Research Project Proposal

for

EVALUATION OF VARIABLE SPEED LIMIT/VARIABLE ADVISORY SPEED SYSTEMS

Submitted by

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for

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Research Unit
200 Hawthorne Ave. SE, Suite B-240
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April, 2013

Research Project Work Plan
for

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1.0 Identification

1.1 Organizations Sponsoring Research

Oregon Department of Transportation (ODOT)
Planning and Research Unit
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Salem, OR 97301-5192 Phone: (503) 986-2700

1.2 Principal Investigator(s)

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1.3 Project Coordinator

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2.0 Problem Statement

Increasing population and urbanization has led to the nation's urban areas often experiencing congestion. This congestion has been getting worse over past decades. In 2011, $121 billion dollars were lost in the U.S. to congestion in the form of delay time and fuel wasted (1). Freeway congestion also reduces safety and deteriorates air quality (2). One method to combat this congestion, when the construction of additional lanes is not an option, is to utilize Active Traffic Management (ATM) systems.

Weather also presents considerable challenges to highway mobility, both in terms of safety and operations. From a safety standpoint, weather (i.e. precipitation in the form of rain, snow or ice) reduces pavement friction, increasing the potential for crashes when vehicles are traveling too fast for conditions. Weather affects the operations of freeways; heavy rain can reduce freeway capacity up to 30 percent, and heavy snow can reduce free flow speeds up to 64 percent (3). New approaches utilizing weather responsive variable speed limit (VSL) and variable advisory speed (VAS) systems have shown promise in reducing weather related crashes and driver speeds in inclement weather conditions (4).

ATM, VSL and VAS systems are in the process of being implemented on the OR 217 and Mt. Hood Safety and Traveler Information projects to address the issues described above. The next section will provide more background on the locations and systems being deployed, as well as the significance of this proposed research project.

2.1 Background and Significance of Work

OR 217 is one of the most congested and least reliable freeways in the Portland area (5). This fact, coupled with the large gap in funding that is preventing the construction of additional lanes to add capacity, has led the Oregon Department of Transportation (ODOT) to develop a plan to deploy an ATM system on OR 217. This system will include a congestion responsive variable advisory speed system, travel time postings and end of queue warnings to improve safety and reliability for drivers. Additionally the project will include a weather responsive VAS system utilizing on-site weather sensors to post advisory speeds based on current road weather conditions to improve safety.

Evaluating the performance of this ATM project will be vital in determining how and where to implement similar systems around the state. Congestion continues to get worse in many locations, and understanding how best to utilize ATM strategies will be a valuable tool to combat the safety and reliability problems associated with increasing traffic demand. The wet weather VAS system evaluation will also result in identifying the possible safety benefits gained through the use of such a system. The quantitative evaluation process will establish a methodology to allow for objective measurement of the potential benefits of this and similar systems that may be deployed elsewhere in the future.

The OR 26 / OR 35 Mt. Hood Safety and Traveler Information project is being developed to combat the negative effects inclement weather has on safety and provide traveler information to drivers of this 67 mile corridor. The system will post appropriate speed limits to VSL signage and warnings to variable message signs (VMS). On-site weather sensor stations will monitor real-time road weather conditions and this information will be used to determine appropriate speeds to be communicated to drivers using the VSL signage.

The OR 26 / OR 35 Mt. Hood corridor experiences snowy and icy conditions which may lead to weather related crashes when drivers are traveling too fast for the conditions. Evaluating this system should lead to a better understanding of the costs and benefits of these types of systems and allow for the justification of investments in these types of systems elsewhere. Understanding how the weather-responsive VSL system performs will provide valuable information pertaining to the operations of this system and systems for other possible deployment locations. Again the evaluation methods developed for this corridor will allow for the objective determination of potential benefits at this site and be transferable for future applications.

3.0 Objectives of the Study

The objective of this study is to evaluate the performance of the OR 217 ATM system and the OR 26 / OR 35 VSL/VMS system in addressing congestion, travel times and crashes based on the specific issues of each corridor. The OR 217 ATM will provide travel time information to enhance user experience, queue detection and warning to address rear end crashes, advisory speeds to better match existing traffic flow conditions, and weather responsive curve warning to address inclement weather crashes. The OR 26 / OR 35 system employs a variable speed limit system and variable message signs to provide drivers with information regarding speed limits that are appropriate for road conditions and traveler information during winter weather, addressing weather-related crashes. As drivers change their speed behaviors for different conditions, they will be traveling at safer speeds and crash occurrence is expected to decline.

To this end, the overall objectives for this research are to investigate the performance and effectiveness of the aforementioned systems once they are deployed and to provide guidance based on these evaluations for future deployments in similar locations. The research will build upon the past efforts completed in Oregon by the researchers, as well as incorporate additional approaches to evaluation, such as user surveys and examination of sustainability aspects. Major research objectives and benefits include:

- Evaluate the impacts and performance of the system on various aspects of speeds under different target conditions, reductions in different crash types (ex. rear end, run off the road, etc.), improving aspects of sustainability, and providing travelers with useful, accurate information.
- Provide ODOT with statistically valid metrics that indicate the effectiveness of the systems in meeting their intended purposes.
- Develop guidance to assist in future deployments of similar systems at other locations. This will allow for transferability of such systems to sites with similar congestion and/or safety problems.

4.0 Implementation

The product of this research will be a determination of the effectiveness of the respective ATM and VSL systems in reducing congestion and crashes, as well as providing drivers with reliable estimates of travel times. Research results will be disseminated via the final project report, as well as journal publications and conference presentations produced by the researchers. Based on the overall evaluation, ODOT will have a better understanding of the benefits of such systems in addressing specific conditions. This will allow for a determination of whether such systems may be deployed at other locations throughout the state that face similar conditions and challenges. Collectively, this will produce improvements to Oregon’s highway network in terms of reliability and safety. It is expected that ODOT Headquarters staff and District Managers will assume responsibility for wider implementation with consideration of policies related to ATM and VSL utilization that might be developed or modified as part of this research effort.

5.0 Research Tasks

The following sections present a high-level overview of the research tasks that are expected to occur as part of the proposed project. Note that, as part of project Task 3, the precise experimental designs will be developed in full detail. The information presented in this proposal represents the researchers’ initial approaches to the overall evaluation effort.

5.1 Task 1: Literature/State of the Practice Review

This task will encompass a literature review and identify the current state of the practice for both active traffic management and variable speed limit / variable advisory speed systems. Consequently, the literature review will focus on these two types of systems. The focus of the review will be on both urban and rural systems, with the expectation being that past and current work related to ATM systems will be more urban-focused, while VSL systems will have both urban and rural applications.

The approach taken in completing this overall task will employ a comprehensive literature search through sources such as, but not limited to, the Transport Research International Documentation (TRID) database, the EI Compendex database, Federal Highway Administration (FHWA) websites, Transportation Research Board (TRB) websites, Institute of Transportation Engineers (ITE) websites, American Association of State Highway and Transportation Officials (AASHTO) websites, state DOT websites, and other databases (e.g., Google Scholar). The review will search for peer-reviewed papers and journal articles, agency reports, agency websites dedicated to ATM, VSL or VAS systems, and other relevant documentation and information, including ongoing research, as identified by the TRID’s Research in Progress database.

5.1.1 Active Traffic Management Systems

This portion of the literature review will identify and discuss past and current work and the state of the practice related to ATM systems. It will focus on where such applications were made, the components the systems used, the information conveyed to drivers and the mechanisms used, and the overall success of the systems in addressing the targeted issue(s). Specific attention will be paid to documenting the different metrics used to analyze the performance of the system in meeting its intent, such as changes in average speeds, speed variation, travel time changes, and similar measures.

A preliminary review conducted during the course of proposal preparation identified the following information on ATM systems (note that this is not a comprehensive review or discussion). ATM strategies, specifically speed harmonizing VSL systems, queue warning systems and the dynamic posting of travel times have been implemented in a handful of U.S. locations in recent years, with European (Germany, The Netherlands, and U.K.) experience dating back to the 1970s (6). Recent U.S. experience with ATM development and implementation has been reported in Colorado for a 20-mile stretch of Interstate-70 west of Denver and Minnesota for a 16-mile segment of Interstate-35 near Minneapolis (7, 8). Some of the major benefits of these types of ATM methods are increased throughput, decreased accidents (rate and severity), increased trip reliability, and the reduction of traffic noise, emissions and fuel consumption (6). Metrics to evaluate these systems include the use of traffic sensor data to measure effects on demand, throughput, travel time, travel time variability, speed compliance, mean speed, lane utilization and the speed differential between lanes (9). Micro-simulation models have also been utilized to measure the potential benefits of ATM methods (7, 9). Traditional safety analysis methods could be applied to measure the effectiveness of these ATM strategies on crashes. Techniques also exist to quantify the possible noise reduction effects as well as emission and fuel consumption reductions, though these methods are typically indirect measurements.

5.1.2 Variable Speed Limit, Variable Advisory Speed and Message Sign Systems

This portion of the literature review will identify and discuss past and current work and the state of the practice related to VSL and VAS systems, with a specific focus on weather-controlled VSL systems and systems that use variable message and similar signs to provide drivers with additional information on conditions and speeds. The proposing researchers completed a similar review during the course of previous research for ODOT, and that material will be relied on during the completion of this portion of the work (4). Consequently, efforts related to VSL systems will focus on more recent work that has been published or initiated since that previous project. A more significant component of this subtask will be on the review of VAS and message sign systems that provide drivers with some form of speed or warning/notification during different weather-related roadway conditions.

Time Frame: Month 1 – Month 4
Responsible Party: WTI/MSU
Cost: $15,094.31
Deliverable: Interim Report #1
TAC Decision/Action: Review and Comment

5.2 Task 2: Site Review and Data Collection Infrastructure

This task will encompass initial site familiarization activities for the OR 217 and US 26/OR 35 corridors. The research team would review the project sites with ODOT staff assistance and input. This review may consist of on-site visits, but more likely would entail off-site examination of highway and system design plans and Geographic Information System (GIS) files, assessment of past and current traffic and speed data from each corridor, and other review work as needed. It will also involve a review of data accessed via Portland Oregon Regional Transportation Archive Listing (PORTAL), which provides data such as travel times, average speeds and traffic volumes that are of interest to the work. The intent of this task is to better understand the past and current conditions and operations in each study corridor, identify existing data collection infrastructure (ex. sidefire radar units, loop detectors, etc.) that can provide data for later analysis activities, and identify locations where additional data collection equipment may be required for deployment in support of the research. Note that at this time, in the absence of a detailed system information from ODOT (specifically for from the US 26/OR 35 corridor), the number and location of specific data collection equipment cannot be specified.

Time Frame: Month 2 – Month 5
Responsible Party: WTI/MSU, ODOT
Cost: $24,009.17
Deliverable: Summary Report indicating current infrastructure that can support research analysis and additional infrastructure needs.
TAC Decision/Action: Coordinate and provide any available data and files needed by the researchers in conjunction with the ODOT Research Section.

5.3 Task 3: Data Collection and Experimental Designs

Based on the findings and observations of Task 2, this task will design the data collection and experiments in support of before and after analysis of the systems on each corridor. The research team would design a data collection plan in support of analysis activities, including establishing what data will be collected, the location and duration of data collection locations, and other necessary aspects. The data collection design would be based on the final experiments that the researchers identify as being carried out to analyze the before and after performance and impacts of the systems. In order to successfully establish the effectiveness of the systems deployed in each corridor, a number of analyses are anticipated. These include analysis of speed data, safety (crash) data, sustainability, and user (driver) satisfaction. The prospective approaches to data analysis and the anticipated data needs are discussed in the following subsections.

5.3.1 Speed data performance measures

The primary function of the systems will be to modify vehicle speeds under different congestion and weather conditions. Ultimately, the changes in speed behaviors should result in improved travel times and safety, with a reduction in the different crash types presently observed at the study sites. The evaluations conducted during this task would track vehicle speeds under various conditions and scenarios (congestion, queue warning, weather, etc.) to determine whether drivers are reacting as expected to the system (ex. driving slower under lower advisory speeds, when warned of a queue, etc.).

Continuous speed data would be collected at points identified in the previous task throughout each corridor using the various speed measurement technologies that are present in the field before and after system deployment at each site. Concurrent with recording vehicle speed data, the system would also record the current state of the system – the posted speed limit, any warning messages posted (i.e. queue related, weather related, etc.) and any supplemental data being collected and used in each system, such as any prospective Bluetooth readings from the OR 217 corridor.

Using the aforementioned data streams, comparisons of speed trends between various conditions and speed limits (advisory or posted) would be examined. The before data would serve as baseline data under the various conditions of interest with which to compare vehicle speeds under similar conditions after the speed limit adjustment system has been deployed. Comparisons would include mean speeds, 85th percentile speeds and speed variance, among other speed statistics.

5.3.2 Safety data and performance measures

Safety data would ordinarily be used to support a before and after crash analysis, providing one of the metrics for the effectiveness of the overall systems. This data presents a challenge to the proposed research given the anticipated deployment dates for each system (OR 217 in February of 2014 and US 26 /OR 35 in the fall of 2014). In the case of OR 217, an early 2014 deployment data might somewhat allow for adequate crash data to become available in support of an "after" deployment statistical analysis. The development of such an analysis methodology, in addition to evaluating the actual before and after performance of the OR 217 corridor, would also establish the approach that could be employed in the future to evaluate the longer term safety performance of this and other corridors.

Crash data from the US 26 /OR 35 corridor would be more of a concern, as it is unlikely that this data would become available in the state crash database in an adequate amount of time to allow for inclusion in a meaningful statistical analysis. If such limited data is used, it would be done with the understanding that the level of certainty in the results produced from it would likely be suspect. Instead, more reliance would be placed on using surrogate measures in assessing effectiveness. Such safety surrogates would likely include measurements of individual vehicle speeds before encountering a VSL or VMS sign with a reduced speed limit and vehicle speeds at a point after such a sign. In the case of this surrogate, if vehicles exhibit statistically significant reductions in speeds after passing a VSL/VMS sign that is active, it is a good indication that they are reacting to the sign in the intended manner (10). This is a response that has a direct impact on highway safety, as reduced speeds on snow covered or icy roads translate into reduced crashes.

5.3.3 Sustainability data and performance measures

Sustainability analysis is expected to focus on two measures: 1) travel time (primary measure) and 2) speed harmonization (secondary measure). Each of these performance measures would be supported by information derived from the speed data being collected. Primarily, this would consist of travel time data produced and other speed data measurements in the corridors. Sustainability would be more of a focus on the OR 217 corridor given its existing congestion issues; however, to the extent applicable, sustainability metrics would also be produced for the US 26 /OR 35 corridor as well. In measuring sustainability, the researchers would quantify improved travel times (and potentially the corresponding potential fuel use savings that result) and the overall impacts of speed harmonization (the adjustment and coordination of the maximum appropriate speed limit based on prevailing traffic conditions, road surface condition and weather condition information) to determine the impacts of the system on traffic flow characteristics.

5.3.4 User satisfaction performance measures

User satisfaction data would measure how drivers observe, perceive and accept the travel time system on the OR 217 corridor. Data to support these measurements would be collected via a short, online survey. Such a survey would seek feedback from drivers on whether they notice the information being conveyed by the system, how they react to that information, if they trust/accept the travel time, speed and any other information the system is providing, and their general views toward the system. Note that the questions used in this data collection would slightly vary for each corridor, as the systems deployed on each are aimed to address different issues.

The exact approach to obtaining survey responses from the public would be established during this subtask. However, based on past project experience, the research team has found that obtaining driver feedback is best accomplished by a multifaceted approach. The target respondents in the case of this project are drivers on each respective corridor. Consequently, one approach to distributing the link to the user survey might consist of outreach to larger local employers whose employees are likely to use the route during their commute. The survey link would be provided to those employers for distribution via internal email lists. Another approach might be to distribute the email to any members of the public that have provided comment and contact information to ODOT projects in the general study area. This approach has yielded useful results in past surveys conducted by the researchers.

Survey data will be summarized using descriptive statistics and similar approaches in order to convey the information collected in a straightforward manner. Whenever applicable, textual replies from survey respondents will be provided in order to provide additional data on the thoughts and views of the public regarding the system.

Time Frame: Month 5 – Month 10
Responsible Party: WTI/MSU
Cost: $32,196.03
Deliverable: Interim Report #2
TAC Decision/Action: Review and Comment on analysis approaches

5.4 Task 4: Data Collection

This task would collect the various speed, crash, survey and other necessary data to support the different performance measurements outlined in the prior task. As part of this effort, analysis pilot studies would be conducted using a sample of data (speeds, crash [if available], travel times, etc.) to determine if this data is of the necessary quality and accuracy to support each prospective analysis procedure, as well as to demonstrate that the proposed analysis procedure can be completed and is appropriate. If a particular analysis procedure proves infeasible during this task, it would be revised as necessary or replaced by a new measure if appropriate.

Data integrity will be validated through manual examinations. For speed data, this would entail examination of the different data sources and files to ensure that there are no glaring errors (incorrect time stamps) or missing periods of data. Should errors be identified, prospective approaches to addressing them would be developed and recommended. As the speed data will serve as an input to travel time and sustainability evaluations, these checks also apply to that aspect of the work. Crash data would be reviewed to ensure that the records are reasonable in terms of crash types (ex. rear end collisions correspond to periods of congestion as indicated from speed and other data) and that all information necessary has been recorded. Finally, user survey data will be examined to ensure that a sufficient number of responses have been obtained and that respondents have largely completed their survey responses.

Once the initial data streams have been evaluated and validated and the analysis methodologies proven sound, full scale data collection activities would commence. This would consist of data collection efforts over extended periods of time. For speed data this would likely encompass multiple weeks over different seasons and conditions for the OR 217 system and throughout the course of the winter months of 2014-1015 for the US 26 /OR 35 system. For crash analysis, this would attempt to include as many months of data as possible, recognizing that there will be a time lag between when a crash occurs and when it becomes available in the state database. When crash data is not available, surrogate measures, such as observed changes in speeds between two points would be employed. For user expectations, survey data would be collected from local users approximately two months (or longer, to be determined in consultation with the project panel) following system deployment to allow for drivers to become familiar with the systems in operation.

The data would be obtained from existing equipment deployed in the field (ex. loop detectors, sidefire radar and other supplemental devices deployed as needed based on identification during Task 2), requisite databases (ex. crash data), online survey collection, and other sources that may be identified during the course of previous tasks.

Time Frame: Month 8 – Month 15
Responsible Party: WTI/MSU
Cost: $40,870.25
Deliverable: Interim Report #3
TAC Decision/Action: Review and Comment on data collection approaches as needed

5.5 Task 5: Final Data Analysis

This task will encompass the final analysis and evaluation of all data collected following the processes established in Task 3 and validated by pilot studies in Task 4. While the exact analysis methodologies would be established during the course of project Task 3, the following subsections provide initial thoughts on prospective approaches that might be employed.

5.5.1 Speed data analysis

The speed study (before and after deployment of each system) would likely include the three following analyses approaches. First, speed characterization using various descriptive statistics would be performed. This includes examining speed profiles (how gradual the reduction in speed), speed variation and average speeds before and after deployment of the systems. Characterization of these aspects would help to better understand the speed selection behavior at the study site and the effect of the deployed system in influencing the aforementioned behavior. Second, statistical tests for the difference in mean speeds and variances before and after deployment of each system would be conducted for different conditions. Using different condition classifications (congestion, weather, etc.), the data before and after system deployment will be stratified and the statistical F-test and t-test (at an appropriate significance level) would be used in examining whether speeds and speed variation have significantly changed upon the deployment of the systems. Finally, numerical analyses may assess aspects such as the percentage of vehicles traveling above the posted or advisory speeds during various conditions both before and after system deployment.

5.5.2 Crash analysis

Ideally, crash data for a nominal period of time would be available to support a statistical evaluation of trends before and after deployment of each system. As mentioned previously, it is expected that the time lag between crash occurrence and data availability in the requisite databases will limit the ability to conduct such analyses during this project. This is particularly true for the US 26 /OR 35 corridor, where deployment is expected to occur in late 2014 and the proposed project ending in approximately mid-2015.

Should such data be available, the following approach may be employed to evaluate each site. Of interest to this work is whether safety improved throughout and at specific points along each corridor in terms of reduced crashes attributed to deployment of the respective systems. The change in safety before and after system deployment can be assessed using one of the following equations:

$\delta = \pi - \lambda$ or $\theta = \lambda / \pi$

Where:

δ = crash reduction (or increase)

θ = index of safety effectiveness

π = the predicted number of crashes in the after period without the presence of the speed limit adjustment system, and

λ = the number of reported crashes in the after period (with speed limit adjustment system present) (11)

Note that in employing this method, the number of predicted crashes in the after period (using the observed before period data) is developed using standard estimation approaches such as those presented in the Highway Safety Manual or other past published research. Even if crash data is not available, the development of such a prospective approach could still be documented as part of the work in order to allow for a future evaluation of these or similar systems to be made.

Should crash data not be available or sufficient with which to draw valid conclusions, a second approach that may be employed is the use of a surrogate for safety, such as changes in vehicle speeds at points before and after the location of critical system signage. Using this approach, vehicle speeds would be collected and analyzed 1000-1500 feet immediately upstream of the signage, and a similar distance downstream. Statistically significant changes in speeds between these two points (not related to the presence of a queue) would be indicative that the system was meeting its objectives and drivers were changing their speed behavior. Such changes could be assumed to translate into a safety improvement, namely, a reduction in the potential for crash occurrence and crash severity due to higher speeds and speed variability.

5.5.3 Sustainability analysis

This portion of the work would determine the final results of sustainability metrics. The exact metrics that will be employed in the analysis will be finalized during the course of Task 3, and may include analysis of changes in travel times (and potential fuel use reduction) and speed harmonization effects. Quantifying such information is expected to aid ODOT in pursuing future congestion mitigation funding by demonstrating the positive impacts, primarily on the OR 217 corridor, that ATM and VSL systems may produce.

5.5.4 <u>User expectation analysis</u>

This portion of the work will summarize and present the results of the user expectations survey. As discussed earlier, the analysis will consist largely of descriptive statistics in order to present the findings of user responses to different questions. Textual responses provided by respondents to open-ended questions will also be provided in their entirety. Finally, a summary and discussion of the findings will be developed to provide ODOT with guidance to address potential user concerns or enhance user observation and acceptance of similar systems that may be deployed in the future.

Time Frame: Month 9 – Month 22
Responsible Party: WTI/MSU
Cost: $39,593.20
Deliverable: Draft (month 23) and final (month 24) project reports in Task 6
Deliverable: N/A – Final results would be integrated with draft final report delivered in month 23
TAC Decision/Action: Review and Comment on analysis results when presented in draft final report.

5.6 Task 6: Final Report

The final task of this project will focus on the development and compilation of the final project report. The report will document in detail the research efforts during all project tasks and will incorporate the contents of the interim reports produced throughout the course of the project. It would also incorporate recommendations on how the results can be used when considering and applying such systems to other corridors facing similar issues.

A draft of the final report will be provided to ODOT project personnel two (2) months prior to the completion of the project. This will allow enough time for the report to be reviewed by ODOT project staff and the project panel and their comments to be incorporated in the final report in a timely manner. Specifically, based on this initial feedback, the researchers will make the appropriate revisions to the final report. Document edits and responses to comments made by the researchers will be tracked and provided to ODOT following the initial round of revisions. This will allow ODOT personnel to follow how specific edits and comments were addressed.

Time Frame: Month 20 – Month 24.
Responsible Party: WTI/MSU.
Cost: $18,087.67
Deliverable: Draft (month 23) and Final (month 24) project reports
TAC Decision/Action: Review and comment on draft final report.

6.0 Time Schedule

The proposed work tasks are estimated to last for twenty-four (24) months. The research plan with specific tasks and deliverables are shown in the following table in a Gantt chart format. The duration of each task is illustrated in terms of months. Note that the estimated start date of the project is June, 2013; the precise start date is subject to final contract execution.

Project Tasks	FY13 Qtr 4 June	FY14 Qtr 1 July - Sep	FY14 Qtr 2 Oct - Dec	FY14 Qtr 3 Jan - Mar	FY14 Qtr 4 Apr - Jun	FY15 Qtr 1 July - Sep	FY15 Qtr 2 Oct - Dec	FY15 Qtr 3 Jan - Mar	FY15 Qtr 4 Apr - May
Task 1: Literature Review Deliverable: Interim Report #1		*							
Task 2: Site Review and Data Collection Infrastructure Deliverable: Summary Report of findings			*						
Task 3: Preliminary Data Collection and Experimental Designs Deliverable: Interim Report #2				*					
Task 4: Data Collection Deliverable: Interim Report #3								*	
Task 5 :Final Data Analysis Deliverable: N/A (deliverable is draft report in Task 6								*	
Task 6: Final Report Deliverable: Draft and Final report documents									* (Draft) * (Final)

*Deliverables

7.0 Budget Estimate

The estimated budget by task and by fiscal year for this twenty-four (24) month project is listed in the table below. Total required funding is $169,850.64, of which ODOT is expected to provide 100 percent. The WTI team will be led by Dr. Ahmed Al-Kaisy, Ph.D. P.E., Professor and Program Manager – Safety and Operations, Dr. David Veneziano as Co-PI, Levi Ewan as Research Associate, and the WTI administrative support staff. A graduate student will also be employed to assist in all aspects of the work. According to the MSU policy, all the direct costs from the ODOT account will be charged an indirect cost (IDC). Montana State University's IDC rate is 44 percent and applies to all categories of the project except graduate student tuition costs.

	FY--13	FY--14	FY--15	Total
Personnel				
Ahmed Al-Kaisy Principal Investigator	$1,244.96	$11,827.12	$11,827.12	$24,899.20
David Veneziano Co-Principal Investigator	$688.12	$6,537.14	$6,537.14	$13,762.41
Levi Ewan Research Associate	$936.52	$8,896.96	$8,896.96	$18,730.43
Graduate Student Researcher	$1,145.45	$10,881.82	$10,881.82	$22,909.09
Business Manager	$56.78	$539.37	$539.37	$1,135.52
Tehcnical Editor	$0.00	$619.48	$619.48	$1,238.96
Total Salaries	$4,071.83	$39,301.89	$39,301.89	$82,675.60
Fringe Benefits				
Ahmed Al-Kaisy Principal Investigator	$373.49	$3,548.14	$3,548.14	$7,469.77
David Veneziano Co-Principal Investigator	$227.08	$2,157.26	$2,157.26	$4,541.59
Levi Ewan Research Associate	$355.88	$3,380.84	$3,380.84	$7,117.57
Graduate Student Researcher	$114.55	$1,088.18	$1,088.18	$2,290.91
Business Manager	$18.17	$172.60	$172.60	$363.36
Tehcnical Editor	$0.00	$235.40	$235.40	$470.80
Total Fringe Benefits	$1,089.16	$10,582.42	$10,582.42	$22,254.01
Total Personnel Costs	$5,160.99	$49,884.31	$49,884.31	$104,929.61
Comunications	$25.00	$150.00	$125.00	$300.00
Graduate Student Tuition	$0.00	$7,000.00	$7,000.00	$14,000.00
Travel	$0.00	$1,500.00	$1,500.00	$3,000.00
Total Direct Costs	**$5,185.99**	**$58,534.31**	**$58,509.31**	**$122,229.61**
Total Indirect Costs (44%)	**$2,281.84**	**$22,675.10**	**$22,664.10**	**$47,621.03**
Total Project Costs	**$7,467.83**	**$81,209.40**	**$81,173.40**	**$169,850.64**

8.0 Key Personnel and Facilities

Dr. Ahmed Al-Kaisy, will serve as Principal Investigator on the proposed project. He is a Professor and the principal transportation faculty member in the Department of Civil Engineering at Montana State University (MSU). He is also the Program Manager for the Safety and Operations Focus Area at the Western Transportation Institute (WTI) and a registered professional engineer in the state of Montana. Dr. Al-Kaisy has long teaching experience in many areas of transportation engineering, including traffic operations and management, traffic flow theory, traffic safety, signal optimization and control, highway design, and intelligent transportation systems. With extensive research experience in the fields of traffic flow, control, operations and safety, Dr. Al-Kaisy has widely published in many scholarly journals such as Transportation Research, Transportation Research Records, Journal of Advanced Transportation, and the Journal of Transportation Engineering (to name but a few). He has authored/co-authored around eighty (80) refereed publications half of which are fully refereed journal publications. Dr. Al-Kaisy is an active member on many university committees and is affiliated with a number of national and international professional organizations.

Dr. David Veneziano, Co-Principal Investigator for the proposed research, is a Research Scientist II in the Safety and Operations group with WTI at MSU. Dr. Veneziano earned his Ph.D. in Transportation Engineering from Iowa State University in 2006. He has twelve (12) years of experience in various aspects of transportation research, including safety and operational analysis, winter maintenance applications, Intelligent Transportation Systems and remote sensing, serving as Principal or Co-Principal Investigator on a number of past and current projects. Recent Project experience includes “Montana Rest Area Usage: Data Acquisition and Usage Estimation (Funded by Montana DOT)”, “Evaluating the Effectiveness of Winter Chemicals on Reducing Crashes in Idaho (Funded by Idaho Transportation Department)”, and “Development of a Toolkit for Cost-Benefit Analysis of Specific Winter Maintenance Practices, Equipment and Operations Funded by Clear Roads.” He brings multidisciplinary education and research experience to this project.

Levi Ewan earned his B.S. in Civil Engineering from Montana State University (MSU) Bozeman and will receive his master’s degree in Civil Engineering at MSU with a focus on transportation in May, 2013. He is joining WTI in a research capacity following graduation. Levi is a member of Chi Epsilon, a civil engineering honor society, and the Institute of Transportation Engineers. At WTI, Levi has played a key role on the previous ODOT Variable Speed Limit research project, serving as a graduate research assistant and completing a number of activities for that work. He has also completed several other research projects for sponsors that include the Montana Department of Transportation (Roundabout Public Education and Outreach; Intercity Bus Service Study; Livability for Montana Transportation research projects) and research for the Federal Lands Highway Division (Traffic Calming for Rural Two Lane Roads).

The Western Transportation Institute is the nation’s largest transportation institute focusing on rural transportation issues. The Institute was established in 1994 by the Montana and California Departments of Transportation, in cooperation with MSU. A primary focus for WTI has been Safety and Operations, the vision of which is to advance the state of the practice and improve highway operations and safety through innovation and multi-disciplinary partnerships. WTI has an annual budget exceeding $7 million and a 50-person multidisciplinary staff of professionals, students and associated faculty from engineering (mechanical/industrial/civil), computer science, fish and wildlife, ecology, business, and economics. WTI has conducted research in more than 30 states at local, state, and federal levels. The research team will have access to the extensive research facilities at the WTI and the College of Engineering at MSU for the successful completion of this project.

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