Connected Vehicle Pilot Deployment Program Phase 1

Participant Training and Education Plan – ICF/Wyoming **- Final**

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7. Author(s) Mohamed Ahmed (University of Wyoming), Deepak Gopalakrishna (ICF), Vince Garcia (Wyoming DOT), Ali Ragan (Wyoming DOT), Tony English (Trihydro), Shane Zumpf (Trihydro), Rhonda Young (University of Wyoming), Fred Kitchener (McFarland Management), Nayel Ureña Serulle (ICF), Eva Hsu (ICF)		**8. Performing Organization Report No.** Task 9 Report
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15. Supplementary Notes Kate Hartman (COR), Sarah Khan (CO)		

16. Abstract

The Wyoming Department of Transportation's (WYDOT) Connected Vehicle (CV) Pilot Deployment Program is intended to develop a suite of applications that utilize vehicle to infrastructure (V2I) and vehicle to vehicle (V2V) communication technology to reduce the impact of adverse weather on truck travel in the I-80 corridor. These applications support a flexible range of services from advisories, roadside alerts, parking notifications and dynamic travel guidance. Information from these applications are made available directly to the equipped fleets or through data connections to fleet management centers (who will then communicate it to their trucks using their own systems). The pilot will be conducted in three Phases. Phase 1 includes the planning for the CV pilot including the concept of operations development. Phase 2 is the design, development, and testing phase. Phase 3 includes a real-world demonstration of the applications developed as part of this pilot.

This document is an overview of the training and education (T&E) activities that will be utilized in this pilot. As such, it identifies and describes the needs and approaches that will be used to train various users of the WYDOT CV-Pilot Demonstration. Users include drivers of various equipped vehicles, back-office personnel at WYDOT and fleet management centers, other agency personnel who will be involved in the maintenance and operations of the pilot system components.

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1 Introduction

1.1 Project Scope

Wyoming Department of Transportation (WYDOT) is one of the first wave of Connected Vehicle (CV) Pilot sites selected to showcase the value of and spur the adoption of Connected Vehicle Technology in the United States. Connected Vehicle Technology is a broad term to describe the applications and the systems that take advantage of dedicated short-range communications (DSRC) between vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) to improve safety, mobility and productivity of the users of the nation's transportation system.

As one of the three selected pilots, WYDOT is focusing on improving safety and mobility by creating new ways to communicate road and travel information to commercial truck drivers and fleet managers along the 402 miles of Interstate 80 (I-80 henceforth) in the State. For the pilot project, WYDOT will work in a planning phase through September 2016. The deployment process will happen in the second phase (ending in September 2017) followed by an 18-month demonstration period in the third phase (starting in October 2017).

Systems and applications developed in the pilot will enable drivers of connected vehicles to have awareness of hazards and situations they cannot even see. Specifically, WYDOT hopes to improve operations on the corridor especially during periods of adverse weather and when work zones are present. Through the anticipated outcomes of the pilot, fleet managers will be able to make better decisions regarding their freight operations on I-80, truckers will be made aware of downstream conditions and provided guidance on parking options as they travel the corridor, and automobile travelers will receive improved road condition and incident information through various existing and new information outlets.

1.2 System Overview

This project will develop systems that make relevant information directly available to, and shared among, equipped fleets. Information is also shared through linkages with fleet management centers (who will then communicate it to their trucks using their own communication systems) and other external agencies and partners.

Supporting the applications and the CV environment of roadside, vehicle and back-office infrastructure are core services that allow safe, secure, reliable operations of the system. The main project objectives of the pilot to be accomplished and demonstrated are as follows:

- Deploy and operate a set of vehicles that are equipped with on-board units (OBU) with DSRC connectivity. These vehicles will be a combination of snow plows, fleet vehicles, emergency vehicles and private trucks that will broadcast a basic safety message, collect vehicle, weather and road condition data, and provide it remotely to the WYDOT Transportation Management Center. These vehicles will also receive in-vehicle alerts

through the infrastructure and wirelessly from various applications developed as part of the pilot through a human-machine interface (HMI)

- Deploy roadside units (RSUs) with DSRC connectivity that are able to transmit advisories and alerts to equipped vehicles along I-80.
- Leverage the data provided from the equipped vehicles to develop and demonstrate a suite of V2V and V2I applications. As part of the pilot, several applications will be developed to support wide-area travel advisories, variable speed limit postings, forecast road condition information, spot-specific warnings, work zones, emergency alerts, and parking notifications.

A detailed explanation of the Wyoming CV Pilot project can be found in *Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps) (*Gopalakrishna, et al., 2015).

1.2.1 Major System Capabilities

Eight functions are performed by the system of interest:

1. Collect CV Data – Connected vehicle data from field may be collected from vehicle OBUs directly or through RSUs. Data collected include Basic Safety Messages Part I and Part 2, Event Logs and other probe data (weather sensors etc.). These messages are ingested into the operational data environment (ODE) where the data is then further channeled to other sub-systems.
2. Fuse relevant weather data - Data used for weather-related processing are passed from the ODE to the PikAlert System. These may include directly measured weather observations or information from vehicles that may support understanding of weather. The PikAlert system also fuses external non-CV data (such as NWS warnings, alerts, and NOAA radars).
3. Generate Alerts and Advisories - The PikAlert system then generates segment-level advisories and alerts of road conditions both current and forecast based on customizable thresholds.
4. Support Data Brokerage - The WYDOT Data Broker is a sub-system that is responsible for interfacing with various WYDOT Transportation Management Center (TMC) systems gathering information on current traffic conditions, incidents, construction, operator actions and road conditions. The data broker then distributes information from PikAlert, the ODE and the WYDOT interfaces based on business rules. The data broker develops a traveler information message (TIM) for segments on I-80, and provide event or condition information back to the WYDOT interfaces.
5. Distribute TIM Messages – The data broker distributes the TIM message to the operational data environment (ODE) which will then communicate the message back to the OBUs, RSUs and the situational data warehouse (SDW).
6. Store data – Data generated by the system (both from the field and the back-office sub-systems) are stored in the WYDOT data warehouse.
7. Measure and manage performance – System monitoring and performance measurement are conducted based on the data collected in the data warehouse on periodic basis.
8. Support safety and situational awareness - In the field, vehicle OBUs and RSUs communicate over DSRC to support both situational awareness and safety awareness applications.

The system functions described in the previous paragraphs are implemented through the following seven applications that combine both the back-office and mobile distribution capabilities:

- Road Weather Advisories for Trucks - This application provides the capability of collecting road weather data from WYDOT Fleets and Connected Trucks and using that data to develop short-term warnings or advisories that can be provided to individual commercial vehicles or to commercial vehicle dispatchers.
- Automatic Alerts for Emergency Responders - This application provides the capability for connected trucks to transmit an emergency message when the vehicle has been involved in a crash or other distress situation.
- CV-enabled Weather-Responsive Variable Speed Limits - This application uses road weather information from connected trucks and WYDOT Fleet vehicles as well as current and historical data from multiple sources to determine the appropriate current segment-specific safe speed and other traffic management strategies.
- Spot Weather Impact Warning - This application will alert drivers to unsafe conditions or road closure at specific points on the downstream roadway as a result of weather-related impacts (e.g., high winds, flood conditions, ice, and fog).
- Work Zone Warnings - This application provides information about the conditions that exist in a work zone to vehicles that are approaching the work zone.
- Situational Awareness - The application determines if the road conditions measured by other vehicles represent a potential safety hazard for the vehicle containing the application.
- Freight-Specific Dynamic Travel Planning- This application provides both pre-trip and en-route travel planning, routing, and commercial vehicle related traveler information for fleet management center.

1.2.2 User Needs

Through the process of identifying user needs, the team has identified what the project stakeholders want from the intended system. Three main groups of needs include:

i) Centers' Needs, such as TMC, highway patrol (dispatch), and fleet management centers, truck facility operators, amongst others.
ii) Field Needs, related to commercial truck drivers, personal auto travelers, maintenance supervisors, snow plow operators, and highway patrol (in the field).
iii) Wide Area Needs, namely 511 phone, application and website consumers and media.

A detailed description of the needs is provided in the *Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps)* Document (Gopalakrishna et al., 2015).

1.3 Participant Training and Education Plan Objectives

This document is an overview of the Participant Training and Education Plan (T&E) plan utilized in this pilot. The T&E defines how the Wyoming Team will train and educate all participants of the CV-Pilot Demonstration phase, and of subsequent operational phases of this project. Participants are identified as either drivers, operational staffs, or instructors. Each group is then decomposed into its several type of members, for which specific training and education plans has been identified. In this manner, the Plan describes five training and education methods through hands-on (Truck Simulator, Desktop Simulation and Field Demonstrations) and lecture approaches (Workshop and Online Training and Education).The document also describes the responsibilities

and roles for training within the WYDOT CV-Pilot Demonstration. There are three parallel objectives that will be met through the proposed training and education plan:

1. First, the training of end-users of the applications in a rigorous and safe manner to make sure that the pilot objectives are met. Understanding of participant issues and challenges early and developing a structured training program for participants will create a group of participants that are invested the pilot's success. In fact, consideration of how participants will use the system and the training approaches might influence the system design itself.
2. Second, ensure that the stakeholders who are impacted by the pilot are clear on how the pilot will occur. Preventing misconceptions and addressing any concerns early will allow for greater buy-in from stakeholders who are not fully aware of the objectives and what it would mean to their operations in the short-term and long-term.
3. Third, clearly specify the approach to perform maintenance and updates, as well as the roles of WYDOT and other partners who will have equipment installed as part of their infrastructure. Providing guidelines on how, what and when to manage the systems developed as part of this task is critical given the diversity of systems (software, hardware, roadside equipment and traditional ITS) that need be at a high degree of operational readiness during the pilot.

Note that this plan does not cover the need for general education of the public and other external stakeholders about the pilot program. These are discussed in our outreach plan. The end result of this Plan would be group of trained participant, with in depth knowledge of the systems (within their respective level). This will minimize any concern from a driver and operational staff perspective, such of distracted driving and correct equipment installation, respectively.

1.4 IRB Application and Approval Summary

The ICF/ Wyoming team understand that any activity conducted as part of the pilot should minimize the risk to human participants, ensure participants consent and full inform them of the possible risk associated with the research, and endorse equity and justices to all participants. Moreover, data that may include Personally Identifiable Information (PII) will be collected as part of this pilot. Hence, a careful consideration of human use approval is necessary.

The Office of Research and Economic Development at the University of Wyoming (UW) is responsible for the administration of research ethics. The ICF/ Wyoming team has submitted a proposal to the registered University of Wyoming's Institutional Review Board (IRB) for their review and approval. The Institutional Review Board (IRB) committee is composed from diverse academic and scientific disciplines, as well as from the public. The approval procedure conforms to the US Department of Health and Human Services (HHS) regulations and policies Federal Protection of Human Subjects Regulations 45 C.F.R. 46.115(a)(6), 45 C.F.R. 46.103(b)(4), and 45 C.F.R. 46.103(b)(5) for the protection of human subjects' rights and welfare. The IRB proposal included a description of the purpose of the research project, description of human subject participants, recruitment procedure, number of participants, incentive to be provided, expected tasks, time needed to complete an experiment/ training module, method of data collection, participation termination process, equipment used, etc. The proposal explains the procedures of protecting the privacy and confidentially of the participants (e.g., how, where, and for how long the data will be stored, who will have access to the data, and other confidentiality issues). Risks to subjects are described in detail of any reasonably foreseeable risks or discomforts to the subjects as a result of each procedure/experiment, including discomfort or embarrassment with

survey or interview questions, exposure to minor pain, discomfort, injury or harm from possible side effects from using research equipment. A description of the procedure to obtain informed consent or to provide information to participants are also included in the proposal. As part of the proposal, the actual consent forms, as well as a description of when and by whom the subjects will be approached, how information will be relayed to subjects, and how collected feedback are explained in the proposal.

The ICF/Wyoming team met with the UW IRB on May 19th, 2016 and discussed the IRB review comments. The IRB official comments were received in writing on May 20th, 2016 and the ICF/ Wyoming submitted an updated IRB proposal addressing the board's comments. The IRB proposal was officially approved on May 24th, 2016 (see Appendix). It is anticipated that an IRB amendments will be submitted as the project progress in Phase 2 and 3.

1.5 Organization of the Report

This report is divided into eight sections that tackle the different aspects of the Training and Education Plan. Particularly:

- Section 2 provides a list of the references used in this document.
- Section 3 summarizes the notes and glossary of acronyms used in this report.
- Section 4 describes the participants (i.e., trainees) of this pilot project.
- Section 5 describes the training and education approach.
- Section 6 defines the roles and responsibilities within the scope of this task.
- Section 7 indicates the key challenges for this task.
- Section 8 provides the schedule for this task.
- Appendix contains a copy of the IRB approval letter.

2 References

The following table lists the documents, sources and tools used to develop the concepts in this document.

Table 2-1. References.

#	Documents, Sources Referenced
1	Deepak Gopalakrishna, et al. (2015). *Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps), ICF/Wyoming*. U.S Department of Transportation.
2	U.S. Department of Health & Human Services (2009). *Code of Federal Regulations Tittle 45 Public Welfare, Part 46: Protection of Human Subjects*. Washington, DC.

3 Notes and Glossary

The following table defines selected project specific terms used throughout this Training and Education Plan document.

Table 3-1. Glossary of Terms.

Term	Definition
Automatic Alerts for Emergency Responders	Application that provides the capability for connected trucks to transmit an emergency message when the vehicle has been involved in a crash or other distress situation.
Basic Safety Message	Connected V2V safety applications are built around the SAE J2735 BSM, which has two parts BSM Part 1: Contains the core data elements (vehicle size, position, speed, heading acceleration, brake system status) Transmitted approximately 10x per second BSM Part 2: Added to part 1 depending upon events (e.g., ABS activated) Contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies) Transmitted less frequently The BSM is transmitted over DSRC (range ~1,000 meters). The BSM is tailored for low latency, localized broadcast required by V2V safety applications
Commercial Vehicle Operator Portal	Provides forecasted road condition information on common commercial vehicle routes.
CV-enabled Weather-Responsive Variable Speed Limits	Application that uses road weather information from connected trucks and WYDOT Fleet vehicles as well as current and historical data from multiple sources to determine the appropriate current segment-specific safe speed and other traffic management strategies.
Freight-Specific Dynamic Travel Planning	An application that provides both pre-trip and en-route travel planning, routing, and commercial vehicle related traveler information, which includes information such as truck parking locations and current status.
Road Weather Information for Freight Carriers	An application that is a special case of the Road Weather Advisories and Warnings for Motorists application focuses on Freight Carrier users.

Term	Definition
Situational Awareness	An application that determines if the road conditions measured by other vehicles represent a potential safety hazard for the vehicle containing the application.
Spot Weather Impact Warning	An application that will alert drivers to unsafe conditions or road closure at specific points on the downstream roadway as a result of weather-related impacts.
Transportation Management Center	Center that collects information and informs the public about changing travel conditions.
Warnings about Upcoming Work Zone	An application that provides information about the conditions that exist in a work zone to vehicles that are approaching the work zone.

Table 3-2. Acronym List.

Acronym/Abbreviation	Definition
CA	Construction Administration
CDL	Commercial Driving License
ConOps	Concept of Operations
CV	Connected Vehicle
CVOP	Commercial Vehicle Operation Portal
DB	Data Broker
DMS	Dynamic Message Signs
DSRC	Dedicated Short Range Communication
DW	Data Warehouse
FHWA	Federal Highway Administration
HMI	Human-machine interface
I-80	Interstate 80
IC	Incident Console
IE	Independent Evaluator
IRB	Institutional Review Board
ITS	Intelligent Transportation Systems
NWS	National Weather Service
OBU	On-board unit
ODE	Operational Data Environment
RSU	Roadside unit
PA	PikAlert™ System

Acronym/Abbreviation	Definition
PII	Personally Identifiable Information
PM & ES	Performance Measurement and Evaluation Support
RCRS	Road Condition Reporting System
SCMS	Security Credential Management System
SDW	Situation Data Warehouse
T&E	Training and education
TIM	Traffic Incident Management
TMC	Transportation Management Center
TPI	Third-Party Information Service Providers
TRAC	Transportation Reports and Action Console
UW	University of Wyoming
V2I	Vehicle to infrastructure
V2V	Vehicle to vehicle
VSL	Variable Speed Limit
WDOT	Wyoming Department of Transportation
WHP	Wyoming Highway Patrol
WTI	Wyoming Traveler Information System
WYDOT	Wyoming Department of Transportation
WYOSIM	Wyoming Driving Simulator Lab

4 Training and Education Participants

The Stakeholder Registry developed under the Program Management task 1 was utilized to identify the various groups of stakeholders that will need to be kept informed or require more formal instructions. The main stakeholder groups identified for training and education are:

1. Training Instructors
2. CV-Pilot Participants
    a. Drivers of Equipped Vehicles
    b. WYDOT TMC and Highway Patrol Dispatch Personnel
    c. WYDOT Operational and Support Personnel
    d. Fleet Management Center Personnel (CVOP Users)
3. General Public (Third Party Interface Users)

The following sections provide details about the participants various stakeholder groups that will require training and education as part of the pilot.

4.1 Instructors

The instructors are those who will be training the participants for their role in the CV-Pilot. These may include specific WYDOT staff identified at the TMC, representative from fleet and other partners who will train their drivers. However, these instructors also need to be trained. For this, the pilot team's systems experts and curriculum developers will provide information and training to instructors. The systems experts and curriculum developers should work with the instructors to make sure that the modules are designed in a way to attain the highest knowledge retention rates as well as including a variety of learning styles to engage the trainees and keep a positive learning environment.

4.2 CV-Pilot Participants

4.2.1 Drivers of Equipped Vehicles

The drivers are those who will be operating the equipped vehicles and will also be in charge of providing information (e.g., feedback, operational status, parking data) to the system. Drivers of connected vehicles include the following categories:

- WYDOT Snow Plow Drivers
- WYDOT Highway Patrol Drivers
- Other WYDOT, City and Trihydro Fleet Drivers
- Commercial Truck Drivers

A total of about 400-500 drivers would need to be trained over the course of the project.

4.2.1.1 Qualifications

For all drivers, only those with a valid U.S. driver's license and, when applicable, a valid Commercial Driving License (CDL) will be allowed to participate in the pilot. To the extent possible, all drivers should have at least three years of good driving record while working for partnering companies (or similar), including WYDOT. Similarly, the pilot will attempt to ensure that considered officers from Wyoming Highway Patrol will have at least two years of experience. Finally, the pilot will verify that WYDOT drivers have been trained in the appropriate policies and use of state vehicles.

4.2.1.2 Driver Recruitment

Participants will be WYDOT employees, drivers from partnering commercial trucking companies and Trihydro, and Wyoming Highway Patrol (WHP). An email will be sent via the WYDOT system for participation. WYDOT will provide a letter of agreement to solicit the participants for this project. It is anticipated that 400-500 drivers will be recruited for training and education over the course of the project, although this number may change depending on hardware cost and ultimate system design. Snow plow and highway patrol drivers will be recruited in the pilot by WYDOT. Partnership agreements with cities, Trihydro and commercial vehicles allow for recruitment of other drivers.

4.2.2 WYDOT TMC and Highway Patrol Dispatch Personnel

The following WYDOT personnel require training as part of the pilot.

4.2.2.1 TMC Operators

TMC operators will be tasked with taking information collected from the CV pilot system and using it to update roadside ITS infrastructure, such as Variable Speed Limits (VSL) signs and Dynamic Message Signs. This new information will be presented by the pilot system to TMC operators in a way that is very similar to how they currently receive information. TMC operators will also be charged with sending traveler information messages to RSUs as well as notifying highway patrol dispatch when emergency notifications are received from the CV pilot system.

Training will be focused on how to identify the data source as coming from the CV pilot system and what to do in the event information is not accurate and how/when to send information to RSUs. When fully staffed, there are 17 full-time operators and up to five seasonal operators, all of which will receive training.

4.2.2.2 Highway Patrol Dispatch

Highway Patrol Dispatchers will be tasked responding to notifications of incidents along I-80, some of which may be first identified by the pilot system. They are responsible for dispatching Wyoming Highway Patrol troopers to the scene of the crash. Similar to TMC operators, dispatchers will be receiving the information in a way similar to current format. Therefore, dispatches will be trained to identify the data source as coming from a connected vehicle and what to do in the event information is not accurate. When fully staffed, there are 45 full-time dispatchers, all of which will receive training.

4.2.3 WYDOT Operational and Support Personnel

The following WYDOT personnel require training as part of the pilot.

4.2.3.1 ITS and Telecom Technician Staff

WYDOT's ITS Technicians will be tasked with ensuring roadside equipment involved in the pilot (RSUs in general but also the supporting structures, software, hardware and communication infrastructure) receives regular maintenance and performing emergency repairs in the event a piece of equipment malfunctions. They will need to be taught how to perform both tasks. While the equipment will primarily be in ITS technicians' area of responsibility, telecom technicians will also receive training in order to provide assistance.

In addition, this group may also be required to maintain OBUs for WYDOT fleet vehicles. They will be trained on installation, repair and maintenance of on-board equipment that are deployed on snow plows, highway patrol vehicles and other WYDOT fleet vehicles.

In general, and depending on their role, it is desired for the technical staff to be have the following qualities: i) support of ITS equipment (5 years of experience); ii) security equipment (5 years of experience); iii) database background (10 years of experience); iv) knowledge of power over Ethernet (2 years of experience); v) development with Java (3 years of experience); and vi) installation of vehicle aftermarket equipment (3 years of experience). All ITS and Telecom technicians will receive training.

4.2.3.2 Maintenance Supervisors

WYDOT's maintenance supervisors will be tasked with responding to employees' (in this case snow plow drivers) questions and concerns about the connected vehicle project. Training will include a detailed description of the scope and goals of the project (including privacy implications) and a general description of the hardware and software to be used and the types of information sent from snow plows and other CV fleet vehicles. All maintenance supervisors will be trained.

4.2.3.3 WYDOT Supervisory and Support Staff

WYDOT's supervisory and support staff, such as Quality Assurance Analysts, will be tasked with making sure information collected from CVs is being used properly by the TMC operators. For this, training is needed in order to ensure they are able to answer questions from those inside and outside of the department. Training will include a detailed description of the scope and goals of the project (including privacy implications) and a general description of the hardware and software to be used and the types of information collected. All supervisory and support staff will receive training.

4.2.3.4 WYDOT Development Staff

WYDOT's Development Staff will be tasked with ensuring information made available to the agency through CVs is incorporated into existing systems in a useful way. For this, training is needed in order to make sure there is an understanding of what the data means and limits of its use. In general, and depending on their role, the development staff will need the ability to develop with Java (minimum 3 years of experience) and database background (minimum 10 years of experience). All development staff will receive training.

4.2.4 Fleet Management Centers

There are currently over 800 firms registered to the CVOP, and that need to be educated in the project. The current version of the portal will be updated with more information as a result of this project. When users visit the website for the first time after the changes have been made, the new features will be highlighted in a short tutorial that explains what the new information is and how it relates to the CV project. A document (in an easily accessible format, such as PDF) with the information will also be made available on the website for those who need future access.

4.3 The General Public

The general public uses WYDOT's webpage and other information systems on a regular basis. Enhanced information provided to these systems as a result of the CV project should be transparent to the users. In this sense, FAQs for each site will be updated to address changes. Furthermore, a new third-party interface is being developed to allow other data providers (WAZE, DriveWyze, etc.) to inform their users of issues collected by the CV project. A *Users Guide* will be created for those using the third-party interface. This will include a description of the service and the information provided along with a list of FAQs.

4.4 Summary of Training and Education Needs

It is important that all participants clearly understand the Pilot project. Both drivers and staff personnel need to understand the hardware and software being installed either in the vehicle, the Human Machine Interface (HMI) and/or the on-board computing at the center of operation. Furthermore, from a driver perspective, training is also needed to support operation and maintenance of the system as direct input from drivers is needed to run certain applications and to identify malfunctions and systems issues that may occur during the pilot. Specifically, drivers need to know what to do to address regular and unforeseen maintenance, updates, data downloads, and any other operational aspect of the system. Similarly, training is also necessary to understand when, how and what to report as the support from the drivers is key in ensuring an efficient operation of the system. From a staff perspective, training is needed to understand the new system, software and interfaces and how to use and assimilate the new information that is being provided. **Error! Reference source not found.** details the particular users and the needs f each group that will be addressed with the T&E Plan.

Table 4-1. User's Training and Education Needs.

User	Need
Instructors	
Instructors for various stakeholder group	• Clearly understand the scope (including privacy implications), goals and components of the project • Clearly understand the design and application of each training and education module • Instructors for each user group will need to be trained to effectively satisfy the user's needs listed below • Develop a variety of learning styles to engage the trainee and keep a positive learning environment
Drivers of Equipped Vehicles	

User	Need
Snow Plow	• Understand how to interact with the new or updated interface • Understand when they expect to receive alerts and when they do not • Understand how to provide information through the HMI, e.g., report a crash or parking availability • Interpret the new information provided through the HMI and how to react to them timely and properly • Be able to provide feedback about the CV applications' usefulness/ effectiveness and issues via survey questionnaires and personal interviews • Understand when software/firmware need to be updated and when data need to be downloaded • Understand procedure to notify malfunction of the system's hardware and/or software • Provide minor troubleshooting • Know who to call in case of any equipment issues or malfunctions
Connected Truck	
Connected HP Vehicle	
Fleet Vehicles	
WYDOT TMC and Highway Patrol Dispatch Personnel	
TMC Operator	• Understand how to interact with the new or updated interface in order to send emergent information to RSUs • Identify, interpret and evaluate for accuracy any new information provided through the new or updated interface • Understand how to use the new CV information to update roadside ITS infrastructure • Provide minor troubleshooting
HP Dispatch	• Understand how to interact with the new or updated interface • Identify, interpret and evaluate for accuracy any new information provided through the new or updated interface • Understand how to use the new information to dispatch Wyoming Highway Patrol troopers to the scene of the crash • Provide minor troubleshooting
WYDOT Operational and Support Personnel	
ITS and Telecom Technician Staff	• Learn how to install and uninstall equipment and software • Understand how to provide regular maintenance and emergency repair of equipment and software • Provide troubleshooting support
Maintenance Supervisors	• Clearly understand the scope (including privacy implications), goals and components of the project • Have general knowledge of maintenance and repair procedures in order to evaluate performance and supervise related tasks
WYDOT Supervisory and Support Staff	• Clearly understand the scope (including privacy implications), goals and components of the project • Have general knowledge of the types and uses of information collected, received and sent to/from CV fleet vehicles in order to supervise and ensure its correct usage
WYDOT Development Staff	• Clearly understand the data sources and limitations of data • Understand how to provide regular maintenance and emergency repair of equipment and software • Provide troubleshooting support
Fleet Management Center	
CVOP Users	• Have general knowledge of the scope, goals and components of the project • Understand the new features of the portal and the new information provided
General Public	
Third Party Interface Users	• Have general knowledge of the scope, goals and components of the project • Understand the new features of the interface and the new information provided

5 Training and Education Approach

5.1 Training and Education Content

In general, and when possible, the T&E Plan for all drivers and staff members will leverage existing WYDOT training protocols by integrating any new material within them. For instance, the plan will build upon current training curriculum for TMC operators, Maintenance, ITS and Highway Patrol Dispatch personnel.

Each training and education module will be tailored to address the needs of each specific user of the system (as identified in Section 4) and may be adapted for each training methodology (explained in Section 5.2). However, common content has been identified across and within groups and are explained next.

5.1.1 Instructors

The instructors for the different trainee types should receive proper training as well. The ICF/Wyoming team will ensure that instructors for both the drivers and operational staff have the required skills and knowledge about the CV-system to deliver an effective training to participants. In addition to the training materials that will be provided to drivers and operational staff, the instructors will receive training on how to collect performance data and evaluate the trainees.

5.1.2 Drivers

All T&E modules will start by clarifying the capabilities of all applications that drivers may interact with, as it is imperative that drivers understand their purpose and limitations. The modules will provide a clear distinction between Connected Vehicles and Autonomous Vehicles, ensuring that the driver knows what to expect from the system—e.g., vehicles will not brake for them.

The modules will define all physical equipment (e.g., HMI and respective cables) and their location, as well as all visual elements of the system interfaces (e.g., signal strength, battery percentage, and message buttons). Modules will provide insight on the information a driver could receive or send, including Basic Safety Messages (BSM), each type of Warning, each type of Advisory, Maydays, and probe data.

Reaction to the various messages will also be discussed, as this is equally important as understanding the messages provided through the CV-system. The training team understand that all conditions cannot be simulated nor foreseen; however, the modules will explain, to the extent possible, how a driver should react to each type of received information. For instance, if a warning is received that the Variable Speed Limit changed from 75 mph to 45 mph, the module will address proper responses, such as how fast the driver should brake. Furthermore, the module will also train drivers on how to interact with the system, including actions to acknowledge a message, stop a sound, review previous messages, and input information, amongst others. It

should be noted that inputting information will also include how to provide parking and weight information, in the case of connected trucks, and crash reporting.[1]

5.1.3 Operational Staff

Back-Office personnel will receive training to understand the type of equipment and software being used in the CV pilot project. The modules will focus on:

- Identifying components.
- Using the equipment
- Minor troubleshooting (equipment and system)
    - Restart, recharge, check physical and wireless connections, etc.
- Training on software

Particularly, for CV Technician the modules will seek to provide a consistent installation and maintenance procedure across providers by adding to the previous list:

- Installation of equipment
- Maintenance and Operation
    - Hardware maintenance
    - Software updates and data acquisition (i.e., downloads)

It should be noted that all modules will be tailored to each platform and operating system.

5.2 Training Methodologies

The T&E Plan will efficiently use different methodologies to train system users (e.g., snow plow, WHP, and truck drivers), system managers and staff (e.g., TMC operators, technicians, etc.) as well as instructors. These methodologies are categorized into two main categories; in-person/ online instructional clinics, and live demonstrations and test drives. Having an array of options will ensure that the plan is accessible to all stakeholder participants of the project. The development of the T&E Plan will be conducted with consultation with the heads of the various departments involved in the pilot at the local and State levels. In addition, coordination with the appropriate office manager(s) will take place with the partnering truck companies to ensure active participation of the trainees. Table 5-1 provides a summary matrix that specify what methodology will be available to the drivers and operational staff. Each training module is explained in detail in the following subsections.

[1] The module will provide training on procedures to report incidents where the connected vehicle might have been involved or not, and what steps to take in the event of a crash.

Table 5-1. Summary training matrix.

	Hands-On			Lecturing	
User	**Driving Simulator**	**E-Training**	**Field Demonstrations**	**Workshop T&E**	**Online T&E**
	Instructors				
Instructors for Drivers	X	X	X	X	X
Instructors for Operational Staff				X	X
	Equipped Drivers				
Snow Plow	X	X	X	X	X
Connected Trucks	X	X	X	X	X
Connected WHP Vehicles	X	X	X	X	X
Fleet Vehicles	X	X	X	X	X
	Operational Staff				
TMC Operators				X	X
WHP Dispatchers				X	X
ITS and Telecom Technician Staff				X	X
Maintenance Supervisors				X	X
WYDOT Supervisory and Support Staff				X	X
WYDOT Development Staff				X	X
	Fleet Management Centers				
CVOP Users					X
	General Public				
Third Party Interface Users					X

5.2.1 Driving Simulator – Equipped-Trucks and WHP

The ICF/Wyoming team will utilize the Driver Simulator Lab (WYOSIM) at the University of Wyoming to provide a comprehensive hands-on training and education in a simulated environment for some of the equipped-drivers, namely those of equipped trucks and patrol vehicles. The motion-base driving simulator consists of both a passenger vehicle and a freight truck open cockpit cabs. The Driving Simulator's passenger vehicle cab is a 2004 Ford Fusion, and the freight truck cab is a 2000 Sterling AT9500 18-wheeler semi-trailer. The two cabs are interchangeable as a roll away component mounted on a three degrees of freedom D-Box motion platform, comprising 4 electro-mechanical linear actuators. The motion base provides two rotational and one translational degrees of freedom (roll, pitch, and heave). The provided motion cues immerse the driver into a real driving experience with kinematic changes in velocity and acceleration. The simulator has a high-fidelity control loading system that provides force-feedback on the steering wheel and brakes based on the vehicle state. Rich audio cueing is provided via 3000W 5.1 multi-speaker sound system. In addition, one low frequency vibration transducer is mounted on the vehicle floor to provide engine and road feel vibrations. The simulator is equipped with a high definition SimObserver system as well as an advanced SmartEye Tracking system to capture and analyze digital video recordings for performance evaluation. The system allows for capturing and playing back six synchronized views of a simulation experiment along with

recorded driving data. A Human-Machine Interface (HMI) will be mounted on the dashboard to train participants on the various CV-system applications.

The simulator has an open architecture software with complete source code of simulation creator tool. The open architecture offers flexible tool that allows to develop driving scenarios and build roadways that replicate the actual environments to suite the ICF/ Wyoming CV applications. The participants will be trained and educated on the basic CV-system components, the various range of the corresponding HMIs and alerts they may receive, and the proper response they should implement. The participants will be trained on contingency plans they should follow in case of a system malfunction or a crash. Prior to the actual training in the simulator, the participant(s) will be given a general overview of the CV deployment and its goals, and they will be informed on their particular role. Driving and responses to CV alerts data will be collected for evaluation.

5.2.2 E-Training

The ICF/Wyoming team will develop an E-Training module to provide an interactive desktop simulation tool to train all equipped-drivers on simulated scenarios of the CV applications. All drivers will participate in this module, as it will also serve as a way to obtain the necessary consent from drivers that will be part of this CV-Pilot. In this sense, an abbreviated version will be available for those who will also be trained with the Driver Simulator.

This module will be based on similar driving scenarios developed in the driving simulator. The participants will be trained on the basic CV-system components, the various range of the corresponding HMIs and alerts they may receive, and the proper response they should implement. The participants will be trained on contingency plans they should follow in case of a system malfunction or a crash. Prior to the actual training in the simulator, the participant(s) will be given a general overview of the CV deployment and its goals, and they will be informed on their particular role. Driving and responses to CV alerts data will be collected for evaluation. In addition, the E-training module will be developed to extend existing training for snow plow drivers, and Wyoming Highway Patrol.

5.2.3 Field Demonstration – Equipped-Trucks and WHP

Field demonstrations and test drives at the WYDOT facility will be used to provide training to drivers on the various CV applications. These demonstrations will showcase, in a simulated and real-life conditions, the functional concepts, capabilities, and appropriate required responses of the CV-system and its applications. The trainees in these demonstrations will participate as actors or spectators. Actors will be part of the demonstrations as active drivers receiving instructions from the trainers. The trainees may also participate in the demonstrations as spectators (e.g., passengers) to watch the demonstrations. The ICF/Wyoming team will provide hands-on training on the equipped Snow Plows, CV trucks, and WHP vehicles. This module will provide an overview of the actual installed system, demonstrate the various in-vehicle CV-system components and their functions, illustrate how to use and interact with the system (e.g., HMI) via a demo mode, and how to perform basic troubleshooting.

5.2.4 Workshop

5.2.4.1 In-person/ Workshop Training - Operators

The existing TMC operator training is done through a combination of presentations and one-on-one instructions. For a change in Standard Operating Procedure, a TMC Quality Control Analyst will create a presentation that outlines changes and meet with employees during every shift. Documentation is kept to ensure every employee receives the training and updated materials. For a change in a process that doesn't result in a Standard Operating Procedure change, a "how-to guide" is made and emailed to every operator. Once operators have read they guide, they are asked to sign off to show they have read and understand the change.

The TMC operators will interface with the connected vehicle project via updates in the Transportation Reports and Action Console (TRAC) system. The TRAC system acts like a task list management system and pulls tasks from the patrol's computer aided dispatch system and other systems. The TRAC system is very familiar to the TMC operators but they will each receive one-on-one training to fully understand connected vehicle tasks and actions they should take.

The Highway Patrol Dispatch existing training will be extended to include the new CV applications.

5.2.4.2 In-person/ Workshop Training – Field Staff

Technicians and maintenance staff will be trained by the ICF/Wyoming team on how to install and troubleshoot malfunctioning systems as well as updating the hardware and software if needed. The technicians and maintenance staff will be trained on how to download the data remotely if applicable and in-house. Telecom employees will receive hands-on training for installation and will have access to a “how-to” guide.

5.2.4.3 In-person/ Workshop Training – Development Staff

Development staff will be trained by the ICF/Wyoming team on how to interface with data sources. The developers will receive hands-on training and documentation to understand the sources of data and data limitations.

5.2.5 Other Online Training

Other online training will be created to support refreshers and how-to guides for specific aspects of the pilot program. These may include simple PowerPoints, FAQs, user guides that illustrate work flows, installation and maintenance, use of new traveler information sources, and any changes to existing protocols. The online training will be utilized mainly to train operational staff and also support use of new features in the CVOP and the third party interface.

5.3 Evaluation of Training

To ensure an optimum training outcomes, evaluation will be performed for the different training methodology. Depending on the training methodology, different evaluation approach will be utilized. Driving data as well as post-survey questionnaire will be used for the driving simulator based training. Desktop simulation will utilize response data collected from the software and a

written assessment that will be performed at the end of the module. Oral assessment will be utilized for the in-person training. For online training, randomized quizzes will be developed to assess participants' understanding of the system. Feedback from the participants will be solicited following the start of the operational period about their roles in the pilot and the training they received. Feedback will be collected via in-person and online survey questionnaires. Future training will be updated by incorporating participants' feedback. This may include updating the depth and breadth of the information provided, confusions about the CV-system capabilities or operations that might have been introduced in the original training, the way the learning materials were provided, etc.

5.4 Summary of Training Products

The T&E Plan contains five training methodologies as summarized in Table 5-1, for which specific training products will be developed. The ICF/Wyoming team understand that training and education is a continuous effort and no final list of products can be defined, as the needs may evolve and change over time. However, the following is a preliminary list of products that will be developed:

1. E-Training Module for All Drivers: All drivers need to take and pass this module. Furthermore, this module will help in obtaining the necessary informed consent from the participating drivers. This module will be tailored to each type of driver through extensions of the existing training provided to them, namely:
    a. Snow Plow Driver Training Module Extension which will address any unique issues/questions pertaining to snow plow drivers (for example, use of the RCRS system in conjunction with the pilot)
    b. Highway Patrol Training Module Extension
    c. Commercial Vehicle Training Module Extension
    d. Fleet Vehicle Training Module Extension

2. Driver Simulation Training Module: This will provide the drivers with a simulated environment where they can practice the tasks that they will be performing as part of the CV-Pilot. Given its capacity and logistic limitations, this module is expected to be used to a smaller number of participants who can travel to the UW campus.

3. CVOP Training Module: This module is an animated slideshow within the CVOP explaining the CV-Pilot project and the new features of the upgrade portal.

4. WYDOT Third Party Interface Training Module: This module is a set of resources (e.g., technical specifications, FAQs, and troubleshooting) explaining the CV-Pilot project and the new features of the new/upgrade interfaces.

5. Field Demonstrations: This module will mostly be available for WYDOT and other fleet drivers of the CVs but may be conducted at specific locations at partnering fleet agencies. Its goal is to provide in-the-field demonstration of the systems, better explaining its capabilities and limitations.

6. Operator Training Module: This module includes lectures, slides, and hands-on experience. This module will be tailored to each type of operator through extensions, namely:
    a. TMC Operators Training Module Extension

   b. Highway Patrol Dispatch Training Module Extension

7. Operation and Maintenance Training Module: This module will target field staff with maintenance responsibilities, providing them with the know-how on how to operate and maintain the system under regular and emergency situations.

8. General Education Modules: This module provides general information of the CV-Pilot, describing its components and explaining its scope and objectives. This is mainly targeted to WYDOT Management, such as maintenance supervisors and other supervisory staff, as well as WYDOT Support Staff, including meteorologist. This module will also be used to orient motor vehicle enforcement personnel.

6 Roles and Responsibilities

The successful execution of this Training and Education Plan requires the strong commitment and participation of key team members, partners, and stakeholders. The responsibilities of each group is dependent on their project role. Table 6-1 below defines the roles and responsibilities of each group within the Wyoming CV-Pilot Project.

Table 6-1. Roles and Responsibilities of the CV-Pilot Team.

Project Role	Responsibility (Training and Education support)
Wyoming CV-Pilot system development and execution	• Ensure system design, operations, and functionality of the CV-system are well articulated and covered properly in the T&E plan. • Support Training and Education efforts. • Design training and education plan for equipped drivers. • Perform training and education plan for equipped drivers. • Conduct T&E evaluations and incorporate participants' feedback to update the T&E modules. • Support Independent Evaluators with T&E evaluation and other assistance as needed. • Prepare final Training and Education Report.
Wyoming CV-Pilot Training and Education team	• Design an adequate training and education plan that suits the needs of equipped drivers, technicians and maintenance staff, and operations staff. • Work with system design/build team to ensure an up-to-date learning materials are incorporated in the T&E plan. • Conduct T&E evaluations and incorporate participants' feedback to update the T&E modules. • Support Independent Evaluators with T&E evaluation and other assistance as needed. • Prepare final Training and Education Report.
University of Wyoming	• Obtain and maintain human use approval. • Act the IRB of record for all partners. • Ensure compliance with the IRB regulations.
System Partners/Vendors	• Provide and support a system, and learning materials such as hardware and software manuals that supports the T&E plan.
WYDOT TMC, including meteorologists	• Actively participate in CV-Pilot deployment and operation. • Participate in system training. • Operate systems as designed/instructed. • Support training data collection, as required. • Participate in surveys/interviews, as requested. • Monitor and collect action logs that may be needed to update training and education plan.
Commercial Vehicle Fleet Managers	• Participate in surveys/interviews, as requested
Connected trucks/drivers	• Participate in system training.

Project Role	Responsibility (Training and Education support)
	• Operate systems as designed/instructed. • Support training data collection, as required. • Participate in surveys/interviews, as requested. • Monitor and collect action logs that may be needed to update training and education plan.
Connected snow plows/drivers	• Participate in system training. • Operate systems as designed/instructed. • Support training data collection, as required. • Participate in surveys/interviews, as requested. • Monitor and collect action logs that may be needed to update training and education plan.

7 Key Challenges

The major challenges for training and education include:

- Institutional Review Board (IRB) requirement
- Participant characteristics
- Planning and coordination of training
- Participant turnover

This section covers the key challenges directly related to the ICF/Wyoming CV-Pilot and how they are being addressed.

7.1 IRB Requirement

All research involving human subjects must be approved by an accredited Institutional Review Board (IRB). The IRB certification as well as proper training for all the principal investigators and researchers involved in the CV-Pilot must take place prior any recruitment activity for participants. The Institutional Review Board (IRB) at the University of Wyoming (UW) will act as the IRB of record on this CV-Pilot, the UW IRB is accredited through the US department of Health and Human Services (HHS) – the Office for Human Research Protections (OHRP) - Federal-Wide Assurance # 00000186. The ICF/Wyoming team understands that the process of the IRB application and approval may be a daunting task, the team has started the process of the IRB early on to avoid any delays. An IRB application has been submitted on April 19th, 2016 and has been approved by the UW IRB on May 23rd, 2016. It is anticipated that multiple amendments to the original application will be prepared and submitted as the CV-Pilot progresses in Phase 2 and 3.

7.2 Needed and Desired Participant Characteristics

Certain characteristics of the participant in the ICF/Wyoming CV-Pilot are needed and desired for the successful deployment of this pilot. For example, technical staff will need to have a minimum of 5 years of experience in supporting ITS, whereas it is desired that Wyoming Highway Patrol drivers have 2 or more years of experience working for Highway Patrol. Guaranteeing that all conditions are met throughout the duration of the pilot may be a challenge. The ICF/Wyoming team will analyze all requirements and provide flexible conditions where possible.

7.3 Planning and Coordination of Training

The various participant groups and training methodologies introduced in this document will require a great deal of planning and coordination. The design of the different training modules

cannot be started until some of the pilot applications have been fully developed. The planning and coordination of training will take into consideration the large number of participant groups, training approach, as well as the available resources for training. The ICF/Wyoming team will attempt training approaches that ensure the highest knowledge retention rates such as hands-on and field demonstration before moving into other approaches with less knowledge retention rates such as online training. The pilot team will plan training session and workshop as to accommodate the maximum number of participants using the fewest resources. Moreover, multiple training sessions will be carefully planned to ensure higher attendance rates.

7.4 Participant Turnover

Perhaps the most challenging key issue in this pilot is going to be participants' retention for the long study period in Phases 2 and 3. This issue may be encountered for all participant groups including instructors, operational and technical staff as well as drivers. The team will work on recruiting and training new participants in case of participants' dropout. The training and education will be made available throughout Phase 2 and 3. In addition, the ICF/Wyoming team will evaluate strategies to ensure a minimum participant turnover, such as providing incremental incentives for participants.

8 Planning and Coordination of Training Activities

8.1 Schedule

The schedule for training and education activities, shown in Table 8-1, follows the key pilot objectives and deliverables. The training and education activities will have a duration of 20 months and are set to start at the beginning of Phase 2 of the CV-Pilot Project—i.e., month 1 of the T&E Plan coincides with month 1 of Phase 2. Within this scope, key T&E deadlines include:

- **IRB Approval:** The University of Wyoming will be acting as the IRB of record for all partners. An IRB proposal has been submitted to the University of Wyoming Institutional Review Board on April 19th, 2016 and was approved on May 23rd, 2016 for one-year period. A request to extend the approval accompanied by a report on the status of the project and any updates to the original protocol will be submitted to the IRB at the University of Wyoming one month prior to the expiration date.
- **Training Material Deadline**: End of September, 2017 – All training modules, software, equipment, online/offline materials, etc. are ready.
- **Training**: Beginning of October, 2017 – All training to all users initiate and will continue throughout Phases 2 and 3.

8.2 Procurement of Necessary Facilities and Equipment

While existing training facilities, such as the driving simulator lab (WYOSIM) at the University of Wyoming and demonstration areas at WYDOT, will be utilized for training, In addition, software upgrades and technical support for the driving simulator necessary for the training on Phase 2 will be included in the program budget for Phase 2 and Phase 3.

Table 8-1. Wyoming CV-Pilot Training and Education Plan Schedule.

Activity	2016										2017												2018												2019											
Phase 1	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
IRB Application and Approval																																														
Complete T&E Document																																														
Phase 2																																														
IRB Update and Renewal																																														
Preparation of Training Materials – Drivers																																														
Preparation of Training Materials – Operational Staff																																														
Preparation of Training Materials – Instructors																																														
Phase 3																																														
IRB Renewal																																														
Training - Instructors																																														
Training – Drivers and Staff																																														
Collect Feedback																																														
Evaluation																																														
Update Training Modules																																														
Prepare T&E Report																																														

Appendix. IRB Approval Letter

UNIVERSITY
OF WYOMING

Vice President for Research & Economic Development
1000 E. University Avenue, Department 3355 • Room 305/308, Old Main • Laramie, WY 82071
(307) 766-5353 • (307) 766-5320 • fax (307) 766-2608 • www.uwyo.edu/research

May 24, 2016

Dr. Mohamed Ahmed, Ph.D., P.E.
Assistant Professor
Civil & Architectural Engineering
University of Wyoming

Protocol #20160524MA01205

Re: *"Ahmed-Wyoming DOT Connected Vehicle Pilot Deployment-Phase 2 and 3"*

Dear Dr. Ahmed:

The Institutional Review Board for projects involving human subjects reviewed the proposal referenced above at their meeting May 19, 2016. The proposal was approved as one that would not involve more than minimal risk to participants, subject to minor revisions. We have received the requested revisions and the revised protocol is approved.

IRB approval for the project/research is for a *one-year period*. If this research project extends beyond *May 23, 2017*, a request to extend the approval accompanied by a report on the status of the project (Annual Review Form) must be submitted to the IRB *at least one month prior to the expiration* date. Any significant change(s) in the research/project protocol(s) from what was approved should be submitted to the IRB (Protocol Update Form) for review and approval prior to initiating any change. Per recent policy and compliance requirements, any investigator with an active research protocol may be contacted by the recently convened Data Safety Monitoring Board (DSMB) for periodic review. The DSMB's charge (sections 7.3 and 7.4 of the IRB Policy and Procedures Manual) is to review active human subject(s) projects to assure that the procedures, data management, and protection of human participants follow approved protocols. Further information and the forms referenced above may be accessed at the "Human Subjects" link on the Office of Research and Economic Development website: http://www.uwyo.edu/research/human-subjects/index.html.

You may proceed with the project and we wish you luck in the endeavor. Please feel free to call me if you have any questions.

Sincerely,

Colette Kuhfuss

Colette Kuhfuss
IRB Coordinator
On behalf of the Chairman,
Institutional Review Board

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487

www.its.dot.gov

FHWA-JPO-16-294

U.S. Department of Transportation