ARKANSAS STATE HIGHWAY COMMISSION

# MINUTE ORDER

District: Statewide



County: Statewide

Category: Miscellaneous

**WHEREAS,** the planning and design of highways in Arkansas accounts for future traffic demand and behavior; and

**WHEREAS,** connected and autonomous vehicle (CAV) technologies are expected to continue to advance within the next 20 years, resulting in changes to travel behavior and vehicle operating capabilities; and

**WHEREAS,** a need exists to evaluate how CAV technologies will impact traffic operations on the highway system; and

**WHEREAS,** a pooled fund study has been established to allow participating states to provide input in developing methodologies to estimate how CAV technologies will impact traffic operations as well as provide feedback on priority needs; and

**WHEREAS,** participation in this pooled fund study will be highly beneficial to the Department.

**NOW THEREFORE,** the Director is authorized to participate in this pooled fund effort and enter into the necessary agreements to fulfill the Department's commitment.

Approved:

Chairman

Vice-Chairman

Member

Member

Member

TPP:ASB:5/10/17

Submitted By:

Assistant Chief Engineer - Planning

Approved:

Director

Minute Order No. 2017 051

Date Passed JUN 7 2017

Form 19-456
Rev. 7/19/2016

# Pooled Fund Study

## Highway Capacity Manual Adjustments for Connected and Autonomous Vehicle Technology Implementation

- **Developing "Highway Capacity Manual" Capacity Adjustments for Agency Connected and Autonomous Vehicle Operational Planning Readiness under Varying Levels of Volume and Market Penetration** is a pooled fund study led by the Oregon Department of Transportation (DOT).
- The purpose of the study is to develop highway capacity adjustments for connected and autonomous vehicles (CAV) for practical planning purposes.
- This study will benefit the Department by helping better evaluate highway capacity needs in the future.
    - The planning and design of highway projects typically consider forecast traffic conditions 20 years into the future.
    - CAV technologies are being implemented into the current vehicle fleet. This is expected to continue at an accelerating rate within the next 20 years.
    - Although there is ongoing research regarding the impacts of CAV technologies on highway operations, much of it focused on detailed modeling methods. Research on how CAVs will impact highway operations for practical planning purposes currently does not exist.
    - Because traffic conditions on Arkansas highways are unique compared to many states, participating in this pooled fund study will allow the Department to provide input into the research project.
- Oregon DOT has contributed $40,000 for FY 2017-2018 for this pooled fund study.
- The minimum financial participation for Arkansas is $15,000 per year for two years (FY 2017- 2018).

# Solicitation Detail View

## Developing "Hiqhway Capacity Manual" Capacity Adjustments for Agency Connected and Autonomous Vehicle Operational Planning Readiness under Varying Levels of Volume and Market Penetration

### General Information

**Solicitation Number:** 1447
**Status:** Solicitation posted
**Last Updated:** Apr 24, 2017
**Solicitation Expires:** Apr 24, 2018
**Lead Agency:** Oregon Department of Transportation

### Contact Information:

**Lead Agency Contact:**

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### Financial Summary:

**Commitment Start Year:** 2017
**Commitment End Year:** 2019
**Commitments Required:** $150,000.00
**Commitments Received:** $40,000.00

### Commitments by Organization:

| Agency | Year | Commitments |
|---|---|---|
| Oregon Department of Transportation | 2018 | $20,000.00 |
| Oregon Department of Transportation | 2019 | $20,000.00 |

### Study Description

**Background:**
The capability of Connected and Autonomous Vehicles (CAV) is progressing at a faster rate with particular focus on technological performance, and its wide-ranging potential impacts on safety, operation, and regulatory issues. For example, CAVs could travel closer together at smaller headway which enables higher capacity through existing infrastructure. Existing CAV research is often limited in terms of scope, scale, approach, or underlying assumptions, and has not sufficiently addressed questions about the large-scale impacts of CAV on highway capacity, which are required by decision-makers to inform policies.

Moreover, the Highway Capacity Manual (HCM) is at risk of becoming outdated or limited in relevance/usefulness as the CAV technologies become more prevalent on the market. The current HCM has multiple limitations regarding CAV analysis including:

(1) Capacity-related HCM methods cannot be used to evaluate projects or facilities that would utilize CAV technology, as the impacts of CAV strategies are not accounted for.

(2) Lack of existing analysis guidance regarding the suitability of the HCM for analyses involving CAV strategies.

(3) Limited consideration of market penetration and the effects they will have on the realized outcomes associated with CAV technologies on various facilities.

These limitations drive a critical need to develop HCM capacity adjustments (CCAV) to be prepared for future CAV operations under varying levels of volume and market penetration.

**Objectives:**
The research objectives of this project are to develop the highway capacity adjustments for CAVs at different levels of volume and market penetration in order to adapt the use of HCM in analyzing CAV applications. The major highlight of this project is the project team working closely with Technical Advisory Committee (TAC) through an iteratively updating and revising process.

The major approach for this problem is through a scenario simulation planning framework and through simulation tools in which the CAV and non-CAV behavior are coded differently. The interactions among and beyond CAVs and non-CAVs are specified in details in the simulation scenarios. It is important to note that this research intends to focus on CAV and not Connected Vehicles (CV) nor Autonomous Vehicles (AV). This is because CV and AV on their own are not anticipated to greatly impact highway capacity. Significant capacity gains are only anticipated when both vehicles are automated (driven by computer) and connected (computer driven vehicles coordinating and optimizing with one another).

This project plans on testing market penetration at varying levels of volumes to see how market penetration impacts both throughput (maximum pre-breakdown flow rate) and recovery time after congestion subsides (breakdown flow rate and maximum discharge flow rate) under various conditions. This research also attempts to measure how incidents (crashes) and events (weather, local surges in entering or exiting volume) impact throughput and recovery time at varying levels of volume and market penetration.

The expected products of this research are highway capacity adjustment lookup tables and figures for different facilities (freeway, arterials) at different levels of CAV market penetration. This project is designed to address the limitations identified with respect to the CAV effects in HCM analysis procedures. It is anticipated that the project team and the project TAC will work closely regarding the iterative nature of assumptions and results associated with the defined scenarios to ensure the usefulness of the project products for agency operational and planning readiness. The project team is also expected to be receptive to relevant research elsewhere and what new CAV advancements could possibly emerge over the project period.

This project will benefit public agencies to accommodate highway capacity related analysis under the impacts of CAV for different levels of volumes and market penetrations. Specifically, it will inform agencies about how CAV market penetration will affect capacity leading to better informed investment decisions in area freeways, new roundabouts and signals, and safety projects. This research will also put the HCM at the forefront of CAV research in terms of operational readiness of CAV applications and technologies.

**Scope of Work:**
The project team and TAC will work together closely through an iterative process to achieve the following specific research tasks, and estimated costs and duration to be undertaken by the researchers for the study:

Task 1: Literature Review and CAV Analysis Gaps. A focused review of the operational impacts of CAV will be conducted under Task 1, in particular on the operational impacts on highway capacity. This review will systematically assess what has been done in terms of modeling scenarios, parameters, tools, and methodologies. The purpose of this review is to create an initial set of knowledge to inform the modeling work in this project. Stage 1: A literature review will be built and then reviewed by the TAC. Stage 2: Feedback from the TAC will be used to update literature review and project objectives, which will then be shared with other agencies.

Task 2: Scenario Identification and Test Prioritization. Suggestions from the TAC and feedback from task 1 will be used to identify the CAV modeling scenarios and their applications based on the HCM, for example, the impacts on link or junction capacity, capacity at merging or diverging, or capacity of different facility types. List and prioritize scenarios for different road configurations with identifying the market penetration rates and traffic volume. List and justify the assumptions for each test.

Task 3: Model Framework: the Impacts of CAV on Highway Capacity (HC). Following the assumptions defined by TAC, capacity gains and operational outcomes associated with individual CAV applications will be modeled and analyzed to all

scenarios within the research, as functions of market penetration rate, roadway characteristics/configuration (e.g., mixed-flow lanes or dedicated lanes for CV traffic), traffic characteristics, and the design parameters being used by automobile OEMs (e.g., following distances and headway). Capacity gain for each combination of capability and market penetration will be compared to the base no-build situation (no CAVs) based on HCM. The project team will prepare a presentation of framework to the TAC and update models based on feedback. An interim presentation including project status, process, and feedback from various committees will also be prepared for TAC members to present in TRB mid-year and annual meeting.

Task 4: Monthly Testing and Reporting for TAC Review and Publication. The project team will accomplish the prioritized testing from task 2 and prepare a monthly memo for the TAC to review and approve from Month 6 to 12 including (1) approved testing scenarios, (2) issues raised and how they are resolved, and (3) findings/results of testing. Modifying the strategy-specific models of CAV-related capacity and operational impacts from Task 2 to make them compatible with current HCM methods, assumptions, inputs, and outputs. The TAC will review findings and revise prioritized testing list and operation assumptions. An integrated interim report and presentation will be prepared for TRB meeting and online publication.

Task 5: Create the HCM Adjustments Lookup Tables and Figures. Developing an analysis framework/methodology for accurately capturing the effects/outcomes of CAV applications in the HCM and other tools, which would include recommended approaches, best practices, and known limitations, and would promote consistency among analysts. Also, identifying the limitations of the HCM and discussing where it fits in an overall CAV analysis toolbox/framework.

Task 6: Draft Preliminary Final Report. The project team will prepare and submit a preliminary draft final report documenting the research study, conclusions, and recommendations. Besides, 2-3 application examples for each facility will be included to demonstrate how the adjustments in HCM can be used in a planning process.

Task 7: Final Report and Delivery. Incorporation of final feedback from the TAC and production of a final report.

**Comments:**
For full partner benefits, a 2-year funding commitment; $15K/yr (paid annually) assuming 5 agencies join the fund, with potential discounts for in kind contributions if necessary for participation.

Project TAC will determine statement of work and selection criteria.

2-yr road map developed/approved by TAC; non-consensus decided by majority rule.

## Documents:

There are no attached documents at this time.



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