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3	Determine effectiveness of deicing and anti-icing chemicals and optimum application rates under different weather conditions	Kim Willoughby 360-705-7978
5	Feasibility of High-RAP (reclaimed asphalt pavement) Hot Mix Asphalt in Washington State This is 1 of 3 problem statements in support of the proposed Green Roads R&D Strategic Initiative.	Kim Willoughby 360-705-7978
7	Feasibility of Warm Mix Asphalt Use for Compaction Improvement in Washington State This is 1 of 3 problem statements in support of the proposed Green Roads R&D Strategic Initiative.	Kim Willoughby 360-705-7978
9	Quantifying the Benefits of Durable Pavement Markings	Doug Brodin 360-705-7972
11	Methodology for Identifying the Benefits of Interconnected Traffic Signals	Doug Brodin 360-705-7972
13	Integration of WSDOT's Emergency Operations Centers	Rhonda Brooks 360-705-7945
15	Transportation Video Surveillance Program	Rhonda Brooks 360-705-7945
17	Speed perception of an oncoming object	Rhonda Brooks 360-705-7945
19	Quantifying Incident-Induced Travel Delays on Freeways Using Traffic Sensor Data (Phase II)	Doug Brodin 360-705-7972
21	Concrete Precast Segmental Continuous Post-Tensioned Box Girder bridges in Seismic Regions.	Kim Willoughby 360-705-7978
22	Instrumentation and Analysis of the I-5 Toutle River Steel Tied Arch Bridges	Kim Willoughby 360-705-7978
23	Construction and Performance of Reclaimed Asphalt Pavement (RAP) in Untreated Aggregate Base	Kim Willoughby 360-705-7978
25	Durability Concerns of Shotcrete	Kim Willoughby 360-705-7978

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26	Evaluate the use of Subsurface Utility Engineering (SUE) within the department and determine how to implement a comprehensive SUE program for use on transportation improvement projects to realize the documented return on investment SUE provides.	Rhonda Brooks 360-705-7945
31	Evaluate noise mitigation measures currently in use along highways to determine which options will provide the lowest cost while remaining aesthetically pleasing to the traveling public	Rhonda Brooks 360-705-7945
35	A Synthesis of Criteria and Methods for Anchoring Precast Concrete Barrier	Rhonda Brooks 360-705-7945
37	Development of Archaeological Deep Testing Protocols for Washington State	Rhonda Brooks 360-705-7945
39	Sensitivity Analysis of $PM_{2.5}$ Dispersion Using Existing Modeling Tools	Rhonda Brooks 360-705-7945
40	Establishing water level recurrence values for Washington State Ferries terminal facility locations	Rhonda Brooks 360-705-7945
41	Investigation of Permeable Pavement Use on Over Water Structures	Rhonda Brooks 360-705-7945
43	Soil Property Correlations with Field Test Results for Common Geologic Units in WA	Kim Willoughby 360-705-7978
44	Influence of Local Zoning on Right of Way acquisition costs	Rhonda Brooks 360-705-7945
45	Managing Bicyclist and Pedestrian Safety	Kathy Lindquist 360-705-7976
47	"Washington State Ferry (WSF) Passenger Demand and Lost Revenue Analysis"	Rhonda Brooks 360-705-7945
49	Financial and Operating Impacts to Washington Transit Systems From Aging Baby Boomers	Tom Hanson 360-705-7975
50	Off site Ferry queuing	Kathy Lindquist 360-705-7976
51	Impacts of school sitting, context, and regulations on travel to school.	Kathy Lindquist 360-705-7976
53	Energy-Efficient High-Speed Battery Locomotive Technology Assessment and Study.	Tom Hanson 360-705-7975
55	Alternatives for Preservation and/or Rehabilitation of WSDOT- owned Airport runways and other low activity or remote public use airports	Kim Willoughby 360-705-7978

OPERATIONS RAC

PROBLEM TITLE
Determine effectiveness of deicing and anti-icing chemicals and optimum application rates under different weather conditions

RESEARCH PROBLEM STATEMENT
Public agencies utilize deicing chemicals to achieve safe winter driving conditions. Extensive laboratory testing and development of anti-icing and deicing chemicals has been done to determine performance characteristics of each chemical currently on the market today. However, very little field research has been preformed to validate or duplicate the laboratory results. Claims are made by each manufacture about their products, representing phase diagrams and basic melting performance, all based on laboratory analyses. Improved knowledge of these performance characteristics in the field environment will allow agencies to make more effective purchasing and application decisions.

RESEARCH OBJECTIVE
Starting with existing laboratory data, performance of deicing chemicals will be reviewed and verified. The test will utilize a Road Weather Information System to document and measure different weather conditions. Test applications of corrosion inhibited liquid Magnesium Chloride, Calcium Chloride, Sodium Chloride and several different solid corrosion inhibited Sodium Chlorides on an unoccupied parking lot, airport or other large paved surface. Testing will evaluate different application rates of each chemical in a variety of different weather patterns. Tests will determine the concentration of chloride when applied, and measure and track hourly to determine effective time and temperature ranges for each rate and product.

A technical committee will be formed from Pacific Northwest Snowfighters pool fund participant. The committee will determine all details of evaluation and reporting. A technical advisor should also be hired with field experience, funded by pooled funds to work directly with the Research Institute to provide ongoing assistance and assurance to the technical committee that this project is progressing and the result will support future business decisions.

ESTIMATE PROBLEM FUNDING AND RESEARCH PERIOD

Cost estimate: $100,000 / $300,000

It is intended this money would be contributed to Pacific Northwest Snowfighters Pooled Funds. We would solicit other participating States to contribute additional funding.

Total project cost is estimated at $300,000.

Research Period: 36 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
Public agencies are under extensive pressure to provide safe winter operating conditions while reducing application rates to lessen both cost and environmental impact. If this research is successful, the results would shape our winter maintenance programs and assist operators and managers in selection the appropriate product and rates for the road and weather conditions they are faced with. Savings in maintenance budgets and improved performance will result when the data collected from this study are available. It will benefit all State DOT's and local agencies responsible for winter maintenance programs. The benefits can be realized immediately following the conclusion of this project.

PERSON(S) DEVELOPING PROBLEM STATEMENT
Chris Christopher/Tom Root

RECOMMENDED PROBLEM MONITOR
Tom Root/PNS TAC

DATE AND SUBMITTED BY
October 2, 2006
Tom Root

PROBLEM TITLE

Feasibility of High-RAP (reclaimed asphalt pavement) Hot Mix Asphalt in Washington State
This is 1 of 3 problem statements in support of the proposed Green Roads R&D Strategic Initiative.

RESEARCH PROBLEM STATEMENT

WSDOT has seen an 80% increase in the average price of HMA over the last four years which has lead to project funding difficulties. One potential helpful practice, increasing the amount of RAP allowed in HMA, has the potential to lower cost as well as benefit the environment while not impacting long-term pavement performance. Currently, WSDOT allows 20% RAP by weight of aggregate in HMA without further testing. While this practice is fairly typical, mixtures with much higher RAP percentages (on the order of 30 to 50%) have been placed and are reportedly performing well[1]. Currently, the best course of action for using high-RAP HMA in Washington and its potential impacts on performance, mix design, the economy and the environment are not yet known.

RESEARCH OBJECTIVE

Determine the feasibility of high-RAP HMA in Washington State. Research has already been done on blending and testing including NCHRP 9-12 (Incorporation of Reclaimed Asphalt Pavement in the Superpave System), and several University of New Hampshire/FHWA Recycled Materials Resource Center (RMRC) efforts. The object of this research is to sort out existing research and determine the feasibility of implementing high-RAP mixtures to include the most promising mix design procedure, as well as the likely impacts to performance, contractors and the environmental. If its use is found feasible, the research would conclude with a WSDOT demonstration project using high-RAP HMA.

GENERAL WORK PLAN

Stage 1: Literature review to recommend a best approach to using high-RAP HMA in Washington. This would consider performance and specifications of any existing high-RAP HMA in Washington.
Stage 2: Contractor, quarry and equipment manufacturer interviews to determine costs and equipment associated with high-RAP use and necessary steps to upgrade existing equipment.
Stage 3: Life-cycle analysis of high-RAP HMA to determine its economic/environmental impacts.
Stage 4: Determination of best circumstances for use of high-RAP HMA.
Stage 5: Assist WSDOT in selecting a region and project on which to demonstrate high-RAP HMA.
Stage 6: Assist WSDOT in writing a special provision for use in the demonstration project.
Stage 7: Assist WSDOT in data gathering and processing for the project and produce a project report.

ESTIMATE OF FUNDING AND RESEARCH PERIOD

Recommended funding:	$85,000
Recommended research period:	24 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

The high cost of HMA and need to reduce this cost in order to more fully fund P1 projects makes this effort urgent. The potential payoffs for high-RAP HMA are lower HMA costs (likely $2.00 to $4.00 per ton less than regular HMA), and environmental benefits through the use of more

recycled material and consequent reduction of waste. If results are positive, implementation would be through specifications that allow, under specific circumstances, high-RAP HMA on WSDOT projects.

PERSON(S) DEVELOPING PROBLEM STATEMENT
Steve Muench, Assistant Professor, Civil and Environmental Engineering, University of Washington

RECOMMENDED PROBLEM MONITOR
Jeff Uhlmeyer, Materials Laboratory

[1] examples are SPS-5 section in US-175 near Crandall, Texas and I-35 near Waxahachie, Texas in Chen, D.H. and Daleiden, J. (2005). Lessons Learned from the Long-Term Pavement Performance Program and Several Recycled Sections in Texas. TR Circular E-C078. Transportation Research Board, National Research Council, Washington, D.C.

PROBLEM TITLE

Feasibility of Warm Mix Asphalt Use for Compaction Improvement in Washington State
This is 1 of 3 problem statements in support of the proposed Green Roads R&D Strategic Initiative.

RESEARCH PROBLEM STATEMENT

WSDOT is constructing and will likely continue to construct more pavements (1) with special engineering characteristics (e.g., asphalt rubber friction course, stone matrix asphalt, polymer modified asphalt) and (2) in challenging compaction situations (e.g., cool weather paving, thin lifts). In these situations, compaction, arguably the greatest determining factor in pavement performance.[2], can be difficult, leading to an increased risk of a poor performance. For instance, 1997 and 1999 late-season construction on SR 2 resulted in poor compaction, patching in year 2 and replacement in year 4 as compared to an expected life of near 10 years. A means to improve compaction in these situations would reduce the risk of poor performance. Sasobit, a Fisher-Tropsch wax from Sasol, Inc, is a warm mix asphalt (WMA) technology able to improve compaction by lowering HMA viscosity at typical HMA placement temperatures. It is relatively straightforward to use and may also reduce rutting potential, reduce HMA plant emissions and energy use. Other WMA technologies may prove equally advantageous. A feasibility study to determine the most promising WMA technology and its associated cost, energy savings, environmental impact and performance impact will allow WSDOT to make a rational decision on the use of WMA and its ability to reduce project risk.

RESEARCH OBJECTIVE

Determine the feasibility of WMA technology use and its potential for compaction quality improvement and associated project risk reduction. Sasobit appears to be the most promising technology, however Evotherm, Aspha-min and WAM Foam will also be investigated. This object of this research is to synthesize U.S. and international experience with WMA and determine the best product for compaction improvement and then assist in constructing a demonstration project.

GENERAL WORK PLAN

Stage 1: Literature review to recommend a best WMA technology and its best use in Washington.
Stage 2: Contractor and equipment manufacturer interviews to determine costs and equipment associated with WMA use and necessary steps (if any) to upgrade existing equipment.
Stage 3: Life-cycle analysis of WMA to determine its economic/environmental impacts.
Stage 4: Assist WSDOT in selecting a project on which to demonstrate WMA to improve compaction.
Stage 5: Assist WSDOT in writing a special provision on the use of WMA for this project.
Stage 6: Assist WSDOT in data gathering and processing for the project and produce a project report.

ESTIMATE PROBLEM FUNDING AND RESEARCH PERIOD

Recommended funding:	$80,000
Recommended research period:	24 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

The urgency is high since compaction is such a large determinant of pavement performance. The payoff would be a logical implementation of WMA with potential savings related to (1) better compaction, (2) reduced energy consumption and (3) reduced emissions. If results suggest

WMA use, implementation would be through specifications that would allow, under specific circumstances, WMA use for compaction improvement.

PERSON(S) DEVELOPING PROBLEM STATEMENT
Steve Muench, Assistant Professor, Civil and Environmental Engineering, University of Washington

RECOMMENDED PROBLEM MONITOR
Linda Pierce, Materials Laboratory

[1] The WSDOT Pavement Guide Interactive lists 7 different papers/studies that state this as part of their conclusions or investigations.

PROBLEM TITLE

Quantifying the Benefits of Durable Pavement Markings

RESEARCH PROBLEM STATEMENT

Why is this an issue for WSDOT? What is the problem?

Durable pavement markings are becoming more desirable because of their longer life cycle. However, accurate prediction of their service life is difficult across the wide range of applications where they may be used. Markings in mountain passes and other areas with frequent snow plow use are subject to degradation from that equipment. Service life may be influenced by the pavement surface on which these products are installed and the installation method used. There are more products on the market for durable pavement markings than there have been in the past. Some of these products have shorter curing times than others, which could provide some savings in traffic control. Some of the products can be applied in a broader range of temperatures, which offers more opportunity for installation. Surface preparation techniques such as grooves for product installation affects the service life of the striping, but increases overall installation costs. That cost increase may be offset by less frequent application. In addition, it would be very helpful to quantify the relationship between highly visible striping and its effect on collision experience. Traffic Engineers and Maintenance Personnel need some clear guidance on when and where use of these products is and is not appropriate.

There have been a couple of limited scope studies to address these issues, but more analysis is needed to develop more conclusive guidance on the benefits of durable pavement markings. A service life test of a variety of products on I-90 over Snoqualmie Pass recently reached the end of it's analysis period, and could serve as a baseline for this type of research. In addition, there are efforts underway to record the retroreflectivity of long line striping on the entire state highway network. This topic lends itself to a scalable research project, where the level of funding can yield different levels of study, all of which will advance the current knowledge base.

RESEARCH OBJECTIVE

How is research anticipated to contribute to a solution?

The objective of this research is to produce guidance for selection of durable pavement markings in a range of roadway and environmental conditions.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$35,000 - $80,000 depending on how much collision analysis is incorporated into the research
Research Period:	12 -18 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

What do you hope to gain from the research? How do you expect the research will be used?

This research is expected to lead to investment decisions that balance initial investment with service life and public safety. Traffic Engineers and Maintenance personnel will use this guidance to plan and manage their budgets and increase safety for motorists.

PERSON(S) DEVELOPING PROBLEM STATEMENT

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Harold White
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509-324-6550

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
Traffic, operations, Maintenance, construction.

RECOMMENDED PROBLEM MONITOR
Ed Lagergren (Traffic Office)

DATE
8/1/2006

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI STATE OR WASHINGTON ONLY IMPLICATIONS?
_X___ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Methodology for Identifying the Benefits of Interconnected Traffic Signals

PROBLEM STATEMENT
Why is this an issue for WSDOT? What is the problem?
Signalized intersections along highway corridors manage conflicting traffic movements and can reduce the more severe types of intersection related collisions. When closely spaced along a corridor, traffic signals may not be maximizing their effectiveness in managing congestion delay and congestion related accidents unless they are interconnected and closely coordinated. While it's generally understood that signal interconnection has benefits, the scale of those benefits has been difficult to quantify. That means that investment decisions must be made without a clear picture of the cost effectiveness. That may result in lost opportunities to partner with local agencies, because the return on investments is not predictable. A means to quantify those benefits for a Benefit/Cost analysis is needed to fully understand the value of investment in signal interconnection. Separate from the signal interconnection issue, there is a desire to independently evaluate the benefits of linking the interconnected signal systems to a traffic control center.
This analysis will likely use before and after studies to evaluate the benefits of signal timing investments. Previous work in this area indicates that there are benefits. More work is needed to expand on that experience and provide more conclusive results. Researchers should coordinate with WSDOT regional Traffic Office(s) to identify appropriate corridors for study.

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?
The objective of this research is to identify the benefits associated with interconnecting traffic signals. The congestion reduction benefits and the collision reduction benefits for an entire corridor need to be quantified. Similar impacts to side street traffic are needed. This research is expected to produce a guidance document for use in evaluating the benefits associated with interconnecting signal systems. The guidance document should address traffic volumes on the major and minor approaches, effectiveness with different signal spacing, and contrast corridors with minor intersections and signals in a grid systems such as couplets. An additional analysis of the value of integrating these systems into a traffic control center is highly desirable.

ESTIMATE PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$75,000
Research Period:	18 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?
This research is expected to yield cost effective decisions for future investments in traffic flow management. Congestion delay and congestion related collisions are expected to be minimized as a result of this research.

PERSON(S) DEVELOPING PROBLEM STATEMENT
Name, email address, and phone number.

Dave Olson
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OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
Traffic, Operations, Maintenance, Construction.

RECOMMENDED PROBLEM MONITOR
Mark Leth, (NW Region Traffic) or Ted Bailey (HQ Traffic Office)

DATE
9/20/2006

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI STATE OR WASHINGTON ONLY IMPLICATIONS?

_X___ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Integration of WSDOT's Emergency Operations Centers

RESEARCH PROBLEM STATEMENT
Why is this an issue for WSDOT? What is the problem?
During daily management of transportation incidents, a Region's Transportation Management Center (TMC) is the focal point for gathering and disseminating information. In the instance of a large scale multi-region incident, the affected region will activate their emergency operation center (EOC). The intent of managing an emergency is to not to have to deviate from normal daily operations to manage an emergency, only increase the number and amount of resources to mitigate the incident. When an emergency happens that requires the activation of the region, multiple regions, and the HQ EOC the normal flow of information from the field to the TMC needs to remain as normal as possible, but with the addition of getting information in and out of the EOC to support the additional resources. Currently there are different configurations for each region and the HQ EOC. The problem is this lack of standardization leads to a lack of all necessary processes to be either not accomplished or accomplished in a non-efficient manner. An example is that currently there is no one software solution that is used by all regions to manage the flow of information from the incident scene, to the TMC, and then to the various EOCs. Another non-standard issue is that each of the regions manages their EOC differently using position titles not concurrent with other EOCs either at the local community level or within WSDOT.

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?
The research will provide a solution to standardize the processes, equipment and functions of all the EOCs using an approach that accounts for the individualization of the regions so that they can retain their current identity, while still merging operations to be able to manage a multi-region or state-wide event. The research will identify the best practices that are available nationally from other state DOT's and response agencies for managing emergency events.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$100,000	estimated amount of funding
Research Period:	24 months	estimated length of time

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?
WSDOT needs to improve its coordination and communication capabilities in this new era of security and hazard awareness. This research will provide a good foundation of standardization from which to tailor an intra-agency process that is both embraced by agency personnel statewide and also achieves the coordinated response to situations that will occur. The results of this research will be used statewide and will assist WSDOT operations personnel in responding to natural or man made disasters in an effective manner.

PERSON(S) DEVELOPING PROBLEM STATEMENT
John Himmel, himmelj@wsdot.wa.gov, 360.705.7973

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
All WSDOT Regions and Headquarters Offices.

RECOMMENDED PROBLEM MONITOR
John Himmel, himmelj@wsdot.wa.gov, 360.705.7973

DATE

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI STATE OR WASHINGTON STATE ONLY IMPLICATIONS
____ National __X_ Regionalor Multi-state ____ Washington Only

PROBLEM TITLE
Transportation Video Surveillance Program

RESEARCH PROBLEM STATEMENT
Currently WSDOT uses about 1,500 CCTV surveillance cameras to monitor traffic in major transportation corridors throughout the state. The surveillance system is not staffed to be monitored 24 hours a day. WSDOT also does not employ personnel with the background, training or established protocols to observe activities captured through video surveillance that may have relevance to security or law enforcement concerns. .

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?
The research objective is to explore the use of surveillance software that will allow the CCTV camera system to be used to its fullest capability as an aide in security, law enforcement and emergency management operations. There is an emerging software technology called video analytics that sifts through streams of surveillance video, sending out alerts when it detects certain actions or situations. This capability would allow WSDOT to use the cameras to their fullest potential while also providing potentially critical information. For example, the application of software algorithms to scan surveillance video gathered by closed circuit television cameras could search for specific visual patterns −− such as a stopped vehicle in a tunnel when there is no traffic backup or slowdown when traffic should be moving, or a vehicle parked too long at a place where it shouldn't be. With the appropriate protocols in place, this information could be useful in early notification of danger. This research will field text the commercially available software and develop protocols for WSDOT officials during implementation of such systems.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$200,000	estimated amount of funding
Research Period:	24 months	estimated length of time

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?
With the continuing threat of potential attacks to the critical infrastructure concerning the transportation industry, we have already spent hundreds of thousands of dollars installing CCTV in identified vulnerable areas, but we have not taken the next step in being able to adequately monitor the surveillance being conducted. With a software program designed for the transportation industry, we will be able to effectively monitor the vulnerable critical infrastructure for the State's transportation system. In addition, agency protocols will be developed to analyze information and ascertain its relevance in a potential emergency situation.

PERSON(S) DEVELOPING PROBLEM STATEMENT
John Himmel, himmelj@wsdot.wa.gov, 360.705.7973

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
All WSDOT Regions and Headquarters Offices.

RECOMMENDED PROBLEM MONITOR
John Himmel, himmelj@wsdot.wa.gov, 360.705.7973

DATE

DOES THE PROJECT HAVE NATIOANL, REGIONAL/MULTI STATE OR WASHINGTON ONLY IMPLICATIONS?

_X_ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Speed perception of an oncoming object

RESEARCH PROBLEM STATEMENT
- How do we perceive the speed of an oncoming object?
- Is Intersection Sight Distance as important as visual contrast?
- Can we decrease collisions by improving visual clues and contrast at intersections?

AASHTO acknowledges that drivers use stationary objects to help determine the speed of an object:

AASHTO – Geometric Design of Highways and Streets, p 118
"Under most other conditions the operator must subconsciously associate the object ahead with stationary objects adjacent to the roadway, such as walls, fences, trees, poles, or bridges, to determine that the object is also stationary or moving at slow speed. These determinations take time, the amount of which varies considerably depending on the distance to the object, the acuity of the operator, the natural rapidity with which the driver reacts, atmospheric visibility, the type and the condition of the roadway, and the type, color, and condition of the hazard. Vehicle speed and the roadway environment probably also influence reaction time."

There is a lot of research on gap acceptance, most of it centers on the length of time that is necessary, on average, for a driver to complete a maneuver. From that we determine the sight distance necessary to provide the driver that amount of time.

However, people still misjudge gaps when sight distance is unlimited. I've found very little research on using how humans perceive the speed of an oncoming object to improve gap acceptance. For example, we know that children and older adults have trouble with speed perception, and we know that contrast sensitivity declines with age. At rail crossings, we need to consider that two objects approaching each other at a 45 degree angle appear to be stationary relative to each other, so providing sight distance isn't always a good thing. These concepts are not discussed in the WSDOT Design Manual except for Chapter 1025 Pedestrian Design Considerations, where they are briefly mentioned from the perspective of the pedestrian.

RESEARCH OBJECTIVE
Research should contribute how we can improve intersection design to account for known issues with sight.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$100,000
Research Period:	12 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
Updated design guidance, improved understanding of the complexity of gap acceptance
Improve intersection design through consideration of issues other than sight distance.

PERSON(S) DEVELOPING PROBLEM STATEMENT
Larry Frostad, frostal@wsdot.wa.gov 509-324-6194

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
Design

RECOMMENDED PROBLEM MONITOR
Larry Frostad

DATE
October 5, 2006

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI STATE OR WASHINGTON ONLY IMPLICATIONS?

__x_ National ____ Regionalor Multi-state ____ Washington Only

PROBLEM TITLE
Quantifying Incident-Induced Travel Delays on Freeways Using Traffic Sensor Data (Phase II)

RESEARCH PROBLEM STATEMENT
From a combination of recent studies and analytical work, it is estimated that more than 50% of freeway congestion results from incidents. Particular attention should be paid to travel delays caused by non-recurrent congestion due to the fact that non-recurrent congestion may be effectively alleviated by cost-effective solutions through traffic management, control, and incident response. Since the Washington State Department of Transportation (WSDOT) has accumulated a large amount of traffic sensor data and incident log data for freeways, quantifying the total travel delay associated with each major incident type becomes possible. The estimated travel delay induced by each type of incidents can help the WSDOT understand incident impacts on travel time, estimate incident cost, and identify effective countermeasures against non-recurrent congestion on freeways.

RESEARCH OBJECTIVE
Final objectives for this research are to develop a queuing-theory based algorithm for estimating incident-induced delay and a computerized system for automating the calculation process and predicating incident impacts on freeway travels in real time. There are two phases for this project. Phase I is currently in progress. A queuing-diagram based algorithm has been developed and implemented in a prototype system. Over 200 incident cases were applied to test the algorithm and favorable results were obtained from the tests. Compared to the widely used occupancy-based algorithm, the queuing-diagram based algorithm demonstrated several major advantages: (1) it can estimate incident-induced delay at recurrent congestion sites; (2) it is able to provide queue length information; and (3) it is adaptive to real-time traffic condition and therefore is robust to various applications.

However, incident data used for Phase I study were manually processed and small in size. This size of incident data was not large enough to cover desired analyses on incident impacts. Also, speed variations along a freeway segment were not considered in travel time calculation. This simplification introduces significant errors when traffic speed varies remarkably over the segment. Therefore, a systematic analysis on freeway incidents and an improved method for travel-time calculation are needed to make the queuing-diagram-based algorithm a reliable method for incident-induced delay estimation and the computerized system a practical tool for predicting incident impacts on freeway travels. Specifically, objectives for Phase II study include: (1) design an incident database for incident data management and quality control; (2) establish a knowledge base for real-time incident impact prediction; and (3) develop an improved travel-time calculation method by taking speed variations into account. At the end of this study, the following products will be delivered in addition to the research report: (1) a computerized system for analyzing incident induced delay and for predicting incident impacts on freeway travels; (2) an incident database in Microsoft SQL Server for efficient data management and inquiries; and (3) an incident-induced delay knowledge base for various types of incidents. All these deliverables are expected to assist freeway incident management and traffic operations.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$75,000
Research Period:	12 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
Incident-induced delays are important information for identifying incident-frequent locations and determining incident response strategies. The occupancy-based approach for incident-induced

delay estimation is not applicable to locations with recurrent congestion. A preliminary study at the University of Washington found that more than 50% of incidents on Seattle area freeways could not be detected by the occupancy-based approach. Also, because high occupancy level may correspond to conditions with many vehicles traveling at high speeds, incident-induced delays may be overestimated by the occupancy-based approach. The proposed queuing-diagram based approach can provide more accurate estimates for incident-induced delays and can be applied to sites with recurrent congestion. Therefore, findings of this study can help WSDOT quantify incident-induced delays, identify incident-prone locations, and optimize incident response strategies.

This project will deploy any applications developed. The incident database, the incident-induced delay knowledge base, and the computerized system for analyzing incident induced delay and for predicting incident impacts on freeway travels can be used by several agencies at the WSDOT, including the traffic office, traffic data office, regional offices, etc. The applications will be designed so there is minimal cost in deployment.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

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OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST

Traffic Data Office
Traffic Office
Regional Offices

RECOMMENDED TECHNICAL MONITOR

Ted Trepanier

DATE

October 16, 2006

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

__X__ **National** ____ **Regional** **or Multi-state** ____ **Washington Only**

PROJECT DELIVERY RAC

PROBLEM TITLE
Concrete Precast Segmental Continuous Post-Tensioned Box Girder bridges in Seismic Regions.

RESEARCH PROBLEM STATEMENT
Research is needed to define details for connecting individual segments of a concrete precast post-tensioned continuous box girder bridge.

RESEARCH OBJECTIVE
Work Plan
The research will perform a synthesis of this type of bridge built in other states and countries that are in high and moderate seismic zones. Testing of scale models with proposed details will also be conducted.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$100,000
Research Period:	2007-09 biennium

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
Results from the research will be used to determine if concrete precast continuous segmental box girder bridges should be constructed in the high and moderate seismic zones in Washington State.

PERSON(S) DEVELOPING PROBLEM STATEMENT
DeWayne Wilson

RECOMMENDED PROBLEM MONITOR
Bijan Khalegi

DATE AND SUBMITTED BY
October 2, 2006 Bridge and Structures Office

PROBLEM TITLE
Instrumentation and Analysis of the I-5 Toutle River Steel Tied Arch Bridges

RESEARCH PROBLEM STATEMENT
Instrumentation and analysis is needed to validate repairs completed to the I-5 Toutle River Tied Arch bridges. Initial research was completed on these bridges in 1998. A rehabilitation project was completed in 2004 to improve details on the bridge to resist further fatigue cracking. Validation of the 2004 repairs is needed to determine how well they are performing.

RESEARCH OBJECTIVE
Work Plan
The research will require adding instruments to the bridge to determine stress and strain amounts in order to see how effective the 2004 repairs are performing.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$150,000
Research Period:	2007-09 biennium

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
Results from the research will be used to determine if a the same repairs used on the I-5 Toutle River bridges should be used on other steel tied arch bridges constructed in Washington State.

PERSON(S) DEVELOPING PROBLEM STATEMENT
DeWayne Wilson

RECOMMENDED PROBLEM MONITOR
Bijan Khalegi / Amy Leland

DATE AND SUBMITTED BY
October 2, 2006 Bridge and Structures Office

PROBLEM STATEMENT
Construction and Performance of Reclaimed Asphalt Pavement (RAP) in Untreated Aggregate Base

RESEARCH PROBLEM STATEMENT
Other state DOT's have allowed the use of RAP to be blended with untreated aggregate base course materials to produce a composite base course material. The percentage of RAP may vary from 25 percent to as high as 100 percent. As more RAP material is incorporated into the base course material, concerns among specifying agencies include the impact on pavement design, the appropriate compaction requirements, and drainage characteristics, all of which may reduce the expected overall long-term performance of both flexible and rigid pavement structures.

RESEARCH OBJECTIVE
The objective of this proposed research is two fold:

The first is to recommend construction procedures for the testing and acceptance of RAP materials used as aggregate base materials. WSDOT currently has no procedures to accept and test RAP materials used for aggregate base. At least four procedures have been used in Washington; however, each has construction and testing limitations. These procedures include testing and acceptance by: (1) roller patterns, (2) modified rice density testing, (3) AASHTO T-180 modified proctor, (4) WSDOT T-606 maximum density. Each of these procedures as well as other testing and acceptance procedures by other agencies needs evaluation and recommendations are needed for use.

The second objective is to evaluate the performance of various base course materials (in Washington and other agencies) which have variable amounts of RAP content up to and including 100 percent RAP. This evaluation would concentrate on the long-term structural and drainage performance of these composite base course materials in relationship to their impacts on the overall performance of both flexible and rigid pavement structures. The findings of this research would be used to develop a proposed specification for the incorporation of RAP materials into untreated aggregate base course materials.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD
It is estimated that $120,000 would be required to support an 18 to 24 month research period.

URGENCY. PAYOFF POTENTIAL AND IMPLEMENTATION
The use of recycled materials in roadway construction continues to increase nationwide. The incorporation of RAP in HMA and base materials are also increasing and may result in substantial cost savings to a specifying agency. However, there may be a point where the incorporation of too much RAP into base course materials may degrade the overall structural performance of both flexible and rigid pavement structures.

Presently, little research is in progress that would allow for the development of a specification for the use of RAP materials in base course. This research would summarize the structural and drainage performance information in regards to long-term flexible and rigid pavement structural performance which ultimately could be used in the development the proposed specification for AASHTO review and eventual adoption. However, even before an AASHTO specification is developed, this research would provide the means for WSDOT to begin utilizing to the fullest extent possible the use of RAP aggregate bases.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

Jeff Uhlmeyer
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Washington State Department of Transportation
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PROBLEM MONITOR

Jeff Uhlmeyer
Pavement Design Engineer
Washington State Department of Transportation
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DATE AND SUBMITTED BY

October 5, 2006
Jeff Uhlmeyer

PROBLEM TITLE
Durability Concerns of Shotcrete

RESEARCH PROBLEM STATEMENT
Shotcrete Fascias walls, with carved architectural features, are structural earth retaining elements for the soldier pile and soil nail walls. This method of construction has become attractive in many States due to its inherent cost and construction time saving potential. This practice could possibly reduce the longevity of the walls due to lack of well consolidated, permeable concrete, and potential for rebar corrosion.

LITERATURE SUMMARY
There is currently no information available to evaluate durability and acceptance guides for shotcrete.

RESEARCH OBJECTIVE
The proposed research will investigate adequacy of consolidation, permeability, rebar corrosion, and quality verification test methods for field placed shotcrete.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$100,000
Research Period:	24 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
Many shotcrete fascia walls are being constructed in the States without any concerns given to the long term durability of this type of structure. Results of this research will provide assurances with respect to long term durability and acceptance guidelines in the field.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Mohammad Sheikhizadeh

OTHER OFFICES/STATES LIKELY TO HAVE INTEREST
All States/owners that employ shotcrete wall fascias can benefit from this research

RECOMMENDED PROBLEM MONITOR
Mohammad Sheikhizadeh

DATE AND SUBMITTED BY
September 18, 2006
Mohammad Sheikhizadeh

PROBLEM TITLE
Evaluate the use of Subsurface Utility Engineering (SUE) within the department and determine how to implement a comprehensive SUE program for use on transportation improvement projects to realize the documented return on investment SUE provides.

RESEARCH PROBLEM STATEMENT
The Northwest Region has requested that a research proposal be developed to investigate the department's use of SUE.
It is currently unclear if the department is effectively using the SUE process to identify and manage utility risk to the extent and benefit that national studies have documented. The consequences of not investing in SUE processes as an integral part of the project delivery process can be inferred from national studies. These consequences include:

- Increase in potential safety hazards
- Increased costs due to unforeseen utility conflicts
- Additional project delays and resultant change orders
- Strained relations and loss of credibility with utility owners
- Unnecessary traffic delays and congestion
- Increased project bids
- Increased loss of service to utility customers

Anecdotal evidence within the department would suggest we might be experiencing these consequences.

Subsurface Utility Engineering Defined
The SUE process involves identifying and managing risks associated with utility-related conflicts on transportation projects. All highways have utilities installed within or adjacent to the highway right of way. Many of these utilities are located underground and thus out of sight. SUE processes identify those unseen utilities thus enabling engineers to identify any conflicts they may cause to project designs. This information provides engineers and contractors with the ability to make proactive, information-based decisions. SUE also provides systematic methods for managing necessary utility relocations. Users of the SUE process include state personnel, specialized consultants, or a mixture of both, depending on the needs of the project and the extent of utility conflicts.

The SUE Process
The SUE process involves varying degrees of effort and information, depending on project needs, project location (urban or rural) and other factors. Generally, the SUE process includes:

- Locating utilities through various means, from simple document searches to physically exposing and locating utilities
- Mapping of discovered utilities at appropriate quality levels, or degrees of accuracy
- Knowing when and to what level to deploy SUE
- Determination of utility condition
- Clear communication of findings to appropriate parties
- Coordination with affected utilities
- Redesign and relocation coordination of project elements or affected utilities
- Relocation cost estimating as appropriate
- Implementation of utility accommodation policies
- Utility relocation management

Past Studies
Over the past decade, various state transportation agencies, universities, government agencies, and private interests have undertaken or commissioned research into the use of SUE. These studies clearly document significant benefits of a well-defined subsurface utility locating program. These studies show an increased savings in project schedule, bids, and project design when SUE is effectively used as an integral part of project development. According to the ASCE, which recognizes subsurface utility data collection as a distinct engineering discipline, "Inaccurate, incomplete, and/or out-of-date information on the existence and location of existing subsurface utilities reduces the engineers, owners, and contractors abilities to make informed decisions and to support risk management decisions regarding the projects impact on existing utilities.[3]" When properly and appropriately used, SUE data gives project owners the information necessary to evaluate risk and make responsible and informed decisions.

Cost Savings
In 1996, the FHWA commissioned Purdue University to conduct a study of 71 highway projects in Virginia, North Carolina, Texas, and Ohio. The targeted projects involved a mixture of interstate, arterial, and collector roads in both urban and rural settings. This study found a mean return on investment of $4.62 for each dollar invested in SUE activities.[4] Of the 71 projects studied, only three showed negative returns on SUE dollars invested in projects.

Many state transportation agencies, including Virginia, Ohio, Maryland, North Carolina, and Florida, have conducted studies regarding the use of SUE in highway improvement projects. One such study demonstrated that the appropriate use of SUE at various stages in the project delivery process returns as much as ten times the dollars invested in SUE process, particularly where there is utility congestion[5], such as in highly urbanized areas.

Cost savings and benefits from using SUE can vary. In Virginia, VDOT was able to avoid 80 percent of utility conflicts using SUE data. These conflicts would not have otherwise been discovered until construction efforts unearthed underground utilities, thus causing delays and increased project costs. By investing $93,553 to dig test holes, it was estimated the project avoided $731,425 in utility adjustments, resulting in a savings of $637,872. In Maryland, the Maryland State Highway Administration reduced utility impacts from 5,000 to 400 linear feet by redesigning a drainage system to avoid three different longitudinal utilities. The investment in SUE was $56,000. The resultant cost savings to the project was over $1.3 million.[3]

It is clear from research already conducted that, during a period of increased project delivery expectations and budgetary constraints, WSDOT cannot afford to ignore the documented return on investment the SUE process provides.

Current WSDOT Practices
The department is currently using SUE, but to what extent and how effectively is unknown as no data exists to measure and report upon SUE usage. The department currently requires utility plans in all contract documents. The level of accuracy of those plans is questionable. Subjective evidence indicates that many project personnel are using lower level SUE processes without any knowledge they are doing so. Others may be generally aware that SUE exists, but are not necessarily using the process correctly to realize its benefits. Whether they know they are using SUE or not, evidence would suggest that engineering personnel are not aware of how to use the

[3] *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data*, CI/ASCE 38-02, (Copyright 2003, ASCE)
[4] "Case Studies, Program Administration, SUE." FHWA. 5 July, 2006 <http://www.fhwa.dot.gov/programadnin/Case.htm>
[5] *Evaluation of an Emerging Market in Subsurface Utility Engineering*, Journal of Construction Engineering and Management, (ASCE March/April 2004)

information they have gathered effectively. There are no specific department policies or programs in existence that provide guidance or direct engineers on how properly use the SUE processes and how to measure utility related risks. The creation of a comprehensive SUE Program that includes specific guidance, training, and resources within WSDOT would allow the department to realize the documented benefits of SUE.

Expected WSDOT Savings
Based on previous study results, areas WSDOT can expect to see improvements include:

- Increased safety
- Reduction in unforeseen utility conflicts and relocations
- Reduction in project delays due to utility relocates
- Reduction in claims and change orders
- Lower project bids
- Reduction in costs caused by unforeseen conflict redesign
- Reduction in the cost of project design
- Reduced travel delays and disruptions during construction
- Increased WSDOT public credibility (increased efficiency)
- Improved contractor productivity and quality
- Reduction in utility companies cost to repair damaged facilities
- Minimize loss of service to utility customers
- Improved working relationships between department and utilities
- Facilitate population of GIS based utility as-built database
- Inducement of savings in risk management and insurance
- Reduction in right of way acquisition costs

RESEARCH OBJECTIVE

A. Determine how WSDOT is using subsurface utility engineering

1. Identify where (urban or rural), when and how SUE has been used within the department
2. Determine the level of utility detail gathered using SUE processes, the cost to obtain that information, how the information was used, and to what extent it benefited the project
3. Discover how many utility conflicts were identified and avoided using SUE processes
4. Identify how many unidentified utility conflicts were encountered during construction (nature and type) and what the effects of those unidentified conflicts were (project delays, staff utilization, change orders, subsequent costs, other)
5. Determine to what extent SUE has used been effectively and/or ineffectively, used and why
6. Identify are potential roadblocks to the implementation and use of a comprehensive SUE program within WSDOT

B. Determine if the manner in which the department is using SUE is realizing the full benefit of the process

1. Provide a benefit/cost analysis of the past use of SUE based in the findings in Section A above.

C. Determine how to implement a comprehensive SUE program within WSDOT

1. What steps need to be taken within the department to use SUE processes to effectively reduce utility related delays, project change orders, and reduce associated costs
2. Identify where appropriate additions or modification may be necessary within existing department guidance (i.e. Plans Preparation Manual, Utilities Manual, Design Manual, and Construction Manual)
3. Recommend strategies for implementation (written guidance, training, monitoring and reporting, etc.)
4. Other pertinent recommendations as identified during research

D. Potential study needs

Development of an electronic system for monitoring and reporting on subsurface utility engineering use, and resultant benefits, cost savings, or cost increases is vital to the success of the study. This system must be capable of subsequent transfer to full time use by WSDOT staff after the study is completed. This system will then allow the continuous tracking of SUE use within the department, serve as a data mart source, and track SUE savings in order to allow better and more comprehensive decision-making based on real data.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $250,000 to 350,000

Research Period: 24 months

Note: the FHWA may be a potential funding source for all or part of this research proposal, pursuant to 23 CFR 645.107(j)[6].

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

Based on study findings referenced within this proposal, the department's current capital improvement program will likely see substantial benefit to the immediate and effective use of subsurface engineering. The proposed research will (1) clarify what the department has been doing, (2) what it needs to be doing, (3) what roadblocks may be encountered in implementation of a comprehensive SUE program, and (4) how to implement such a program. The sooner a SUE program can be implemented, the sooner potential savings can be realized.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

Lee Hughes
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Washington State Department of Transportation
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OTHER OFFICES LIKELY TO HAVE INTEREST

The following offices may have an interest in either direct involvement or the outcome of this research: Design, Construction, Region Utilities, Bridge, Traffic/ITS, Hydraulics.

RECOMMENDED PROBLEM MONITOR
Nancy Boyd, Assistant State Design Engineer
Tom Swafford, Utilities, Railroad, and Agreements Manager

DATE
July 10, 2006

PROBLEM TITLE

Evaluate noise mitigation measures currently in use along highways to determine which options will provide the lowest cost while remaining aesthetically pleasing to the traveling public.

RESEARCH PROBLEM STATEMENT

HQ Design has requested that a research proposal be developed to investigate low cost and aesthetically pleasing noise abatement options.

From 2003 to 2005 noise mitigation costs have risen 58%. The increased average cost during this time span is do to an increase in the footing design to noise walls for seismic and wind resistance along with the inflation of construction materials such as concrete and steel.

Noise Mitigation Defined

Federal law and state policy require that every project that adds through-lanes or significantly realigns roadways must receive a noise evaluation. Outdoor noise impacts (66+ decibels) on locations like homes, schools, churches, day care centers, and hospitals trigger evaluation of whether noise mitigation (e.g., walls, earth berms) will be meaningful and cost-effective. The result is that WSDOT builds many noise barriers that generally halve residents' perception of traffic noise. From 1963 to 2000, we built approximately 65 miles of noise barriers throughout the state. From 2000 and into the future, we are building even more as a part of our construction projects in urban areas. The cost of noise barriers can vary based on the availability of right of way and the materials used.

Noise abatement costs typically include, but are not be limited to:

- ✓ Cost of barriers in place
- ✓ Excavation and embankment
- ✓ Right of way costs associated with noise barrier
- ✓ Concrete foundations and walls
- ✓ Clearing and grubbing
- ✓ Wall fascia treatments

One of the most effective methods of controlling traffic noise is to reduce the noise generated at the source. One means to accomplish this is to absorb the sound on or near the roadway. Alternative noise barrier designs and treatments have been successfully utilized in other states and throughout Europe for a number of years to address different performance needs. In some situations these designs allow for the initial construction of a noise wall to be lower in height than a traditional wall.

Also, retrofitting an existing wall with an innovative top section can reduce noise levels and eliminate the need for costly wall height increases or wall replacements. However, there is no comprehensive compilation of information on such traffic noise reduction products, materials, and technologies. This small budget project will survey the industry and search current literature to explore and document what is currently available.

Noise Mitigation Process

Highway noise is being attacked with a three-part strategy: motor vehicle control, land use control, and highway planning and design.

The responsibilities for implementing these strategies must be shared by all levels of government: Federal, State, and local. Often, local officials can most effectively solve specific noise problems in their areas, as demonstrated in the U.S. Environmental Protection Agency's (EPA) Quiet Community and Each Community Helps Others (ECHO) programs.

The first part of the strategy goes right to the source of traffic noise: the vehicles. For example, vehicles can be designed with enclosures for the engine; fans that turn off when not needed, and better mufflers. Quieter vehicles would bring about a substantial reduction in traffic noise along those roads and streets where no other corrective measures are possible. The EPA has issued regulations placing a limit on the noise which new trucks can make. In addition, many local and State governments have passed ordinances or laws requiring existing vehicles to be properly maintained and operated.

Unfortunately, due to limitations in technology, these EPA regulations for new trucks and State and local regulations for maintenance of vehicles can only partially reduce the noise created by traffic. The best that can be expected is a 5 to 10 dBA decrease in the noise level. Where this is insufficient, other measures must be used.

The second part of the strategy calls for the control of future development. Sometimes, complaints about highway traffic come from occupants of new homes built adjacent to an existing highway. Many of these highways were originally constructed through undeveloped lands. There are several hundred thousand miles of existing highways in this country bordered by vacant land which may some day be developed. Prudent land use control can help to prevent many future traffic noise problems in these areas. Such controls need not prohibit development, but rather can require reasonable distances between buildings and roads as well as "soundproofing" or other abatement measures to lessen noise disturbances. Many local governments are working on land use control.

The third part of the highway noise reduction strategy is highway planning and design. Early in the planning stages of most highway improvements, highway agencies do a noise study. The purpose of this study is to determine if the project will create any noise problems. First, the existing noise levels of a highway are measured or computed by models. Then, the agency predicts what the noise levels will be if the project is constructed. If the predicted noise levels are above Federal noise criteria, the noise study must consider measures that can be taken to lessen these adverse noise impacts. This information is reported at public meetings and hearings if they occur.

This research program will focus on the third part of the strategy.

Past Studies

In an effort to refine its guidelines for noise mitigation, the Texas Department of Transportation (DOT), in cooperation with the Texas Transportation Institute, conducted a national survey of highway-noise-barrier practices. Beverly B. Storey and Sally H. Godfrey discussed the results of the survey in "Highway Noise Barriers: 1994 Survey of Practice" (Transportation Research Record 1523). They concluded that transportation agencies could improve the perception and acceptance of noise control efforts if the public were given both more knowledge about noise barriers and a more active role in their design.

Current WSDOT Practices

The WSDOT will evaluate placing abatement for traffic noise from highways under two project types, Type I (new construction) and Type II (Retrofit).

Expected WSDOT Savings

The WSDOT can expect to see improvements include:

- ✓ Lower Construction cost
- ✓ Lower Design cost

RESEARCH OBJECTIVE

The object of this research is to evaluate various noise mitigation options using the following criteria: (1) cost effectiveness, (2) technology maturity, (3) durability, (4) low cost and convenience in installation, (5) low cost and convenience in maintenance and repair, and (6) aesthetics.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $80 to $100,000

Research Period: 12 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

Based on study findings referenced within this proposal, the department's current capital improvement program will likely see substantial benefit to the immediate and effective use of cost effective noise abatement. The proposed research will (1) clarify what the department has been doing, (2) what it needs to be doing, and (3) what roadblocks may be encountered. The sooner a cost effective solution to noise abatement can be implemented, the sooner potential savings can be realized.

The development and implementation of Type II projects are not mandatory requirements of U.S.C. 23 109(i) or 23 CFR 772. However, WSDOT maintains a prioritized retrofit list in order to provide greater traffic noise abatement as funding allows. Retrofit projects are prioritized in an order reflecting traffic noise levels, number of benefiting residences or residential equivalents, cost, and the achievable noise reductions. Qualifying neighborhoods must have been constructed prior to May 14, 1976 and meet noise impact criteria to qualify for an evaluation and be considered for placement on the retrofit list. Specific retrofit requirements are outlined in WSDOT Directive D22-22.

Sound level abatement for Type II projects are normally constructed in order of their priority but may be constructed out of priority as part of a Type I project, part of some other project, or as a result of legislative direction.

A Noise Abatement Criteria table identifies noise levels that are considered an impact on various land use activity categories. If a noise impact is identified as part of a Type I project or project resulting in substantial alteration of ground contours, further analysis of potential noise mitigation shall be studied following the procedures outlined in the WSDOT Traffic Noise Analysis and Abatement Policy and Procedures Manual.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

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OTHER OFFICES LIKELY TO HAVE INTEREST

The following offices may have an interest in either direct involvement or the outcome of this research: Design, Construction, Region Utilities, Bridge, Traffic/ITS, Hydraulics.

RECOMMENDED PROBLEM MONITOR

Ken Smith, Deputy State Design Engineer

DATE

August 1, 2006

PROBLEM TITLE
A Synthesis of Criteria and Methods for Anchoring Precast Concrete Barrier

RESEARCH PROBLEM STATEMENT
Precast concrete barrier is used frequently along Washington roadways to shield roadside hazards. When struck, the barrier frequently slides a few feet, until the mass of the adjoining segments resists further movement. Under crash test conditions, the amount of sliding is approximately three feet. There are many instances where pre cast barrier is used and three feet or more of slide distance cannot be tolerated. In these situations the concerns with sliding are usually related to protection of personnel, equipment or materials in a work zone, or preventing the barrier from toppling over a steep slope or drop-off. To prevent or minimize sliding the barrier must be anchored to make it more rigid. WSDOT has two basic designs for anchoring concrete barrier. WSDOT designs for differentiate between anchoring to concrete and asphalt pavements. Although these designs have been used for a number of years there hasn't been much effort to evaluate the state of the practice to determine if more efficient designs are available. The current designs do present some concerns about their use.
The design for concrete pavements is often used where barrier needs to be anchored to a bridge deck, and includes brackets at the base of the barrier that are bolted into the bridge deck. Drilling bolt holes into the deck is a concern for the bridge designers, who want to ensure that the reinforcing steel is not compromised in the process. A design with fewer bolt holes or shallower bolt holes is of interest.
The design used for hot mix asphalt pavements uses steel pins driven through the lower face of the barrier into the underlying pavement. The pins are angled into the pavement and require holes drilled through the barrier or casting holes during the manufacturing process. This design does present problems when barrier realignment is required. The pins are difficult to extract and they may break out some of the pavement on impact, particularly when placed close to the edge of pavement.
There is also a need to collect information on when an anchored precast barrier system is used, and how much of the barrier system is anchored.

RESEARCH OBJECTIVE
The objective of this research is to conduct a literature search and a survey of other states to find out what criteria are used to determine when an anchored precast barrier should be used, and what methods are used to anchor the barrier in a range of conditions. The survey should also collect information regarding crash testing of the design, and any performance and maintenance issues associated with the designs. A point of contact will be identified for each state or other entity that responds to the survey. The information gathered will be presented in a synthesis report.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $35,000

Research Period: 9 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
A synthesis project is expected to identify other conditions where barrier anchorage is recommended, and methods of barrier anchorage in use around the country. This information would provide some insight into other designs that may overcome some of the shortcoming and limitations of WSDOT's current designs. The findings may identify one or more designs that could

be put into use by WSDOT. Alternatively, the findings may reveal that there is a nation-wide need to develop more effective anchorage methods. **PERSON(S) DEVELOPING PROBLEM STATEMENT**

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OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST

Traffic, Operations, Maintenance

RECOMMENDED PROBLEM MONITOR

Rod Erickson
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DATE

9/25/2006

DOES THE PROJECT HAVE NATIONAL, REGIONA/MULTI STATE OR WASHINGTON ONLY IMPLICATIONS

_X___ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Development of Archaeological Deep Testing Protocols for Washington State

RESEARCH PROBLEM STATEMENT
Locating deeply buried archaeological sites* without any surface visibility can be problematic. There are several examples of buried archaeological sites in Washington initially identified during construction projects, after the project area was assessed for cultural resources. The most recent and notorious example is Tse-Whit-Zen village discovered during construction of the Graving Dock at Port Angeles, where WSDOT spent approximately $87 million before abandoning the site; continued expenses have driven costs to more than $105 million. The State has suffered politically and economically, and the scientific and spiritual losses associated with the archaeological site are immeasurable.

The WSDOT now recognizes the need for a more proactive approach in project development toward identifying and protecting cultural resources in compliance with federal (Section 106 of the National Historic Preservation Act) and state (Executive Order 05-05; RCW 27.44 and 27.54) laws. The Agency has a greater awareness about historic preservation needs and goals, and has a greater commitment (both financial and planning/review) to identifying cultural resources in project areas earlier in the development process.

The WSDOT now needs to develop sophisticated testing methods focused on geology/geomorphology to identify deeply buried archaeological sites that occur more deeply than conventional techniques are able to detect, and that tend to become very costly to treat during construction phase of projects.

RESEARCH OBJECTIVE
This proposed project seeks to develop a protocol based on geophysical remote sensing and ground-truthing excavation as a means to identify deeply buried archaeological resources in Washington. Development of a comprehensive geology-based landform model will facilitate early phase identification of deeply buried archaeological resources, which in turn will benefit assessments related to archaeological preservation and result in a vast cost savings for the Agency.

The Keystone Ferry Terminal Project is selected as the research location for assessing the efficacy of remote sensing techniques central to deep testing protocols. WSF project areas tend to have always been attractive places to live and to acquire natural resources, both for historic- and prehistoric-period peoples of the Puget Sound. These places thus have a high probability for archaeological resources. Such landforms also tend to accumulate sediments relatively rapidly, and archaeological sites can become deeply buried by geological processes such as coseismic subsidence, floodplain and river delta aggregation, dune accretion, and relative sea level rise.

The Keystone Project has identified five alternative project areas that vary in topographic and geomorphologic settings. This variation presents an ideal situation to test the efficiency of different remote sensing techniques, such as magnetic, electrical resistivity, seismic, and ground-penetrating radar, under differing landform and depositional settings. Anomalies detected and mapped with remote sensing equipment then will be investigated by ground-truthing with a backhoe or crane excavator. Successful detections of cultural materials and features will be used to formulate the most effective protocols for different geomorphologic conditions and settings. Results will have broad applicability to WSDOT projects.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $500,000 (cannot realistically be done without $300,000 due to expenses associated with remote sensing equipment and data processing)

Research Period: 18 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION

The research seeks to produce an effective investigation protocol for detecting deeply buried archaeological sites. Early detection will benefit historic preservation efforts and assist project planning and development. Successful application of deep testing protocols has the potential to save State taxpayers millions of dollars and to foster harmonious political, economical, and social interactions between the State and the many American Indian Tribes that inhabit areas within the state. In addition, continued development of deep-site testing protocols is a recommendation in the JLARC report, Review of Port Angeles Graving Dock Project (Report 06-8, June 30, 2006).

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

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OTHER OFFICES LIKELY TO HAVE INTEREST

Washington State Ferries, Environmental
SR 520 Floating Bridge and HOV Project, Special Projects Construction Site
SR 99 Alaskan Way Viaduct and Seawall Replacement Project
Department of Archaeology and Historic Preservation

RECOMMENDED PROBLEM MONITOR

Recommend a committee formed of WSDOT/WSF archaeologists of Cultural Resources Program and Region Staff, chaired by Program Manager

Ken Juell, Archaeologist, Urban Corridors Office
Trent deBoer, Archaeologist, ESO
Garth Baldwin, Archaeologist, Highways and Local Programs
Barbara Bundy, Archaeologist, ESO and WSF
Sandie Turner, CR Program Manager, ESO

DATE

October 2, 2006

*a site is considered “deeply buried” if found below the maximum practical extent of a archaeological test pit excavated with a shovel (approximately 32 to 40 inches)

PROBLEM TITLE
Sensitivity Analysis of $PM_{2.5}$ Dispersion Using Existing Modeling Tools

RESEARCH PROBLEM STATEMENT
EPA has put forth new regulations for small particulate matter (Particulate Matter 2.5 microns and less in size, e.g. diesel soot), but currently there are no models that exist for PM 2.5. There are some dispersion tools currently available that model the dispersion of other air pollutants such as CO. These models might be able to be modified to be used for PM 2.5 dispersion modeling. However, a sensitivity analysis would need to be done comparing the various models to determine which would give the best results.

RESEARCH OBJECTIVE
Research on this problem would provide us with a model that WSDOT as well as other states could use to model PM 2.5. This research would explore the following:
Mobile 6.2 model – What inputs to this model are most sensitive to create PM 2.5 emissions changes?
Dispersion models (Cal3qhc, Caline, ISC3, Aermod, Calpuff) – Are any of these tools accurate enough when compared with monitoring data to predict PM 2.5 emissions in the future?

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$100,000
Research Period:	12 months

URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION
In our world driven more strongly by quantitative instead of qualitative analysis, the ability to use known models sooner means that we can create early screening techniques to reduce impacts on project timing and budgets. Waiting until PM2.5 designations (or later) would slow down our ability to work quickly with projects. As a co-benefit, this will also help as we evaluate mobile source air toxic emissions for more projects. PM2.5 many times can be a surrogate for diesel particulate matter. Thus, we can integrate better screening techniques for the diesel portion of MSATs as well.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Jim Laughlin / Mia Waters

OTHER OFFICES LIKELY TO HAVE INTEREST
Urban Corridors Office (UCO)
Olympic Region
Northwest Region
South Central Region
Southwest Region

RECOMMENDED MONITOR
Mia Waters

DATE
10/2/06
PROBLEM TITLE
Establishing water level recurrence values for Washington State Ferries terminal facility locations

RESEARCH STATEMENT

Determination of normal and extreme water levels, both high and low, in Puget Sound and vicinity is critical for design of ferry terminal facilities. Water levels in our region vary in response to predictable astronomical tides, but are also influenced by other factors such as storms, El Niño/La Niña events, the Pacific decadal oscillation and local long-term relative sea level change. There is no policy in Terminal Engineering on determining the appropriate water level range to use when designing ferry terminal facilities. Currently, each project manager or designer decides the range for a particular project. If the range is too narrow, it is possible to end up with terminals that cannot accommodate the vessels under all water level conditions. If the range is too broad, the terminals can be over-designed, needlessly increasing cost and/or design complexity. Water level recurrence interval estimates would provide WSF a scientific approach to determining the correct water levels that are expected during the design life of the facility. They depict the return interval of selected high and low water levels based on the more than 100 years of water level measurements made in the Port of Seattle. This would allow WSF to optimize terminal facility designs and more accurately assess ADA requirements and compliance. Water level recurrence estimates would be constructed for each WSF terminal facility location and would be used to determine the correct design water level range.

RESEARCH OBJECTIVE

The development of water level recurrence estimates will provide a scientific basis for determining design elevation ranges for WSF terminal facilities. This will allow the facility designs to be optimized ensuring the ability to accommodate extreme high and low ranges without needlessly increasing cost or complexity. The charts will also be used to more accurately determine terminal design requirements for ADA compliance.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$70,000
Research Period:	6 months

URGENCY, PAYOFF POTENTIAL, IMPLEMENTATION

The research will provide water level recurrence estimates for all WSF terminal facility locations. These estimates will be immediately used in the design of new WSF terminal facilities. The recurrence estimates will also be used to analyze and design for ADA compliance of the terminals.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

Naomi Sandberg, P.E., Marine Mechanical Engineer, Washington State Ferries
Martin C. Miller, Ph.D., Pacific Northwest National Laboratory

OTHER OFFICES LIKELY TO HAVE INTEREST

WSF Vessel Engineering
WSF Operations

RECOMMENDED PROBLEM MONITOR

Naomi Sandberg

DATE August 16, 2006

PROBLEM TITLE

Investigation of Permeable Pavement Use on Over Water Structures

RESEARCH PROBLEM STATEMENT

Over-water Structures (OWS) such as ferry docks, vehicle waiting-areas, ferry loading-ramps, bridges, and floating bridges are unique stormwater source areas. Roads, highways, and other transportation facilities (e.g. highway or ferry maintenance yards) located adjacent to nearshore areas are also problematic with respect to stormwater. Environmental regulations require that stormwater runoff from OWS and nearshore areas must be treated prior to discharge to receiving waters. Treatment of stormwater generated in this unique environment is a difficult task mainly because the minimal space available for treatment limits treatment options and in many cases precludes conventional (end-of-pipe) treatment methods. Research on permeable pavement used in parking lots and roads indicates that it is a cost-effective alternative to traditional impervious pavement materials.

RESEARCH OBJECTIVE

This research project would be designed to determine the feasibility and effectiveness of using permeable pavement materials for stormwater treatment on OWS. The results of this study would provide managers with the information necessary to make decisions as to the applicability of this stormwater treatment approach to other WSDOT-WSF facilities. The components of this study include the following:

1. Field and laboratory testing of permeable asphalt and/or permeable concrete as a stormwater treatment technique for OWS.
2. Field and laboratory testing of permeable asphalt and/or permeable concrete for structural integrity when used in OWS.
3. Evaluation of operational and maintenance (O&M) requirements for permeable pavement when used for OWS.

Questions that could be addressed by this proposal include:

- Can permeable pavement be used on OWS to protect water quality (WQ) of receiving waters located directly under and adjacent to the OWS?
- What pre-treatment (e.g. microbial) will be required to facilitate the use of permeable pavement as a WQ treatment technique for OWS?
- What O&M issues need to be addressed to utilize this approach?

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

This research can be broken into two phases; a laboratory phase and a field test phase. The estimated cost associated with each phase is as follows.

Phase I – laboratory phase: This initial phase would include a literature review, design and construction of bench-scale permeable pavement test platforms, and lab testing of the platforms. These tests would evaluate whether desired changes in water quality could be achieved as (simulated) stormwater passed through the platforms. A limited number of platform design and performance parameters (e.g., thickness, layering, infiltration rates) would be explored. The tests would not be of sufficient duration to evaluate long-term performance (in particular, the potential for plugging of the platforms). This phase could be completed by a graduate student with oversight from university faculty in a one-year time frame.

Phase I Funding - $110,000

Phase II – Field phase: This second phase would include the installation of field-scale permeable pavement test platforms based on findings of the laboratory tests. It would also include stormwater sampling to determine the effectiveness of the pavement. This phase would require

additional personnel and incur greater laboratory costs. It should last through at least two stormwater seasons. Allowing for implementation time before data collection and analysis and data interpretation afterward, and depending on the timing of the project startup, this phase will require a minimum of 24 months; a 30-month duration is probably more realistic.
Phase II Funding - $300,000 to $375,000 (24 to 30-month duration)

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
The potential for cost reduction is high if permeable pavement is shown to be effective as a stormwater treatment technique for OWS and in locations where there is limited space for conventional BMP placement. Partnering opportunities are significant both in Washington and nationwide since most highly urbanized municipalities would benefit from the findings of this research.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Ellie Ziegler
WSF

Mark Benjamin and Richard Horner
UW

Chris May
Battelle (PNL)

OTHER OFFICES LIKELY TO HAVE INTEREST

WSDOT Stormwater Research Office

WSDOT Urban Corridors Office

WSDOT Bridge Office

RECOMMENDED PROBLEM MONITOR
Ellie Ziegler
WSF

DATE
September 27, 2006

PROBLEM TITLE:
Soil Property Correlations with Field Test Results for Common Geologic Units in WA

RESEARCH PROBLEM STATEMENT
Most soil property correlations used by the WSDOT Geotechnical Division for design are based on data obtained in other areas of the US or the world, and are not specific to the geologic units typically encountered in WA. Having more accurate property correlations, such as, for example, consolidation properties, shear strength, and permeability, would be useful for preliminary design, emergency situations when there is not time to get lab testing performed, and even final design if adequate undisturbed samples could not be obtained. Such information would also be useful to evaluate the accuracy of geotechnical property selection by contractors for shoring design, as well as property selection by consultants used in both design-bid-build and design-build contracts. For landslide analysis, these correlations could help in property selection for back-analysis purposes to characterize the slide and select design properties.

RESEARCH OBJECTIVE
Over the years, WSDOT has performed laboratory testing on soils from all over the state. The objective of this research would be to gather the soil test results contained within our files and create a database to store the data and to have a place to put new data as it becomes available. The data would also be analyzed and compared to in-situ test data to develop property correlations specific to State of Washington subsurface conditions. Statistical variation of the property for a specific geologic unit could also be assessed, which would be useful for application to Load and Resistance Factor Design (LRFD). The correlations would then be published in the WSDOT Geotechnical Design Manual to implement the results.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $80,000

Research Period: 12 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
As WSDOT moves to the use of more consultants and design-build projects due to the growth of the WSDOT construction program, the availability of these correlations will be useful for assessing the quality of the geotechnical design property selection process, and may also help to reduce the amount of soil testing needed. For foundation and wall designs in some geologic units, reduced construction costs may be realized as the data can be used to increase consultant and WSDOT staff confidence in using more aggressive geotechnical design parameters.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Tony Allen, WSDOT State Geotechnical Engineer, (360) 709-5450

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST

RECOMMENDED TECHNICAL MONITOR
Tony Allen, State Geotechnical Engineer, 360/709-5450

DATE

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

___ National ____ Regional or Multi-state _X_ Washington Only

PROBLEM TITLE
Influence of Local Zoning on Right of Way acquisition costs

RESEARCH PROBLEM STATEMENT
Local zoning changes can be initiated by local jurisdictions at any time prior to, during or after a transportation improvement thus affecting the cost of right of way acquisition. Transportation improvements also influence how land use is zoned. This interrelationship is compounded by real estate market forces. The theoretical and empirical literature on the interrelationships between zoning, transportation projects and real estate values does not exist.

RESEARCH OBJECTIVE
The objective of this research is to develop a model that estimates the effects of transportation projects, zoning practices and real estate markets on right of way acquisition costs.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$	50,000
Research Period:		12 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
The results of this research will be used by the WSDOT Real Estate Office to improve cost estimating for right of way acquisition.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Gerry Gallinger, WSDOT Real Estate Services Manager

OTHER OFFICES LIKELY TO HAVE INTEREST
Project Programming (CVEP)
WSDOT Regions

RECOMMENDED PROBLEM MONITOR
Gerry Gallinger

DATE
October 2, 2006

MULTIMODAL RAC

PROBLEM TITLE
Managing Bicyclist and Pedestrian Safety

RESEARCH PROBLEM STATEMENT
Why is this an issue for WSDOT? What is the problem?

More than a quarter of the vehicle-pedestrian collisions in Washington State are not on city streets, where travel on foot is expected, but on state roads that are typically considered regional or trans-regional facilities designed for moving traffic. Furthermore, societal costs associated with collisions on Washington State Routes are disproportionately high, with more than 50% of the state pedestrian fatalities occurring on these facilities.

For the first time in several years, collisions involving pedestrians and bicyclists have increased this year both nationally and in this State.[7] While the reasons for this increase are unclear, this alarming trend is likely to continue as the population continues to grow in urban and suburban areas and more people will use transit and non-motorized modes to travel, thereby increasing people's exposure to traffic.

WSDOT now has some of the best data on pedestrian and bicyclist collisions in the nation for all age categories including students and other at risk population groups. All collisions have been geocoded for the entire state, starting in 1999 and continuing to date. These data provide the basis for structuring a systematic and complete approach to monitor trends and prioritize programs that insuring the safety of non-motorized travelers through local and state level programs. The data also promise to identify new approaches to safety that are both preventive and proactive.

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?

This project will focus on collisions involving bicyclists for the first time and look more specifically at known factors with significant relationships to pedestrian collision locations to:

- Develop objective and measurable criteria to identify locations where collisions have been most frequent and/or most severe, using this information to prioritize safety programs and countermeasures
- Analyze the factors most strongly and significantly associated with collision frequency and severity—the factors include road types and design characteristics, traffic and transit conditions, as well as activities and land uses that generate non-motorized travel. These analyses will establish a scientifically sound quantitative approach to planning and implementing safe facilities. They will be the foundation for a proactive approach to safety, or one where the risk of collision can be calculated and special measures can be taken BEFORE collisions occur.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

[7] The number of pedestrian fatalities increased to 4,881 in 2005 from 4,675 in 2004. NHTSA is investigating this year's increase in pedestrian fatalities to determine the causes http://trb.org/news/blurb_detail.asp?id=6658

Recommended Funding: $ 60,000- 90,000 (to match TransNow)

Research Period: 15-18 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?
This research can be put to immediate use in prioritizing projects funded through the state's Pedestrian and Bicycle Safety Grant Program and Pedestrian Risk Program. The outcome of this research can also be used to update WSDOT design guidance. This project would leverage resources already allocated by TransNow and the University of Washington's Urban Design Program. TransNow determined this project to be of importance to other states as well as Washington.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Dr. Anne Vernez Moudon and Paula Reeves

OTHER OFFICES LIKELY TO HAVE INTEREST
Traffic and Design

RECOMMENDED PROBLEM MONITOR
Paula Reeves

LITERATURE SEARCH SUMMARY
Most research studies and programs in this area focus on pedestrian crash characteristics, measures of
Pedestrian and bicyclist exposure and hazard, and specific roadway features and their effects on pedestrian and bicyclist safety. For a complete synthesis of current research view the recent FHWA publication at <http://www.bicyclinginfo.org/pdf/PedSynth/Ped_Synthesis_Report.pdf>.

In otherwords, most research related to pedestrian and bicycle safety is reactive in nature. This proposal takes the next logical step by evaluating elements of the built environment and other contributing factors and circumstances to develop predictive models.

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

__X__ National __X__ Regional or Multi-state __X__ Washington Only

This research may be of interest nationally, but it will be focused specifically on the needs of Washington state.

PROBLEM TITLE
"Washington State Ferry (WSF) Passenger Demand and Lost Revenue Analysis"

RESEARCH PROBLEM STATEMENT
Given the current WSF fare collection design of collecting payment for westbound passengers departing from east Puget Sound terminals the potential exists for significant lost revenue (tariffs) when walk on passengers traveling from West Puget Sound to East Puget Sound find alternative transportation back to the West Puget Sound. The existing WSF payments are collected as follows:

- Walk on passengers pay a round trip toll at the Fauntleroy, Seattle, Edmonds terminals located on the east side of Puget Sound for ferry passage to Southworth, Bremerton, Bainbridge Island, and Kingston located on the west side of the Sound.

- Walk on passengers from the West Puget Sound terminals traveling to Seattle or other ports on the East side of the Puget Sound do not pay a toll. They therefore have an opportunity to ride a ferry to work, for example, and then take a transit bus or share a ride home from the east side of the Puget Sound without paying for ferry passage.

- Additionally, the upcoming Narrows Bridge toll collection will occur on the eastern side of the Sound. This location of toll collection supports the ability for no revenue collected by any WSDOT facility for passage on the Narrows Bridge or ferries for those passengers traveling via ferry in the morning and driving home at night.

RESEARCH OBJECTIVE: HOW IS RESEARCH ANTICIPATED TO CONTRIBUTE TO A SOLUTION?
WSU Faculty Researchers (Jessup and Yoder) will develop estimated passenger travel demand, by route and station that will allow evaluation of potential revenue loss due to the problem described above. This analysis will address the level of need for policy options to modify/improve collection efficiency in order to ensure all WSF service is provided to paying customers.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$80,000
Research Period:	10-12 months

PAYOFF POTENTIAL: WHAT DO YOU HOPE TO GAIN FROM THE RESEARCH – HOW DO YOU EXPECT RESEARCH TO BE USED?
The end result of this research will be significantly improved information regarding passenger travel demand behavior as it relates to utilization of Washington State Ferries. This will translate into improved management and operational efficiency of the Washington State Ferry system, leading to improved service. WSF is a steward of Washington State ferry revenue generated by ferry service. WSF intends to ensure all revenue due for service is paid and reported to legislature.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Melissa Johnson
Johnson@wsdot.wa.gov
206-515-3426

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
Academic researchers interested in travel demand analysis and transportation policy makers concerned with maximizing both transportation service and operational efficiency. Also, other WSDOT planning agencies, especially those related to the operational success of the Tacoma Narrows Bridge.

RECOMMENDED PROBLEM MONITOR

DATE

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

____ National ___ Regional or Multi-state __X_ Washington Only

PROBLEM TITLE
Financial and Operating Impacts to Washington Transit Systems From Aging Baby Boomers

RESEARCH PROBLEM STATEMENT
The demographic of Washington will be significantly changed over the next 30 years by the aging of the baby boomer generation. This could have significant impact on the ridership of both fixed-route and paratransit services. Transit agencies will be better able to plan service if they have a realistic picture of what to expect in terms of demand for services. What will be the ridership characteristics and what modifications to vehicles and facilities will be expected?

RESEARCH OBJECTIVE
To provide transit planners and directors with information to help them make long range plans for budgets and the provision of service to their community.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD
Recommended Funding: $200,000.
Research Period: 18 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
This is not urgent but will become more so every year. The payoff potential will be great as all transit agencies can use the information to improve long range planning without unnecessary duplication of effort. Agencies will be able to use the information immediately when it becomes available.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Park Woodworth, park.woodworth@metrokc.gov 206.263.4494

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST

RECOMMENDED TECHNICAL MONITOR
Robin Phillips, PTO

LITERATURE SEARCH SUMMARY
Substantial literature is available for this project. A Google search of “baby boomer” and “aging” produced 653,000 hits. A literature review should be the first step for the contractor.

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

__X__ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Off site Ferry queuing

RESEARCH PROBLEM STATEMENT
Why is this an issue for WSDOT? What is the problem?
WSF grapples with the issue of effective queuing at ferry terminals. In every community with a ferry terminal there is significant queuing area and impact to surrounding land uses by ferry auto riders waiting for the ferry. Is it possible to have off site queuing that allows ferry auto riders to get to the ferry site from an off site location thereby freeing up land for other land uses or to reduce the impact on existing properties in the immediate vicinity of the ferry terminal? What technologies would make off-site queuing possible? When is off site-queuing possible and when is it impractical or technologically infeasible?

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?
Finding appropriate technologies to allow for off-site ferry queuing will give WSF and other governments options that they presently do not have with regard to queuing space for ferry terminal expansion and addressing ferry auto riders impacts to adjoining land uses.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$ 90,000	estimated amount of funding
Research Period:	12 months	estimated length of time

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?
If effective technologies and strategies can be identified, implementation can be almost immediate as WSF and others implement ferry terminal upgrades and expansion.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Kirk Vinish, Lummi Nation, 2828 Kwina Road, Bellingham, WA 98226. 360-384-2307

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
WSF

RECOMMENDED TECHNICAL MONITOR

LITERATURE SEARCH SUMMARY
Review publications through the Transportation Research Information Services (TRIS) at http://trisonline.bts.gov/sundev/search.cfm and Research in Progress (RIP) at http://rip.trb.org to see if there is related work or additional information to support the project. The WSDOT Library is available to assist in this review

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE OR WASHINGTON ONLY IMPLICATIONS?

____ National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE

Impacts of school sitting, context, and regulations on travel to school.

RESEARCH PROBLEM STATEMENT

Schools are significant trip generators during morning and afternoon peak periods. Growing awareness of school related traffic congestion, the low level of youth walking or biking to school, and increasing levels of childhood obesity and type II diabetes, has resulted in the federally funded, Safe Routes to School program. However, little is known about how the built environment and various transportation investments and incentives, impact youth and adult travel behavior at schools. This research project will identify how school siting, context, and various policies and regulations impact travel to and from school. A discrete choice modeling framework will be applied to isolate the effect of school site land use, shortest path route, sidewalk characteristics, ride share and transit availability and residential land use patterns independently and interactively have on travel to school. A multi-level hierarchical modeling framework will be used to address interactions between multiple students attending the same school sites. Particular attention will be placed on stratifying analyses based on age of youth and distance between home and school – two factors found to be critical in the evaluation of travel patterns to school.

This application leverages investments already made in a land use, travel, air quality database developed as part of the WSDOT funded, "Travel Behavior, Emissions, & Land Use Correlation Analysis in the Central Puget Sound." This application responds directly to WSDOT's own initiative and interest in this issue and further leverages the methods and analysis tools used to evaluate travel to schools in Atlanta, Georgia. It also builds upon the King County funded LUTAQH study which provides vehicle emissions data and a Canada Mortgage and Housing Corporation study providing detailed and updated sidewalk data for residents in the Cities of Seattle, Bellevue, and Redmond and in the Kent East Hill, White Center, Auburn Center, and Sammamish communities.

Taken collectively, the proposed application is highly cost effective and work actually begins with one of the most comprehensive set of environmental, urban form (land use and pedestrian environment), and travel data available in the United States on youth travel to school. The proposed study design will evaluate how different land use patterns in the vicinity of schools, how the transportation infrastructure and services in place, and how household and neighborhood demographics impact travel to school for students, faculty and staff. Where available, crash data, school bus and transit route data, and school related transportation programs will be integrated into the proposed analysis.

RESEARCH OBJECTIVE

How is research anticipated to contribute to a solution?

The two primary aims of the proposed study are:

- To determine the impacts of school siting, transportation infrastructure and services, and context on travel to school.
- To provide information about the potential effectiveness of investments/programs, regulations and policies on travel to school.

Additional products of the research will be vehicle emissions benefits of decreased use of the private automobile for school travel. These evidence based recommendations will provide WSDOT, school boards, and local governments information that can be applied directly to current decisions about transportation and land use around school sites. Results will feed directly into the work that is currently underway in the region as part of the King County LUTAQH phase II study which includes WSDOT, local government, developers, lenders, and other constituents; and at the national level through a comparative evaluation between land use, pedestrian environments (e.g.

sidewalks, crossings), youth travel patterns and household vehicle emissions in a contrasting region of the U.S.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding: $150,000 to $200,000

Research Period: 18 months

Preliminary findings will be made available at six months.

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION

What do you hope to gain from the research? How do you expect the research will be used?
Understanding factors impacting youth and adult travel to school is a state and national priority. This research leverages several efforts already underway totaling over $500,000 in investments. The research creates an evidence base on factors that impact youth and adult school related travel. The proposed study provides a unique approach for WSDOT to integrate several studies already underway and establish new evidence directly relevant in the Central Puget Sound region on this topic of growing national importance. Implementation efforts will require thoughtful and targeted approaches to dissemination of study results to key decision makers that influence regional and local transportation investment priorities, land use policies and development regulations, and school boards.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT

Dr. Lawrence D. Frank, Paula Reeves, Charlotte Claybrooke and
Keith Cotton

OTHER OFFICES LIKELY TO HAVE INTEREST

Traffic, Commute Options, and Design

RECOMMENDED PROBLEM MONITOR

Charlotte Claybrooke

DATE

October 11, 2006

PROBLEM TITLE
Energy-Efficient High-Speed Battery Locomotive Technology Assessment and Study.

RESEARCH PROBLEM STATEMENT
Why is this an issue for WSDOT? What is the problem?
The Washington State Department of Transportation (WSDOT) has been directed by state law to develop, "high-quality intercity rail passenger service…through incremental upgrading of existing [Amtrak] service" (RCW 47.79). Over time, this service has grown and has been branded as Amtrak Cascades service. WSDOT, together with the Oregon Department of Transportation and Amtrak, now operate 11 daily Amtrak Cascades trains between Eugene, OR and Vancouver, BC each day, utilizing European-designed Talgo trainsets, along with F59PHI locomotives and F40PH cab control cars. Three of these Talgo-built trainsets are owned by WSDOT and two by Amtrak.
The recent rise in diesel fuel prices has increased operating costs for ODOT, WSDOT, and Amtrak. With diesel fuel prices at near-record levels, the rail industry is emphasizing conservation and energy efficiency. Electric locomotives and light rail vehicles can recover energy by re-generating electrical power with a process called dynamic brake energy recovery. Unfortunately, diesel-electric locomotives, like the F59PHI used in Amtrak Cascades service, are unable to recover electrical energy from dynamic braking because they can not store or transmit the energy. This limits the energy efficiency of diesel locomotives.

The Project
However, it may be possible to recover, store, and re-use this electrical energy through the use of batteries and other electrical equipment on the cab control cars. This would greatly improve locomotive efficiency, save fuel, improve train performance, reduce environmental impacts, and lower operating costs. The concept is virtually the same one used in hybrid vehicles.

This research project would investigate the feasibility of dynamic brake energy recovery using cab control cars. First, substantial information gathering on railroad parameters and technological approaches would be conducted. Secondly, technological approaches to the concept would be evaluated. Third, costs and benefits of the concept would be identified. Fourth, if favorable results are obtained from the previous steps, a detailed path-forward to prototype development would be performed.

RESEARCH OBJECTIVE
How is research anticipated to contribute to a solution?
This concept has not been investigated in the US for over 25 years. Technology advances in locomotive and electrical equipment during the time have been significant. This research will answer the important questions of what, if any, technological approaches could work, will the concept work in the harsh railroad operating environment, will the concept deliver benefits that outweigh the costs, and how will the concept migrate from paper to prototype.

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommended Funding:	$ 80,000	estimated amount of funding
Research Period:	Six months	estimated length of time

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
What do you hope to gain from the research? How do you expect the research will be used?

Recovery of this lost energy should have significant benefits to rail passenger operations and the environment. These benefits include:

- Reduced emissions
- Reduced diesel fuel consumption
- Shorter travel times
- Reduced operating and maintenance costs

This research will help quantify the cost savings in diesel fuel, the air quality benefits, and the operational improvements (time savings). Ultimately, the research could be used to implement a prototype demonstration project. This would enable WSDOT to test the concept in the actual railroad operating environment.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Jeffrey T. Schultz
schultj@wsdot.wa.gov
360-705-7981

OTHER OFFICES WITHIN WSDOT LIKELY TO HAVE INTEREST
None.

RECOMMENDED PROBLEM MONITOR
Jeffrey T. Schultz

DATE
September 13, 2006

DOES THE PROJECT HAVE NATIONAL, REGIONAL/MULTI-STATE, OR WASHINGTON ONLY IMPLICATIONS?

XX National ____ Regional or Multi-state ____ Washington Only

PROBLEM TITLE
Alternatives for Preservation and/or Rehabilitation of WSDOT-owned Airport Runways and other low activity or remote public use airports.

RESEARCH PROBLEM STATEMENT
WSDOT operates sixteen airports and provides grant funding for other low activity or remote airports throughout the state. Many of these airports are not available for use all-year round due to the type and condition of the runway or remote locations. The types of runways vary from paved to gravel to turf and the condition of the runway can vary as well. Some of the issues facing these airports are how to provide a landing surface that can accommodate higher traffic loads (either more aircraft and/or heavier aircraft), enable all-season use, reduce foreign object debris (FOD), and keep maintenance costs low. Preservation or rehabilitation of the runway and its surroundings are necessary at most, if not all of the airports, to address these issues.

RESEARCH OBJECTIVE
This research would provide alternatives to preserve or rehabilitate the airport runways according to lowest life cycle cost – the cost of the preservation or rehabilitation technique and the maintenance over the life of the surface need to be taken into account.

The objectives include:
- Determine a suite of preservation or rehabilitation techniques for the different types and conditions of the runways
- Determine the feasibility of converting runway(s) into all-season use
- Provide a matrix of preservation/rehabilitation techniques that incorporate the lowest life cycle cost

ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD
Recommended Funding: $80,000
Research Period: 18 months

URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION
The results of this research will provide the Aviation division a matrix of techniques that can be used for preservation or rehabilitation of the runways at the state-owned airports.

PERSON(S) DEVELOPING THE PROBLEM STATEMENT
Kim Willoughby/John Shambaugh

OTHER OFFICES LIKELY TO HAVE INTEREST

RECOMMENDED PROBLEM MONITOR
John Shambaugh/Jeff Uhlmeyer

DATE
October 9, 2006