Fiscal 2016 – 2017
BIENNIAL WORK PROGRAM
STATE PLANNING AND RESEARCH

PART II – RESEARCH

AMENDMENT 2
Revised June 2016

Transportation Development Division
In cooperation with the
Federal Highway Administration

*OREGON DEPARTMENT OF TRANSPORTATION*
The Oregon Department of Transportation ensures compliance with Title VI of the Civil Rights Act of 1964; 49 CFR, part 21; related statutes and regulations to the end that no person shall be excluded from participation in or be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance from the U.S. Department of Transportation on the grounds of race, color, sex, or national origin. The Research Section actively collects Title VI compliance information from our contractors on an annual basis.
Section 23 CFR 420.209(c) Certification

June 1, 2016

I, Michael Bufalino, Research Manager of the State of Oregon, do hereby certify that the State is in compliance with all requirements of 23 U.S.C. 505 and its implementing regulations with respect to the research, development, and technology transfer program, and contemplate no changes in statutes, regulations, or administrative procedures which would affect such compliance.

Appendix A of the Fiscal 2016 – 2017 Biennial Work Program contains a summary of SPR Subpart B program compliance requirement and Oregon’s compliance mechanisms.

Michael Bufalino, Research Manager
BIENNIAL WORK PROGRAM

FOR

STATE PLANNING AND RESEARCH PART II (RESEARCH)

JUNE 2017

AMENDMENT 1, September 2015
AMENDMENT 2, June 2016

Prepared by

Oregon Department of Transportation

In Cooperation With

FEDERAL HIGHWAY ADMINISTRATION

Fiscal Years 2016 and 2017
July 1, 2015 to June 30, 2017
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Seismic Performance Design Criteria For Bridge Bent Plastic Hinge Regions

Statewide Data Standards to Support Current and Future Strategic Public Transit Investment

Method to Estimate Average Annual Daily Traffic For Minor Facilities For Map-21 Reporting And Statewide Safety Analysis

Performance of High Strength Steel Reinforcement in Shear Friction Applications

Compliance and Surrogate Safety Measures for Uncontrolled Crosswalks in Oregon

Coastal Landslide and Bluff Retreat Monitoring for Climate Change Adaptation and Targeted Risk Assessment

Appendix A - SPR Subpart B Program compliance
INTRODUCTION

An effective transportation research and development program serves a vital role in improving the efficiency and effectiveness of the transportation system. Properly organized and executed research and development activities can help the Oregon Department of Transportation (ODOT) achieve its strategic vision for the transportation system by developing the necessary supporting technology. In the private sector, an effective research effort has long been recognized as a requisite for keeping products and techniques competitive in the market-place. To enhance the cost-effective use of public funds, research is also needed in the public sector. In recognition of this fact, the Federal Highway Administration (FHWA) actively encourages the state highway agencies to conduct research and provides financial support through the State Planning and Research (SPR) program.

The FAST Act requires that States set aside 2 percent ($9,976,526 per year for Oregon in FY’16 – FY’17)\(^1\) of the apportionments they receive from four of the core Federal-aid programs for “State planning and research activities”. Of this amount, States must allocate 25 percent for research, development, and technology. The federal allocation for research, development, and technology is referred to as SPR Part 2 (2,494,132 per year for Oregon in FY’16 – FY’17). With the addition of the required state match, the biennium budget estimate for the minimum SPR Part 2 program is $3,117,664 per year. Table 2, on page 8, summarizes the SPR research core program for FY’16 and FY’17.

The Oregon SPR part 2 program is administered by Research Section of the Transportation Development Division of ODOT. The primary objectives for this program at ODOT are:

- coordinate, administer, and supervise research activities within the agency;
- conduct research projects;
- assure the use of proper research methods;
- prevent duplication of effort;
- cooperate and communicate with other agencies doing transportation research;
- assist other transportation providers by sharing and disseminating new technology and research findings;
- serve as an information source; and
- promote the implementation of research findings.

\(^1\) From: “DISTRIBUTION OF 2% STATE PLANNING AND RESEARCH (SPR) FUNDS INCLUDING THE 25% SET-ASIDE FOR RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER (RD&T), AND 5 1/2 PERCENT THAT STATES PARTICIPATING IN THE NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP) CONTRIBUTE FROM FISCAL YEAR 2016 APPORTIONMENTS at: https://www.fhwa.dot.gov/legsregs/directives/notices/n4510805/n4510805_t5.cfm, Accessed 5/25/16
AMENDMENT 2
This amendment to the biennial work program is a complete update of the work program based on information available through May of 2016. Updates have been made to each project based on past project billing and forecasted work. This amendment supersedes Amendment 1 (September 2015) of the biennial work program in its entirety.

RESEARCH SECTION RESPONSIBILITIES
The Research Section coordinates research activities and maintains continuing monitoring on transportation-related research throughout the nation. The Section functions with the guidance of a Research Advisory Committee supported by Expert Task Groups. Specific responsibilities of the Section are:

- Solicit transportation users for research needs.
- Review all research problem statements and obtain the information necessary to formulate a research program.
- Chair Expert Task Groups in order to recommend promising research projects to the ODOT Research Advisory Committee consideration.
- Select principal investigators and Technical Advisory Committee members for each project.
- Conduct literature research as required.
- In some cases, conduct research projects.
- Assist in the preparation of reports covering the results of research and make recommendations for application into policies, procedures, standards, and other guides governing the activities of the Department of Transportation.
- Promote the implementation of the research findings through distribution of research results to appropriate persons for their consideration and use.
- Provide expertise for ODOT in specialty areas pertaining to research and technology.
- Participate in state-sponsored seminars and training meetings to help implement new research findings.
- Provide a liaison with FHWA, universities, consultants, and other agencies conducting and supporting research for ODOT.
- Provide a continuous liaison and surveillance of progress and expenditures for all research projects.
- Provide liaison with the Transportation Research Board and the Cooperative Research Programs.
- Prepare annual and biennial budgets for research activities.
- Conduct periodic Peer Exchanges.

The research portion of the SPR Program aids in the achievement of the above-named objectives. The research is directed toward the solution of local problems with conditions and materials that prevail in Oregon. The Research Section develops or assists in the development of research
study proposals and acts as a coordinator during the projects. The project work may be contracted, conducted by the operating section that has the concern and expertise for the particular program, or carried out by Research Section staff. The Research Section coordinates and maintains oversight of the projects to minimize duplication of effort and to broaden the scope of projects.

Research needs are identified through formal inquiry and through annual solicitation of ideas for State, SPR, multi-state and national projects. Needs are also identified by the Expert Task Groups and/or the ODOT Research Advisory Committee. Informal research needs identification is an ongoing activity, and the annual solicitation for ideas takes place in the fall with review continuing through the winter. Topics are reviewed by Expert Task Groups to determine those for consideration by the Research Advisory Committee. The Research Advisory Committee then evaluates the proposals for merit, assigns priorities, and recommends funding.

Funds are budgeted for projects by fiscal year based on forecasted tasks for research project work. Estimates are based on anticipated material, contract labor and staff-time needs. These estimates are based on “Stage 2 Research Problem Statements”, and then refined in individual project “Work Plans”. Due to the typically fixed costs of the research process estimated research project costs are relatively accurate. Overall research project cost estimates involve little risk. Project timing of university led research is sometimes highly variable, and project schedules must flexible. The variability of schedule necessitates the revision of project budgets during the preparation of this Research Work Program to move project funds between fiscal years based on actual expenditures.

The implementation of research varies with the nature of the project. The projects, if not conducted by the operating sections that have need for the findings, typically at least involves them in the project management and work product review process. In these cases, implementation takes place as the project progresses. To the extent required, research findings are transmitted to concerned individuals for their consideration and appropriate action by additional means, including implementation workshops, conferences, research notes, and a semi-annual research newsletter. The implementation budget in the SPR Work Program provides for preparation of various materials and the conduct of activities to expedite the implementation of research.

Also, the Research Section may participate in the coordination and reporting of Demonstration Projects conducted in cooperation with FHWA, AASHTO and TRB. However, no such projects were active in FY’16 or scheduled for FY’17.

**OTHER RESEARCH SECTION ACTIVITIES**

Research activities in addition to those specifically described in the SPR Program include the following:

**A. Support for the National Cooperative Highway Research Program (NCHRP)** utilized 5.5% of the SPR allocation. The total Oregon SPR allocation is approximately $19,953,052 for FY 2016 – FY 2017. The anticipated total annual support for FY 2016 is $548,709, and support for FY 2017 is also anticipated to be $548,709. Oregon funds NCHRP “off the top” of SP&R, meaning that 75% comes from SPR Part 1 and 25% comes from SPR Part 2. The SPR Part 2 contribution for the NCHRP program is anticipated to be $137,177 per year.
NCHRP is also supported through submittal of problem statements, coordination of ODOT balloting, and service on NCHRP panels. These activities cost approximately $10,000 per year, mainly in staff time.

**B. The Transportation Research Board (TRB)** subscription fee covers the cost of all publications, information service retrievals, registration, and related services provided to the State by TRB. The fee for FY 2016 through FY 2017 is expected to be $110,197 per year. Funds for FY’16 are being obligated through TPF-5(342), which included a 2.5% surcharge to compensate TRB for accepting the fee on a reimbursement basis. As with NCHRP, Oregon’s TRB subscription is shared 75-25% between Part 1 and Part 2. The SPR Part 2 TRB contribution is anticipated to be $27,550 per year.


For budgeted funds set aside for unidentified pooled fund opportunities; the ODOT Research Manager may independently commit up to $10,000. For commitments greater than $10,000, the Research Advisory Committee must be consulted. RAC pooled fund commitment decisions are usually made via e-mail. In addition to TRB and NCHRP support, an average of $101,000 is targeted to Pooled Fund projects in FY’16 and FY’17. Oregon is contributing to four projects, TPF-5(064) “Western Alliance for Quality Transportation Construction (WAQTC)” TPF-5(288) “Western Road Usage Charging Consortium”, TPF-5(343) Roadside Safety for MASH, and TPF-5(255) “Highway Safety Manual Implementation”, using non SP&R finds. Additionally ODOT research is providing services to other states by leading TPF-5(301) “Support Services for Peer Exchanges”. Table 1 summarizes ODOT’s pooled fund participation.
### Table 1 Cooperative Research

<table>
<thead>
<tr>
<th>Study No.</th>
<th>Title</th>
<th>FY'16</th>
<th>FY'17</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPF-5(218)</td>
<td>Clear Roads Winter Highway Operations</td>
<td>$25,000</td>
<td>0</td>
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<tr>
<td>TPF-5(296)</td>
<td>Simplified SPT Performance-Based Assessment of Liquefaction and Effects</td>
<td>$18,000</td>
<td>0</td>
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<tr>
<td>TPF-5(299)</td>
<td>Improving the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis</td>
<td>$15,000</td>
<td>$15,000</td>
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<tr>
<td>TPF-5(259)</td>
<td>Tools for Evaluation of Gusset Plate Connections in Steel Truss Bridges</td>
<td>*</td>
<td>*</td>
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<tr>
<td>TPF-5(307)</td>
<td>Validation of Tsunami Design Guidelines for Coastal Bridges</td>
<td>$20,000</td>
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<tr>
<td>TPF-5(331)</td>
<td>Toolkit for the Deployment of Alternative Vehicle and Fuel Technologies</td>
<td>$10,000</td>
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<tr>
<td>TPF-5(334)</td>
<td>Enhancement to the Intelligent Construction Data Management System (Veda)</td>
<td>$25,000</td>
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<tr>
<td>TPF-5(338)</td>
<td>Simplified CPT Performance-Based Assessment of Liquefaction and Effects</td>
<td>$22,000</td>
<td>$22,000</td>
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<td></td>
<td>Unidentified Projects</td>
<td>$0</td>
<td>$20,000</td>
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<tr>
<td></td>
<td><strong>Subtotal for SPR Pooled Fund Projects</strong></td>
<td><strong>$135,000.0</strong></td>
<td><strong>$67,000.00</strong></td>
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<tr>
<td>TPF-5(064)</td>
<td>Western Alliance for Quality Transportation Construction (WAQTC) ($15,000 FY’16)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>TPF-5(288)</td>
<td>Western Road Usage Charging Consortium ($25,000 per year)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>TPF-5(301)</td>
<td>Support Services for Peer Exchanges (Funded by other states)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>TPF-5(343)</td>
<td>Roadside Safety for MASH ($50,00 per year)</td>
<td>*</td>
<td>*</td>
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<tr>
<td>TPF-5(342)</td>
<td>TRB Core Program Services for a Highway RD&amp;T Program - FFY 2016 (TRB FY 2017)</td>
<td>$27,550</td>
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<tr>
<td></td>
<td>TRB Core Program Services for a Highway RD&amp;T Program - FFY 2017 (TRB FY 2018)</td>
<td></td>
<td>$27,550</td>
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<tr>
<td>NA</td>
<td>2016 NCHRP Assessment</td>
<td>$137,177</td>
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<tr>
<td>NA</td>
<td>2017 NCHRP Assessment</td>
<td></td>
<td>$137,177</td>
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<td></td>
<td><strong>Total</strong></td>
<td><strong>$299,727</strong></td>
<td><strong>$231,727</strong></td>
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</table>

1 Beginning in FY'06 ODOT Research and ODOT Planning agreed to share the cost of the NCHRP and TRB assessments.

2 ODOT is funding TPF-5(064) TPF-5(255) and TPF-5(343) using contributions from sources other than SP&R.

3 ODOT is leading TPF-5(288) and TPF-5(301) using contributions from sources other than SP&R.
E. The Oregon Technology Transfer (T2) Center provides transportation-related information to local government agencies throughout Oregon. The Center is jointly funded by FHWA, the counties and cities of Oregon, and ODOT. T2 is one of 49 such centers across the country (one in nearly every state and Puerto Rico) that are part of FHWA’s Local Technical Assistance Program (LTAP). Present T2 annual funding is at $345,000 through December 2017.

The Technology Transfer Center is housed with the Research Section. The T2 Director, an assistant and three part-time “Circuit Riders” are supervised by the Research Manager.

T2 provides the following services at no cost to client agencies:

1. A lending library of audio/visual materials.
2. A lending library of technical publications.
3. Sponsorship and delivery of training courses, workshops, seminars, etc., including a “Roads Scholar” program.
4. On-site informational presentations.
5. Response to information requests.
6. A quarterly newsletter of information on transportation related topics.

As its name suggests, the T2 Center strives to make each agency in the state aware of the latest and most effective transportation technologies. T2 does this by acting as an information resource and encouraging and strengthening communications between government agencies at all levels.

F. A State-funded Research Account On an ongoing basis, additional funds are budgeted each biennium. This pool constitutes funds for research in addition to the SPR (Part II) program of research described herein. As the opportunity arises, this additional budget allows for some use of SPR Part 1 funding. Otherwise, Oregon Highway Funds will be utilized.

G. A State-funded Indirect Account Approximately $650,000 for the 2016-2017 biennium covers facilities rent and maintenance, some travel, office services and supplies, data and word processing, capital outlay, and miscellaneous other services needed to support the Research Section.
## CORE RESEARCH PROGRAM FUNDING SUMMARY

### Table 2 Biennial Budget for Fiscal 2016 and 2017

<table>
<thead>
<tr>
<th>Project Title</th>
<th>FY'16</th>
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<tr>
<td>301 SPR Project Development</td>
<td>$297,441</td>
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<td>302 SPR Implementation</td>
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<td>303 Unidentified Projects (FY’17)</td>
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<tr>
<td>304 SPR Research Discretionary</td>
<td>$44,905</td>
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<td>719 Climate Change Impact on Coastal River Estuaries in Oregon</td>
<td>$23,071</td>
<td>$24,000</td>
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<tr>
<td>741 Bridge Seismic Retrofit Measures Considering Subduction Earthquakes</td>
<td>$0</td>
<td>$0</td>
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<td>758 Width of Filter Strips for Natural Dispersion of Stormwater in Western Oregon</td>
<td>$36,593</td>
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<tr>
<td>760 Multi-modal PM in Oregon: Developing a Transportation Cost Index</td>
<td>$21,556</td>
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<tr>
<td>761 Evaluation of Weather Based Variable Speed Limit Systems</td>
<td>$30,000</td>
<td>$6,000</td>
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<tr>
<td>762 High Strength Steel Reinforcement for Bridges</td>
<td>$60,000</td>
<td>$0</td>
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<td>763 Mechanistic Design Data</td>
<td>$50,000</td>
<td>$60,000</td>
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<tr>
<td>764 Oregon Road Map for Connected Vehicle/Cooperative Systems…</td>
<td>$77,768</td>
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<td>765 High Strength Steel Bars and Steel Casing on Response of Drilled Shafts</td>
<td>$118,730</td>
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<td>766 Crowdsourcing as a Data Collection Method for Bicycle Performance Measures…</td>
<td>$1,771</td>
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<td>770 Impact of Cascadia Earthquake on the Seismic Evaluation Criteria of Bridges</td>
<td>$85,000</td>
<td>$9,000</td>
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<td>771 Risk Factors Associated with High Potential for Serious Crashes</td>
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<td>772 Investigation of Bicycle and Pedestrian Count Technologies</td>
<td>$89,672</td>
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<td>773 Optimal Timing and Detection Practices for Red Clearance Extensions</td>
<td>$105,177</td>
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<td>774 Road User Charge Economic Analysis</td>
<td>$77,768</td>
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<td>775 Titanium for Strengthening Existing Reinforced Concrete Bridges</td>
<td>$186,500</td>
<td>$10,500</td>
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<td>776 Quantifying Noise Impacts from ODOT Aggregate Source Operations</td>
<td>$70,339</td>
<td>$85,000</td>
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<td>777 Chip Seal Design and Specifications</td>
<td>$55,000</td>
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<td>778 Safety Effectiveness of Pedestrian Crossing Enhancements</td>
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<td>779 Risk Factors for Pedestrian and Bicycle Crashes</td>
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<td>780 Strategies to Increase the Service Life of Bridge Decks</td>
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<td>781 Improving Adaptive/Responsive Signal Control Performance</td>
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<td>782 HMAC Layer Adhesion Through Tac Coat</td>
<td>$124,000</td>
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<td>783 Truck Parking: An Emerging Safety Hazard to Highway Users</td>
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<td>784 Development of Titanium Seismic Retrofits for Deficient Concrete Columns</td>
<td>$204,000</td>
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<td>785 Adjusting Asphalt Mixes for Increased Durability and Implementation of a Tester</td>
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<td>786 Enhancing Landslide Inventorying, LiDAR Hazard Assessment and Asset Management</td>
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<td>787 Eyes in the Sky: Bridge Inspections with Unmanned Aerial Vehicles</td>
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<td>788 Performance-Based Planning and Decision Making - Understanding Mode Choices</td>
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<td>789 Improved Safety and Efficiency of Protected/Permitted Right Turns in Oregon</td>
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<td>790 Work Zone Intrusion Alert Technologies: Assessment and Practical Guidance</td>
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<td>791 Use of Additional Lighting for Traffic Control and Speed Reduction in Work Zones</td>
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### Table 2 (Continued) Biennial Budget for Fiscal 2016 And 2017

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<th>Project Title</th>
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<tr>
<td>792 Construction of Efficient, Cost-Effective and Sustainable Maint. Facilities</td>
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<td>793 Exploring the Relationship Between Freeway Congestion and Safety</td>
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<td>794 Multi-Modal Intersections: Resolving Conflicts…</td>
<td>$33,500</td>
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<td>796 Preventing the Remobilization of Captured Metals in Stormwater Treatment Sys.</td>
<td>$0</td>
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<td>797 Binder-Grade Bumping and High Binder - Improve Performance of RAP-RAS…</td>
<td>$22,000</td>
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<td><strong>New FY’17 Projects:</strong></td>
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<tr>
<td>798 Analysis of Highway System Impacts on TMDL Watersheds using SELDM</td>
<td>$0</td>
<td>$116,091</td>
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<td>799 Lidar for Maintenance of Pavement Reflective Markings and Retro-Reflective Signs</td>
<td>$0</td>
<td>$70,000</td>
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<tr>
<td>800 Quantifying the Performance of Low-Noise Rumble Strips</td>
<td>$0</td>
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<td>801 Employing iRLPD Test Methods for Optimal Asphalt Mixture Performance</td>
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<td>$60,000</td>
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<tr>
<td>802 Seismic Performance Design Criteria for Bridge Bent Plastic Hinge Regions</td>
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<td>$120,000</td>
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<td>803 Statewide Data Standards to Support Current and Future Strategic Public Transit</td>
<td>$0</td>
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<tr>
<td>804 A Method to Estimate Average Annual Daily Traffic for Minor Facilities for MAP-21…</td>
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<td>$66,955</td>
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<td>805 Performance of High-Strength Steel Reinforcement in Shear Friction Applications</td>
<td>$0</td>
<td>$110,000</td>
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<td>Understanding and Mitigating Effects of Chloride Deicer</td>
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<td>High Strength Steel Reinforcement for Bridges</td>
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Table 3 Research Projects Ending In FY’15 or FY’16
301 PROJECT DEVELOPMENT

OVERVIEW AND OBJECTIVES
Funds are not available for individual research studies until a study work plan has been developed and approved. Funds budgeted under this item will be used to develop or assist in the development of SPR projects.

In the fall of each year the Research program issues an open call for research ideas, or research problem statements. While participation is open to anyone, ODOT research focuses on soliciting problem statements from transportation workers and personnel from state and local agencies. In practice up to 100 or more new problem statements are received every year. For the most part, problem statements are prepared by ODOT employees, university researchers, other state and local transportation and agencies, other research organizations, and consultants emphasizing the “bottom up” approach.

The money will cover the costs of soliciting new projects, organizing and facilitating expert task groups, developing stage 1 and stage 2 problem statements, identifying potential investigators, preparing work plans and executing agreements (if any) to carry out the research.

ACCOMPLISHMENTS
The Section selects between 10 and 12 research projects each year. The intensive project development and selection process helps identify research with a high potential to produce a benefit to the State’s efforts to provide for transportation within Oregon. This process includes coordination with experts throughout the agency and with University Transportation Centers. In FY’16 the Section initiated thirteen new projects and prepared ten additional projects forecasted to start FY’17.

CANCELED PROJECT
Project number 796, “Preventing the Remobilization of Captured Metals in Stormwater Treatment Systems.” Was terminated effective April 30, 2016. The project will be terminated because we are unable to develop a project work plan that will sufficiently address the research problem statement with the funds and time available. Since this project was new in FY’16 and we never initiated a research contract, no resources were expended beyond the project development phase.

RESPONSIBLE PARTIES
Responsibility for this activity rests with Research staff and with members of Technical Advisory Committees (TAC). TAC membership is drawn from ODOT professional, technical and operational units, Oregon universities, other transportation agencies, resource agencies and the Oregon Division of FHWA.
**COST INFORMATION**

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*FY’16 expenditure and budget values are estimated.*

*FY’17 budget values are estimated based on forecasted project work.*
OVERVIEW AND OBJECTIVES
When a project ends and the report is published the project budget is no longer available for
continuing activities related to dissemination and implementation of results. These funds
combine implementation activities across projects. The objective is to provide a resource for
more effective, ongoing implementation of research findings and to ensure research is focused on
high priority projects.

RELATIONSHIP OF OBJECTIVES TO OVERALL PROGRAM
Research findings have no practical value until they are implemented. Design and operations
offices and other ODOT programs are concerned with keeping abreast of new technology, but
time restraints prohibit review of many research reports. This budget item will be utilized to
more effectively inform potential users of promising research results. Interaction with
maintenance and construction employees will bring new issues to light, as well as facilitating
sharing of potential solutions and ideas developed by staff.

PROPOSED MAJOR ACTIVITIES.
Research Notes will be distributed widely to management and maintenance crew leaders.
Research will use electronic media and ODOT Internet to make updates and research
information more accessible. Research Notes on project progress will be developed for major
projects of interest. Implementation Guides will be developed, if appropriate, and distributed to
those who would use the research findings.

As in the past, research results will be available on the Transportation Research Information
System (TRIS) maintained by the Transportation Research Board (TRB) and the Bureau of
Transportation Statistics (BTS). TRID can be accessed online at: https://trid.trb.org/ Investigators
are also encouraged to present ODOT results at regional, national and international conferences,
and to publish ODOT supported work in engineering and scientific journals. The ODOT research
maintains published reports online for free download at:
https://www.oregon.gov/ODOT/Programs/Pages/Research-Publications.aspx

Finally, as in the past, on a project by project basis, specific implementation efforts will be
identified and carried out as needed to assure that key implementation agents within ODOT have
the information and the means to make optimal use of implementable research results.

ACCOMPLISHMENTS
On numerous occasions, the Research Section has recommended the implementation of
promising research findings. The implementation item in the SPR Work Program will permit this
activity to be accomplished more thoroughly, and in some cases, more formally.
Events
In 2016 ODOT Research was a major sponsor of the Northwest Transportation Conference, which was held at the CH2M Hill Alumni Center at Oregon State University, on March 15th - 17th. The event involved about two hundred attendees, a hundred National and regionally prominent speakers in 22 sessions.

The ODOT Research Section supports the conference in the following ways.

- Participated on the conference steering committee.
- Section staff prepared and circulated a request for abstracts, and review the abstracts received for inclusion in the conference program.
- Section staff organized several sessions and recruited speakers for those sessions.
- Research Section funds were made available to cover the fees charged or expenses incurred by major speakers.
- Section staff prepared online and printed conference materials including pre conference announcements, the conference registration brochure, a booklet of major speaker bios, preliminary and final conference programs, conference evaluation forms and assorted posters.
- The section sponsored and staffed vendor display at the conference, for the Research Program and the Oregon Technology Transfer Center.
- Section staff chaired sessions and presented research papers.

Projects
Thirteen major projects have been completed to date, and two additional project are expected to be completed by the end of FY’16. When a project moves into final stages, the Technical Advisory Committee discusses implementation issues and proposes an implementation strategy, which may or may not entail specific, post-publication efforts from the Research Section. The FY’17 budget will be used to support research staff time, follow-up analysis, and technology transfer activities for the following projects ending in FY’16:

741 Bridge Seismic Retrofit Measures Considering Subduction Zone Earthquakes
750 Methods for Strengthening Reinforced Concrete Bridge Girders Containing Poorly Detailed Flexural Steel Using Near-Surface Mounted Metallics
756 Improved Safety Performance Functions for Signalized Intersections
768 Evaluating the Use of Crowdsourcing as a Data Collection Method for Bicycle Performance Measures and Identification of Facility Improvement Needs
771 Risk Factors Associated with High Potential for Serious Crashes
767 Towards Effective Design Treatment for Right Turns at Intersections with Bicycle Traffic
766 Effective Measures to Restrict Vehicle Turning Movements
755 Performance Based Selection of RAP-RAS in Asphalt Mixtures
773 Smart Red Clearance Extensions to Reduce Red-Light Running Crashes
760 Multi-Modal Performance Measures in Oregon: Developing a Transportation Cost Index Based upon Multi-Modal Network and Land Use Information
774 Road User Charge Economic Analysis
METHODOLOGY

A cornerstone of our implementation effort is to include key agents of implementation from within ODOT on the project Technical Advisory Committee. These individuals are expected to carry major responsibility for keeping the project focused on implementable objectives, making sure information is delivered into the right hands, and to identify key steps in implementation such as revision of standards and specifications, incorporation into procedures and best practices manuals and guidebooks, etc.

It is not feasible from the standpoint of staff and time to expect operations staff to review all available research reports, but studies identified as being of major importance will be distributed to appropriate offices. In particular, reports generated from research projects conducted in Oregon will be scanned for implementable findings and brief reports presenting suggested implementation procedures will be circulated to potential users.

RESPONSIBLE PARTIES

Implementation is the responsibility of primary users of the research in ODOT Divisions and Regions, with the support and assistance of the Research Section. In order to facilitate the most seamless research implementation, key users are engaged in research project development, management and review, by participation on project Technical Advisory Committees.

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
OVERVIEW AND OBJECTIVES

Through the course of the fiscal year the Research Section receives requests for information and a variety of other requests to perform research typically related to evaluation of new products and methods. These projects typically require a quick response from Research because someone in the organization has made a commitment to the application of an innovation that could benefit from monitoring and evaluation, but will go forward whether Research participates or not. The discretionary fund gives us greater funding flexibility to participate when these opportunities arise.

Similar opportunities arise when universities and other organizations propose small projects involving cost sharing. In the past a number of projects have been undertaken when a medium priority project could be launched because the cost was small, raising the benefit-cost ratio. Many such projects have been or will be funded partially by one of five University Transportation Centers in the region. In addition, projects that would previously have been funded under the “Experimental Features” program will draw on the Research Discretionary Fund. Evaluations of experimental features will continue as appropriate, but combining the funds into a single pool simplifies administration.

RELATIONSHIP OF OBJECTIVES TO OVERALL PROGRAM

This fund provides a means of evaluating innovative products or non-standard methods and materials on an experimental basis, similar to, but more broadly applicable than, the Experimental Features Program. It also provides the flexibility to respond quickly to other Research needs that emerge through the fiscal year, and to commit to small projects without specific approval from the Research Advisory Committee.

ACCOMPLISHMENTS

In FY’15 and FY’16 the Research Section managed several sub-projects under project 304. These projects included publishing results from the 2015 Research Peer Exchange, and two reports: “Studded Tire Use and Damage Analysis”, and “Intelligent Transportation Systems, Advertising Lit Review” The project supported speakers and other conference expenses for the 2014 Northwest Transportation Conference. Ongoing work included TRB Liaison and NCHRP Activity, supporting the AASHTO Technology Implementation Group, Multi-state Research Coordination, Digital Image Rectification of Gusset Plate Connection in Steel Truss Bridges, A Corrosion Sensor Based on Electrical Continuity, and Juniper Certification Project

PROPOSED ACTIVITIES

Project 304 allows for a limited number of discretionary transportation research projects. Expected activities include:

- ODOT staff time
- Consultant Payments
- ODOT Staff travel
• Equipment for the exclusive use of the defined discretionary research project. This allows
the purchase of specialized research equipment.
• Other activities that are necessary and reasonable for proper and efficient
accomplishments of the identified transportation research.

Small projects limited to the above activities may be conducted without amendments to this work
program. All discretionary transportation research project activities funded under Project 304
will be limited to activities that are necessary and reasonable pursuant to 23 CFR 420.113(a) (3).

Sub-projects.

Sub-projects under project 304 include discrete research efforts and research functions that occur
continuously, or cyclically. The current sub-projects are listed below, with balance of funds is spent on yet to
be identified FY’16 and FY’17 research projects. Current and planned sub-projects include:

• **Liaison and NCHRP Activity.** This covers coordination of annual NCHRP balloting,
coordination of problem statement submittal and panel participation. (Status is Ongoing).

• **AASHTO Technology Implementation Group (TIG).** TIG identifies useful and
implementable new technologies and invests in their deployment through various means. TIG
is supported through an assessment on member Departments. This year ODOT paid our
$6,000 TIG assessment using the Research Discretionary Fund (Status is Ongoing).

• **Northwest Transportation Conference** Funds are set aside for speakers and other
conference expenses for the Northwest Transportation Conference, which is held biennially
during even numbered years. The conference is described more fully under on research
implementation above (Status is ongoing).

• **Research Peer Exchange** The purpose of a peer exchange is to give all participants a means
to improve the quality and effectiveness of their research efforts, processes and programs.
The ODOT Research Section hosted a research management peer exchange in FY’15. The
next peer exchange is scheduled for FY’20. (status is inactive with no activity planned in
FY’16 or 17)

• **Multi-state Research Coordination** Provide support for multi-state research coordination,
including response to other states’ requests and support of the AASHTO Research Advisory
Committee and Transportation Research Board State Representatives meeting in July of
2015. (status is ongoing).

• **Digital Image Rectification of Gusset Plate Connection in Steel Truss Bridges Phase
2.** Additional work in the area of digital image rectification is being undertaken in partnership
with FHWA and several other states under TPF-5(259) Tools for Evaluation of Gusset Plate
Connections in Steel Truss Bridges. An account is being established within the discretionary
fund to cover staff time for project coordination (status is continuing).

• **A Corrosion Sensor Based on Electrical Continuity.** The objective of this project was to
develop a simple, inexpensive, robust sensor that could be embedded in existing structures to
provide ODOT with an early warning of in situ corrosive conditions. The concept of the
sensor was based on an electrical continuity check in which a thin, iron-based wire is joined
to the existing concrete by a thin layer of mortar. The small volume of mortar would
equilibrate with the condition of the concrete (particularly the chloride content) with minimal
effect on the concrete condition itself, and if that condition were corrosive, the wire would corrode and electrical continuity would be lost. (status is continuing).

- **Juniper Certification Project** In partnership with *Business Oregon*, ODOT will provide matching funds for a USDA Rural Development program. This project will produce engineering design values for Western Juniper and publication of those results in the National Design Specification, the premier wood products industry trade manual. This will allow the Oregon Department of Transportation, engineers, architects, and other agencies to specify and purchase this species for a variety of applications that may include guard rail blocks, sign posts, beams, decking, sill plates, and posts. (status is continuing).

- **Safety Training Materials** In partnership with university Environmental Health and Safety offices develop safety materials that can be used on all roadside SPR research efforts. The project will produce materials that help train student workers prior to conducting field research on public rights of way. These materials will be available for use by any state DOT’s research program. (status is new)

**RESPONSIBLE PARTIES**
This activity is the responsibility of the ODOT Research Section, as well as members of the technical advisory committee formed to manage each project.

**COST INFORMATION**

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*FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.*
CLIMATE CHANGE IMPACT ON COASTAL RIVER ESTUARIES IN OREGON

OVERVIEW
U.S. Route 101 and other ODOT highways traverse numerous estuaries along Oregon’s coast. These roadways affect, and in turn are affected by, changes in the function of the estuary caused by both the presence of the roadway as well as changes in sea level. Likewise, future climatic changes may also affect the function of both the roadways and the estuaries. A great deal of money and effort continues to be focused on restoring estuaries to their more natural function. To validate present methods, develop improved future methods, and to adapt to changing future conditions it is important to monitor conditions in the estuaries and along the roadways.

OBJECTIVES
The Objective of this research is to improve our understanding of the interactions of ODOT’s facilities with estuary system. Specifically the intent is to gather data to verify that changes in ODOT’s facilities and in the estuary produce the expected results or give new understanding to what really happened.
By monitoring conditions and changes in the Salmon River Estuary a better understanding will be gained of how the roadway/estuary system functions and how it responds to changes of all kinds. In general ODOT will be able to make more informed responses to current and future changes to fulfill our agency mission.
More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
The main focus is to monitor the hydrology of the estuary around the highway, including flow and stage at a number of locations influenced by and influencing the highway and related structures. Additional parameters such as water temperature and salinity will also be monitored at those sites. Elevation profiles will be taken in and around the highway and monitoring sites to track changes due to settlement, aggradation, degradation, channel migration and avulsion, which are also intertwined with the hydrology. The water table will also be monitored at some locations. This project includes ODOT staff time, state vehicle travel, purchase of specialized research and analysis equipment, and supplies.
More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)
RESPONSIBLE PARTIES
ODOT Research Section
ODOT Geo-Environmental Section
ODOT District 4
US Forest Service
National Marine Fisheries Service
Oregon Department of Environmental Quality

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FY'16 expenditure and budget values are estimated.
FY'17 through FY'20 budget values are estimated based on forecasted projected work.
APPROPRIATE WIDTH OF FILTER STRIPS FOR NATURAL DISPERSION OF STORMWATER IN WESTERN OREGON

OVERVIEW

Infiltration is being emphasized as an important technique for managing stormwater. Dispersion of highway runoff in roadside filter strips or separate dispersal areas is a cost effective stormwater management technique that provides both water quality and flow control benefits. Determining the width of the dispersion area needed to infiltrate the design storm is necessary to identify the amount of right-of-way needed and if additional BMPs are required. Research to establish an equation for sizing dispersion areas in western Oregon is needed.

OBJECTIVES

The objective of this research is to expand the data set and understanding of Washington’s LID Design Equation” to the point that an equivalent design approach that is applicable to western Oregon can be developed.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Task #1: Literature and Project Review.
Task #2: Assess Available Data and Determine Knowledge Gaps; Design Study; Purchase Equipment.
Task #3: Perform and Analyze Instrumented Field Study.
Task #4: Assess runoff generation and infiltration capacity relationships.
Task #5: Develop Design Guidance.

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES

ODOT Research Section
ODOT Geo-Environmental Section

Oregon State University (Agreement for $288,084 ending September 2014; Amendment 2 extends contract through June 2016.)
COST INFORMATION

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*FY’16 expenditure and budget values are estimated. Projected end date June 30, 2016.*
EVALUATION OF WEATHER BASED VARIABLE SPEED LIMIT SYSTEMS

OVERVIEW
Increasingly, variable speed limit (VSL) and variable advisory speed (VAS) systems have been used around the world, and in the U.S., to provide traffic- and weather-responsive guidance for drivers in order to achieve the goals mentioned above. By sensing the traffic and/or weather conditions, advisory speed limits can be displayed that are suited to real-time conditions and can warn drivers about congestion and speed conditions ahead. While shown to be cost-effective, ATM and specifically VSL do require significant investments in hardware and software, data collection/management and maintenance. In an environment of limited resources clear criteria are needed to aid in deployment decisions.

Two VSL projects being deployed in Oregon, with five additional systems under various levels of development in the state. ODOT is currently constructing an ATM Project along OR 217, which is operating at or above capacity with closely spaced interchanges and crash rates and congestion higher than regional averages. The OR 217 ATM Project includes variable advisory speeds (based on measured flows and speeds), posting real time travel times, queue warning, and a weather responsive curve warning system spanning seven miles of highway.

The US 26 and OR 35 Mt. Hood Safety and Traveler information project (67 miles) will install a VSL and variable message sign (VMS) system to improve safety along this corridor (a large percentage of crashes occur on snow and ice, linked to inexperienced and overconfident drivers traveling too fast for conditions). A Road Weather Information System (RWIS) will collect real-time winter weather information at along US 26 and OR 35 to allow precise conditions to be monitored. The completed weather-controlled VSL on both corridors will utilize traffic speed and volume detection, weather information, and road surface condition technology to determine appropriate speeds at which drivers should be traveling. These advisory or regulatory speeds will then be displayed on overhead or roadside VMS or dynamic message signs (DMS).

OBJECTIVES
The goal of this project is to evaluate the effectiveness of two new active traffic management (ATM) system projects featuring VSL and VAS components being installed on OR 217 (urban) and US 26/OR 35 (rural/mountain), to aid in optimizing the operation of these systems as well as laying the groundwork for future implementations of ATM and VSL systems across the state. The two systems in Region 1 are the first of potentially many more projects to be implemented.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, Purchase Research materials, Travel, and Staff Time for

- Field and Corridor Reconnaissance.
- Select Study Corridors.
- Experimental Design.
- Pilot Study.
• Corridor Study.
• Evaluation and Recommendations.
• Final Report.

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

This Project is dependent of studying the construction of ITS infrastructure. This project is on hold due to construction project scheduling in the study area. (See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES

ODOT Research Section
ODOT Region 1 Traffic
ODOT ITS Unit
Portland State University (Agreement for $84,000 ending December 2015 with approximately $63,048 expended through May 2016.)
WTI (Agreement for $80,996 ending December 2015 with approximately $23,694.64 expended through May 2016.)
California State Polytechnic University (Agreement for $11,992 is under development with approximately 0 expended through May 2015.)

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An additional $20,000 was allocated to this project in FY’15 to accommodate staff time to install pretest traffic monitoring equipment.

FY’16 expenditure and budget values are estimated.

FY’17 budget values are estimated based on forecasted project hold and construction delays.
OVERVIEW
ODOT began implementation of Mechanistic design practices and principles starting in approximately 2003. At the time, implementation was as a secondary evaluation tool in asphalt concrete pavement design due to uncertainty in the design method precision, lack of ongoing calibration, and lack of data. Three pavement sites were instrumented across Oregon between 2004 and 2008 to gather data to help in moving the implementation of mechanistic design practices forward. Data from the sites was collected as part of a previous research project, but was not completely summarized or analyzed and a large part of the data is currently providing no useful benefit to ODOT. If these data are to be useful in ODOT’s ongoing mechanistic pavement design calibration, the data from the instrumented sites needs to be reduced from its current “raw” format and evaluated.

OBJECTIVES
The objective of this research is to reduce and manipulate existing data and to the extent possible used it to calibrate and improve mechanistic design methods. Because the existing data have not yet been assessed, the researchers will assess the data and determine whether the existing data can be beneficial for improving design of pavements.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, equipment purchases; staff time, and publication costs to:

- Procure and assess data.
- Demonstrate a calculation process for at least one load application and the resulting strain.
- Evaluate the data, output the data to useable formats, and compare the results with other existing models used to predict strain in pavements.
- Provide a user-friendly computer program with user’s guide for reducing future data.
- Prepare a Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)
RESPONSIBLE PARTIES
ODOT Research Section
ODOT Pavement Services
Auburn University (Agreement for the amount of $164,282.59 ending in July 2016, with approximately $94,196.55 expended through May of 2016.) Amendment 1 extends this contract through February 2017.

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
OVERVIEW
Drilled shafts provide significant geotechnical resistance for support of highway bridges, and are used throughout the State of Oregon to meet its structural foundation requirements. Due to changes in construction methods and poor near-surface soils, the use of permanent steel casing for drilled shaft installation has increased. However, geotechnical design models for axial and lateral resistance of drilled shafts are largely based on soil-concrete interfaces, not soil-steel interfaces associated with large diameter steel casing. Owing to the increased understanding of our regional seismic hazards, the amount of steel reinforcement used in drilled shaft construction has increased over the past several decades. This creates a new construction concern for engineers: the increased steel area results in a reduced clearance between adjacent reinforcement bars in the steel cage, such that concrete has an increased difficulty in penetrating the cage, increasing the likelihood for voids and defects within the shaft, which can lead to poor structural and geotechnical performance. The use of high-strength reinforcement steel can lead to increased clearance within the steel cage, mitigating concreting issues. The use of steel casing and the amount of steel area control the axial and lateral resistance of the shaft. Thus, existing approaches need to be evaluated for modern construction methods, and new approaches developed if necessary to ensure desired performance criteria are met.

OBJECTIVES
The objectives of this research are to study the impact of steel casing and high-strength steel reinforcement on the axial and lateral behavior of full-scale drilled shaft foundation elements and to evaluate the appropriateness of existing ODOT design procedures. If necessary, new procedures incorporating the effect of steel casing and high-strength steel reinforcement will be developed. If selected, the Association of Drilled Shaft Contractors (ADSC) and PacTrans will contribute effort and funding to help accomplish these objectives. This project will also evaluate shafts installed at the OSU geotechnical test site 17 years ago by a joint FHWA/ADSC research venture such that interesting side-by-side geotechnical and structural aging effects can be determined.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments; staff time; travel; meetings; and publishing for:

- Literature Review and Survey
- Subsurface Characterization
- Install and Test Instrumented Drilled Shafts
- Evaluate Axial and Lateral Load Transfer
- Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Bridge Preservation Unit
Oregon State University (Agreement for $329,895 ending February 2017 with approximately $220,100 expended through May 2016.) Amendment 1 extends this contract through June 2018.

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
IMPACT OF CASCADIA EARTHQUAKE ON SEISMIC EVALUATION CRITERIA OF BRIDGES

OVERVIEW
The seismic risk used for bridge design and retrofit is defined by hazard maps of ground acceleration values. To generate the maps, an algorithm called a Probabilistic Seismic Hazard Analysis (PSHA) is used to combine multiple regional sources of ground shaking. Each source has a different intensity, probability of occurrence, and distance to a specific location. For Oregon, one key source of ground shaking in the PSHA is from the Cascadia Subduction Zone (CSZ); however, a CSZ earthquake can have significantly different ground motion as a standalone event than what is captured in the values derived from the PSHA.

OBJECTIVES
The objective of this project is to provide ODOT with the best rational estimate of ground acceleration values for designing and retrofitting bridges.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Staff time, consultant payments, research equipment, and travel

- Literature review.
- Disaggregate PSHA data along highway routes.
- Contrast CSZ with PSHA design values.
- Contrast structural damage from subduction earthquakes.
- Evaluate the impact on the dual design criteria.
- Final Report and Recommendations.

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Bridge Section
Portland State University (Agreement for $210,679 ending September 2016 with approximately $205,198 expended through May of 2016.) Amendment 2 extends this contract through September 2016.
### COST INFORMATION

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Contract amount amended in FY'15 to include an additional $19,000 from state bridge funds

Contract amount amendment pending to add $18,474 from state bridge funds

FY'16 expenditure and budget values are estimated.

FY'17 budget values are estimated based on forecasted project work.
OVERVIEW

Oregon has many reinforced concrete bridges that were built in the 1950’s. The bridges from this era commonly have poor reinforcing details such as longitudinal reinforcing bars terminating in areas under stress, inadequate bar splices, and insufficient vertical reinforcement. Consequently, these older ODOT bridges often are evaluated as deficient and require remediation. It is anticipated that on-going load rating and evolving loading requirements will uncover many deficient bridges for years to come.

Current practice and previous ODOT research provide design options for strengthening. A common option is to bond carbon fiber reinforced polymer (CFRP) strips either on the surface or just below the surface. The method relies solely on the adhesive bond to transfer stresses to the CFRP; consequently, the full strength of the CFRP is never utilized because the concrete near the bond fails first. To compensate for the relatively weak bond, more strips are installed to distribute stresses across more bond surfaces. If space is not available for more strips, a more elaborate strengthening scheme may be deployed.

In a current ODOT-funded research project, a titanium alloy bar has been developed that has high-strength and high ductility and is impervious to environmental degradation. The bar can be produced over a wide range of sizes. Unlike CFRP, a key feature of this material is that it can be bent. Consequently, the ends of the titanium bar can be bent to ninety degrees and embedded deep into a beam that needs strengthening. This mechanical anchorage overcomes the problem of the weak bond and allows the titanium reinforcing material to utilize its high strength. These characteristics make it both a structurally and economically effective choice over CFRP and other alternatives.

Based on the current research, a titanium retrofit will be deployed on a bridge over I-84. In the strengthening design, the number of supplemental reinforcement elements per girder line was reduced from twelve for CFRP to four for titanium. The retrofit is expected to be less costly and have better structural performance than CFRP.

The characteristics of titanium reinforcement, particularly its ability to be bent, open up possible cost savings for a wide range of strengthening situations. Three areas listed in the Research Objectives have been identified for further research to exploit the advantages of titanium reinforcement for strengthening.

OBJECTIVES

The research has three objectives to expand the use of titanium reinforcement: (1) Develop a splicing method that allows supplemental reinforcing bars to be deployed along the full length of girders including through the intermediate diaphragms that protrude from most beams. (2) Develop an unbonded strengthening detail that eliminates the need to cut grooves into the concrete surface, thereby reducing labor costs, epoxy material costs, and construction time. (3) Develop methods to apply exterior titanium bars to strengthen girders with inadequate transverse reinforcement.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx
PROPOSED ACTIVITIES
Consultant payments, staff time, purchase of equipment, travel, and publication for:

- Literature review
- Splice Details
- Unbonded Methods
- Shear Strengthening
- Analysis and Design
- Methods for analysis and design
- Reporting

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Bridge Section
Oregon State University (Agreement for $400,000 ending in September 2016, with approximately $392,934 expended through May 2016.)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.

FY’17 budget values are estimated based on forecasted project work.
OVERVIEW

The potential listing of the sage grouse as “endangered” by US Fish and Wildlife (expected in 2015) has the potential for significant impact to ODOT aggregate source operations. Oregon Department of Fish and Wildlife (ODF&W) has issued a whitepaper in 2012 that provides interim guidance for mitigation for sage grouse habitat from activities associated with industrial-commercial developments. Such developments include rock quarries. The interim guidance provides requirements for decibel thresholds, use of propagation models with output binned in 5-decibel contours, and recommended mitigation. It is unknown if activities from ODOT aggregate source sites comply with these very low noise thresholds. This uncertainty has potential impacts to development and delivery of projects in Regions 4 and 5 that depend heavily on material from ODOT quarries. Data are needed to determine compliance with the decibel thresholds and identify potential mitigation. There is also a great need to collect data for development of a methodology that can be applied throughout the state for determining noise impacts to sage grouse habitat and habitat for other noise sensitive species as well as other noise sensitive uses from rock quarries.

OBJECTIVES

The key objective of this project is to establish how noise produced by ODOT aggregate source operations compares to standards being put forward to protect sage grouse populations. This research project will be divided into two phases: 1) collection of ODOT aggregate quarry noise measurements, and 2) analysis of quarry noise measurements including production of noise contour maps.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments, staff time, data collection, data analysis, writing, and publication.

Phase 1 of this project will be completed by SLR consulting in June 2017.

Phase 2 of this project is under development in May 2016. Once it begins; more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

Phase 1 noise measurements are 50% complete, with 100% completion expected in June 2016.

Phase 2 of this project is projected to begin July 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES

ODOT Research Section
ODOT Geo-Environmental Section

SLR Consulting (Phase 1) (Agreement for $56,883.00 ending in September 2016, with approximately $42,651 expended through May 2016.)

(Phase 2, in Development OSU Agreement for $127,578 ending June 2018)

COST INFORMATION

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FY'15 expenditure and budget values are estimated.

Work plan under development

FY'16 budget values are estimated based on forecasted project work.
OVERVIEW
Thin preservation treatments are becoming more important because of their success to extend pavement life and the high cost of total road rehabilitation. Hicks et al. (2000) reported that for every dollar spent on maintenance before the age of rapid deterioration saves $6 to $10 in future rehabilitation costs. Chip sealing is a common preventive maintenance tool that results in more economical pavements as a result of pavement life extension. Chip seals are the main tool that ODOT uses for preservation of low volume roads and use has expanded to all types of facilities, including the interstate. Our chip seal program comprises approximately $7 million per year. The budget allocated for chip seals is cost effective and covers an extensive amount of lane miles. In past years, chip seals were predominantly applied by Maintenance crews, however, now ODOT is outsourcing a portion of this work to contractors who need better guidance.

The technique used to apply chip seals is currently referred to as more of an ‘art’ than ‘science’. The method involves an experienced person conducting a visual inspection during the application and making adjustments in binder and/or aggregate (chip) rate. Many of the experienced individuals within ODOT are nearing the end of their careers or have already retired. Over the last two construction seasons, there have been multiple failures. One project had to be repaved the following season at a cost of $1.8 Million. Also, when proper chip embedment is not achieved, there is potential for windshield claims. In another case, the claims totaled more than the actual project cost. There are design tools available which use math and science to select appropriate shot rates for binder and chips which could improve success. NCHRP Synthesis 342 reported that more quantitative methods are becoming available and these methods can lead to improved performance. These quantitative tools are used by other agencies both in the USA and internationally. A commonly accepted methodology is the McLeod Method. New Zealand (NZ), United Kingdom (UK), South Africa (SA), and Australia (AU) all have quantitative design procedures for design and construction of chip seals. ODOT’s specifications need to be revisited to ensure the agency is: a) providing better guidance to Maintenance crews and contractors, b) conducting the appropriate tests and construction practices, and c) providing the best-quality product to reduce the risk of claims.

OBJECTIVES
The objective of this research is to document methods and report the performance of chip seals designed using different methodologies. Once quantified, the research will identify best practices that can be implemented.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, staff time, purchase experimental equipment, travel, and publication for:
More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Pavement
Iowa State University of Science and Technology (Agreement for $175,000, through July 2016, with approximately $18,538 expended through May 2015.) Amendment 1 extended the contract through December 2016)

COST INFORMATION

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FY'16 expenditure and budget values are estimated.
FY'17 budget values are estimated based on forecasted project work.
OVERVIEW
Data-driven safety decision-making—including implementation of the Highway Safety Manual—requires the development of crash modification factor (CMFs) for various roadway improvements. Over the last decade, the Oregon DOT has systematically implemented many pedestrian crossing enhancements (PCEs) across the state. The most commonly deployed treatments include continental crosswalk markings, pedestrian median islands, curb bulb outs, pedestrian activated flashing beacons and advanced stop bars. The existing literature on driver yielding clearly indicates that medians are a significant pedestrian safety feature and pedestrian-hybrid beacons improve driver stopping compliance (both of these are included in the FHWA countermeasures clearinghouse). Rectangular Rapid Flash Beacons (RRFB) also improves yielding but the safety effects have not yet been quantified.

Still, many questions remain regarding the quantification of the positive impact of PCEs on overall crashes (i.e. medians may also reduce vehicle crashes) and the transferability of national results. As driver behavior and culture vary, estimates of safety effects are more accurate and relevant when developed from a robust, local data set. In Oregon, installations of crosswalks on state highways at mid-block or uncontrolled intersections require the approval of the State Traffic-Roadway Engineer (STRE). A careful integration of the well-documented installations of PCEs across the state with relevant traffic, roadway features, and land use data presents provide a unique opportunity to conduct robust research to estimate measures of PCEs safety effectiveness in the Oregon design contexts for improved data-driven decisions.

OBJECTIVES
The objective of this research is to estimate, as robustly as possible, the effectiveness of PCEs on multimodal safety in Oregon design contexts (i.e. not only pedestrian crashes but also motorized vehicles and bicycle crashes in the vicinity). This research will carefully consider the type of enhancement, the geometry, the surrounding land uses, and pedestrian/vehicle exposures. The results of this research will provide high value to decision-makers and will guide future PCE deployments. The results of this research can also set the foundation for future cost/benefit analysis of PCEs.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, staff time, purchase of equipment, travel, and publication for:

This project is under development in June of 2014. Once it begins; more information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
This project is under development in June of 2014. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Active Transportation Section
ODOT Transportation Data Section
Portland State University (Agreement for $130,000 ending in September 2016, with approximately $90,666 expended through May 2016.)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
779  RISK FACTORS FOR PEDESTRIAN AND BICYCLE CRASHES

OVERVIEW

In Oregon, pedestrian and bicyclist fatalities comprise more than 15% of all traffic deaths and are of primary concern for many communities in Oregon (there were 56 bicycle and 247 pedestrian fatalities in the last five years). Oregon has identified pedestrian and bicycle crashes as a primary focus area for investing infrastructure funding and has marked approximately $4 million in the All Roads Safety Program to help address this key need. However, developing a plan for targeted investments is challenging because pedestrian and bicycle crashes are uncommon enough to make it difficult to predict where they will occur next. This random nature also makes it difficult to identify high crash locations and corridors. The identification of risk factors and the magnitude of their influence on the likelihood of future crashes were significantly constrained by limited roadway information used in the analysis such as bicyclist and pedestrian volumes, the presence of a crossing treatment, presence of a turn lane, driveway activity, and sight distances. To improve ODOT’s ability to target limited resources more certainty is needed about the most important risk factors.

OBJECTIVES

The objective of this work is to develop a tool for ODOT to improve methods to identify and prioritize locations with increased risk, rather than a simple crash history, so they can be proactively treated. Using the consultant’s work as a starting point, this research would continue to investigate the factors related to the common causes of pedestrian and bicycle crashes. This research will seek to identify key risk factors that contribute to higher than average numbers of serious or fatal pedestrian and bicycle crashes to generate best practices in pedestrian and bicycle problem identification and prioritization, and identify data elements that support decision making and prioritization.

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments, staff time, purchase of equipment, travel, and publication for:

- Literature Review
- Data Collection Plan
- Data Collection
- Development of Risk Models
- Development of Risk-based Prioritization Tool
- Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)
RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic-Roadway Section
Portland State University (Agreement for $82,349 ending in August 2016, with approximately $69,658 expended through May 2016.)
Oregon State University (Agreement for $82,594 ending in August 2016, with approximately $15,499 expended through May 2016.)

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
OVERVIEW
Corrosion of the steel in reinforced concrete bridge decks is an important issue for structures that are exposed to chloride-containing de-icing chemicals or marine salts. Once the amount of chloride at the steel reaches a critical level, corrosion is likely to initiate. ODOT has a large number of bridges that are vulnerable to this form of deterioration. The cost of repairing or replacing bridge decks after corrosion initiation and damage is considerably high. Pre-emptive actions that prevent corrosion initiation are more cost effective than repair or replacement of bridge decks that have already experienced corrosion. An obvious indicator of a corrosion problem is visible damage; unfortunately, if corrosion damage is visible, the window for preventive action is likely closed.

ODOT uses chloride depth profiling on occasion to provide quantitative insight into the corrosion risk of bridge elements, but the method is time consuming and relatively expensive and is not practical for routine monitoring of bridge decks with current ODOT resources. Other measurement technologies are at various stages of maturity and are likely to be useful either by themselves or when used in combination. Whatever measures are used, values need to be turned into predictions about time to corrosion damage and when to apply pre-emptive action. Much valuable research is already available on detection technologies and models to predict corrosion.

Every year, ODOT treats the riding surface of select bridge decks with sealers, coatings and thin overlays to protect the decks from deicing chemicals. Currently, the decks are selected based on the judgment of field personnel occasionally with additional data from chloride profiles. There is no routine methodology in place to select decks based on quantitative measurements coupled with time-to-damage predictions. Fortunately, ODOT can exploit the extensive existing research to develop a selection protocol based on Oregon service conditions.

OBJECTIVES
The objective of the research is to provide ODOT with a protocol to select bridges for its ongoing bridge deck treatment operations using quantitative tools that are practical and quick.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, equipment purchase, staff time, travel and publication activities to produce:

- Literature Review and the Development of Detailed Research Plan
- Laboratory Study
- Modeling Study
- Development of Bridge Deck Evaluation Protocol
- Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Bridge Section
Oregon State University (Agreement for $239,000 through September 2016 with approximately$235,850 expended through May of 2016)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
OVERVIEW

ODOT is turning towards adaptive/responsive signal control strategies to improve the operational performance of coordinated corridors and networks. However, these newer control strategies require more information from the detection systems than more traditional control strategies. This requirement for higher resolution detection data could be addressed through the selection of in-pavement detection; however, due to the capital costs associated with in-pavement detection systems ODOT is increasingly selecting non-invasive or passive detection systems such as video cameras, micro-wave, radar, or micro detection pucks, which are also easier to install and maintain.

These non-invasive systems are currently performing below those standards established by the use of in-pavement detection. As such, ODOT is currently operating adaptive and responsive signal control by applying legacy timing and installation practices, and in doing so is not maximizing the benefits of its investment in advanced control strategies. The use of passive detection can degrade optimal intersection performance up to 20%, resulting in longer delays to the public, inefficient use of cycle time, increased traffic queuing, increased fuel consumption, increases risk of traffic crashes due to congestion and results in sub-optimal signal operations.

Current ODOT standards of practice for purchase, installation, layout and timing of non-invasive systems requires updating. More realistic costs, installation practices, detection zone layouts and timing parameters are needed in order to capture the full measure of the more powerful data driven traffic signal controller systems currently being deployed throughout the State of Oregon.

OBJECTIVES

This research will develop a realistic installation guideline that supports the requirements of advance traffic signal controller operations, hybrid detection installations, and non-invasive detection optimization. This guideline shall provide prototypical detection configurations and new timing standards that reducing or eliminating performance degradation. These guidelines will include a cost analysis that appropriately considers equipment and installation costs as well as the cost of increase delay to the motoring public due to the degradation of signal performance. The costs of this delay can be as much as ($18 per delay hour per/day per passenger vehicle) and as much as ($70 per delay hour per/day per interstate transit vehicle).

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

This project is under development in June of 2014. Once it begins; more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)
RESPONSIBLE PARTIES

ODOT Research Section

ODOT Traffic-Roadway Section

Northern Arizona University (Agreement for $160,000 ending September 30, 2016, with approximately $128,325.60 expended through May 2016.)

COST INFORMATION

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*FY’16 expenditure and budget values are estimated.*

*FY’17 budget values are estimated based on forecasted project work.*
OVERVIEW
Pavement layer adhesion is a major factor in the structural integrity of a pavement system. The inability of layers to adhere can cause premature cracking and lead to early pavement failure. This factor is even more important on thin HMAC wearing courses (<2”) which are becoming more common among highway preservation treatments. The main approach to layer adhesion has been through the emulsified tack coat. Tracking of the tack coat by construction equipment has always been an issue. It is taught that tack coat application is critical to performance, yet by the time the paver lays HMAC, most of the tack is gone. There are new asphalt emulsions being formulated that help combat this issue but are not yet refined enough for regular use or are pricey and proprietary.

OBJECTIVES
Recent research on tack has been able to identify harder base asphalt for emulsions and optimum application rates to provide a better bond. NCHRP Report 712 developed the Louisiana Tack Coat Quality Tester (LTCQT), to evaluate the quality of the bond strength of the tack coat in the field. The LTCQT may be developed as a tool for the paving inspector to ensure an adequate tack is being applied and if the tack is ready for construction traffic to reduce the tracking potential of the tack coat.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant Payments, Research Materials and Equipment, Staff Time, Travel, and Publication for:

- Evaluation of Tack Coat Set Time and Tracking – Lab Testing
- Three Dimensional Finite Element Model to Evaluate the Effect of Structural Characteristics on Tack Coat Shear Stresses
- Evaluation of Tack Coat Test Methods and Procedures – Field and Lab Evaluation
- Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Technical Services, Construction Section
Oregon State University (Oregon State University (Agreement for $140,000 through December 2016 with approximately $90,847 expended through May of 2016)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
OVERVIEW
It is nationally recognized that commercial motor vehicle operators often cannot find adequate and safe parking for rest purposes. This is especially true for Oregon, where high-use corridor rest areas are experiencing a heavy demand for commercial vehicle parking, one that exceeds capacity. These rest areas are intended for short-term safety breaks, yet they are increasingly used for long-term parking—private truck stops are also experiencing capacity shortfalls. The economic recovery and driver hour-of-service regulations have recently contributed to the rising demand. Use of these facilities is particularly high during the winter months when hazardous road conditions restrict or bring traffic to a standstill. Recent studies performed by Pahukula and Hernandez (2014) and Islam and Hernandez (2013) have shown factors related to weather and fatigue increase the injury severity level potential of commercial motor vehicle involved crashes.

Because of the commercial vehicle parking shortages and limits on stays in public rest areas (Oregon Administrative Rule 734-030-0010 allows a vehicle to remain in a rest area for up to 12 hours in a 24-hour period), commercial motor vehicle operators may be contributing to unsafe situations by driving without a needed short break and/or by parking on roadway access ramps, shoulders, at highway interchanges and on facilities running through cities and towns. Currently, there is an active ODOT solicitation of interest for a trucking parking facility at Biggs Junction (I-84 at US 97) that seeks creative and innovative ideas to address the problem through a proposed public/private partnership mechanism. Although this effort is focused at a specific site, ODOT would benefit greatly by identifying all potential locations across the State.

OBJECTIVES
Assess commercial vehicle parking needs and analyze safety on high-use corridors in the State, the research objectives are intended to determine:

- what other states are doing to address the truck parking shortage and related safety implications
- what data are available to measure the extent of the problem (e.g., identifying truck parking supply and demand)
- opinions of commercial motor vehicle operators with regards to parking shortages and parking location decisions
- future demand for truck parking based on freight forecasts prepared in the OFP to identify priority locations for adding truck parking capacity
- safety risks (benefit) of capacity enhancements

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Set up a workshop including venue, food, and travel for regional trucking experts; consultant payments; staff time; equipment purchase and calibration, field testing and observation, data acquisition; data analysis; TAC presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
Oregon State University (Oregon State University (Agreement for $168,000 through June 2017 with approximately $53,000 expended through May of 2016)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
DEVELOPMENT OF TITANIUM SEISMIC RETROFITS FOR DEFICIENT CONCRETE COLUMNS

OVERVIEW
Hundreds of bridges in the Oregon bridge inventory are supported on seismically deficient reinforced concrete columns. Reinforced concrete (RC) columns designed prior to the mid-1970’s have details which make them susceptible to premature failure during earthquakes. In particular, lap splices and widely spaced transverse reinforcement are insufficient to develop and maintain strength under repeated loading. Splices are typically located just above the footing elevation in hinge regions where there is significant ductility demand. Transverse reinforcement is often too widely spaced and insufficient to adequately confine the core area, prevent buckling of the longitudinal reinforcement within the flexural hinge region, and provide sufficient shear strength. These deficiencies have led engineers and researchers to develop different retrofitting methodologies to improve their seismic performance.

This research will evaluate new retrofit methods are proposed which employ a novel use of continuous spirals of a high-strength titanium alloy bars, supplemental longitudinal titanium alloy bars, and are combined with low shrinkage concrete or grout to externally protect nonductile rectangular RC columns.

OBJECTIVES
A research program is proposed to develop seismic retrofits for nonductile rectangular RC columns using high-strength titanium alloy bars. The objectives of the proposed research project are to:

- Establish the structural effectiveness of titanium alloy bars for seismic retrofitting RC columns
- Determine the economic feasibility of the retrofit methods
- Develop analytical models to describe the behavior and performance of retrofitted nonductile RC columns
- Develop design methods that can be used to achieve desired seismic performance for nonductile RC columns

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments; bridge piling experimentation (destructive testing), in-lab experimentation of newly developed retrofits, and testing in-field; data acquisition; data analysis; technical presentations, final report; staff time, travel, and publication for:

- Literature Review
- Bridge Pile Testing
- Lab Experiments
- Field Tests of retrofits
- Analysis, and
• Final Report

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES

ODOT Research Section
ODOT Bridge Section
Oregon State University (Agreement for $400,000 through January 2018 with approximately $0 expended through May of 2016)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
ADJUSTING ASPHALT MIXES FOR INCREASED DURABILITY AND IMPLEMENTATION OF A PERFORMANCE TESTER TO EVALUATE FATIGUE CRACKING OF ASPHALT CONCRETE

OVERVIEW

Asphalt concrete fatigue cracking has been accepted to be a major distress mode in Oregon. ODOT’s Pavement Management system has shown that mixes placed in the last 20 years have had a tendency to develop premature cracking after 6 to 8 years of service life before reaching the structural design life of 15 years. The widespread nature of this distress would suggest that it is an issue with the way mix is designed and produced and not a specific project related problem. Thus, current test methods and design guidelines should be modified and improved to be able to develop more durable asphalt mixtures with longer service lives. In order to determine the most feasible test method and analysis protocol to be used in district and contractor laboratories in Oregon, accuracy, precision, time, cost, efficiency, and practicality of different cracking tests should be evaluated.

OBJECTIVES

This research would have five major objectives: i) compare the results of direct tension fatigue (DT), indirect tensile (IDT), semi-circular bending (SCB), and beam fatigue tests using various energy and fatigue life parameters to determine how well they agree; ii) investigate the effectiveness of each test for identifying the impact of polymer modification, recycled asphalt content, compaction level, aggregate properties, and binder contents on mixture cracking performance; iii) investigate the effectiveness of each test in predicting in-situ cracking performance; iv) evaluate the tests for time, cost, efficiency, complexity, and practicality for use in district and contractor laboratories in Oregon; and v) investigate the effects of aggregate properties (toughness, abrasion resistance, durability, gradation, % of P200, etc.), volumetrics (Va, VMA, VFA, Pbe/P200), binder content, air void content and binder grade on durability to provide recommendations to the Contractor Mix Design Guidelines.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments, equipment purchases, staff time, travel and publication for:

- Literature Review
- Laboratory Testing and analysis of a test matrix of specimens with various material properties
- Review of historical pavement performance data
- MEPDG cracking simulations
- Evaluation of mixture durability properties
- Final report

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
Oregon State University (Agreement for $170,000 through June of 2017 with approximately $0 expended through May of 2016)

COST INFORMATION

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work.
ENHANCING LANDSLIDE INVENTORYING, HAZARD ASSESSMENT AND ASSET MANAGEMENT USING LIDAR

OVERVIEW
Landslides are frequent hazards that result in major economic, environmental and social impacts for operation, maintenance and construction of Oregon highways. Current databases of landslides in Oregon are limited and fragmented since they are based on a variety of inventories/geologic maps and have been mapped sporadically over time. Often, when large landslides occur on Oregon highways, there is no information about whether it is a reactivated existing landslide or a new slope failure. Therefore, it is critical that a baseline inventory of landslide hazards occur so a baseline quantity of existing landslides can be established - especially those of which are ongoing. Such knowledge is crucial to asset management, especially in the wake of significant rain events or seismic activity (e.g. Cascadia subduction zone event).

The combination of geomatics-based hazard mapping and a reliability-dependent application of soil and rock mechanics for future slope risk, integrated with publicly available geology and soil maps would enable large-scale assessment of landslide hazards affecting state highways. The outputs would provide enhanced measures to assess management costs, prioritize areas of concern, decide to expand or reduce potential site investigation, and assess potential future route planning. Furthermore, a superior and consistent framework for classifying landslides would further inform prioritization, mitigation needs and mitigation technique selection, a critical consideration in asset management. One of the most important tasks in managing infrastructure is inventorying hazards, like existing landslides, in order to cost-effectively strategize about maintenance and management of infrastructure. These benefits would complement the efforts of the ODOT’s current Unstable Slopes Program and Seismic Lifeline evaluation initiative.

The information developed by this project will allow ODOT to work with other agencies to assess the overall risk to infrastructure on a regional scale. It provides a baseline of information from which to project future impacts from landslide activity from an existing reference point with respect to existing landslides.

OBJECTIVES
Produce a research project identified by the ODOT Research Advisory Committee for the SPR Part 2 Program.

This project will develop a refined risk assessment and prioritization of assets by integrating transportation networks, landslide activity, soil and geology maps, and reliability-based approaches with Lidar data on a landscape scale. Objectives include:

1. Advance the CCM algorithm to include input from available soil and geology maps to improve landslide identification.

2. Associate identified landslides and their unique criteria with basic landslide types or modes of failure (e.g., rotational, translation, etc.) for classification of landslide age and activity. This will establish the first consistent and non-subjective framework for landslide classification.
3. Implement statistical functions that detect hazards based on available geology maps or manual input.

4. Provide an easy-to-use landslide prioritization framework that uses a given DEM to map current landslides and problematic regions. This map would directly assist in assessing hazards, asset management, and evaluating mitigation techniques of slope-related problems along ODOT right-of-way. Prioritization will be based off of identified landslide deposits, classified age, classified activity, size and proximity to the highway. Evaluate refined output and quantify the resulting time and cost-savings due to CCM application.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Performs research of Oregon landslide issues; Set up a workshop including venue, food, and travel for regional landslide experts; consultant payments; staff time; equipment purchase and calibration, field testing and observation, data acquisition; data analysis; TAC presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
Oregon State University (Agreement for $250,000 through December 2017 with approximately $0 expended through May of 2016)

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*FY’16 expenditure and budget values are estimated.*

*FY’17 budget values are estimated based on forecasted project work*
OVERVIEW

UAVs are capable of flying a pre-loaded path and can carry digital cameras and other sensors. They are excellent for accessing spots that are dangerous or hard to reach by humans without the use of specialized climbing equipment. During flights, operators can view live video from the camera to determine areas that may need detailed inspection. Digital photographs from onboard cameras can be processed, mosaicked, georeferenced, and converted into 3D point clouds for analyses.

Because of the rapid emergence of UAV-related technology in recent years, there is growing interest in the feasibility of inspecting structures with UAVs. For example, Hallerman and Morgenthal (2013) concluded that UAVs can be effective for inspecting industrial chimneys and historical buildings. Sa et al. (2015) investigated the use of a UAV for inspecting poles. Ellenberg et al. (2014), and Eschmann et al. (2013) showed that UAV imagery can be used to detect cracks and other defects in structural elements.

Because of low flight costs, UAVs can also be flown regularly to monitor ground and structural changes. For instance, Hallerman et al. (2014) showed that imagery from a UAV can be used to monitor deformations along dams and earth retaining walls.

Although some very recent work has been published on the feasibility of using UAVs for some structural inspections, much more work is needed if DOTs intend to implement UAVs in their bridge inspection programs. First, this project aims to test and evaluate the effectiveness of inspecting bridges (and, as discussed below, wireless communication towers) with UAVs. To date, no peer-reviewed papers have been found on inspecting these types of structures with UAVs. Second, a cost-benefit analysis will be provided on using UAVs for inspecting these structures as compared with conventional inspection methods. Third, this project will give practical recommendations on how to best and safely perform UAV inspections. Recommendations will include how to best plan a flight mission and set the camera acquisition parameters.

OBJECTIVES

The overall goal of this research is to determine the capabilities and limitations of performing structural inspections with UAVs. In addition to investigating bridges, the research team will also evaluate the performance of UAVs in inspecting wireless communication towers. Similar to bridges, communication towers also need to be routinely inspected, requiring extensive climbing, bucket trucks, and ropes and harnesses. Because the inspection of bridges and communication towers present similar safety concerns, and because UAVs could potentially reduce their inspection dangers and costs, both types of structures will be investigated. This research seeks to:

- Evaluate the performance of UAV-based methods for inspecting bridges and communication towers
• Identify which ODOT inspection requirements can and cannot be satisfied with a UAV inspection.

• Provide a cost-benefit analysis of performing UAV inspections for communication towers and bridges.

• Develop procedures/guidelines for how to safely and effectively perform UAV inspections of bridges and communication towers. These guidelines will include recommendations on any necessary UAV-related equipment and image processing software.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments; staff time; UAV equipment purchase and calibration, set-up of test bridge/beam on campus; In-lab experimentation of imagery capture, Testing in live field conditions; Data acquisition; Data analysis; TAC presentations, Final Report; and Travel;

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
ODOT Bridge
Oregon State University (Agreement for 180,000 through January 2018 with approximately $9,153 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.

FY’17 budget values are estimated based on forecasted project work.
Performance-based planning helps us to understand the potential impacts of decisions we make, supporting cost-effective investments and policy choices that we know can help us achieve our goals. In addition, it can enable monitoring of progress and facilitate needed adjustments, help us to communicate to the public, and assist us with meeting federal regulations and the intent of MAP21. ODOT has successfully developed a process for and applied performance-based planning in statewide and regional scenario planning efforts. These efforts have led to significant interest by regions and locals to integrate the process and tool ODOT developed into other planning and decision-making efforts. Additionally, ODOT planning is using the tool to help quantify modal and topic plan visions and policies and better communicate the anticipated benefits in ways seeming to resonate well with stakeholders and elected officials. As popularity for using the tool and process grow, there is recognition that a deeper understanding is needed to determine how mode choices and mode share may be impacted by policy and investment decisions. This is particularly important when starting to apply the tool in a broader base of planning and decision-making processes to truly understand what may be the best decisions for the entire transportation system (multimodal and intermodal).

Research is needed to understand how traveler’s mode choices may change in response to different policy and investment decisions. As an example, we have a good sense of how household vehicle miles traveled (VMT) is likely to change in response to policies like pricing, but we do not currently have the ability to estimate what effect that might have on travel by other modes, and how household mobility/accessibility might be affected. Placing ODOT’s performance-based planning process in a multimodal context would enable ODOT, regions, and locals to cost-effectively deliver a transportation system that best achieves respective goals and to integrate what is learned from the research into existing tools.

OBJECTIVES

This project will research the key drivers of multi-modal analysis, as they relate to individual households, annual household travel, household budgets and price sensitivity. The research will explore travel survey (household and transit) and consumer expenditure data. The general research findings will support planning questions on these topics, and will bolster ODOT, region, and local analysis capabilities specifically by implementing a module that can be plugged into existing tools (specifically the Regional Strategic Planning Model – RSPM).

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments; staff time; equipment purchase and calibration, field testing and observation, data acquisition; data analysis; TAC presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
Portland State University (Agreement for $74,143.00 through February 2017 with approximately $8,166 expended through May of 2016)
Brian Gregor Consulting (Agreement for $30,000 through February 2017 with approximately $0 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work
OVERVIEW

The design of phasing schemes at signalized intersections are complex multifaceted transportation engineering problems. Right-turn operations place a significant challenge to engineers attempting to develop optimal phasing solutions for safety and efficiency. There is a surprising absence of specific guidance at the national and state level on how phasing alternatives should be selected, and how they compare in terms of operational and safety performance. Available documents such as the Traffic Signal Timing Manual (FHWA, 2008) or the ODOT Traffic Signal Policy and Guidelines (ODOT, 2013) are excellent resources, but critical questions remain with regard to what in-situ conditions: turning volumes (vehicles, bicycles, and pedestrians), vehicle classifications, lane configurations (single receiving lane for both right turns and conflicting lefts), and gap profiles warrant protected/permitted right turns. Turning vehicles are the primary collision risk for non-motorized users and when these turning movements need to be controlled directly, proper driver response to traffic control is critical.

The challenge of designing the phasing schemes for protected/permitted right turns in Oregon has been widely identified by local traffic signal experts, presenting an opportunity for a research-based solution. Staff members from ODOT, Washington County, Clackamas County, the City of Salem, and several other agencies have been participating in an ad hoc collaboration to identify and document issues, and have determined that the gaps in the existing knowledge necessitate new research. This need has intensified with the recent allowance of the Flashing Yellow Arrow (FYA) to indicate a permitted right turn (MUTCD, 2009). While traffic engineers have a good understanding of driver comprehension and response to the circular green ball or a solid green arrow for right turning movements, significant questions remain regarding the FYA for right turn movements, as well as driver responses to the solid red arrow in Oregon.

OBJECTIVES

The goal of the research is to develop an understanding of the safety and operational implications of using the FYA to indicate a permitted right turn, and to provide general guidance as to when Protected/Permitted Right Turns (PPRT) phasing should be used to maximize the safety of non-motorized road users and the overall efficiency of ODOT’s signalized intersections.

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments; staff time; equipment purchase and calibration, field testing and observation, data acquisition; data analysis; TAC presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

(See Quarterly Reports at the link above.)
RESPONSIBLE PARTIES

ODOT Research Section

ODOT Traffic Services

Oregon State University (Agreement for $90,000 through August 2017 with approximately $0 expended through May of 2016)

Portland State University (Agreement for $70,000 through August 2017 with approximately $2,828 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.

FY’17 budget values are estimated based on forecasted project work.
OVERVIEW

Roadway construction and maintenance operations commonly require workers to conduct their work in close proximity to ongoing traffic. Short-term work zones (WZs) on high speed roads often involve working adjacent to passing vehicles separated by only a line of traffic markers. This worksite condition presents significant safety risk for both the workers and passing motorists. Inattentive or speeding drivers, careless workers, misplaced drums, and hazardous roadway conditions can lead to crashes and ultimately WZ injuries and fatalities. Other factors that can cause an increase in WZ crashes include: increase in nighttime work; lack of consistency of WZs; distracted drivers; and increase in vehicle miles travelled.

New technologies are publicly available that alert workers of work area intrusions. Prior work zone safety studies conducted by ODOT did not target work area intrusions and the technologies available to warn of intrusions. Literature is available from the device manufacturers that describe the specifications of each individual technology; however no studies have been found that provide a comprehensive review and comparison of the available technologies and present recommendations for their use in practice. Objective evaluation is needed that addresses the capabilities and effectiveness of the technologies, ease of use, viable application conditions (e.g., short-term/long-term work zone; stationary/mobile operation; and nighttime/daytime shift), and current cost and feasibility of implementation.

OBJECTIVES

The goal of the proposed research study is to provide ODOT traffic control, construction, and maintenance staff with guidance on the use of intrusion alert systems in work zones. To meet this goal, the research will include the following tasks:

- Document the work zone intrusion alert technologies and practices that are currently available and being developed.
- Select and pilot test a sample of intrusion alert technologies for evaluation and testing in ODOT work zones.
- Evaluate each of the selected technologies in active ODOT construction and/or maintenance work zones.
- Prepare documentation for ODOT that describe the capabilities and cost effectiveness of each technology evaluated.
- Provide recommendations for use of the technologies on future ODOT construction and maintenance work zones.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant Payments; staff time; equipment purchase and calibration, field testing and observation, data acquisition; data analysis; TAC presentations, final report; and travel;
More information on proposed activities can be found in the Project Work Plan at the link above.

**ACCOMPLISHMENTS**

(See Quarterly Reports at the link above.)

**RESPONSIBLE PARTIES**

ODOT Research Section

ODOT Traffic Services

Oregon State University (Agreement for $240,000 through August 2017 with approximately $13,417 expended through May of 2016)

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*The overall project budget is revised down by $36,000 in Amendment 2 due to cost savings on project equipment.*

*FY’16 expenditure and budget values are estimated.*

*FY’17 budget values are estimated based on forecasted project work*
OVERVIEW

Much of the construction work that occurs on high-speed roadways takes place at night, exposing workers to hazards that are not present or as great during the daytime (e.g., impaired drivers, lack of sufficient lighting, and icy conditions at night). As a result, special measures are taken during nighttime work to protect workers and motorists in work zones, including workers wearing reflective clothing, flaggers using lighted STOP/SLOW paddles, and the use of illuminated signs for traffic control. Working at night also requires illuminating the work area. Construction crews typically employ light towers, balloon lights, or other lighting systems in order to see and conduct their work. The actual type of lighting system used depends on various factors such as the amount of light needed and the nature of the work operation (e.g., stationary or mobile, and short- or long-term). FHWA and OSHA publish standards for the minimum and recommended lighting in work areas.

The potentially positive impact that work area lighting can have on vehicle speeds is promising for safety in other areas of a work zone. A work zone may extend for several miles. Adding lighting to areas where the paver and typical work area lighting are currently not present may be a low cost means of making motorists more aware of workers on the roadway, reducing vehicle speeds throughout the work zone, and further protecting workers on the roadway.

OBJECTIVES

The proposed research study aims to: (1) determine whether additional lighting added throughout a work zone can benefit work zone safety; and (2) develop recommended practices for strategic use of lighting systems in work zones to help control and reduce vehicle speeds. The following specific objectives are proposed for the study:

- Document current work area lighting systems and practices in preservation project work zones.
- Determine the typical work patterns and activities in preservation project operations.
- Identify potential strategies for additional illumination of work zones using available lighting systems.
- Select and test one or more lighting strategies in an actual work zone to assess the impacts of the lighting on vehicle speeds, worker safety, contractor operations, and work performance.
- Develop recommendations for ODOT for additional work zone lighting to enhance work zone safety.

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx
PROPOSED ACTIVITIES
Consultant payments; staff time; literature review; pilot testing; data acquisition (in-field); data analysis for multiple sites; tac presentations, final report; and travel.
More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Traffic Services
Statewide Construction Office
Transportation Safety Division,
Region Transportation Safety Coordinators in each Region
Oregon State University (Agreement for $175,000 through June 2017 with approximately $35,858 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work
CONSTRUCTION OF EFFICIENT, COST-EFFECTIVE AND SUSTAINABLE MAINTENANCE FACILITIES

OVERVIEW

There are approximately 89 maintenance stations within ODOT, and a large assortment of other sheds, storage, and support buildings. Many of these maintenance stations are old, beyond their life expectancy, inefficient, or functionally obsolete (unable to accommodate larger-size, modern equipment). There is an urgent need to systematically replace these buildings to support the agency maintenance mission. A typical maintenance station can cost up to $8-$9 million, representing a significant capital cost burden over the next several years. A new maintenance station recently constructed in Sisters became the first in Oregon to incorporate renewable energy – in the form of geothermal heating and solar water heating. Even more sustainable and cost-effective solutions could have potentially been accomplished by utilizing high performance design practices, sustainably produced materials, increased insulation, more efficient lighting, water-saving techniques, waste reductions, etc.1-4

The goal of this research is to document and provide such information for ODOT decision makers to make the most efficient use of the funding for maintenance station buildings.

OBJECTIVES

The main goal of this research project is to produce guidance that includes options for enabling ODOT to construct high performance maintenance facilities that will: increase operational functionality, reduce environmental impact, increase energy efficiency, and lower life cycle costs.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Task 1: Literature review
Task 2: Field studies
Task 3: Stakeholder outreach
Task 4: Definition of evaluation criteria
Task 5: Development of proposed, cost effective solutions
Task 6: Analysis of propose solutions
Task 7: Document performance of most

Consultant Payments; staff time; literature review; pilot testing; data acquisition (in-field); data analysis for multiple sites; tac presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Facilities
Oregon State University (Agreement for $193,000 through August 2017 with approximately $16,104 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.

FY’17 budget values are estimated based on forecasted project work
OVERVIEW
The goal of this project is to evaluate the effectiveness of ATMS featuring VAS components (similar to being installed on OR 217 (urban) and US 26/OR 35 (rural/mountain)) specifically for real-time safety improvements. The real-time safety evaluations will provide the groundwork for future implementations of ATMS and VAS systems across the state.

OBJECTIVES
• Identify corridors of interest with ATMS and control corridors without ATMS.
• Explore sources of historical crash data for the corridors.
• Merge crash data with the traffic and weather information being archived for the corridors.
• Create a database and procedure for merging of future crash data with traffic and weather information.
• Create a prototype pilot crash risk assessment framework for selected freeway corridors to assess the real-time safety.
• Perform quantitative real-time safety evaluations of existing ATM deployments (e.g., OR 217, I-5, I-405 or US 26/OR 35 if applicable).
• Provide final results, lessons learned, guidance and recommendations for future implementations.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Staff time; literature review; pilot testing; data acquisition; data analysis; tac presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
(See Quarterly Reports at the link above.).

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Region 1
ODOT ITS
Transportation Safety Division,

**COST INFORMATION**

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*FY’16 expenditure and budget values are estimated.*

*FY’17 budget values are estimated based on forecasted project work.*
OVERVIEW
While FHWA, AASHTO, and numerous interest groups, provide guidance as to intersection design at midblock trail crossings, detailed guidance is not provided for the design of trail crossings near rail crossings. Lack of design options results in confusion, muddled priorities, and a missed opportunity to address potential conflicts.

An important issue when designing a multi-use pathway road crossing, adjacent to a railroad crossing, is ensuring that drivers of motor vehicles, who usually control the fastest and heaviest vehicles involved in the pathway crossing, are aware of the presence of trail users, either through appropriate sight distance, a warning device, or some combination of the two. Infrastructure design should also ensure that the vehicles do not foul up the railroad crossing when the pathway crossing is occupied. Trail users, especially cyclists and joggers, also should be provided with adequate sight distance to observe vehicles, and as they have a responsibility to slow or stop before crossing the road to ensure the safety of themselves and others. This work will provide transportation engineers and planners with more practical guidance than exists in the current literature, providing them with a framework for designing site-specific solutions.

OBJECTIVES
Provide background, information, and guidance for infrastructure designers, planners, and interested parties, when faced with complex and problematic intersection design that involves railroad crossings and multimodal users including bike, ped, and motor vehicles.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Literature review
Field studies
Stakeholder outreach
Definition of evaluation criteria
Development of proposed, cost effective solutions per location
Analysis of propose solutions
Document performance of most viable scenarios

Consultant Payments; Staff Time; Literature Review; Pilot Testing; Data Acquisition (In-Field); Data Analysis for Multiple Sites; TAC Presentations, Final Report; and Travel;

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Rail Division
Transportation Safety Division,
ODOT Traffic
University of Washington (Agreement for $193,000 through August 2017 with approximately
$12,910 expended through May of 2016)

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FY’16 expenditure and budget values are estimated.
FY’17 budget values are estimated based on forecasted project work
OVERVIEW
General reduction in pavement program funding levels over the past decade and the possible consequent increase in pavement road roughness within the next couple years created a need for low cost yet effective alternative ways to rehabilitate, preserve and maintain roadway network in Oregon. Recycling highway construction materials and minimizing the use of virgin materials can reduce the pavement life cycle costs, improve highway network condition, conserve natural resources, and protect the environment. Although the recycling of asphalt pavements is beneficial in most cases by reducing the need for virgin materials and construction costs, asphalt pavements with high recycled asphalt pavement (RAP) and recycled asphalt shingle (RAS) contents should be carefully designed to avoid premature cracking (West et al., 2013, NCHRP 752). The use of binder-grade bumping and high virgin binder content were determined to be effective in improving cracking performance. Increased crack resistance allows the use of higher RAP/RAS contents. While these two strategies generally increase the cost of virgin binder used in the asphalt mixture, increased RAP/RAS content and improved RAP/RAS performance will reduce the overall life-cycle cost of recycled asphalt concrete material used in construction. Mechanistic-empirical (ME) pavement design methods and laboratory testing need to be combined with different modeling methods to investigate the performance benefits of using binder-grade bumping and high binder content in RAP/RAS mixtures.

OBJECTIVES
i) identify the effects of binder-grade bumping and higher binder content on RAP/RAS performance; ii) determine the impact of these alternatives on increasing RAP/RAS contents; iii) evaluate the impact of higher RAP/RAS contents on asphalt mixture compaction; iv) evaluate the effect of blending on mixture performance; and v) investigate the impact of RAP/RAS content, virgin binder grade, and binder content on in-situ cracking performance.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Literature Review
Laboratory Investigation
Blending of Virgin and Recycled Binders
Mechanistic-Empirical Modeling –
Final Report
Consultant payments; staff time; literature review; pilot testing; data acquisition (in-field); data analysis for multiple sites; tac presentations, final report; and travel;

More information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
(See Quarterly Reports at the link above.)

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Maintenance
Statewide Construction Office
Oregon State University (Agreement for $170,000 through June 2017 with approximately $0 expended through May of 2016)

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FY'16 expenditure and budget values are estimated.
FY'17 budget values are estimated based on forecasted project work
OVERVIEW

ODOT’s stormwater treatment program faces increasing pressure from existing and future permitting requirements from both the Endangered Species Act and the Clean Water Act. An integrated strategy for highway system level assessment of water quality within a watershed is needed to address strategic planning for stormwater treatment and facility placement. Considering that stormwater banks can be used both to off-set lack of complete treatment on projects due to constraints and as in-lieu treatment for small projects where treatment would not be cost effective, bank establishment should require demonstration of the level of benefit to the watershed. Implementing a stormwater banking strategy requires an understanding of highway impacts on watersheds that goes beyond single site analysis. Unfortunately, the impact of ODOT’s highway system on watershed water quality is currently very poorly understood. The Stochastic Empirical Loading and Dilution Model (SELDM), recently developed in cooperation with the FHWA by the U.S Geological Survey—and now FHWA’s preferred stormwater quality model—is intended for project specific analysis. Following the 2014 ODOT sponsored project to calibrate and test SELDM in Oregon, ODOT and the USGS realized that the model was capable of being used to calculate the watershed scale impacts of the highway system.

OBJECTIVES

The proposed research project aims to expand the usefulness of SELDM to watershed level analysis. The procedures to be developed will allow the practitioner to determine both the total and relative pollutant loading attributable to highway sources at any point on a watershed’s stream network. Specifically, the objectives of this proposed study are to:

1. Develop techniques and protocols for SELDM scale-up. The newly optimized SELDM model will enable impact analysis of water quality from multiple highway discharge points in a watershed as well as from specific points within the watershed.
2. Demonstrate SELDM scale-up protocols using empirical data from Oregon watersheds with highway runoff pollutant related TMDLs and multiple highway discharge points.
3. Develop a guidance manual and final report for watershed level analyses using SELDM, based on the results and experience gained in step 2.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Task #1: Develop procedure for using SELDM to perform watershed level analysis of highway system water quality impacts.

Task #2: Test the procedure developed in Task 1 by performing analysis using the developed SELDM Watershed impact procedure.
Task #3: Develop guidance document and final report for using SELDM to perform watershed scale analysis.

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

**ACCOMPLISHMENTS**

This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

**RESPONSIBLE PARTIES**

ODOT Research Section

ODOT Geo-Environmental Section

Contract under development with US Dept. of Interior: USGS (Agreement for ODOT contribution $106,091; USGS matching contribution $57,126)

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**REVISED BUDGET**

*Budget values are estimated based on forecasted project work.*
OVERVIEW

ODOT currently tracks several metrics for compliance of pavement markings, including appearance and retro-reflectivity. The Maintenance Section of ODOT uses a van, which travels the state every summer, to capture retro-reflectivity values on lane markings, which are analyzed and used in creating a plan of action for maintenance (e.g., vendor replacement if covered under warranty, or in house or contracted maintenance). Unfortunately, issues arise due to the timing and frequency of the data acquisition. Often, individual hand-held reflectometer readings are required after winter months to recheck compliance, which may be risky (roadside) and staff time intensive. Sign retro-reflectivity evaluations suffer from similar limitations, and are more cumbersome for crews in making the retro-reflectivity measurements.

Mobile lidar scans of state highways are now being conducted on a regular basis through ODOT Geometronics. This technology supports a wide range of transportation applications [Olsen et al., 2013] within a single dataset that is acquired more safely and efficiently than conventional methods. In addition to capturing geometric information along the highways, a side product of lidar scans is intensity (return signal strength), which can be calibrated to produce estimates of reflectivity. Research is currently needed to: a) develop and test operational procedures for generating retro-reflectivity data from ODOT’s mobile scanner, and b) evaluate the effects of challenging conditions, including rain and ice, which are commonly encountered in the winter/spring seasons after plowing when crews evaluate lines for summer work.

OBJECTIVES

In light of these research needs, this study seeks to:

- Develop a model for retro-reflectivity and radiometric calibration for ODOT’s mobile lidar system.
- Generate a set of quality control metrics for pavement marking and sign retro-reflectivity based on information derived from mobile lidar data
- Establish procedures for creating GIS data layers from the output of the above steps to support decision making by supervisors and integrate analysis results into ODOT’s overall workflows.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Proposed activities include consultant payments; ODOT staff time; literature review; research methodology plan; pilot testing; data acquisition (in-field); data analysis; TAC presentations, final report, research note, and travel;

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
This project is under development in as of May 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Geometronics
ODOT Pavement Markings Committee
ODOT Engineering Automation
Oregon State University (Agreement for contract total of $165,000 ending November 2018)

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Budget values are estimated based on forecasted project work.
QUANTIFYING THE PERFORMANCE OF LOW-NOISE RUMBLE STRIPS

OVERVIEW

Roadway departure crashes account for 66% of all highway fatalities in Oregon, the majority of which happen on rural highways. Rumble strips, either on the shoulder or on the center-line, are a low-cost countermeasure which has been shown to significantly reduce roadway departure crashes. The noise and vibration generated by the rumble strips alerts drivers when they are departing the traveled way. In Oregon, these are either milled-in or installed with raised durable striping. Previous research indicates that on rural 2-lane roadways, shoulder rumble strips (SRS) reduce run-off-road (ROR) fatal injury crashes by 33% and all ROR crashes by 15%. Center-line rumble strips (CRS) have been shown to reduce head-on and sideswipe crashes by 30%. Even though they are inexpensive to install, easy to maintain, and have a very long service life, it is not possible to install rumble strips on many roadway segments due to noise concerns. Residents living adjacent to highways have complained to ODOT regarding the noise generated by traditional milled-in rumble strips. As a result, rumble strips are not currently installed on many roadway segments – even where there is documented evidence of lane departure crashes.

A newer sinusoidal pattern design produces a lower noise profile and may be a solution. There is an opportunity to scientifically quantify the noise differentials between traditional and sinusoidal milled rumble strips. It is generally believed that sinusoidal rumble strips generate the necessary in-vehicle vibration and noise and reduced roadside noise; however, little to no research has been conducted to date. Further, although ODOT has expressed interest in experimenting with the sinusoidal design, there have been issues in finding contractors willing/able to include the modified rumble strips in their work.

OBJECTIVES

The proposed study will evaluate the feasibility of using sinusoidal as a substitute for traditional milled rumble strips on highway segments with lane departure crash problems. A quantitative and empirical comparison of the in-vehicle noises and vibrations and roadside noises of sinusoidal and traditional rumble strips will give an indication as to whether the sinusoidal pattern can potentially be used as a substitute for the traditional pattern in areas with lane crash problems.

The full work plan is under development as of May, 2016. When complete, more detailed information regarding the project and its objectives will be available at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant Payments; Staff Time; Literature Review; Contractor and Agency Outreach; Pilot Study; Data Acquisition (In-Field); Data Analysis; TAC Presentations, Final Report; and Travel.
This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
The project is expected to start in July, 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section
Oregon State University (Agreement in Development)
Portland State University (Agreement in Development)

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Budget values are estimated based on forecasted project work.
OVERVIEW
Due to recent changes in aggregate and binder specifications and due to the increased use of additives, Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS), asphalt mixtures are becoming significantly stiffer than before. While these changes have improved rutting resistance, they have resulted in significant reduction in the mixture durability (cracking resistance). As the RAP content increases, the resistance to fatigue damage decreases. Also the introduction of RAS at levels near 20% into the mixture creates the largest reduction in durability. State highway agencies need simple, practical and reliable tests for evaluating performance of asphalt mixtures. This study proposes to evaluate one such promising test.

OBJECTIVES
A new testing methodology called incremental Repeated Load Permanent Deformation (iRLPD) has been developed. The optimal design concept would prevent making the mixtures too stiff. The iRLPD tests may be utilized to determine how much a mixture can be stiffened before it loses its durability and become vulnerable to cracking. The objective of the research is to develop an optimal design tool to be used to modify mix design when the quality of RAP changes during the production so that the mixture remains within the acceptable performance range.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
This research project will:

- Identify three mixtures predominantly used in Oregon to be characterized. Collect information on the mixtures and the project locations and establish test parameters.
- Characterize Oregon materials by testing materials using the iRLPD. The tests will determine the resistance of the mixtures to rutting and cracking. Also the data will be analyzed to determine the traffic levels for the mixtures in their environmental conditions.
- Prepare training materials on the iRLPD test method tailored for Oregon’s environmental conditions.
- Provide onsite training for ODOT Personnel.
- Prepare final report.

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section

COST INFORMATION

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Budget values are estimated based on forecasted project work.
OVERVIEW
Seismic design of new bridges and assessment of existing bridges in Oregon needs to consider two-levels of performance criteria; life-safety and operational. The life-safety performance criteria are intended to ensure that the bridge does not collapse under the design earthquake; however the bridge is expected to sustain significant damage. The operational performance criteria are intended to limit the seismic damage resulting from a specific demand level so that functionality of the bridge is minimally impacted. Within the Western parts of the state, the structural design of the substructure is often governed by the operational performance criteria and not the life safety criteria. The current design methodology for the operational performance criteria has two main components: use of a specific seismic hazard that has traditionally been lower than that used for life safety performance, and limit of the material strains to stricter levels than those used for life safety.

The operational criteria govern bridge bent design, but limited confidence exists in the selection of the appropriate material limits for achieving rapid return to operational condition. This lack of knowledge has cascading effects on the direct cost and on construction schedule of bridges, especially when considering the retrofit of existing bridges. This is currently being highlighted in retrofit assessment projects conducted on a select number of bridges where the designers are finding that the operational performance under the Cascadia Subduction Zone (CSZ) event governs the amount of retrofit required.

Current material strain limits are based on experimental data generated for reinforced concrete columns that are either based on 1) modern detailing requirements, 2) exhibit excessively poor detailing relative to those used in existing bridges in Oregon, or 3) do not consider the cumulative damage effects from the long duration CSZ event. Recently completed tests of a bent representative of ODOT detailing were completed as part of a project on earthquake duration effects (Dusicka et al 2015). One of the tangent results provided limited, but tantalizing, data that pointed to seismic performance that was better than anticipated, given the lack of modern detailing. The possible contributing factors of this surprising result may be the intermediate (between excessively short and modern) lap-splice lengths utilized in vulnerable ODOT bridges prior to the 1980s, the constant axial load considered and the slow rate of loading. Focused research is therefore needed to assess the influence of these variables; specifically on the types of detailing used in Oregon due to the potentially positive outcome on the overall seismic bridge design.

OBJECTIVES
The main objective of this research is to quantify the steel and concrete strain limits to be used for the seismic assessment of bridge bents considering the operational performance design criteria of existing reinforced concrete bridge bents. Multi-column bents are typical for bridges in Oregon and are therefore more representative of the need to gather performance related data. The proposed research is for experimentally evaluating large-scale reinforced concrete subassemblies representing critical parts of the bents. These primarily represent column-to-crossbeam and column-to-foundation aspects of the bent. Of key interest from the experiments are the
monitoring of material strains and deformations as the column reaches target seismic performance levels.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES
Consultant payments, purchase of research materials, travel, and staff time for:

- Literature review
- Large-scale destructive testing experiments
- Analysis of test results
- Comparison of test results to state-of-the-practice analyses
- Produce final report and disseminate findings

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section
Portland State University (Agreement is in development)

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REVISED BUDGET

Budget values are estimated based on forecasted project work.

81
OVERVIEW

At the national level, some transit agencies are providing rich and informative data. However, Oregon public transit agencies vary in terms of their level of technical expertise and resources available to collect and share data. Much of the data required for understanding, planning, setting policy, and prioritizing investments in the statewide transit network is not easily available or not available in any standardized format. In particular, ridership data is not available in a standard format, and ridership data collected varies significantly by transit agency. Some transit agencies have only limited data in a variety of formats, and other agencies have comprehensive ridership data. The lack of standardized ridership data makes it impractical for organizations like ODOT to obtain detailed real-world information about large scale transit networks.

The development, validation, and testing of the public transit ridership data standard as well as the open source, web-based software tools will facilitate its use. The Rail & Public Transit Division (RPTD) and the Transportation Planning and Analysis Unit (TPAU) of ODOT will support continued operation and maintenance of the public transit ridership data standard. In particular, RPTD partners will be invited to use and test the public transit ridership data standard and open source, web-based software tools.

The public transit ridership data standard is expected to facilitate the sharing of ridership data, and improve understanding, planning, setting policy, and prioritizing investments in multi-agency transit networks.

OBJECTIVES

The goal of this research project is to develop a public transit ridership data standard for all Oregon public transit agencies to follow for the purposes of improved data collection, storing, sharing, reporting, and analysis. These core functionalities of the standard will be supported with the development of open-source, web-based tools for use by transit agencies, ODOT, regional planners, modelers, and vendors.

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Perform a comprehensive literature review on the current state of transit ridership data.

Preliminary design and development of a public transit ridership data standard.

Issue final draft of public transit ridership data standard with implementation recommendations.

Develop functional and technical requirements of the open source, web-based software tools to support the public transit ridership standard.

Develop and test open source, web-based software tools to support ridership data standard.
Develop documentation for the open source, web-based software tools to support ridership data standard.

Prepare final report.

Consultant Payments; Staff Time; Literature Review; Pilot Testing; Data Acquisition (In-Field); Data Analysis for Multiple Sites; TAC Presentations; Final Report; and Travel;

This project is under development in September of 2015. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES

ODOT Research Section

ODOT Rail and Public Transit Division

Oregon State University

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Budget values are estimated based on forecasted project work.
OVERVIEW

The Moving Ahead for Progress in the 21st Century Act (MAP-21) identifies Average Annual Daily Traffic (AADT) as a fundamental data element (FDE) required for a state’s safety data system for all public roads. The Oregon Department of Transportation (ODOT) will have to report AADT for every highway facility across the state, whether it is owned by the state, county or city. The new Fixing America’s Surface Transportation (FAST) act emphasizes data collection and application for prioritizing transportation investments and safety studies and is expected to have similar reporting requirements. ODOT generates AADT estimates for major state facilities but not minor state facilities. Also, counties and cities typically have very little traffic count data and few estimates for their local highway AADTs. There is a clear need to develop methods to estimate traffic volumes on highway facilities that are not available through Highway Performance Monitoring Systems (HPMS) or other state data collection programs. AADT for minor roads is also needed to measure crash rates, for predictive-level safety analysis.

Common ways to estimate AADT include using long term traffic counts obtained from Automated Traffic Recorders (ATR) which count traffic volumes throughout the year, using short term counts with appropriate adjustment factors, or by applying growth factors to historical AADT information. Historical AADT information is not always available. Traffic counts are expensive and extending short-term counts to cover all highway links will not be economical or practical. Traffic engineers have developed different approaches to estimate traffic counts; existing approaches can be categorized as regression models, travel demand models, and heuristics such as neural networks. These approaches have not been yet tested, adapted or applied to meet the new MAP-21’s requirements. ODOT must devise a least-cost methodology to meet the MAP-21 and FAST reporting requirement for AADT for every highway facility, regardless of jurisdiction.

OBJECTIVES

This research will develop and recommend practical methods to estimate AADT for minor roads to meet MAP-21 and FAST reporting requirements and a statewide evaluation for safety. It is expected this research will build off of previous research conducted under SPR 756 “Improved Safety Performance Functions for Signalized Intersections,” August 2015. SPR 756 devised methods to estimate minor road traffic volumes used for intersection-related crash analysis.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Literature review
Data Collection
Development of Methodology
Conduct a pilot demonstration and implement the methodology in ODOT Region 2
Provide recommendations on future data needs to improve AADT estimation accuracy

Final Report

Expenditures will include Consultant Payments; Staff Time; Literature Review; Pilot Testing;
Data Acquisition (In-Field); Data Analysis for Multiple Sites; TAC Presentations, Final Report;
and Travel;
This project is under development in May of 2016. Once it begins; more information on proposed
activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS
This project is under development in May of 2016. Once it begins, accomplishments may be
viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section

COST INFORMATION

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Budget values are estimated based on forecasted project work.
OVERVIEW

High strength steel (HSS) reinforcing bars with nominal yield strengths greater than 60 ksi are commercially available and can provide economic and constructability benefits when used in shear friction interfaces in bridge structures. However, concerns arise due to lack of laboratory test results from members containing HSS reinforcement. Because of this, the current LRFD specifications limit the yield stress of the interface reinforcement to 60 ksi for the shear friction resistance calculations.

To date, only a limited number of tests (Harries et al. 2012, Zeno 2009) have been performed to characterize the shear friction resistance in members containing HSS reinforcement. Results from these tests indicate that using the full yield strength of the HSS reinforcing steel could overestimate the shear interface capacity of the specimens.

Completed in 2015, the Oregon Department of Transportation and Region X University Transportation Center (PacTrans) supported a focused research project to investigate the effects of HSS reinforcement on concrete shear interface behavior. The tests were performed at Oregon State University. Test results indicate that as long as the reinforcing bars yield, a stress higher than 60 ksi may be used to estimate the shear friction resistance. However, based on a group of other test specimens from the same project, it was found that when the reinforcing bars did not yield the results are in agreement with the findings in Harries et al. (2012). The reinforcement bar size and spacing between the bars may have played a role in this difference between the two sets of specimens.

To clarify the influence of bar size and bar spacing and to gain a better understanding of the effects of reinforcement bar strength on the performance of shear friction interfaces, further research is proposed. The proposed program will include test variables not considered in the previous phase of research, such as interface roughness, other high strength steel concrete strength, reinforcement grades with various stress-strain characteristics, reinforcing bar size, and reinforcing bar spacing.

OBJECTIVES

The objective of this research is to evaluate and define the performance of A706 Grade 80, ASTM A615 Grade 100, and ASTM A1035 (120 ksi) reinforcing steel performance in shear friction applications. Understanding the performance is crucial for evaluating and assessing the applicability of the current design equations for RC structures using HSS reinforcement. If successful, the research will provide necessary data for supporting a recent working agenda item (WAI) presented to the AASHTO-T10 committee by Oregon DOT.

More detailed information regarding the project and its objectives can be found at the link below:

https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Consultant payments, purchase of research materials, travel, and staff time for:
• Literature Review
• Development of high-strength stress-strain characteristics
• Develop experimental design
• Perform experimental testing
• Produce final report and disseminate findings

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES

ODOT Research Section
ODOT Bridge Section
Oregon State University (Agreement is in development)

COST INFORMATION

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Budget values are estimated based on forecasted project work.
OVERVIEW

In 2013 and 2014 there were 52 and 55 pedestrian fatalities in Oregon respectively. A high proportion of the crashes took place at crosswalks and/or nearby intersections. The trend in 2015 was unfortunately upwards with 77 pedestrian fatalities.

Traffic laws and regulations provide a legal framework that protects pedestrians when they are most vulnerable, i.e. at crosswalks. Unlike most states, Oregon is more sympathetic towards pedestrians regarding driver obligations and how pedestrians demonstrate their intention to utilize a crosswalk. The majority of states require drivers to yield to pedestrians but in Oregon drivers must stop for pedestrians as soon as they move onto the roadway in a crosswalk with the intent to proceed. Furthermore, the Oregon Revised Statutes require that a driver, before crossing a crosswalk, stops and remain stopped for pedestrians until pedestrians have cleared the lane in which the vehicle is traveling as well as the adjacent lane. Dissimilar compliance laws, users and roadway characteristics preclude a direct transfer of crosswalk surrogate safety research results that have been (or will be) developed in other states.

Designing a crosswalk for a desired level of safety is problematic because prediction models for crosswalk safety are still unreliable and very difficult to calibrate to local conditions. Even if prediction models for crosswalk safety improve significantly, it would likely take several years of service before safety levels could be reliably measured.

Crosswalk stopping compliance, stopping distance, and approach speeds can be readily observed from video footage or sending staff out to the field. If some of these field measurements are good surrogates for safety levels, then it will be possible to modify crosswalk design features or nearby roadway characteristics and readily observe whether surrogate safety measures have changed significantly. Surrogate safety measures can be utilized to provide more timely feedback regarding safety levels and help rank short-term project priorities. Many questions remain related to the link between surrogate measures and crosswalk safety performance and the transferability of out of state results. As states crosswalk laws, driver behavior and culture vary significantly, surrogate safety measure studies are more accurate and relevant when developed from a robust, local data set.

OBJECTIVES

The objective of this research is to analyze, as robustly as possible, the effectiveness of field measurements and surrogate safety measures to develop a proactive approach to evaluate crosswalk safety performance. The proposed research aims to answer these questions: (i) Can surrogate safety measures be used as a reliable predictor of a crosswalk expected safety performance? (ii) Is it possible to utilize field-based surrogate safety measures as a tool to examine the need of crosswalk improvements?

More detailed information regarding the project and its objectives can be found at the link below: https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx
PROPOSED ACTIVITIES

Literature and Data Collection Technologies Review
Analysis of Crosswalk Pedestrian Crash Data in Oregon
Selection of key surrogate safety measures
Identification of Study Locations and Pilot Data Collection
Data Collection
Surrogate Data Effectiveness Evaluation
Final Report
Consultant Payments; Staff Time; Literature Review; Pilot Testing; Data Acquisition (In-Field); Data Analysis for Multiple Sites; TAC Presentations, Final Report; and Travel;

This project is under development in September of 2015. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.

ACCOMPLISHMENTS

This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES

ODOT Research Section

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Budget values are estimated based on forecasted project work.
OVERVIEW

Rising seas and extreme coastal weather events pose significant risks for the safety, reliability, and effectiveness of ODOT infrastructure and operations along the coast. Coastal landslides and shore cliff erosion are particularly sensitive to climate drivers with sea-level rise, storm frequency and intensity, wave scour, and rainfall amounts influencing landslide movement and coastal bluff erosion. Coastal bluff retreat rate is also directly proportional to climate change effects and in many locations directly threatens disruption of ODOT’s coastal infrastructure. Though landslides and coastal bluff erosion are common processes that affect coastal highways every year, bluff retreat and rate of movement are not well characterized. In 2014, ODOT’s Coastal Climate Change Vulnerability Assessment identified this limited information regarding coastal bluff retreat as an issue of concern. Research to directly address this concern is needed in order to optimize ODOT infrastructure planning, secure lifeline routes, and address the climate change adaptation focus of the Oregon Transportation Commission work plan. In sum, given the limited research on coastal landslide movement and bluff retreat with respect to changing climate drivers, a more long-term and in-depth monitoring study with modeling potential is needed to provide useful information for ODOT infrastructure planning.

OBJECTIVES

The goal of this research for ODOT is to develop a more comprehensive data driven framework for prioritizing coastal asset management. This is new research for ODOT building upon recent smaller-scale foundational efforts and recommendations.

More detailed information regarding the project and its objectives can be found at the link below:
https://www.oregon.gov/ODOT/Programs/Pages/Active-Research-Projects.aspx

PROPOSED ACTIVITIES

Task 1: Select representative coastal landslide and bluff sites for monitoring.

Task 2: Obtain and organize pre-existing geotechnical data.

Task 3: Establish protocol for 7 year monitoring project.

Task 4: Equip and monitor selected sites bi-annually for a 7 year duration.

Task 5: Analyze and model data.

Task 6: Deliver final report.

This project is under development in May of 2016. Once it begins, more information on proposed activities can be found in the Project Work Plan at the link above.
ACCOMPLISHMENTS
This project is under development in May of 2016. Once it begins, accomplishments may be viewed by selecting Quarterly Reports at the link above.

RESPONSIBLE PARTIES
ODOT Research Section
ODOT Geo-Environmental Section
Oregon State University (OSU Agreement for $634,000 ending October 2024; ODOT Administration total $27,000)

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Budget values are estimated based on forecasted project work.
### APPENDIX A - SPR SUBPART B PROGRAM COMPLIANCE

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<td>The Program must be implemented in compliance with its approved work program.</td>
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<td>23 CFR 420.115, 23 CFR 420.209</td>
<td>Documentation that describes the State DOT’s management process and the procedures for selecting and implementing RD&amp;T activities must be developed by the State DOT and submitted to the FHWA Division office for approval. Significant changes in the management process must be submitted by the State DOT to the FHWA for approval.</td>
<td>ODOT Research Procedures Manual Approval: March 2010</td>
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<td>23 CFR 420.207</td>
<td>The State DOT's RD&amp;T work program must, as a minimum, consist of a description of RD&amp;T activities to be accomplished during the program period, estimated costs for each eligible activity, and a description of any cooperative activities including the State DOT's participation in any transportation pooled fund studies and the NCHRP. The State DOT's work program should include a list of the major items with a cost estimate for each item. The work program should also include any study funded under a previous work program until final report has been completed for the study.</td>
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<td>23 CFR 420.207</td>
<td>The State DOT's RD&amp;T work program must include financial summaries showing the funding levels and share (Federal, State, and other sources) for RD&amp;T activities for the program year.</td>
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<td>23 CFR 420.209 (a)(2)</td>
<td>The State must use all FHWA planning and research funds set aside for RD&amp;T activities… to the maximum extent possible.</td>
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<td>23 CFR 420.209 (a)(3)</td>
<td>The State must have procedures for tracking program activities, schedules, accomplishments, and fiscal commitments.</td>
<td>Budget tracking spreadsheet, TEAMS system and project quarterly reports.</td>
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<td>23 CFR 420.209 (a)(4)</td>
<td>The State must use support and use of the TRIS database for program development, reporting of active RD&amp;T activities, and input of the final report information.</td>
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<td>23 CFR 420.209 (a)(5)</td>
<td>The State must have procedures to determine the effectiveness of the State DOT's management process in implementing the RD&amp;T program, to determine the utilization of the State DOT's RD&amp;T outputs, and to facilitate peer exchanges of its RD&amp;T Program on a periodic basis.</td>
<td>Program Performance Measures, RD&amp;T implementation program, Research Annual Report contents</td>
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<td>23 CFR 420.209 (a)(6)</td>
<td>The State must have procedures for documenting RD&amp;T activities through the preparation of final reports. As a minimum, the documentation must include the data collected, analyses performed, conclusions, and recommendation. The State DOT must actively implement appropriate research findings and should document benefits.</td>
<td>Publication of research reports, Research Notes, and Annual Report</td>
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<td>23 CFR 420.209 (a)(7)</td>
<td>The State must participate in peer exchanges of its RD&amp;T management process and other State DOTs' programs on a periodic basis. Note: FHWA has guidance defining &quot;period&quot; as at least once every 5 years for a minimum of 2-3 days.</td>
<td>October 2014, Oregon Research Peer Exchange.</td>
</tr>
<tr>
<td>Regulatory Basis</td>
<td>SPR Subpart B Program compliance requirement</td>
<td>Compliance Mechanism</td>
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<td>23 CFR 420.209</td>
<td>The State DOT must include a certification that it is in full compliance with the requirements of this subpart in each RD&amp;T work program. Note, the language to be used for this certification is specified in the regulation.</td>
<td>Work Program transmittal letter</td>
</tr>
<tr>
<td>23 CFR 420.117(e)</td>
<td>Suitable reports that document the results of activities performed with FHWA planning and research funds must be prepared by the State DOT or subrecipient and submitted for approval by the FHWA Division Administrator prior to publication. The FHWA Division Administrator may waive this requirement for prior approval.</td>
<td>March 2015 Division Prior Approval Waiver Letter</td>
</tr>
<tr>
<td>23 CFR 420.117(e)</td>
<td>The FHWA’s approval of reports constitutes acceptance of such reports as evidence of work performed but does not imply endorsement of a report's findings or recommendations. Reports prepared for FHWA-funded work must include appropriate credit references and disclaimer statements.</td>
<td>March 2015 Division Prior Approval Waiver Letter, Report disclaimer</td>
</tr>
<tr>
<td>23 CFR 420.121(c)</td>
<td>The State DOT must administer the RD&amp;T program consistent with their overall efforts to implement section 1001(b) of The Transportation Equity Act for the 21st Century and 49 CFR part 26 regarding disadvantaged business enterprises.</td>
<td>ODOT procurement and contracting process.</td>
</tr>
<tr>
<td>23 CFR 420.121(h)</td>
<td>The nondiscrimination provisions of 23 CFR 200 etc. with respect to Title VI of the Civil Rights Act of 1964 and the Civil Rights Restoration Act of 1987 apply to all programs and activities of recipients, subrecipients, and contractors receiving FHWA research funds, whether or not those programs or activities are federally funded.</td>
<td>Annual Title VI reporting, Research Annual Report contents</td>
</tr>
<tr>
<td>23 CFR 420.121(j)</td>
<td>Procedures for the procurement of property and services with FHWA research funds must be in accordance with 49 CFR and/or other applicable regulations.</td>
<td>ODOT Research Procedures Manual, TEAMS accounting system, Program Oversight by ODOT management</td>
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<td>23 CFR 420.113</td>
<td>(a) Costs are eligible for FHWA participation provided that the costs: 1) are for work performed for activities eligible under the Section of title 23 applicable to the class of funds, 2) are verifiable from the State DOT's or the subrecipient's records, 3) are necessary and reasonable for the proper and efficient to accomplish of project objectives and meet the other criteria for allowable costs in the applicable cost principles, 4) are included in the approved budget or amendments thereto, 5) were not incurred prior to FHWA authorization, and (B) indirect costs are allowable if supported by a cost allocation plan and indirect cost proposal prepared, submitted and approved as required.</td>
<td>ODOT Research Procedures Manual TEAMS accounting system Program Oversight by ODOT management</td>
</tr>
<tr>
<td>23 CFR 420.117</td>
<td>(b) The State DOT must submit performance and expenditure reports, including a report from each subrecipient, that contain as a minimum: (i) Comparison of actual performance with established goals; (ii) Progress in meeting schedules; (iii) Status of expenditures in a format compatible with the work program, including a comparison of budgeted (approved) amounts and actual costs incurred; (iv) cost overruns or underfunds; (v) Approved work program revisions; and (vi) other pertinent supporting data.</td>
<td>Project Quarterly Reports Annual Work Program Research Annual Report contents</td>
</tr>
</tbody>
</table>