m̃ MINNESOTA

Safe Automation through Engagement (SAE): Automated Transportation Solutions through Collaborative Public Engagement

Minnesota's approach to collaboratively apply automated driving systems to promote greater equity, safety, and mobility through direct community engagement

Proposal Submitted by:

Minnesota Department of Transportation

In partnership with

University of Minnesota

Polaris Industries, Inc.

March 21, 2019

DEPARTMENT OF TRANSPORTATION

Sarah Tarpgaard, HCFA-32   March 21, 2019
US Department of Transportation (USDOT)
Federal Highway Administration (FHWA)
1200 New Jersey Avenue SE, Mail Drop: E62-204
Washington, DC 20590

RE: NOFO #693JJ319NF00001 Automated Driving System Demonstration Grants

Ms. Tarpgaard:

Please accept the enclosed proposal submitted by the Minnesota Department of Transportation (MnDOT), in partnership with the University of Minnesota (UMN) and Polaris Industries.

This collaborative public-private partnership was assembled to provide transportation leadership, academic knowledge, and industry expertise to demonstrate the safe introduction of automated driving systems (ADS) to Minnesota communities experiencing transportation challenges.

The physical ADS demonstrations described in this proposal focus on communities throughout Minnesota, including communities with disabilities, aging populations, low-income, communities of color, and tribes. The challenges they face are not unique to Minnesota. Rather, these market failures are prevalent throughout the country. Minnesota offers the unique opportunity to demonstrate how ADS can operate under challenging winter conditions.

Notably, our proposal focuses on engaging with the public to identify and find safe ADS solutions to overcome transportation barriers they face. By convening workshops, listening sessions and together developing demonstration ideas, the market can validate safe automation with direct community feedback. The interaction and education from these demonstrations will directly inform local, state and federal policy and rulemaking. We believe Minnesota's ADS expertise and our proposed demonstrations will provide a solutions-based framework that can be replicated in other communities and programs to safely advance ADS to promote future mobility.

Regards,

Margaret Anderson Kelliher
Commissioner

Summary Table	
Project Name/Title	Safe Automation thru Engagement (SAE): Automated Transportation Solutions thru Collaborative Public Engagement
Eligible Entity Applying to Receive Federal Funding (Prime Applicant's Legal Name and Address)	Minnesota Department of Transportation 395 John Ireland Blvd St Paul, MN 55155-1800
Point of Contact (Name/Title; Email; Phone Number)	Jay Hietpas, PE Connected and Automated Vehicle Executive Director 1500 W County Road B2, MS 50 Roseville, MN 55113 jay.hietpas@state.mn.us 651-503-2850
Proposed Location (State(s) and Municipalities) for the Demonstration	8 static, parking lot, fixed route and service pilot demonstrations in locations throughout Minnesota, including urban, suburban and rural locations.
Proposed Technologies for the Demonstration (briefly list)	Polaris GEM e6 shuttle enhanced with SAE Level 4 automation and related accessibility hardware and software
Proposed duration of the Demonstration (period of performance)	3 years
Federal Funding Amount Requested	$3,899,727
Non-Federal Cost Share Amount Proposed, if applicable	$850,000
Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable)	$4,749,727

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Safe Automation through Engagement (SAE): Automated Transportation Solutions through Collaborative Public Engagement

Part 1: Project Narrative and Technical Approach

1.1 Executive Summary

A. Vision, Goals and Objectives

Overview

Minnesota - the *Bold North* - is a region filled with dichotomies: rolling prairies and Great Lakes, Fortune 100 companies and small businesses, growing cities and rural towns, humid summer days and extreme winters. The Minnesota Department of Transportation (MnDOT) and its partners – the world renowned University of Minnesota and Fortune 500 innovator Polaris - believe that by combining their national expertise and innovation to conduct demonstrations in Minnesota communities experiencing transportation barriers we can harness safe transportation technologies - including automated driving systems (ADS) - to solve market failures to dramatically improve the quality of life for Minnesotans and communities across the world.

The proposed demonstrations are not limited to one route, one community, or one technology. We believe in solutions-based ADS technology that brings Polaris's technological expertise, MnDOT's strong demonstration experience, and the University's renowned ADS research together with Minnesota communities to understand how the vehicle design, software and interface will meet the mobility needs of the future. This project will bring Level 4 automated vehicles throughout the state to test in urban, suburban, and rural communities. Eight demonstrations will be

held in spring, summer and winter months to test Minnesota's extreme weather conditions and build off previous cold weather tests.

In addition, demonstrations will be coordinated with direct public engagement in communities experiencing transportation challenges, including aging populations, low income families and people with disabilities. This allows the industry and researchers to hear directly from users to ensure that transportation technologies benefit the public and may inform future policy and rulemaking at the local, state and federal level. While two-thirds of Americans are generally hesitant to accept ADS, after being able to see, touch and feel the technology through public ADS demonstrations, recent Minnesota surveys show support of ADS increased by 100%.

Vision

If industry does not work with government, academia and communities to develop ADS, technology will be developed in a vacuum and will fail to incorporate the needs of communities experiencing transportation barriers. To avoid inequitable outcomes, public and private collaboration is critical. For example, in some rural Northern Minnesota communities, public transit service ends at 4:30 p.m. Dial-a-ride services can take up to a week in advance to schedule. For some persons with disabilities, the cost of one week of transportation can

equal nearly 70 percent of their monthly social security or disability income. With nearly 1 in 5 Minnesotans having a disability, the needs of these communities are significant. The opportunities human-centered design and solutions-based ADS technology pose have the ability to transform lives.

This proposal will use public feedback to engineer vehicles and software and develop technology and policy solutions to inform rulemaking and policy. Anticipated outcomes include: insights on how to develop more accessible vehicles, and an engagement toolkit for other jurisdictions to use. In addition, this proposal provides the tools and industry expertise to develop a cost-model to show ADS technology affordability

Why Minnesota?

Minnesota is best positioned for this opportunity because of its:

- Strong experiences testing and demonstrating ADS
- Decades of experience developing solutions-based automated technologies for the federal government and others
- Research on how ADS technologies will impact our transportation network and communities
- Robust public engagement to inform technology solutions and programs, and
- Culture of long-range strategic planning, public engagement and intelligent transportation systems (ITS) development.

This proposal will:

1. Conduct eight demonstrations including static, parking lot, fixed-route and service pilots
2. Demonstrate ADS in rural, suburban and urban communities throughout the state
3. Test ADS in cold-weather climates
4. Test ADS in rural towns and busy urban areas to examine complex use-cases
5. Engage with the public to inform use-cases in partnership with disability communities, low-income populations, and the elderly, and
6. Develop metrics and evaluation criteria for public perception, vehicle safety and accessibility data.

This project builds off the work of the Minnesota Governor's Connected and Automated Vehicles (CAV) Advisory Council and the statewide 2018 Automated Vehicles Visioning workshop. The Council understands the importance of demonstrating ADS. This is a top priority for MnDOT executive leadership and the state.

In planning these demonstrations and testing priorities, Minnesota will continue its work with transportation challenged communities to identify technology and policy opportunities to address market failures. Only by working with transportation challenged communities can we find solutions to these market failures.

> *Only by working with transportation challenged communities can we find ADS solutions to market failures.*

Goals and Objectives

| Safety | Trust | Collaboration | Data |

This project will:

1. Use best practices to develop ADS technology to safely address transportation challenged communities' market failures
2. Generate public perception and accessibility metrics for ADS development
3. Develop a data sharing repository, methodology, and public-private data sharing plan
4. Build a toolkit for other jurisdictions to collaboratively develop ADS technology with community-based solutions and market-failures in mind, and
5. Develop a cost-model for ADS technology.

Eight demonstrations will be located throughout Minnesota, including urban, suburban and rural locations. The pilots will include:

- 5 static pilots
- 1 parking lot demonstration
- 1 fixed-route demonstration (3-5 days)
- 1 service pilot up to 2 weeks.

A total of up to 6 vehicles will be deployed throughout the state.

To address the US DOT's goals associated with safety, data for rulemaking, and collaboration, our goals for this project include:

Our objective is to develop community-informed ADS demonstrations that promote solutions-based automated transportation through meaningful public engagement to build public trust in ADS and collaboratively promote transportation safety, equity, and mobility.

1. **Safe, solutions-based technology**: Develop ADS technology solutions by understanding the direct needs of transportation challenged communities to optimize the technology with human-centered engineering.

2. **Build public trust:** Develop community-informed ADS demonstrations that build public trust in transportation technologies through meaningful public engagement.

3. **Demonstrate collaborative public-private partnerships**: Form collaborative public-private partnerships among the ADS industry, research institutions and government to gather data for rulemaking and policy.

4. **Data and metrics to evaluate safe automation**: Understand what defines a successful demonstration by creating metrics to assess the safe integration of ADS to solve market failures. Gauge public perception and share data among public and private entities.
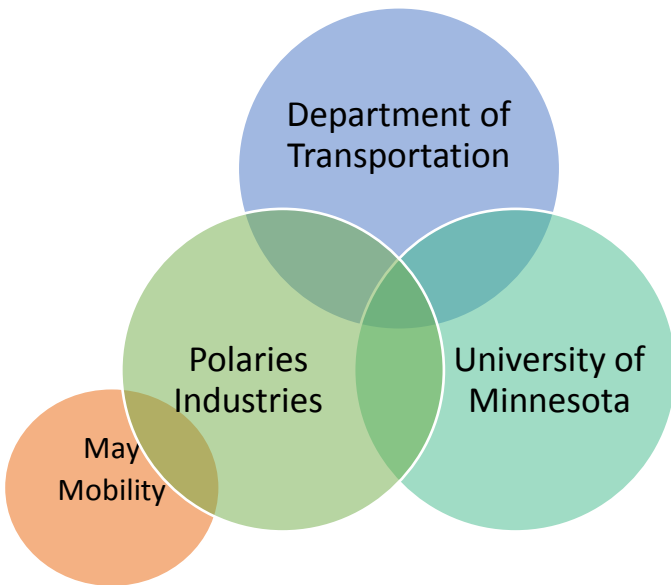
B. Key Partners, Stakeholders and Team Members

MnDOT's Connected and Automated Vehicles Office (CAV-X) will lead this effort in partnership with the University of Minnesota and Polaris Industries supported by May Mobility.

MnDOT has extensive experience in automated vehicle demonstrations, ITS testing and deployment, public engagement, data management and evaluation. Most recently, MnDOT conducted Level 4 automated vehicle cold weather testing at its off-road MnROAD facility and in public demos during the Super Bowl and Minnesota State Fair. Static demos were held at the Minnesota Transportation Conference. In 2019 multiple demos are being hosted in the Twin Cities on public streets. To-date, over 3,000 people have participated in demos to advance ADS development.

The University of Minnesota has a rich history and active research in ADS technology. For over 30 years, the Center for Transportation Studies (CTS) has served as a catalyst for transportation innovation in the state and nationwide. The Humphrey School of Public Affairs is actively working with communities, lawmakers, and stakeholders to better understand ADS issues. Currently the University is developing a model for deploying ADS in small towns and rural areas and supports research regarding equity and ADS. The National Science Foundation also awarded the University funding to research how ADS will reshape transportation to advance smart, connected communities through "smart cloud computing."

This public-private partnership is completed with Polaris Industries, a Minnesota-based company with over a decade of experience developing ADS. Polaris' ADS solutions are used in the defense industry and in the public sector, including smart cities throughout the U.S. Founded in 1954 Polaris now offers over 30 brands of vehicles including GEM – an all-electric low-speed vehicle (LSV) designed with street-legal safety features to transport people around campuses, facilities and neighborhoods comfortably and sustainability.

Polaris is partnering with May Mobility, a leader in this space. May Mobility - an Ann Arbor, Michigan start-up founded in 2017 - works alongside communities to design safe self-driving vehicles and developing unique services to advance mobility. To date, May Mobility has deployed commercial fleets of Level 4 fixed-route shuttles in Detroit, Michigan and Columbus, Ohio. Nearly 40,000 rides have been provided in their self-driving shuttles.

We believe that this combination of government, research and private industry collaboration is a critical component for successful demonstrations.
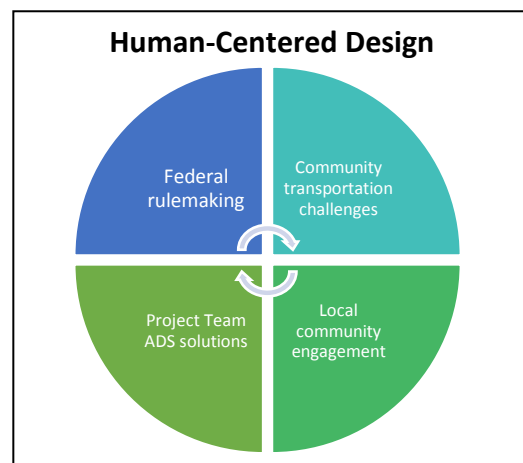
Key Stakeholders

Key stakeholders include local governments, the Minnesota Council on Disability, the Department of Human Services, Area Aging Associations and Independent Living Centers, the Department of Public Safety, policy makers, and advocacy groups like Mobility Mania.

This proposal creates a framework to use demographic mapping and census data to identify market failures and transportation challenged communities. Key communities are identified by analyzing population size, race, ethnicity, age, income, disability, veteran status, education, employment, and means of travel.

One rural Minnesota community that experiences accessibility, affordability and transportation challenges is Grand Rapids. A small town of 11,000, nearly one-fifth of its population has a disability; 20 percent of the population is over the age of 65 and it has limited transit service.

This proposal creates a framework to work with communities like Grand Rapids to create demonstrations based on the needs of each community. While each location may be unique, they experience common transportation barriers observed throughout the country. Creating a framework to conduct solutions-based demonstrations is a revolutionary new way to develop ADS technology to address market failures for the public's benefit.

The Minnesota Governor's Advisory Council on Connected and Automated Vehicle and the Interagency State CAV Team (I-CAV) will provide oversight and support. The Council includes business, industry, labor, advocacy groups, tribes and local government to guide the state as it develops CAV policy and tests ADS. Such groups include Mobility Mania, Xcel Energy, American Family Insurance, the Teamsters, Amazon, Polaris, Minnesota tribes, the City of Minneapolis, venture capitalists, and lawmakers.

Human-Centered Design

Federal rulemaking · Community transportation challenges · Project Team ADS solutions · Local community engagement

C. Issues and Challenges to be Addressed, Demonstrated Technology and Performance Improvements

Market Failures
The market failures addressed in this proposal include:

1. Cold weather operation
2. Rural, low-income communities
3. Accessibility for aging and disabled
4. Transit and first/last mile barriers
5. Other market failures discovered through public engagement

Cold weather. Minnesota endures extreme cold weather events from blowing snow and ice to Polar Vortex temperatures of 60 degrees below zero. . Understanding how

ADS operates in cold climates is critical for full deployment.

Rural, low-income. The team evaluated demographic criteria in suburban and rural areas to understand how poverty rates impact transportation and quality of life. Higher poverty rates make transportation unaffordable which can lead to challenges in employment, physical and mental health, housing, education and more.

Disabilities and aging. Some communities experience significant inaccessibility due to physical, visual, cognitive and other disabilities. In some parts of Minnesota 1 in 5 are disabled or elderly. A lack of transportation prevents access to hospitals, pharmacies, healthy activities and grocery options. [1]

Transit and first/last mile. Even though the Twin Cities boast some of the nation's strongest transit – including light rail and bus-rapid-transit (BRT) - there are many first and last mile market failures. Micro-mobility can often take days to schedule in advance and is costly. In some rural areas, transit service is limited from infrequent bus stops or a lack of service on weekends.[2]

These factors can significantly limit the quality of life for Minnesotans. By addressing these market failures in discussions with transportation challenged communities the industry can understand what communities expect from ADS and the future of transportation.

Demonstrated Technology

The eight demonstrations will use Polaris GEM e6 vehicles in various static and dynamic pilots. The GEMs will be enhanced with SAE Level 4 automation as well as features such as tactical, audio and video instructions, an accessibility ramp and other accessibility aids.

Demonstrations will be held in various locations throughout the state. Five static demonstrations will be conducted alongside public engagement to allow communities to see, touch, and feel the technology. One demonstration will be a fixed-route for 3-5 days. One parking lot demonstration will also be held and a final two-week service pilot demonstration will be held on Twin Cities public roads to provide broad data-gathering and analytical data from the public to test the vehicle.

Routes will be discussed with community members in public engagement workshops to understand the origins and destinations that meet their needs and address current market failures like lack of first mile/last mile transportation.

The following data will be gathered:

- *Vehicle and network data*: Service metrics; vehicle telematics; safety-related data to improve vehicle software and transportation network operations

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[1] http://www.cts.umn.edu/Publications/ResearchReports/pdfdownload.pl?id=1244

[2] http://arrowheadtransit.com/wp-content/uploads/2018/09/new-grand-rapids1-1.pdf

- *Accessibility data*: User interface improvements; hardware improvements for disabled users; cost-analysis; assessment of travel time, frequency, stops and origin/destination data
- *Public perception*: Public attitude; level of support of ADS; increased awareness and improved public perception of ADS.

D. Geographic Area of Demonstration

The first of eight demonstrations will be a static demonstration pilot in rural Grand Rapids, Minnesota. Other demos be held in rural, suburban and urban locations around the state.

One demonstration will be a rural, fixed-route demo in northwestern or southeastern Minnesota where no ADS demonstrations have been conducted to-date. The final demo will be a 2-week service pilot in a higher population density location such the Twin Cities, Rochester, or Duluth.

Subsequent demo locations will be finalized after Task 1 and Task 2 focus criteria are refined and the host-sites are finalized working with the community. Communities will be selected for rural and urban characteristics to understand the differences and similarities that may exist for ADS deployment.

E. Proposed Performance Period

This project will take place over three years. The six static and parking lot demos will be held from fall 2019 through late spring 2020. The parking lot demo will be held in winter to ensure adequate winter weather testing. Previous demo experience shows that it takes at least 30 days to establish baseline data, develop use-cases, and conduct feasibility analysis.

The fixed route pilot will be held in summer 2020. The Project Team will then take the data from this demo and enhance the GEM to make adjustments from community feedback for the final capstone demo. The final capstone two-week demo will be held in winter 2020-21.
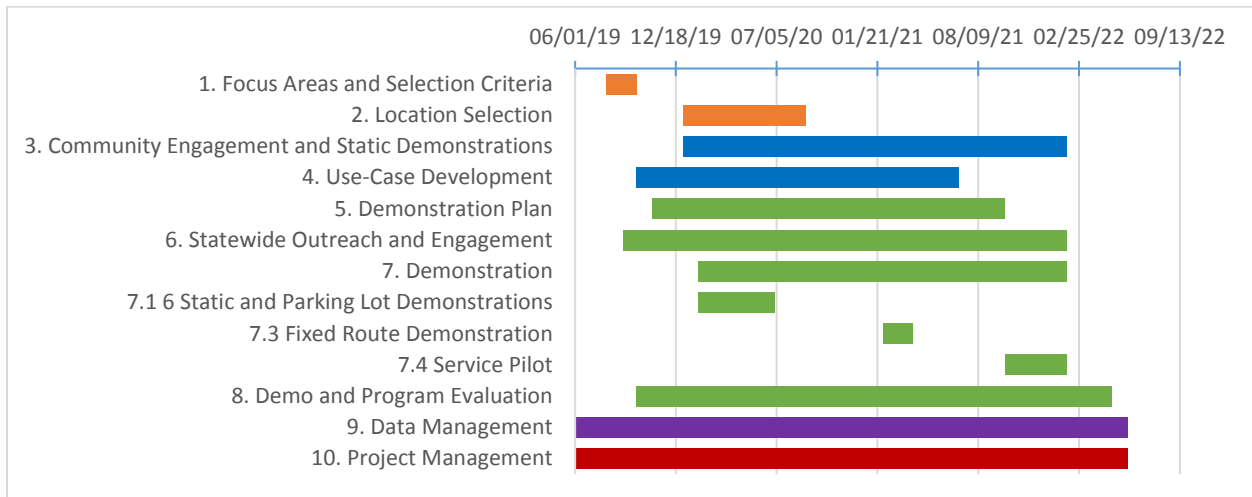
The first two years will focus on demonstrations to support public outreach and engagement. Demo and program evaluations will be conducted in the last six months of the project. Task 7 demonstrations will occur approximately six months apart to analyze vehicle performance and safety data and integrate the findings into the ADS for subsequent demonstrations.

1.2 Goals

This proposal aligns with NOFO goals of the ADS demonstration program in the following ways:

A.   **Safety**: Minnesota was one of the first states to establish a goal to eliminate traffic fatalities. This project and the state place safety above all else in its vision for CAV.

Polaris and May Mobility follow best practices for vehicle safety which is critical to any technology demonstration. All Polaris ADS projects include redundant safety systems. Fleet attendants and shutdown systems are in place for operator control, including standard SAE and IEEE approved eStop devices placed on the exterior and interior of the vehicle. Human-in-the-loop intervention is also a safety measure that may be used for these tests. As part of Polaris's Safety Program, a *System Safety Goal* list will be created, and the resulting functional safety requirements will be established for the base platform and autonomy operation.

In addition to Polaris' proven safety plans for successful ADS deployment, this project will be conducted in coordination with law enforcement, engineers, planners and community organizers.

B.   **Data for Safety Analysis and Rulemaking**: This proposal will gather significant amounts of data including:

- Service metrics, incident reports, vehicle-specific telematics to inform safety and accessibility learnings
- *Winter weather* data relating to how ADS operates in these conditions;

- *Public perception* and survey data to help inform public engagement and policy development.
- *Human factors* analysis including how pedestrians and people with disabilities interact with ADS and whether vehicles that meet Americans with Disability Act requirements are actually accessible by all populations.

C.   **Collaboration**: This proposal creates a true public-private partnership with state government, automated vehicle industry, and academic research institutions.

Demonstrations will also be held in coordination with law enforcement, local government, advocacy groups and the public.

The proposal builds off the year-long effort in 2018 wherein the CAV Advisory Council

MnDOT and Polaris Demonstration at 2018
Minnesota State Fair

held over 40 public meetings throughout the state to discuss ADS and gather community feedback to create policy recommendations. This collaborative effort culminated in the 2018 CAV Executive Report which includes over 100 recommendations to update state policy to accommodate ADS and other shared mobility technologies.

Ten policy subcommittees focusing on issues including infrastructure, traffic safety, insurance, data security, and accessibility were created. These policy teams will support and inform the demonstrations, evaluations and data analysis.

> *This collaborative framework is critical for the success of ADS technologies and can serve as an example across the U.S.*

1.3 Focus Areas
This project addresses all the focus areas identified in the NOFO as described below.

A. Significant Public Benefits

- *Meeting communities where they're at*: This proposal includes eight physical demonstrations in communities throughout Minnesota who have expressed interest and desire in using ADS, but have not had the means to host a demonstration.
- *Demonstrations improve public perception*: After extensive public ADS demonstrations, MnDOT conducted surveys gauging public perception. While two-thirds of Americans are generally hesitant to accept ADS, after Minnesotans were able to see, and touch the technology, two-thirds were supportive of ADS.
- *Addressing market failures serves the public benefit*: Industry alone is not going to address every market need. Through demonstrations we can understand and meet the needs of transportation challenged communities. This data directly informs automakers to provide safer, more accessible ADS.
- *Cost efficiencies*: Working with end-users saves money in research and development. These saved costs can be passed on to benefit consumers.
- *Equity*: By showing how partnerships can meet the needs of *all* communities, equity concerns are highlighted at the very beginning of this transformational change and can assuage public fears or perceptions instead of igniting them.

Demonstrations will educate the public and allow opportunities for road users to interact with the technology, provide feedback to industry and allow for public feedback on the safe introduction of ADS to the transportation network.

B. Addressing Market Failures and Other Compelling Public Needs

As discussed on pages 5-6 this proposal addresses multiple market failures:

1. Cold weather testing
2. Rural, low-income communities
3. Accessibility and aging challenges
4. Transit and first/last mile barriers
5. Other market failures discovered through public engagement

C. Economic Vitality

Polaris is a Fortune 500 company headquartered in Medina, Minnesota committed to growing business and talent locally. Polaris' GEM product meets Buy American requirements. In its CAV Executive Report, Minnesota prioritized economic development, business opportunity and workforce training to grow the ADS and AV industry and showcase technology industry talent.

D. Complexity of Technology

This proposal will utilize the Polaris GEM e6 with modifications from May Mobility that allow for autonomous operation at an SAE Level 4.

E. Diversity of Projects

This proposal will include demonstrations in

1. Diverse geographic locations, including urban, suburban and rural communities
2. Disparate climates including winter testing and warm weather testing in summer
3. Areas with transit with light rail, buses and bus-rapid-transit where first- and last-mile solutions are lacking

4.   Transportation challenged communities as described below.

F. Transportation challenged Populations

The Project Team and their stakeholders have conducted extensive engagement with Minnesotans that face transportation challenges. In 2018 the Minnesota Governor issued an executive order establishing the CAV Advisory Council and I-CAV Team, directing them to work with:

- Elderly Minnesotans
- People with disabilities
- Low-income communities
- Communities of color
- Tribes

The Project Team hosted over 40 public meetings throughout Minnesota to discuss transportation market failures and related policy. Each transportation challenged community's highest priority was to host demonstrations in their community to understand how ADS can solve market failures. This proposal builds on those conversations and uses feedback from these communities to create solutions-based demonstrations.

> *In each of these transportation challenged communities, one of the highest priority recommendations was to host demonstrations in their community*

Demonstrations will look at the following criteria:

1. Vehicle design changes for persons with mobility challenges
2. Hardware/software solutions for hearing/visually impaired

May Mobility shuttle

3. Systems for non-verbal commands, interactions and cyber risks
4. Vehicle network tracking for fleet management
5. Circulator routes to expand operating hours and lower costs of transportation
6. Personal mobility and transit first/last mile coordination
7. On-demand routes that connect public transportation infrastructure (e.g. light rail or bus routes) to destinations, improving service levels.

Vehicles may have wheelchair ramps, modifiable user interface for hearing, visual and cognitive disabilities. Fleet attendants will assist with prototype systems as needed.

G. Prototypes

This proposal will utilize the Polaris GEM e6 vehicle platform, with modifications by May Mobility for autonomous operation and additional modifications to better engage with transportation challenged communities. While the GEM vehicles are deployed today in Michigan and Ohio, the vehicles used in this program will be prototypes, constructed to meet the transportation needs of each community.

1.4 Requirements

This project will demonstrate how a small transit-style vehicle can solve transportation challenges. This proposal meets the NOFO requirements as described below.

A. SAE Level 4

Each demonstration will use the Polaris GEM enhanced with SAE Level 4 automation by May Mobility. Polaris GEM vehicles are all-electric, low-speed vehicles that meet requirements to operate on streets in Minnesota posted up to 35 mph.

The automated GEM vehicle, can operate as an SAE Level 4 vehicle and can transport up to five passengers plus a fleet attendant. The Project Team will operate the automated GEM vehicles in the dynamic demonstrations with a fleet attendant present at all times.

B. Physical demonstrations

All eight demonstrations are physical demonstrations.

C. Data Sharing

As described in the *Data Management Plan,* over 250,000 data points will be collected to assess vehicle performance. This data will be available for up to seven years. The Project Team will strive to make a portion of the data accessibility to Cooperative Automation Research Mobility Application (CARMA). This data is key for scalability for larger operations and full deployment.

Data will be used to improve vehicle and system design and performance as well as to inform rulemaking. Polaris is in compliance with federal data sharing agreements in its previous work with the

Department of Defense under similar programs related to ADS.

D. User Interface

The Project Team will work with communities to define demonstrations, design and configure the solution to match their unique transportation challenges.

By using human-centered design methodology, we will begin by spending time observing and understanding members the community in order to build empathy for their day-to-day needs, perspectives, and challenges. These observations are synthesized into metrics for Polaris engineers to create design solutions through ideation, prototyping, and testing of solutions to validate concepts. This provides solutions tailored to user needs.

E. Scalability

The eight demonstrations will create a best practices toolkit for similar communities across the country and industry to replicate. Demonstrations and technology will be scalable for applications in various communities.

Safe Automation thru Community Engagement
Demonstration Grant Proposal Tasks
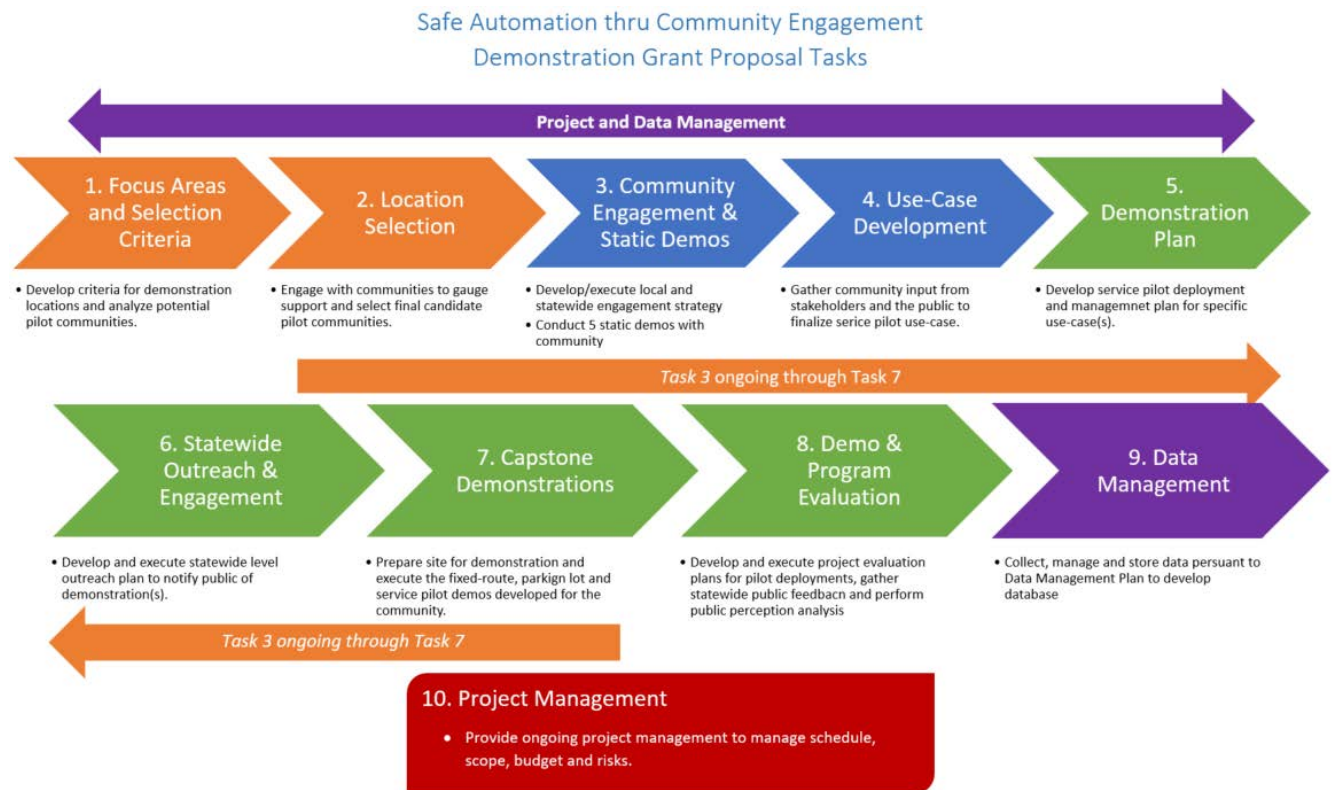
1.5 Approach

The Project Team approach to the ADS demonstrations is described below in 10 separate tasks.

Task 1: Focus Areas and Selection Criteria

This project will use physical demonstrations to show how ADS can address market failures, particularly for transportation challenged populations.

Subtask 1.1 Refine Criteria: This task will refine community selection criteria to ensure adequate consideration of all market failures and the ability for a physical demonstration to adequately address the user needs. Building upon previous research

from MnDOT, Governor's Advisory Council on CAV and the University, demographic analysis will create location selection criteria to identify potential communities and locations for hosting demonstrations.

Additional criteria will be included to ensure that locations provide quality automated demonstrations, such as:

- central business districts,
- campuses or dense residential developments,
- public and/or private roads
- speed limits of 35 mph or less
- routes will not cross highways.

Lead: University of Minnesota

Support: MnDOT, Polaris

Subtask 1.2 Community Identification: Once selection criteria are finalized, it will be used to identify Minnesota communities as potential host sites. A preliminary list of communities and information about the extent to which they exhibit the selection criteria will be developed.

Lead: University of Minnesota

Support: MnDOT, Polaris

Subtask 1.3 Community Prioritization: Using the preliminary list of communities and information summarized in Task 1.2, a workshop will be hosted to further evaluate and select additional communities for hosting demonstrations. Before approaching communities to gauge their interest, workshops assess the community's user needs and support. Facilitated workshops will discuss the selection criteria to allow participants direct feedback which is reviewed in Task 2.

Lead: University of Minnesota

Support: MnDOT, Polaris

Deliverables:

- Process document with selection criteria for identifying communities with market failures that may be addressed by ADS
- Preliminary list of targeted communities exhibiting market failures
- Prioritized list of targeted communities exhibiting market failures

Task 2. Location Selection

Subtask 2.1 Preliminary Outreach: The priority communities identified in Task 1 will be approached about their interest in a static ADS demonstration. The static demonstration will bring a vehicle to the community and host an educational event to allow the community to see, feel, and ask questions about ADS. This task will also gauge the level of community interest in performing a more-involved fixed route or service pilot demonstration within the community.

The Project Team will first engage local government and advocacy groups. Contacts within the communities will be identified. If a community is receptive, an initial outreach and engagement meeting will be held with all parties in attendance. The meeting will consist of a presentation by the project team staff and a Q&A session.

The Project Team will ask stakeholders questions related to hosting a static demonstration event. The meeting will also gather information on the viability of an expanded demonstration. Discussion questions may include:

- Are there certain areas you would like to see an automated vehicle?
- What are your major concerns, if any, about using ADS in Minnesota? In your community?
- What do you see as some of the benefits of using ADS in your community?
- What destinations would you visit if you had regular transportation?
- What barriers do you experience in using (or trying to find) transportation?

This process will be repeated for each identified target community and questions will be tailored to their demographics and other Task 1 focus areas.

Subtask 2.2 Final Community Selection: Dependent on the outcome of the preliminary outreach meeting with community stakeholders, a minimum of six final communities will be selected. If a community is not interested, the process will be applied to the next highest priority community on the list developed in Task 1.

Lead: MnDOT

Support: University of Minnesota, Polaris

Deliverables: Summary of final communities selected for demonstrations

Task 3: Community Engagement and Static Demonstrations

In this task, plans for generating awareness, input and support for the demonstration will be developed and executed in collaboration with community stakeholders. To ensure the integrity of conducting demonstrations, safety, and research with people in these communities, the University will seek review from its Institutional Review Board (IRB). IRB reviews research projects involving human participants, working with investigators to ensure adequate protection and informed, un-coerced consent.

Subtask 3.1 Develop community engagement plans for:

1. Static demonstrations
2. Fixed route demonstration
3. Service pilot demonstration

Identify and meet with local stakeholders to develop outreach strategy best suited to target community. Stakeholders may include local transit providers, chambers of commerce, educational foundations, and others.

After meeting with these focus groups, engagement plans and messaging strategies for promoting the demonstrations will be developed.

Lead: University of Minnesota

Support: MnDOT

Subtask 3.2 Execute community level static demonstration engagement event: A key part of these public engagement plans will include static vehicle demonstrations. Community members will be invited to discuss transportation challenges, and can interact with specific features of the vehicle designs as well as view videos and engage

with Project Team members in learning more about ADS. In these events, the Project Team will focus on understanding "what is the problem we are solving for?" to design a solution that fits the needs and scale required.

To do this we will use a human-centered design methodology, where we will begin by spending time observing and understanding members the community. These observations will be synthesized into a collection of key insights to define the problems or opportunities for which we wish to design solutions. This then leads to cycles of ideation, prototyping, and testing of solutions in order to rapidly test and validate the concepts generated through the process. This should then yield relevant solutions tailored to the community, leveraging self-driving technology to meet needs identified through the process.

Lead: University of Minnesota

Support: MnDOT, Polaris, May Mobility

Subtask 3.3 Execute fixed route and service pilot engagement plans:

These engagement plans would build off the static demonstration engagement. Additional stakeholders, transportation advocacy group leaders, business leaders, and members of the public will provide feedback to develop the ADS pilot route. This engagement plan serves as a tool to assist in use-case development, as outlined in Task 4.

Lead: University of Minnesota

Support: MnDOT, Polaris, May Mobility

Deliverables:

- Static demonstration, fixed route and service pilot engagement plans tailored for each community
- Host five static demonstration engagement events
- Outreach/engagement materials to execute tactics identified in each engagement plan
- Meeting agendas, presentations, handouts, videos and meeting minutes

Task 4. Use-Case Development

Subtask 4.1 Stakeholder Input: Following the static demonstrations, communities will be asked about their interest and capacity for an expanded operational demonstration.

Two communities will be selected for the pilot demonstrations with agreement from the project team and host communities. The project team will work with communities to further define market failures and develop ADS technology application use-cases. Transportation challenges will be prioritized and then analyzed to understand the predicted impact ADS may have on solving the identified challenges. MnDOT, Polaris, May Mobility, the University and local stakeholders will collaborate to identify the final demonstration approach.

Lead: MnDOT

Support: Polaris, May Mobility, University of Minnesota

Subtask 4.2 Community Input: Engagement materials developed in Task 3 will be used to facilitate a community meeting to provide an end-user perspective to the project team. The local community will assist in refining the final demonstration

approach and route. Meetings will generate public awareness and support for the demonstration.

Public input will be compiled and integrated into the final demonstration plan developed in Task 5. Input from these public meetings will also inform public perception baseline data, continuing the CAV Advisory Council efforts from 2018.

Lead: MnDOT

Support: Polaris, University of Minnesota

Subtask 4.3 Finalize Demonstration Use-Cases: The Project Team will work with communities to define demonstrations that match their unique challenges.

The Project Team will support via voice of customer, focus groups, and product development forums the information needed to determine the optimum configuration of the vehicle and ADS. This may include:

- Vehicle design changes for ADA accessibility and compliance
- Hardware/software solutions for hearing/visually impaired
- Safety systems for non-verbal commands, interactions and cyber risks
- Vehicle critical network tracking [fleet management] type devices.

The Project Team will conduct a Concept Selection Review (CSR) to validate the use-cases and address the vehicle features best suited to meet the host community needs. A CSR uses a structured analysis of quantitative and qualitative blended tool to recommend vehicle design features. This information will be available to U.S. DOT

and may be used in the public domain. Example demonstrations could include:

- Circulator route which expands operating hours and lowers total cost of transportation
- On-demand routes that connect public transportation infrastructure such as light rail or bus routes to end destinations improving convenience and service levels.

Lead: MnDOT

Support: Polaris, University of Minnesota

Deliverables:

- Final use-case summary
- Chosen concept for demonstration and data behind the CSR
- Template for gathering community input

Task 5. Demonstration Plan

Planning and preparation is critical for a successful demonstration once the final site has been selected. The layout of the site, proper permitting, management of customers and a plan for day-to-day operations must be addressed. Some infrastructure modifications may be made to maximize safety and overall user experience.

Subtask 5.1 Site Plan Sheets: Site plan sheets for the proposed demonstrations will be developed by the project team and will include the following:

- Site layout:
  - Route origin, destination, and pick up points
  - Traffic control
  - Customer waiting/loading areas
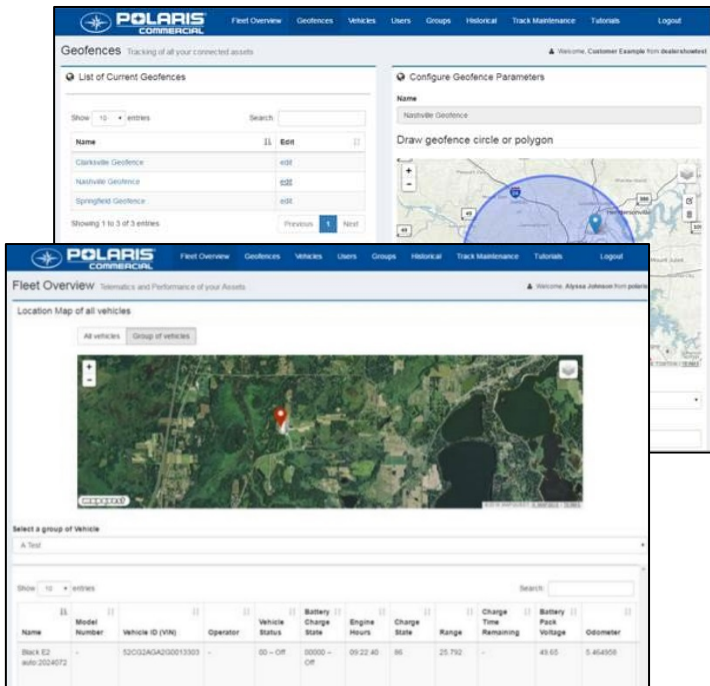
Polaris ADS Geofencing and Telematics for Demonstration Management Plan

- Vehicle storage area (drop off/pickup area if not stored on-site)
- Demonstration-related signage
- Schedule and operating hours

Lead: MnDOT

Support: Polaris

Subtask 5.2 Permit Plan: In order to ensure all permits and exemptions are correctly issued, the project team will develop a comprehensive list of all possible required documents from the local road authority, impacted local stakeholders, and federal authorities (if applicable). These entities may include the city, county and NHTSA.

Permit plan will be developed in parallel with site plan sheets to ensure all necessary permits are obtained. This ensures permits and exemptions are acquired in a timely manner to meet the schedule.

Lead: MnDOT

Subtask 5.3 Demonstration Management Plan (DMP): The DMP will manage vehicle operations and customer interactions during the demonstration. The DMP may be developed in conjunction with the site plan to include:

- Safety plan
- Queue management
- Risk assessment & mitigation strategies
- Vehicle storage and delivery schedule
- Demonstration communication plan

- customer interaction expectations
- wayfinding signage
- talking points
- handouts
- posters and displays

A well-developed DMP ensures the demonstration is executed safely and effectively, and ensures the public's experience with ADS technology meets or exceeds expectations.

Lead: MnDOT

Support: Polaris, University of Minnesota

Deliverables:

- Demonstration site plans
- Demonstration management plan sets
- Completion of required permits

Task 6: Statewide Outreach and Engagement

A key goal of project is to increase awareness of the uses, benefits, opportunities and challenges with ADS.

Subtask 6.1 Develop Statewide Level Outreach Plan: MnDOT, the University and Polaris will develop a statewide outreach

plan to bring attention to demonstrations. The plan will address many different audiences, including elected officials, advocacy groups, and industry and trade organizations. Key messaging will focus on how ADS may address transportation issues. Key methods will be identified and prioritized, including traditional media, social media, conferences and sponsored activities.

Lead: University of Minnesota

Support: MnDOT, Polaris

Subtask 6.2 Execute Outreach Plan: Upon completion of task 6.1, the Outreach Plan will be implemented with workshops, social media and traditional media.

The University will host a workshop to present demonstration results and form policy recommendations. Participants may include federal, state and local officials, stakeholders, and researchers.

Lead: University of Minnesota

Support: MnDOT, Polaris

Deliverables: Outreach Plan, Workshop Toolkit and Handouts

Task 7. Demonstration

The capstone of this project will be two large-scale ADS demonstrations. Host communities will be chosen to maximize the learnings for this NOFO.

1. **Fixed Route Demonstrations**: The first demonstration will be approximately a 1 mile looped course to maximize accessibility for the community participants per the CSR developed in Task 4.

The demonstration will last 3-5 days and be held in summer 2020 to maximize ridership. Data from social, vehicle/network performance and accessibility will be gathered and compared to baseline data for the community, and extrapolated for similar use cases to inform solution design and recommendations. Learnings from this demonstration will be used to inform the service pilot.

2. **Service Pilot**: Approximately six months after the fixed route demonstration, the Project Team will conduct an ADS service pilot programmed to meet a unique transportation challenge.

The demonstration will be held for 1-2 weeks to gather statistically significant data on the effectiveness of the solution in addressing the transportation challenges defined.

This demonstration will be held in winter 2020-21 to test ADS cold weather challenges. Data from this demonstration will provide the foundation of the evaluation reports. Example analysis includes:

- Level of service
- accessibility
- effects of weather
- edge case conditions, and
- public perceptions.

A cost-analysis will be conducted to compare the demonstrated solution to "next best alternatives" to inform future programs.

Parking lot demonstration(s) may be held for 1-2 days in winter months to gather public feedback and insure adequate weather variables are captured. Routes will

be less than a .25-mile loop in a controlled location. Target communities will be invited to offer feedback.

Outreach activities will be organized alongside the community service pilot demonstration or separately.

Subtask 7.1 Site Preparation: Pilot sites will be set up according to the site plans and layouts no less than two days before the demonstration begins. This includes traffic control, customer management infrastructure (e.g. tents, queueing equipment, heaters, etc.), and public communications signage for wayfinding. Permits will be obtained no later than two weeks prior to the pilot.

Following site set up, the vehicle will conduct 1-2 days of tests on the demonstration route to validate technology and minimize risk prior to public interaction and service.

Lead: Polaris

Support: MnDOT, University of Minnesota

Subtask 7.2 Demonstration Execution

The pilot demonstrations will be carried out in accordance with the developed demonstration management plans. There will be a fleet attendant on-board the vehicle at all times. In addition to the fleet attendant, there may be members of the Project Team on designated days (i.e. an outreach activity day) stationed at a stop(s) along the route to further engage the public in discussions about the technology.

During this period, engagement activities tied to the evaluations outlined in Task 8 and Task 9 may take place.

Lead: Polaris

Support: MnDOT, University of Minnesota, May Mobility

Deliverables: At least two ADS demonstrations; up to one additional parking lot/closed course demonstration

Task 8. Demonstration and Program Evaluation

The goal of this task is to evaluate vehicle safety and performance, accessibility impacts, and statewide public feedback after demonstrations and public engagement activities.

Subtask 8.1 Develop Evaluation Plan

Demonstrations will provide data that will inform both the Project Team and US DOT on safety and performance metrics for deployment of ADS. An evaluation plan will be developed which focuses on three primary areas of assessment: (1) vehicle and transportation network performance; (2) public attitude and perception; and (3) accessibility.

1. Vehicle and transportation network performance: Polaris will conduct an Edge Case Analysis - a comprehensive safety plan showing the items tested in a baseline demonstration, an assessment of the performance during the demonstration, and the gaps needed to achieve measurable

performance including "edge case" scenarios of vehicle operation. The Edge Case Analysis will address the needed developmental algorithms to maximize performance against the edge cases.

Evaluation data will assess how the ADS operated in winter weather and other conditions, how many times the vehicle stopped and whether the emergency stop was used. Other data points may be used, including route perception aids, infrastructure quality and vehicle intent.

2. Public attitude and perception
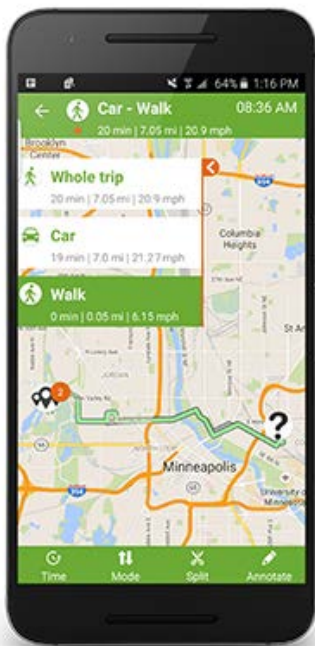
The public attitude and perception evaluation continues the work MnDOT began in 2018 to evaluate Minnesotans' perceptions of AVs and feedback during AV demonstrations through statewide surveys and at the Minnesota State Fair.

Pre- and post-demonstration data on user knowledge, impressions, support, concerns, and perception of ADS will be compiled by the University using traditional survey instruments and the University's *Daynamica* Mobility app.

3. Accessibility

The Project Team will develop accessibility metrics that can be aggregated and are

specific to the pilot ADS systems evaluated in this project. The University will assess ADS accessibility to that of other transportation systems, such as private driving, transit, or biking travel time and cost. Results will provide guidance in identifying how ADS can improve accessibility to transportation.

Lead: MnDOT

Support: Polaris, University of Minnesota

Subtask 8.2 Execute Evaluation Activities

The vehicle and transportation network performance, public attitude and accessibility evaluation activities will be executed. Following the execution of the evaluation plans, analysis of each performance area will be conducted and a final evaluation report will be compiled and submitted to U.S. DOT.

Lead: MnDOT

Support: Polaris, University of Minnesota

Deliverables: Final Evaluation Report with public attitude summary, vehicle and transportation network performance report, accessibility analysis report, and edge case analysis.

Task 9. Data Management
The Project Team recognizes the value of learning about the impacts of transportation reliability and safety for communities as they seek to adopt ADS. This Project is one of the first that will integrate social, vehicle and accessibility data. From the market failures, the Project Team will collaborate to identify which soft and/or hard data will provide the most useful transportation insights and support improvements in ADS and the safe integration of ADS into the nation's

transportation networks. These will include but not be limited to the deliverables in Task 8. We will define the process of sharing this information and with whom based on guidelines set forth per Freedom of Information Act (FOIA).

Task 9.1: The data management plan drafted for this proposal will be refined for tracking and reporting throughout the demonstrations. Data will be collected, managed and analyzed in three areas:

1. *Public Attitude and Perception: S*oft data through surveys and other means outlined in Task 8.
2. *Vehicle and Transportation Network Performance Data:* Service, Incident, Vehicle Specific Data such as telematics to assess vehicle, software and network operations.
3. *Accessibility:* Documented metrics as described in Task 8.

Lead: Polaris

Support: MnDOT, University of Minnesota, May Mobility

Task 9.2: Execute activities outlined in data management plan.

Lead: Polaris

Support: MnDOT, University of Minnesota, May Mobility

Deliverables: Data Management Plan, Public attitude and perception data, vehicle and transportation network data, accessibility data

Task 10. Project Management

The Project Team will manage scope, schedule, budget and risk throughout the project.

Subtask 10.1 Project Team Kick-Off and Project Management Meetings

MnDOT will create a list of Project Team members, including relevant U.S. DOT staff and stakeholders, to maintain a project contact list through the duration of the project. Project Team meetings will occur as part of Tasks 1-9. MnDOT will convene a project kick-off meeting with the Project Team and convene the biweekly project update meeting phone calls.

Subtask 10.2 Risk Analysis Matrix

The Project Team will regularly review and update a risk matrix to address local, state and federal regulatory and legal requirements, related technology and maintenance, and community risks. These risk are very low because of the pre-work the Project Team has conducted and because of the vast expertise the key personnel possess.

Subtask 10.3 Data Sharing

The Project Team recognizes the value of learning about the impacts of transportation reliability and safety for communities as they seek to adopt ADS. This Project is one of the first that will gather social, vehicle and accessibility data. From the market failures, the Project Team will collaborate to identify which soft and/or hard data will provide the most useful transportation insights and support improvements in ADS and the safe integration of ADS into the nation's transportation networks. We will define the process of sharing this information and with whom based on guidelines set forth per Freedom of Information Act (FOIA).

Subtask 10.4. Non-Federal Resources Contribution and Management

The Project Team is contributing non-Federal resources to this Project to show its commitment to cost-sharing. The non-Federal contribution will be used to bring on project support for the various project tasks and activities, e.g. project management and oversight support, marketing efforts, demonstration staffing, etc.

Subtask 10.5 Budget, Invoicing and Progress Reports

The Project Team will prepare quarterly progress reports and other reports as desired by the FHWA and U.S. DOT under 2 CFR 200.415 to address work performed, addressing problems and how they are mitigated, and budgeted. The Reports will also address how the Project meets and aligns with FHWA and DOT Strategic Goals, such as those outlined in the U.S. DOT

Automated Vehicles 3.0 guidance. MnDOT will prepare annual budget reviews and program plans in accordance with FHWA requirements and facilitate annual calls with the FHWA to review annual budget reviews and program plans.

Subtask 10.6 Project Management

MnDOT will provide project oversight, management and quality assurance/quality control for the duration of the project.

Deliverables: Project Team and Stakeholders Contact List; Kick-Off Meeting; Agendas and Minutes; Arranging meeting dates and times; Progress Reports; Budget Tabulation; Annual Budget Review and Program Plan; Invoices and Progress Reports.

Lead: MnDOT

Safety Automation thru Engagement – Project Deliverables

TASK	DELIVERABLES
Task 1 Focus Areas and Selection Criteria	1. Process document with selection criteria to identify communities with market failures 2. Preliminary list of targeted communities exhibiting market failures 3. Prioritized list of targeted communities exhibiting market failures
Task 2 Location Selection	4. Summary of final communities selected for demonstrations
Task 3 Community Engagement and Static Demonstrations	5. Static demonstration public engagement plan 6. Fixed route public engagement plan 7. Service pilot engagement plan 8. 5 static demonstration engagement events 9. Outreach and engagement materials 10. Meeting agendas, presentations, handouts, videos and meeting minutes
Task 4 Use-Case Development	11. Final use-case summary 12. Chosen Concept for demonstration and data behind the Concept Selection Review 13. Template for gathering community input
Task 5 Demonstration Plan	14. Demonstration site plans 15. Demonstration management plan sets 16. Completion of required permits
Task 6 Statewide Outreach and Engagement	17. Statewide Outreach Plan 18. Workshop Toolkit and Handouts
Task 7 Demonstrations	19. At least 2 ADS pilot demonstrations, 20. Up to 1 "parking lot"/closed course demonstration
Task 8 Demo and Program Evaluation	21. Public Attitude Summary Report 22. Vehicle and Transportation Network Performance Analysis Report 23. Accessibility Analysis Report 24. Edge Case Analysis 25. Omnibus Survey Report 26. State Fair Survey Report
Task 9 Data Management	27. Data Management Plan 28. Public attitude and perception data 29. Vehicle and transportation network performance data 30. Accessibility data
Task 10 Project Management	31. Project Team and Stakeholders Contact List 32. Kick-Off Meeting 33. Agendas and Minutes; Arranging meeting dates and times 34. Progress Reports 35. Budget Tabulation 36. Annual Budget Review 37. Program Plan 38. Invoices and Progress Reports