDOT RESEARCH</td>
<td>Group 9</td>
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<tr>
<td>Mr. John Butterfield</td>
<td>UDOT REGION 2</td>
<td>Group 3</td>
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<tr>
<td>Mr. Steven Call</td>
<td>FHWA</td>
<td>Group 5</td>
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<tr>
<td>Mr. Larry Cerceone</td>
<td>COMPTETK STR. COMPOSITES</td>
<td>Group 8</td>
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<tr>
<td>Mr. Jerry Chaney</td>
<td>UDOT ENVIRONMENTAL</td>
<td>Group 4</td>
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<tr>
<td>Dr. Anthony Chen</td>
<td>UTAH STATE UNIVERSITY</td>
<td>Group 5</td>
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<tr>
<td>Mr. Dan Church</td>
<td>PARSONS BRINKERHOFF</td>
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<tr>
<td>Mr. Richard Clarke</td>
<td>UDOT MAINTENANCE</td>
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<tr>
<td>Ms. Michelle Cline</td>
<td>PARSONS BRINKERHOFF</td>
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<tr>
<td>Mr. Ryan Cole</td>
<td>GERHART COLE INC</td>
<td>Group 7</td>
</tr>
<tr>
<td>Ms. Patricia Cramer</td>
<td>UDOT PRECONSTRUCTION</td>
<td>Group 7</td>
</tr>
<tr>
<td>Mr. Richard Crosland</td>
<td>UDOT REGION 3</td>
<td>Group 4</td>
</tr>
<tr>
<td>Ms. Lori Dabling</td>
<td>UDOT PROJECT DEVELOPMENT</td>
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<tr>
<td>Mr. Alan DeMann</td>
<td>MCNEIL GROUP</td>
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<tr>
<td>Ms. Joni DeMille</td>
<td>UDOT RESEARCH</td>
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<td>Mr. Ted Didas</td>
<td>MCNEIL GROUP</td>
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</tr>
<tr>
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<td>UDOT STRUCTURES</td>
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<tr>
<td>Mr. David Eisenberger</td>
<td>T.Y. LIN INTERNATIONAL</td>
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<tr>
<td>Mr. Michael Fazio</td>
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<td>Mr. Jacob Fetshaw</td>
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<tr>
<td>Mr. Phillip Gale</td>
<td>GENEVA PIPE</td>
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<tr>
<td>Mr. Brent Gaschler</td>
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<tr>
<td>Dr. Travis Gerber</td>
<td>BRIGHAM YOUNG UNIVERSITY</td>
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<td>Ms. Elizabeth Giraud</td>
<td>UDOT ENVIRONMENTAL</td>
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<td>Mr. Doug Graham</td>
<td>HORROCKS ENGINEERS</td>
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<td>Dr. W. Spencer Guthrie</td>
<td>BRIGHAM YOUNG UNIVERSITY</td>
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<td>Dr. Marv Halling</td>
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<tr>
<td>Mr. Craig Hancock</td>
<td>UDOT ETS</td>
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<tr>
<td>Ms. Amanda Holm</td>
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<td>Mr. David Holmgren</td>
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<td>Dr. Rollin Hotchkiss</td>
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<td>Mr. Justin Jar</td>
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<td>Mr. Sean Keenan</td>
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<td>Mr. Kelly Lund</td>
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<td>Mr. Lonnie Marchant</td>
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<td>Dr. Peter Martin</td>
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<tr>
<td>Ms. Mitzi McIntyre</td>
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<td>Mr. Mac McKee</td>
<td>UTAH STATE UNIVERSITY</td>
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<tr>
<td>Mr. Jim McMinimee</td>
<td>UDOT PROJECT DEVELOPMENT</td>
<td>Administrative</td>
</tr>
<tr>
<td>Mr. Scott McNeil</td>
<td>MCNEIL GROUP</td>
<td>Group 10</td>
</tr>
</tbody>
</table>
APPENDIX C

WORKSHOP EVALUATION RESULTS
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**Workshop Evaluation**

Total Number of Responses: 66

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<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree (%)</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Strongly Disagree (%)</th>
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<tr>
<td>1) The Workshop was well organized.</td>
<td>44</td>
<td>56</td>
<td>0</td>
<td>0</td>
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<td>2) The general sessions were productive.</td>
<td>29</td>
<td>61</td>
<td>5</td>
<td>2</td>
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<tr>
<td>3) The keynote and lunch speakers were interesting.</td>
<td>44</td>
<td>52</td>
<td>3</td>
<td>0</td>
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<tr>
<td>4) I would like more presentations on past / current projects.</td>
<td>45</td>
<td>45</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>5) The breakout group facilitator was effective.</td>
<td>48</td>
<td>47</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>6) The members of our group were productive, open minded, and worked well together.</td>
<td>42</td>
<td>53</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7) We had a good set of problem statements to start with.</td>
<td>35</td>
<td>58</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>8) The breakout problem statement refining process was efficient and effective.</td>
<td>23</td>
<td>67</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>9) To make good decisions, we had the right people in attendance in our group.</td>
<td>20</td>
<td>72</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>10) The voting process was fair and effective.</td>
<td>33</td>
<td>63</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>11) The meeting facilities were satisfactory.</td>
<td>53</td>
<td>46</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>12) The Miller Center is a good UTRAC location.</td>
<td>56</td>
<td>43</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>13) The lunch arrangements and food were satisfactory.</td>
<td>32</td>
<td>58</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>14) Overall, the workshop was worth the time spent?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15) The duration of the workshop was …?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16) How many UTRAC Workshops have you attended?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Too Long Just Right Too Short

<table>
<thead>
<tr>
<th>This was my 1st</th>
<th>5</th>
<th>95</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3-4</td>
<td>5+</td>
<td></td>
</tr>
</tbody>
</table>
Additional Workshop Evaluation Comments

Nice job, esp. Darin’s work up front
Thanks!
Thanks Kelly
I thought UTRAC was more effective than ones I have attended in the past. I haven’t attended for a few years, so I was pleased to see the change.
One group received some 10+ additional problem statements after the breakout session began. Discussing more than 10 statements is difficult to begin with.
As a new attendee I would have been better informed/prepared if an introductory overview had been provided – I found good value in the workshop.
A general invite to UDOT for problem statement submittal would be good.
We needed more ideas and members in our group.
Was organized, interesting and informative too.
Great effort – Keep up the good work!!!
Why was traffic & safety opted out? Need to see their problem statements.
Would love to see ‘consultant’ groups interested in Research projects and submit on statements.
Wished there were more participants
Well done and valuable to UDOT
Should have a second vote after the first cut has been made.
I think I had “fun”. Could be held every other year.
UTRAC could be held every 2 years and be sufficient.
Don’t allow proposals to be submitted the day of the workshop; hold firm to the required submittal deadline.
Would have like to have a better balance between designers and academicians.
Have a class at the UDOT conference describing how this UTRAC process works. It may drum up more interest from consultants (designers).
Food was terrible
Excellent!
Very professional approach to improving processes, productivity. The workshops are “fun”.
Box lunch sandwich was soggy. Great keynote speaker.
The following charts graphically depict the responses collected on the Workshop Evaluation form, and compares the results for each of the three past years.

1. **The Workshop was well organized.**
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

2. **The general sessions were productive.**
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree

3. **The keynote lunch speakers were interesting.**
   - Strongly Agree
   - Agree
   - Disagree
   - Strongly Disagree
I would like more presentations on past / current projects.

The breakout group facilitator was effective.

The members of our group were productive, open minded, and worked well together.
We had a good set of problem statements to start with.

The breakout problem statement refining process was efficient and effective.

To make good decisions, we had the right people in attendance in our group.
The voting process was fair and effective.

The meeting facilities were satisfactory.

The Miller Center is a good UTRAC location.
The lunch arrangements and food were satisfactory.

Overall, the workshop was worth the time spent.

The duration of the workshop was ...?
How many UTRAC Workshops have you attended?

- 2007
- 2008
- 2009

This was my 1st