Amendment 4B to the Addendum for the

Human Factors/Safety and Automated Vehicle Program

The following work plan covers the University of Iowa's (UI) support for the Human Factors/Safety and Automated Vehicle Program for the Iowa Department of Transportation (DOT). Dr. Dan McGehee, Director of the National Advanced Driving Simulator and a professor in the department of mechanical and industrial engineering, is designated as the Program Manager (PM).

All tasks will be assigned to the PM, Dr. Dan McGehee, and will be coordinated through Ms. Sandra Larson, Systems Operations Bureau Director for the Iowa DOT. These tasks may be modified during the year by mutual agreement between Dr. McGehee and Sandra Larson. The allocation of resources to support Iowa DOT programmatic needs will be re-evaluated periodically and annually. It is anticipated that others will be supported through this work plan, and will work at the direction of Dr. McGehee to complete the work plan tasks. All support staff, students or sub-consultants supported through this work plan will be identified and approved by the Iowa DOT.

All work performed through this work plan will be as directed and approved by the Iowa DOT. Progress made on the work plan tasks specifically detailed in Amendment 4B of the Addendum will be identified and detailed in the written program monthly progress reports. Updated work plans for additional and expanded efforts will be identified and submitted to Sandra Larson for Iowa DOT approval. The work plans also include proposed out-of-state travel to participate in meetings and conferences, subject to Iowa DOT approval and the availability of resources. Potential travel includes investigator and staff travel to project meetings in Chicago, Des Moines/Ames, meetings with the selected vendors and to the build site (anticipated Detroit or southern region) and planning for additional domestic travel that may present itself during the proof of concept preparation phase.

The existing executed Management Agreement between the University of Iowa and the Iowa DOT will apply to this addendum.

Track 4B: Information for Machines – Automated Vehicle Control – Proof of Concept

The purpose of 4B is to demonstrate the capability to conduct automated vehicle testing in Iowa and ingestion by the vehicle of map data to support levels of vehicle control. The proposed task approach culminates in an initial automated control proof of concept in a UI vehicle. All proof of concepts, demonstrations, tests, and usage of the automated vehicle will be done under the strict supervision of a trained and approved driver. While the UI will build, procure and own the vehicle, the Iowa DOT will pay for the use of that vehicle during the planning, development, analysis, testing and proof of concept/demonstration activities.

Task 1: Vehicle Function and Driving Scenario selection

Task 1 will begin as a collaborative effort between the Iowa DOT, the UI, ISU, and HERE (referred to as the project team) to identify the vehicle function controls that will be demonstrated as well as the driving scenario in which the proof of concept demonstration will occur. The project team will meet to discuss the vehicle function options and prioritize the capabilities that are feasible for the proof of concepts. Additionally, the UI will document and work with the project team to plan the future automated control proof of concepts to take place in 2018 (this will be documented in the 4B Final Report (Task 6)).

- Milestone: UI memo to the Iowa DOT detailing the vehicle functions and driving scenario to be demonstrated in 4B

Task 2: Investigate system vendor options and select vendors

Based on the scenarios selected in Task 1, Task 2 documents the vehicle specifications and requirements. This process will involve Iowa DOT, HERE and potential vendors and suppliers. UI will contract with one or more vendors for the actual build and preparation of the vehicle. This vehicle will be owned by the UI. All system specifications, assumptions, and vendor selection criteria will be documented throughout the process and will be delivered to the Iowa DOT in the 4B Final Report. Additionally, the UI will update the Iowa DOT regarding the status of all vendors and the vendor selection requirements in its frequent communications and in the monthly reports.

It should be noted that the UI plans to procure and work with multiple partners to build the vehicle.

- Milestone: Vendors selected
- Deliverable: Memo to Iowa DOT confirming the selected vendors

Task 3: Build the Vehicle

During Task 3, the vendors will construct and program the vehicle. The UI will manage, supervise, and work very closely with the selected vendors to ensure the timeline is met and to ensure full understanding of the automated vehicle functions in relation to the mapping architecture. The UI will procure and participate in the construction of the automated vehicle (AV). The UI will actively manage the build, receive biweekly updates from the vendors. The biweekly updates will be held via teleconference meetings between the UI and the vendor and the UI will detail all progress in the frequent communications and monthly reports to the DOT. Any unforeseen risks or concerns will be brought to the attention of the Iowa DOT should there be an effect on the overall schedule, deliverable, and timeline. Task 3 will include extensive documentation of the build process and the specifications required (compiled into the 4B Final Report). While the majority of the meetings will occur remotely via teleconferencing, Webex, or Skype platforms between the UI and the vendor, the UI will travel to the build site and

programming sites during critical timepoints (exact dates to be determined).

- Milestone: Vehicle received by UI from vendor
- Deliverable: Memo confirming that a successful automated vehicle function bench test was completed at the vendor location and the vehicle is ready for testing

Task 4: Proof of Concept - Testing the Vehicle

Upon receipt of the vehicle in Iowa City and successful software testing at NADS, the UI will begin the initial testing on a closed course. After several successful closed-course trials, the UI will test on-road during off-peak hours.

The UI will test and evaluate the vehicle functions and performance under a variety of conditions (e.g., weather, traffic, and roadway), in-vehicle data displayed, and other situations to be determined during discussion and collaboration with the Iowa DOT. The UI will document every test of the AV and this documentation will be included in the 4B Final Report. The Iowa DOT (and the project team) will be invited for a site visit to the UI NADS (and Iowa City area) to experience the full functionality of the automated vehicle.

- Milestone: UI invites the Iowa DOT to NADS for a site visit to demonstrate the functionality of the full integration

Task 5: Public Demonstrations of the Automated Vehicle Control Proof of Concept

In Task 5, the UI will work with the Iowa DOT and project team to develop the overall marketing proof of concept demonstration outreach announcement and planned demonstration. Task 5 will include the date of the proof of concept demonstration, the setting, the route, time, and how the demonstrations will be communicated to the public (in the form of press releases, short videos (for social media), long videos (YouTube), infographics, and the public messaging to be used for the demonstrations. The project team will work together on all communications and public outreach regarding the demonstrations. The marketing plans will also detail the number of days of demonstrations that will be open to the media. The Iowa DOT will approve all components of the demonstration(s) and the overall public outreach and marketing plans.

- Milestone: Completed Proof of Concept Demonstrations

Task 6: Final Reporting

For Task 6, the UI will deliver a 4B Final Report that fully details Task 1 – 5. The Final Report will include the entire specification, build, and Automated Vehicle Control Proof of Concept process undertaken by the team as well the results of the proof of concept demonstrations (how they were publicized, time, place, setting, attendees, comments from public and stakeholders). Additionally, the Final Report will include the lessons learned from the initial proof of concepts and propose the Future Automated Control Proof of Concept or Demonstration possibilities. Proof of concept or demonstration possibilities include, but are not limited to: winter weather automated vehicle control proof of concept, rural town to urban city connection proof of

concept, movement of goods proof of concept, agricultural proof of concept or several other proof of concept possibilities to be determined and discussed. The UI will propose future research and proof of concept plans to the Iowa DOT in subsequent amendments.

- Deliverable: 4B Automated Vehicle Control Proof of Concept Final Report

Assumptions

The UI's Amendment 4B is operating under the assumptions listed below. Upon further information and finalization of the Vision Document prepared by HERE and the overall timeline, the UI will amend the deliverables to fit the updated needs identified by the Iowa DOT. If these assumptions are not met, the UI's tasks, deliverables, and milestones under 4B may require re-adjustment and scoping to best meet the project needs. Each monthly progress report will detail the progress towards all milestones and deliverables and include feedback if the project assumptions progress differently than noted below and their effect on the overall project.

- Assumption 1: HERE map data will be available to support navigation and automated driving

- Assumption 2: HERE map data will contain enough resolution (a minimum of 20 cm with 100 meter ahead in real-time) and lane information to support automated driving scenarios

- Assumption 3: HERE will work with the system vendor(s) that the UI selects and provide support for integration of the map and cloud data with the vendor's vehicle system

- Assumption 4: Pinpoint GPS infrastructure, via access to Iowa DOT's RTK (Real Time Kinematic) network, will be available to guide a vehicle on the High Definition map.

- Assumption 5: Iowa DOT will approve the overall testing and proof of concept plans.