

JULY 2019



CONNECTED AND AUTOMATED VEHICLE STRATEGIC PLAN

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This report was prepared by the Minnesota Department of Transportation Office of Connected and Automated Vehicles, known as CAV-X, with special thanks to stakeholders across the department who shared their time and thoughts to help guide the development of this plan.

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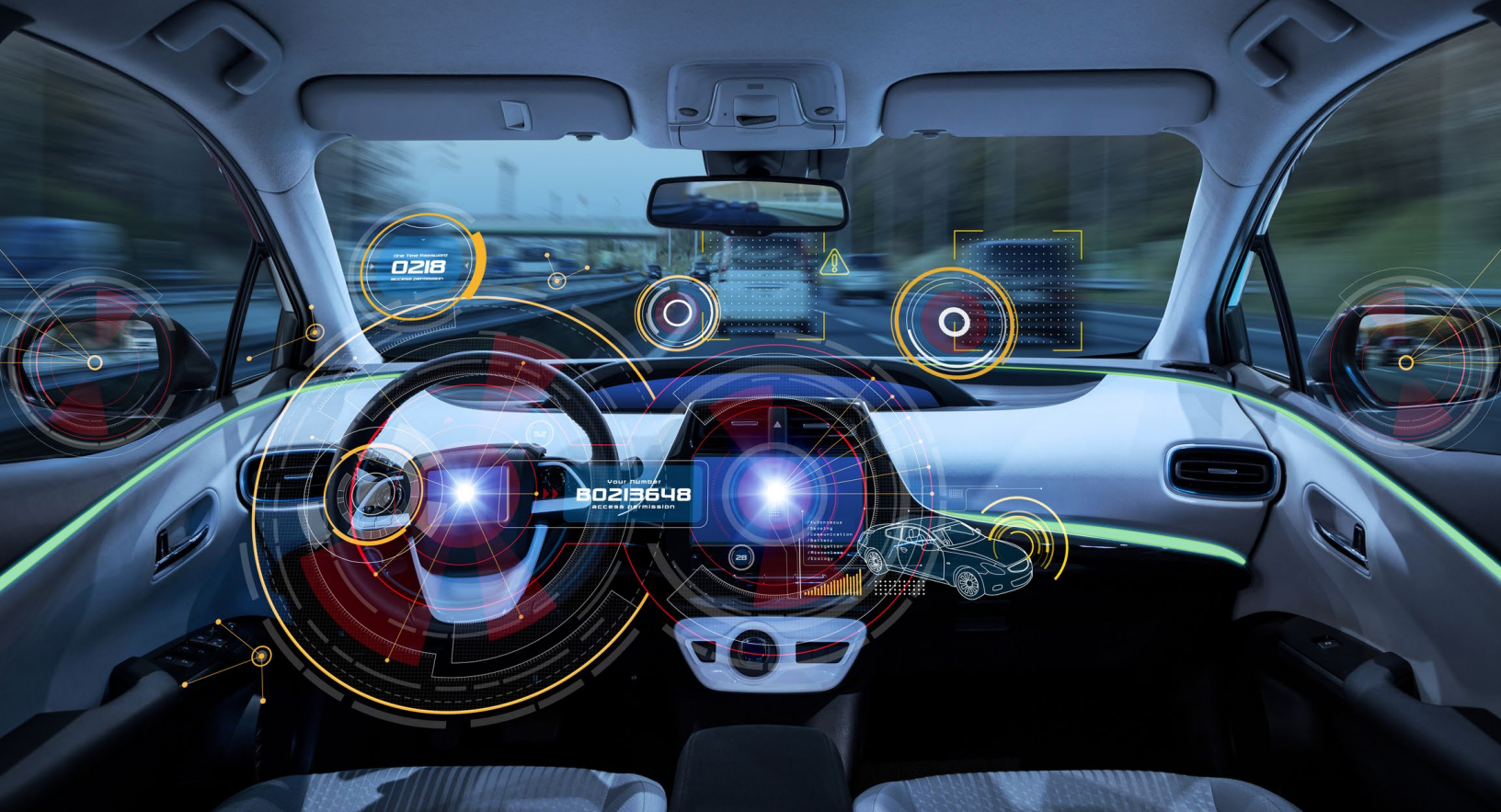
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EXECUTIVE SUMMARY

Background

What would a world look like where cars and trucks drove themselves? How do trends in shared mobility and electric vehicles impact our transportation system? Connected vehicles can communicate with infrastructure and other vehicles while automated vehicles use computers to take over human driving tasks such as steering, braking, and accelerating. Private companies are rapidly developing connected and automated vehicle (CAV) technologies. How do we plan for a future in which our transportation system - and our society - may be greatly transformed by these changes?

CAVs have the ability to greatly increase safety, mobility, efficiency and public health. Automation can significantly decrease the number of collisions attributed to human error. Shared mobility allows greater access to transportation, jobs and health care. Connected vehicle

technology can help transportation agencies better manage traffic and emergencies. Electric vehicles can minimize environmental impacts and health.

Without proper planning and coordination, it is difficult to manage the risks of a changing transportation system. The future expansion of these technologies – including when they will be available to the public – is unclear. How does a transportation agency plan for an unpredictable future?

The Minnesota Department of Transportation (MnDOT) Office of Connected and Automated Vehicles (CAV-X) worked with transportation experts, communities and the general public in months of extensive research, workshops, outreach and analysis to prepare for these rapid advancements in technology and mobility. The MnDOT CAV Strategic Plan will guide the agency's investment decisions and policies in the coming years as CAV technology advances.

Planning Process

The MnDOT CAV Strategic Plan is part of a “family of plans” that connects vision and policy direction for transportation in Minnesota. This plan will be updated every three years to help guide strategic investment and decision-making.

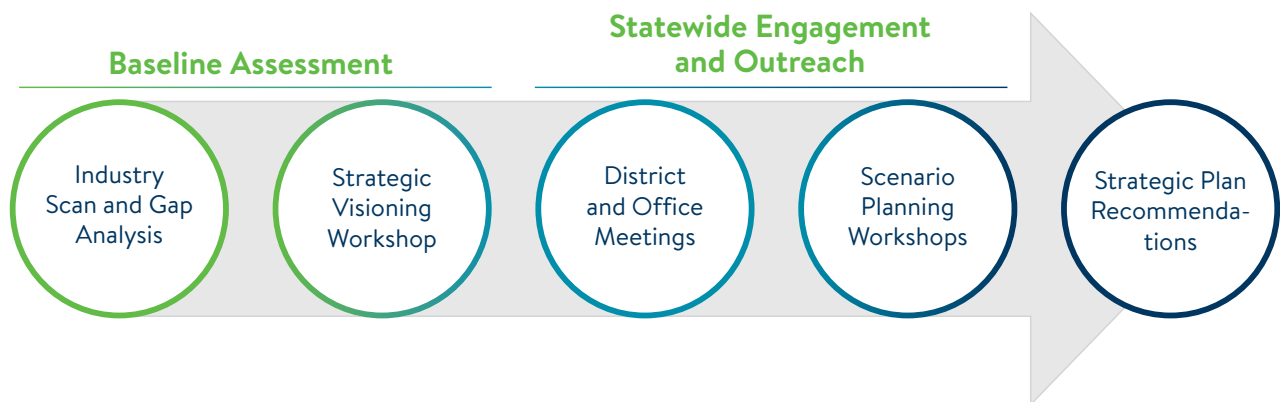
To form the MnDOT CAV Strategic Plan recommendations, MnDOT conducted an industry scan, gap analysis and strategic visioning workshop, met with MnDOT districts and technical offices, convened statewide scenario planning workshops and spoke to Minnesota communities.

MnDOT first reviewed gaps in the CAV industry to find areas of opportunity for research and investment in Minnesota. Next, a strategic visioning workshop was held

with partners from across Minnesota to share knowledge and collaboratively develop a statewide CAV vision. MnDOT then conducted scenario workshops across the state to ask transportation stakeholders and communities their views of CAV and how they want MnDOT to plan for the future.

The MnDOT CAV Strategic Plan also considered recommendations from the [2018 Governor’s Advisory Council on Connected and Automated Vehicles Executive Report](#) (Advisory Council). The Advisory Council is a public-private partnership among government, industry and non-profits that developed CAV policy priorities for the state of Minnesota.

Figure 2. The MnDOT CAV Strategic Plan Development Process



MnDOT's CAV Approach

With broad input, MnDOT developed a three-pronged approach to harness the benefits and manage the risks of CAV: investing strategically, innovation, and sharing knowledge.

STRATEGIC INVESTMENT

Make modest strategic investments, recognizing that CAV technology is in its infancy and will change quickly

INNOVATION

Question assumptions, embrace new ideas and partners, and remain nimble to shifts in technology in a rapidly changing environment

KNOWLEDGE-SHARING

Be transparent with the public and share ideas and lessons learned with other organizations and the industry

Focus Areas and Strategies

The strategies and recommendations in the MnDOT CAV Strategic Plan address MnDOT's organizational and business priorities to meet the agency's vision of

a multimodal transportation system that maximizes the health of people, the environment and the economy.

The MnDOT CAV Strategic Plan is divided into 9 focus areas to reflect MnDOT's organizational and business functions:



1. Capital Investment. What projects and capital investments should MnDOT be making or stop investing in?



2. Research and Development. What should MnDOT research and develop to address Minnesota challenges and help advance CAV statewide and nationally?



3. Partnerships. How can MnDOT partner with public and private entities to develop a statewide vision for CAV?



4. Regulation and Policy. What law and policy changes are needed to safely test CAV in Minnesota?



5. Operations and Maintenance. How does CAV impact MnDOT operations and how do we plan for these changes?



6. Strategic Staffing. How does MnDOT's workforce need to change to support CAV technological advancements?



7. Multimodal. How does MnDOT engage cyclists, pedestrians, transit, rail and other modal partners to prepare for CAV?



8. Communications. How do we engage the public, legislators, employees, and state and local agencies about CAV?



9. Long Range Planning. How should MnDOT's long range plans address CAV?

Connected and automated vehicles can advance a multimodal transportation system that maximizes the health of people, the environment and the economy.



Key Themes and Summary of Strategies

This plan includes 65 recommendations across the nine focus areas. Section III provides detailed information on recommendations, timeframe to initiate implementation, relative cost to implement, staff effort to implement, lead MnDOT office, and internal stakeholders.

Listed below are several key recommendations:



1. Capital Investment

- > Strategically build out fiber optic and communications infrastructure to support CAV and transportation systems management and operations (TSMO)
- > Update design standards to account for truck platooning
- > Pilot pavement marking projects that support human drivers and CAV
- > Invest in electric vehicle infrastructure at state facilities



2. Research and Development

- > Continue the Minnesota CAV Challenge procurement program to encourage industry innovation
- > Continue investments in connected vehicle test corridors to determine resources necessary to design, operate and maintain these technologies in urban and rural environments
- > Encourage third party testing to validate CV test corridors
- > Pilot alternative communication technologies (e.g. DSRC and 5G) and business models in order to maintain flexibility to changing market conditions



3. Partnerships

- > Continue the CAV Advisory Council Interagency CAV Team
- > Conduct Statewide CAV workshops for stakeholders to share ideas and shape future policy
- > Promote industry partnerships to advance CAV technologies and grow Minnesota's economy



4. Regulation and Policy

- > Authorize safe testing of automated vehicles
- > Modernize utility statutes and policies to support the build-out of CAV communication infrastructure through public-partnerships
- > Update data stewardship, retention policies and privacy statutes to address CAV data



5. Operations and Maintenance

- > Identify CAV data that will enhance MnDOT operations and improve traffic safety and operations
- > Pilot projects to collect and analyze CAV data received from vehicles, and share MnDOT data with vehicles or other third parties
- > Develop strategies on how to maintain and operate connected vehicle infrastructure



6. Strategic Staffing

- > Develop an employee engagement plan that seeks opportunities to improve worker safety and operations using CAV, and also identifies risks and impacts
- > Identify skill gaps needed to support CAV technologies, update civil service requirements, and develop a CAV talent pipeline



7. Multimodal

- > Pilot CAV transit opportunities in greater Minnesota
- > Convene transit workshops to share lessons learned
- > Conduct bike and pedestrian stakeholder outreach and solicit feedback on how to integrate CAV into a multimodal system
- > Encourage safe testing of freight AV technologies



8. Communications

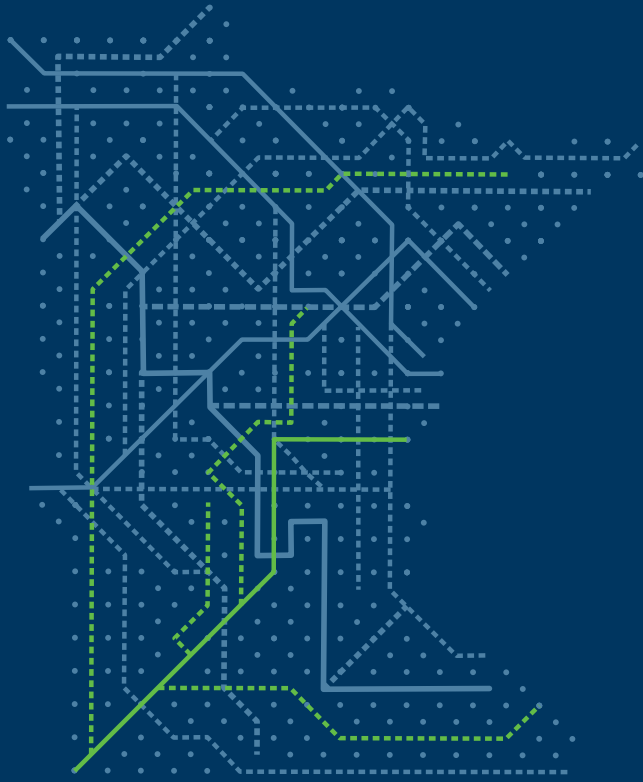
- > Increase internal awareness of CAV through broadened communications
- > Conduct public demonstrations throughout Minnesota
- > Develop CAV public engagement and communication plans that solicit feedback
- > Conduct regular industry outreach to share information and develop partnership opportunities



9. Long Range Planning

- > Review other statewide plans for potential implications and points of interface with CAV
- > Provide CAV resources and support to local, regional, and tribal governments





I.

INTRODUCTION



I. INTRODUCTION

With rapid advancements in technology and automobiles, connected and automated vehicles (CAV) have the ability to transform our society into one that is safer, more equitable, efficient, and sustainable. While it is unclear when fully automated vehicles will be fully available, it is clear that CAV will fundamentally change the way we live our lives.

This MnDOT CAV Strategic Plan outlines strategies and recommendations for the Minnesota Department of Transportation (MnDOT) to harness the benefits and manage the risks of a changing transportation system to better the quality of life for all Minnesotans. These strategies are the result of a year of research, statewide workshops, community conversations and analysis. These recommendations will help MnDOT – and the state – prepare for the opportunities and challenges with this revolution in transportation.

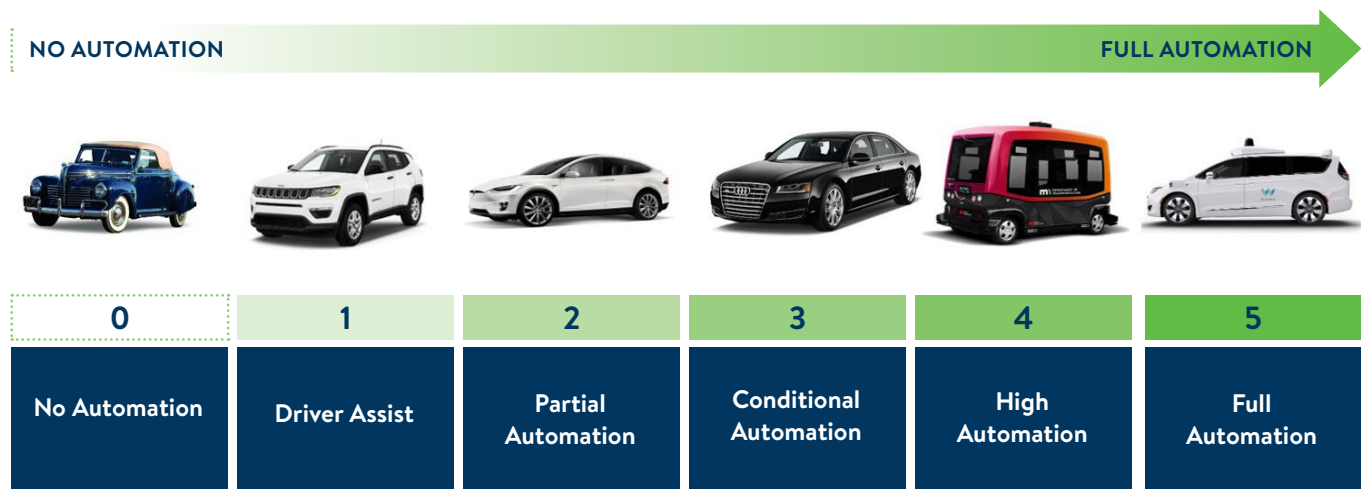
What are Connected and Automated Vehicles?

The MnDOT CAV Strategic Plan addresses emerging trends in transportation, including electric vehicles and shared mobility. By analyzing trends in automated, connected and electric vehicles and shared mobility, the agency can prepare for what may be a fundamental shift in how society moves.

AUTOMATED VEHICLES

Automated vehicles (AVs) use sophisticated computer programming, cameras and sensors to take control over some, or all, human driving tasks such as steering, braking and accelerating. Highly automated vehicles may not have a steering wheel or a human driver; however, fully “driverless” vehicles are not anticipated to be on streets for many years. The federal government has adopted the Society of Automotive Engineers (SAE) levels of automation (*Figure 1*) showing the evolution of automated vehicles. It is expected that our transportation system will have a mixed fleet of both automated and non-automated vehicles for many years to come.

Figure 1. Levels of Automation



CONNECTED VEHICLES

Connected vehicles (CVs) use different technologies to communicate with other vehicles, infrastructure (e.g., traffic signals), pedestrians, bicyclists and other objects, such as trains and smartphones. Connected vehicles can provide information and alerts to drivers and other vehicles to reduce crashes, improve traffic flow and save energy. An example of CV technology is truck platooning. Platooning uses technology to electronically link vehicles. This can reduce congestion, save fuel and minimize driver stress.

Connected and automated vehicles are vehicles that combine both automated and connected technology. CAV is a broad term that encompasses both CV and AV technology.

ELECTRIC VEHICLES

Many AVs are being built as electric vehicles but the future is unclear whether the industry will broadly adopt electric vehicle (EV) technology. EVs use an electric motor as the primary propulsion system. Types of electric vehicles include: 100 percent battery electric vehicles, hybrid-electric vehicles, and plug-in hybrid electric vehicles. EVs may be charged at home, work or public charging stations. Currently, there are few stations that rapidly charge EVs. Infrastructure investment is important to

support electrification and automated vehicles. Advancing electric vehicles promotes Minnesota's goals to reduce greenhouse gas emissions and meet the state's climate change reduction goals.

SHARED MOBILITY

Shared mobility is the idea that transportation services could be shared among users. Mobility-as-a-service (MaaS) allows users to arrange various modes of transportation in a single trip, such as a bike share to a public transit stop and then a rideshare to an ultimate destination. With MaaS, fewer people own personal vehicles. With transportation network companies like Uber and Lyft expanding around the world, trends show a change in travel behavior. In the future, fewer people may choose to own private vehicles due to social norms or vehicle costs; however, the future of these trends is unclear.



MnDOT's CAV Approach

MnDOT developed a three-pronged approach for its CAV program, focusing on strategic investment, innovation and knowledge-sharing. These approaches guide the MnDOT CAV Strategic Plan.

STRATEGIC INVESTMENT

Make modest strategic investments, recognizing that CAV technology is in its infancy and will change quickly

INNOVATION

Question assumptions, embrace new ideas and partners, and remain nimble to shifts in technology in a rapidly changing environment

KNOWLEDGE-SHARING

Be transparent with the public and share ideas and lessons learned with peer agencies and the industry at large

MnDOT's CAV Initiatives

To promote innovation and the safe testing and deployment of CAV technology, MnDOT is collaborating with industry, public safety, local governments and communities across Minnesota. Currently, Minnesota's efforts are focused on public outreach, research and testing and innovative industry partnerships.

PUBLIC OUTREACH

Several public demonstrations were held allowing Minnesotans to see, touch and better understand CAV technology. Pilot projects were conducted to help Minnesotans, policymakers and industry understand how AVs adapt to Minnesota's cold weather climate, because a vast majority of the nation's testing is currently done in warm weather climates.



Recent testing of automated shuttle vehicle at MnROAD facility

Automated Vehicle Demonstrations – MnDOT hosted a series of public demonstrations in the winter of 2017-2018 with an automated shuttle. Demonstrations were held at the MnROAD testing facility near Albertville, the State Capitol and downtown Minneapolis during the Super Bowl. More than 1,300 people rode the shuttle during the three-day demonstration in Minneapolis.

Additional demonstrations were held on the Midtown Greenway with Hennepin County, at the University of Minnesota in Minneapolis, and at 3M's corporate campus and Rochester. In 2019 MnDOT is planning a series of automated vehicle demonstrations in the Twin Cities and St. Cloud, Minnesota.



Automated vehicle exhibit at 2018 Minnesota State fair

State Fair – In partnership with Polaris and AutonomouStuff, MnDOT debuted the first CAV exhibit at the Minnesota State Fair in August 2018. The exhibit included a level 4 automated shuttle to help the public learn about the technology and share feedback.

Governor's Advisory Council on Connected and Automated Vehicles – Alongside the CAV Strategic Planning process, MnDOT worked with the Governor's Advisory Council on Connected and Automated Vehicles (Advisory Council). In March 2018, Minnesota's Governor issued Executive Order 18-04 that established a 15-seat Advisory Council represented by members of business, labor, tribes, mobility advocates, public safety and others. The Council was required to draft a report by December 2018 recommending changes to state law, rule and policy related to CAV. An Interagency CAV Team was also created representing the state's executive agencies to collaborate on CAV programs.

Ten subcommittees were created focusing on policy areas including equity, accessibility, infrastructure, revenue, cyber security, insurance, land use, traffic safety, driver's licensing and registration and others. More than 45 public meetings were held throughout the state to gather feedback and recommendations. Over 100 recommendations were issued in the [Executive Report](#).

These were reviewed to ensure the Advisory Council and MnDOT CAV Strategic Plan recommendations align and are coordinated with MnDOT's program and statewide goals.

Destination CAV – Minnesota is a place of innovation and collaboration. To reflect the state's entrepreneurial spirit and CAV priorities, the "Destination CAV" brand was developed as part of the MnDOT CAV Strategic Planning process. The brand is intended to be used for CAV activities statewide. The purpose of the brand is to reflect the state's CAV goals, promote statewide coordination and engage the public and industry on Minnesota's CAV priorities.



RESEARCH AND TESTING

Minnesota is one of the pioneers in cold weather testing for CAV. Given Minnesota's extreme weather conditions, this testing is critical to understand how vehicles operate in this environment and communicate with other vehicles and infrastructure to support this evolving technology.

Innovative Procurement and Ideas – Recognizing that private industry can often innovate faster than government, MnDOT partnered with the Department of Administration to develop a new contracting method – the "Minnesota CAV Challenge." This challenge allows public and private partners to propose new ideas to the state on how to use CAV to improve safety, access and mobility, build public trust, and address many other Minnesota priorities. In its first year, MnDOT met with 26 vendors to hear different ideas from industry and academia to improve quality of life with CAV. Two new programs were created through this process: the Automated Bus Consortium and an automated truck-mounted attenuator to increase worker safety.

Cold Weather Testing in Greater Minnesota – MnDOT tested automated low speed shuttles at the MnROAD facility, allowing MnDOT to collaborate with private industry to understand how automated vehicles operate in extreme cold weather conditions, including snow, ice and salt. This helps the industry adapt technology to operate in these environments. Local industry experts also used sophisticated maps to test automated vehicle technology in winter 2019 during near white-out conditions during the polar vortex.

Connected Corridors – MnDOT is currently working on two Connected Corridors to test CAV technology. The Trunk Highway 55 Connected Corridor from the city Plymouth to the city of Minneapolis uses connected vehicle technology in signal systems to communicate with vehicles, create maps to help guide vehicles, and improve pedestrian safety. Understanding that Greater Minnesota has an important role in transportation safety, MnDOT is planning an 85-mile connected corridor on Trunk Highway 52 from St. Paul to Rochester. This corridor will use connected vehicle technology to improve traffic and incident management.

Public and Private Research – Research institutions such as the University of Minnesota are looking into how CAV impacts our land use and zoning, how humans will be impacted and use this technology and innovative ways to test and develop CAV technology. Several Minnesota companies are also rapidly advancing CAV technology through research and testing. 3M's Connected Roads division researches how to improve safety for both humans and artificial intelligence. VSI Labs works with the auto industry to research and test how to integrate technology into vehicles. Polaris is also developing CAV technology for recreational and commercial products. In addition, many Minnesota engineering and consulting firms are working with the public sector to safely plan, test and deploy CAV.

Regional and National Research and Collaboration – MnDOT and other public agencies work with regional and national policy and technical committees to advance CAV technology and ensure Minnesota's voice is represented. MnDOT works with other states in "pooled fund" studies to research CAV technology and to address uniform CAV design and safety standards.

Goals

To further the agency's mission to plan, build and operate a safe, accessible, efficient and reliable multimodal system, the MnDOT CAV Strategic Plan developed goals for MnDOT's CAV program.

The action plan that follows in this document links each strategy to one or more of these goals.



SAFETY – Support deployment of CAV technology to improve safety and achieve Toward Zero Death (TZD) goals to eliminate traffic-related deaths



EFFICIENCY – Harness CAV technology to improve the efficiency of the transportation system for the movement of people, goods, and services



EQUITY AND ACCESSIBILITY – Use CAV technology to improve transportation equity and accessibility for all Minnesotans



ECONOMIC BENEFITS – Position Minnesota as a place to safely test and deploy CAV in order to advance public benefits and encourage workforce and economic development



TRUST AND UNDERSTANDING – Engage the public and other stakeholders to build trust and develop understanding of CAV



READINESS – Support MnDOT in preparing the organization to proactively address changes in transportation technology



SUSTAINABILITY – Emphasize CAV technologies that have the potential to promote environmental and fiscal sustainability

Focus Areas

The MnDOT CAV Strategic Plan is organized around nine focus areas based on MnDOT's organizational and business functions.



1. Capital Investment. What projects and capital investments should MnDOT be making or stop investing in?



2. Research and Development. What should MnDOT research and develop to address Minnesota challenges and help advance CAV statewide and nationally?



3. Partnerships. How can MnDOT partner with public and private entities to develop a statewide vision for CAV?



4. Regulation. What law and policy changes are needed to safely test CAV in Minnesota?



5. Operations and Maintenance. How does CAV impact MnDOT operations and how do we plan for these changes?



6. Strategic Staffing. How does MnDOT's workforce need to change to support CAV technological advancements?



7. Multimodal. How does MnDOT engage cyclists, pedestrians, transit, rail and other modal partners to prepare for CAV?



8. Communications. How do we engage the public, legislators, employees, and state and local agencies about CAV?



9. Long Range Planning. How should MnDOT's long range plans address CAV?

Statewide Vision and Policy

The strategies and recommendations in the MnDOT CAV Strategic Plan address MnDOT's vision of a multimodal transportation system that maximizes the health of people, the environment and the economy.

MnDOT's CAV Strategic Plan is part of a "family of plans" that connects vision and policy direction for transportation in Minnesota. This plan will be updated every three years to help guide strategic investment and decision-making.

The MnDOT CAV Strategic Plan will help inform the priorities in the agency's [Minnesota Go](#) 50-year statewide vision that seeks to:

- connect Minnesota's people, natural resources and businesses
- provide safe, convenient and efficient movement of people and goods, and
- allow flexibility to adapt to changes in society

The MnDOT CAV Strategic Plan also supports the [Statewide Multimodal Transportation Plan \(SMTP\)](#) which outlines the state's transportation priorities for the next 20 years. By reviewing current CAV trends and policies, MnDOT is able to update its policy objectives and strategies to address a CAV future.

In 2018 MnDOT created a Strategic Operating Plan (SOP) to translate long-term policy plan objectives into actionable strategies for the next five years. These strategies reflect MnDOT's highest priorities, strategies and performance metrics to achieve MnDOT's vision and mission. The MnDOT CAV Strategic Plan recommendations were assessed to ensure they meet MnDOT's three SOP goals of customer trust, operational excellence and workforce excellence.

Key Assumptions

ELEMENTS OF CAV

Minnesota is preparing for CAV by addressing four key trends: automated vehicles, connected vehicles, electric vehicles and shared mobility. Electrification is important

to consider because most AVs are assumed to be built on electric platforms and EVs could impact revenue models. Pricing of transportation and new business models are referenced where relevant but not treated as a separate element of CAV in this plan. While there is growing interest in unmanned aerial vehicles (UAVs) including drones, this plan focuses on surface transportation.

MIXED FLEET AND TIMELINES FOR ADOPTION

This plan assumes there will be a mixed fleet of CAV and conventional vehicles throughout the lifespan of the plan. A future where all the vehicles on the roads are connected and automated is unlikely. If all vehicles on the roads were to become connected and automated, it would likely not happen for at least four or more decades.

This plan further assumes that CAVs will be designed to safely and efficiently interact with human-driven, unconnected vehicles and other modes in the transportation system. This is based on assumptions that a consumer would not purchase a vehicle that cannot function in a mixed fleet of both automated and non-automated vehicles. Another assumption is that the US DOT will require that CAVs safely operate in mixed traffic.

US DOT GUIDING PRINCIPLES

This plan aligns with the six key automation principles outlined in the US DOT's [Preparing for the Future of Transportation: Automated Vehicles 3.0](#):

1. Prioritize safety
2. Remain technology neutral
3. Modernize regulations
4. Encourage a consistent regulatory and operational environment
5. Prepare proactively for automation
6. Protect and enhance the freedoms enjoyed by Americans

The MnDOT CAV Strategic Plan acknowledges the need to remain technology neutral. MnDOT upholds the principle that the public will continue to use non-automated vehicles to support the freedom and independence of Minnesotans.

EQUITY AND ACCESSIBILITY

Without strategic planning and policy and meaningful public engagement, many users will be excluded from CAV's potential benefits. MnDOT must prioritize mobility strategies that address equity, accessibility, sustainability and public health. Minnesota can be a leader in reducing disparities for communities disproportionately impacted by limited access to transportation and opportunity. CAV policies and recommendations must prioritize people and communities first in developing a multimodal transportation

To achieve this goal, MnDOT will reach out to engage diverse voices from many perspectives including but not limited to: people who walk and bike, people with disabilities, limited income communities, the aging population, unbanked individuals, families with children, people with limited English proficiency, people who are unemployed or underemployed, black and indigenous peoples, caregivers, other communities of color, undocumented immigrants, homeless, youth, women, and members of the LGBTQIA communities.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

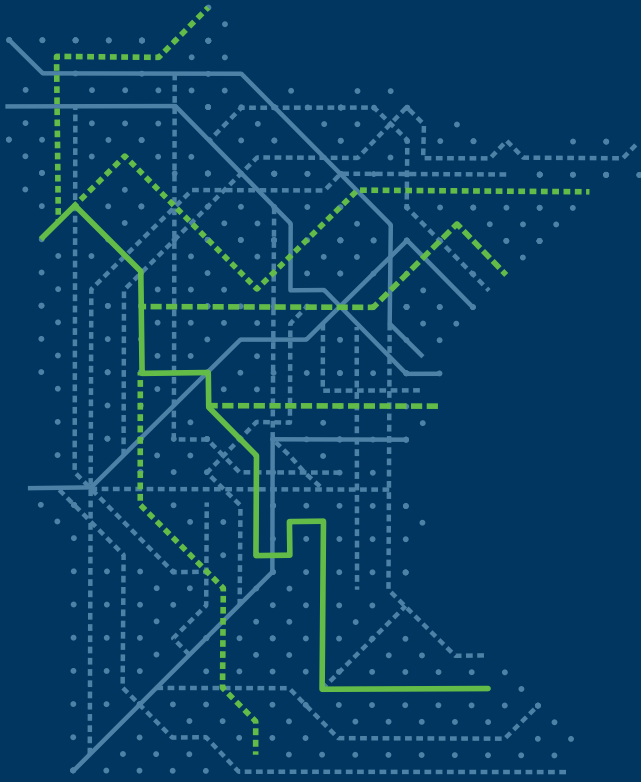
While the strategies and recommendations in the MnDOT CAV Strategic Plan will guide the agency's future investment decisions and policies, these actions may impact many Minnesotans. MnDOT – through its [Public Engagement Policy](#) – is committed to increasing transparency in these decisions through collaboration and ensuring everyone has the opportunity to participate in developing policies and programs. Throughout the development of MnDOT's CAV program, the agency must work with the many partners, including but not limited to:

- > CAV Advisory Council and Interagency CAV Team
- > Colleges, universities and vocational schools
- > Communities experiencing transportation barriers
- > Communities of color
- > Counties, cities and townships
- > Executive state agencies

- > General public
- > Industry and technology companies
- > Metropolitan Council and metropolitan planning organizations
- > Minnesota Council on Disability
- > Minnesota Guidestar
- > Minnesota Legislature
- > Minnesota Tribes
- > Other state departments of transportation
- > Public safety and local law enforcement
- > Regional development organizations
- > Traffic safety organizations
- > Transit agencies
- > Trucking and freight industry
- > U.S. Department of Transportation
- > Vulnerable road users

This is not an exhaustive list of who MnDOT will need to collaborate with to plan for CAV impacts to transportation. Engaging Minnesotans is critical to building a transportation system that meets the needs of both humans and connected and automated vehicles.





II.

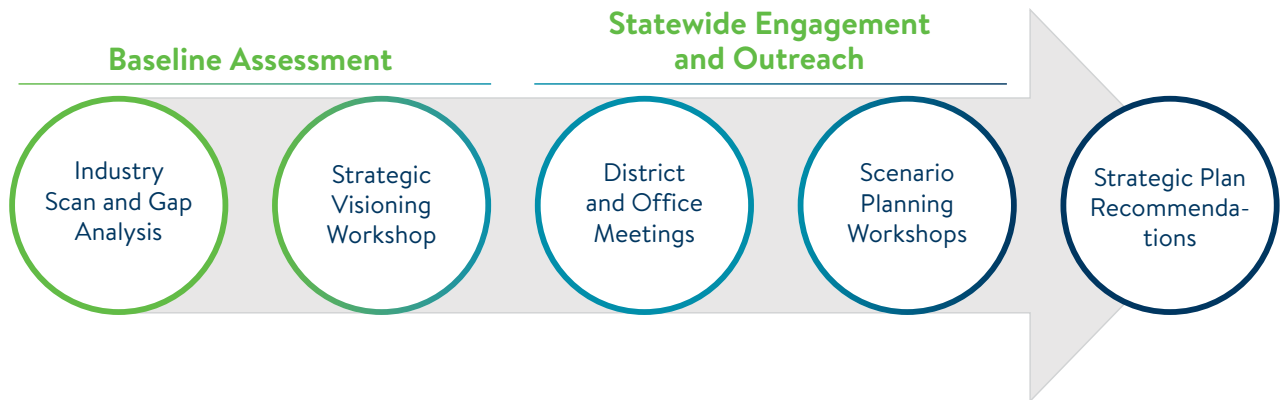
PLANNING PROCESS



II. PLANNING PROCESS

The MnDOT CAV Strategic Plan recommendations were developed through a one-year process of research, meetings with stakeholders, gathering feedback and discussions (Figure 2). This process is described below.

Figure 2. The MnDOT CAV Strategic Plan Development Process



Baseline Assessment

A baseline for the strategic planning process was set by two key activities: an industry scan and gap analysis, and the recommendations of a stakeholder-driven strategic visioning workshop.

INDUSTRY SCAN AND GAP ANALYSIS

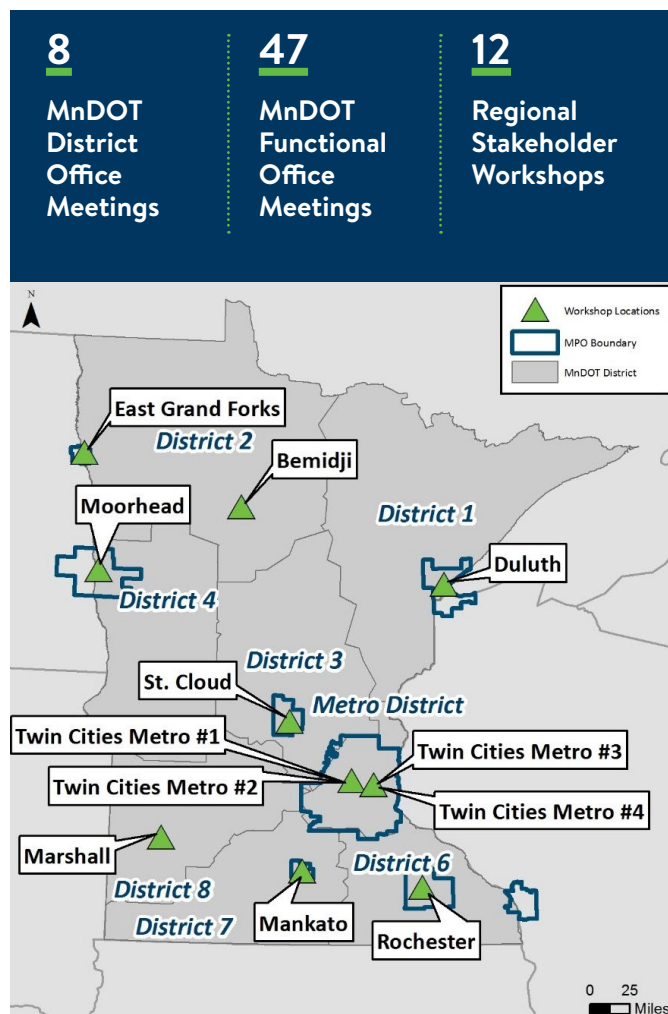
The starting point for the MnDOT CAV Strategic Plan was to review and summarize current CAV activities around the country and globally, compare it to activities in Minnesota and assess gaps – areas in which Minnesota is not engaged but potentially could be or should be. Several gaps were identified, including a lack of laws and policies authorizing automated vehicles, limited commercial testing and deployment, and opportunities to advance electric vehicle policy.

STRATEGIC VISIONING WORKSHOP FOR AUTOMATED VEHICLES

In June 2018, MnDOT, the University of Minnesota’s Center for Transportation Studies (CTS), the McKnight Foundation and others held an automated vehicles visioning workshop. The workshop convened over 100 representatives across the public, private, academic, and nonprofit sectors and featured presentations from a wide range of experts. Participants engaged in interactive discussions and small group working sessions to prioritize strategies. MnDOT was a key partner and is continuing to work with the University on CAV research. The workshop strategies most relevant to MnDOT have been incorporated into the MnDOT CAV Strategic Plan.

Statewide Engagement and Outreach

Broad stakeholder input was gathered in developing these recommendations. MnDOT's CAV-X team held 60 different meetings with internal and external stakeholders.



MNDOT DISTRICTS AND OFFICES

CAV-X staff met in person with each of the eight MnDOT districts around the state and functional offices. Conversations included an introduction to CAV (“CAV 101”) and the strategic planning process, and concluded with interactive discussions of the nine plan focus areas. When size allowed, small groups broke out to discuss their questions and feedback regarding how MnDOT should prepare for CAV. Comments and recommendations were documented, analyzed and included in the recommendations. In addition to meetings

with the eight district offices, discussions were conducted with the MnDOT functional offices below.

1. Administration
2. Aeronautics
3. Audit
4. Bridge
5. CAV-X
6. Chief Counsel
7. Civil Rights
8. Communications
9. Construction
10. Environmental Stewardship
11. Equity and Diversity
12. Electrical Services Section
13. Finance
14. Freight and Commercial Vehicles
15. Human Resources
16. Land Management
17. Maintenance
18. Minnesota IT (MnIT)
19. Materials and Road Research
20. Organizational Planning & Management
21. Project Management & Technical Support
22. Public Engagement and Constituent Services
23. Regional Traffic Management Center (RTMC)
24. State Aid
25. Statewide Radio Communications
26. Sustainability and Public Health
27. Traffic Engineering
28. Transit and Active Transportation (OTAT)
29. Investment Management
30. Transportation System Management

STATEWIDE SCENARIO PLANNING WORKSHOPS

The MnDOT CAV Strategic Plan included a scenario planning process that addressed the challenge with planning for an unknown future. MnDOT developed four scenarios specific to Minnesota. The scenarios captured a broad range of potential changes to modes of transportation, technologies, policy changes, users and Minnesota communities.

1

SCENARIO: ADVANCING TECHNOLOGY

Today's technology gets incrementally better and becomes more common

Today's technology advances slowly and becomes more common. Advanced automation is uncommon. Few vehicles are connected, automated, electric or a part of a shared fleet.

2

SCENARIO: CONNECTED INFRASTRUCTURE

Connected vehicle technology advances more rapidly than automation

The public sector makes significant investments in connected and electric vehicle infrastructure because automated vehicle technology has lagged. Little focus is on shared transportation.

3

SCENARIO: PRIVATE AUTOMATION

Automated vehicles are common, but not all benefits are realized

Automated vehicles rapidly multiple with a mix of privately owned cars and competing mobility providers. Congestion is common in urban areas as cooperation and sharing lag.

4

SCENARIO: INTEGRATED MOBILITY

Connected and automated transportation is widely available and serves everyone

Connected and automated transportation is integrated, affordable, and serves everyone. Car ownership drops and shared rides are common. Fleets are highly connected, automated and electrified.

In scenario planning workshops held throughout Minnesota, participants were asked to envision opportunities and challenges CAV could bring by 2040. Small groups explored one of four scenarios to discuss the specifics of one potential future, and provided feedback to MnDOT on how to prioritize its current activities to capitalize on the opportunities and mitigate potential challenges. Discussions at the workshops covered a wide variety of topics that need to be explored in more detail with stakeholders throughout Minnesota over the coming years. The feedback from these workshops has been incorporated into this strategic plan particularly in the long range planning recommendations. More information about the scenario planning workshops can be found here: www.mndot.gov/automated.

Workshop participants included city and county planners and engineers, metropolitan planning organizations and regional development organizations, local transit agencies, non-profits, social services, and MnDOT staff. More than 1,750 comments were collected from the workshops. Twelve workshops were conducted in the following locations around the state:

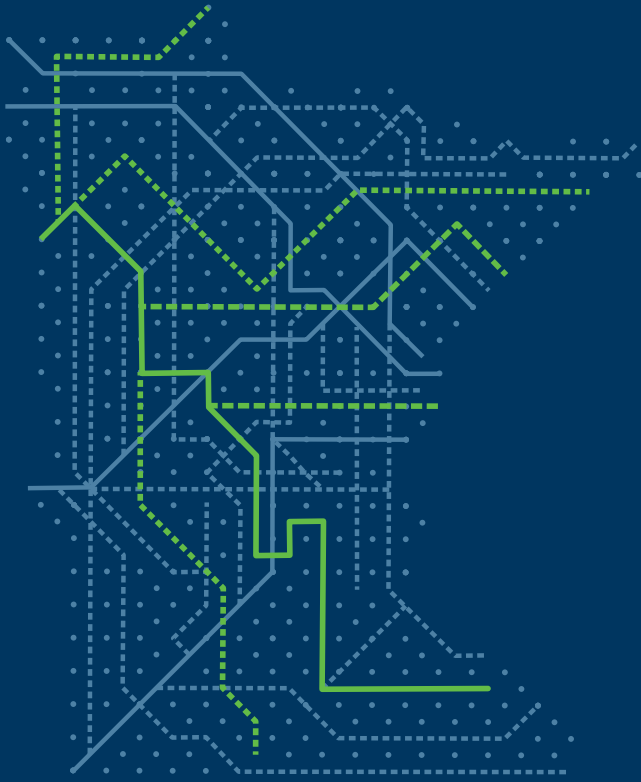
- > Bemidji
- > Duluth
- > East Grand Forks
- > Mankato
- > Marshall
- > Moorhead
- > Rochester
- > St. Cloud
- > Twin Cities Metropolitan Area (4 workshops)

SCENARIO PLANNING TAKEAWAYS

Workshop participants discussed how CAV might be able to support safety, expand freight, improve efficiency, reduce congestion, and increase mobility and access. However, CAV appeared to raise concerns over data, security, equity, and funding. A majority of participants were interested in a future that supports integrated mobility across all modes of travel (scenario 4) and that keeps CAV accessible and affordable for all. However, participants cautioned that unless the state creates policies to address these challenges, scenario 3 (private automation) may likely be in our future.

MnDOT reviewed the proposed MnDOT CAV Strategic Plan strategies to understand which might be more or less important for each of the four CAV scenarios. Priority for some strategies were changed and others were removed to ensure MnDOT remains strategic, innovative and collaborative in planning for CAV regardless of which future may come. The important strategies in this plan help MnDOT align CAV work with agency priorities and make business sense under all potential CAV scenarios.





III.

RECOMMENDATIONS



III. RECOMMENDATIONS

How to Read this Action Plan

STRATEGY AND GOAL ALIGNMENT

At the beginning of each strategy is a list indicating which of the CAV goals the strategy addresses.



	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

DESCRIPTION

Brief description of the recommended action.

VALUE TO MNDOT

Statements to answer the question, “Why should MnDOT do this?”
This is to help make sure the action is truly valuable to MnDOT and that MnDOT is the appropriate organization to lead it.

WHEN TO INITIATE

A recommended timeframe for initiating the action.

- 1

1 YEAR: Begin working on the recommendation immediately, within the first year of the plan.
- 1-3

1-3 YEARS: Begin working on the recommendation within 1-3 years.
- 3-5

3-5 YEARS: Begin working on the recommendation within 3-5 years.
- 5+

5+ YEARS: Long range recommendation may not be started for 5 years or more after the plan is published.

ANTICIPATED LEVEL OF CAPITAL INVESTMENT REQUIRED

The level of capital investment necessary to carry out the action. Given the high-level nature of this plan, the categories are intentionally broad and not associated with specific dollar values.



Can be completed with existing resources



Requires moderate capital investment including potentially hiring consulting or outside resources



Requires significant capital investment

ANTICIPATED LEVEL OF STAFF EFFORT

The level of staff effort necessary to carry out the action.



LOW: Can be accomplished with existing staff



MEDIUM: Requires additional staff or significant shifting of responsibilities



HIGH: Requires significant additional staff resources

LEAD

The MnDOT office champion which will be responsible for the recommendation

MNDOT STAKEHOLDERS

MnDOT offices and districts who will need to be involved, informed and ensure coordination with external stakeholders. For ease of reading, “Office of” was deleted from each specialty office title.

STRATEGY 1

GOAL ALIGNMENT

Assess Connected Vehicle Infrastructure Needs

Widespread deployment of CV technologies is not recommended at this time because the technology and standards continue to evolve. However, investment in CV technologies can cost-effectively and efficiently prepare MnDOT for CAV advancements. MnDOT will assess investments in fiber-optic communications networks, upgrade signal controllers, and update traffic signal cabinet space standards. This ensures that facilities constructed today are ready for the CV infrastructure of tomorrow with minimal cost.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 1 — Assess Communications Infrastructure and Public-Private Partnership Feasibility Study to Support CV Technologies

DESCRIPTION

Assess communications infrastructure needed to support CV technologies (including fiber optic, radio towers, and small cell technologies) and conduct a feasibility study to identify:

1. Partnership opportunities with private industry to build out required infrastructure, including using public right-of-way for both government and private benefit.
2. Design parameters, including splice box locations, road side unit locations, power, and wireless communication devices.
3. Corridors where communications infrastructure should be installed immediately to support CAV testing and TSMO applications.
4. Corridors to install communications as part of a planned construction project.
5. Corridors to install conduit for future communications (e.g., bridges) as part of planned construction projects.
6. Corridors to install wireless communications devices in lieu of fiber optics
7. Whether additional right-of-way is needed for telecommunications infrastructure

VALUE TO MNDOT

- Identify feasibility, scope and cost of building out infrastructure for CV
- Build CAV readiness into construction projects

INITIATE



CAPITAL






STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- District Offices
- Electrical Services Section
- Land Management
- MnIT
- RTMC
- State Aid
- Statewide Radio Communications
- Traffic Engineering

Recommendation 2 – Build Traffic Signal Infrastructure for CV Readiness					
DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT	
<p>Build CAV readiness into new or upgraded traffic signals by:</p> <ul style="list-style-type: none">Installing traffic signal controllers with signal phasing and timing (SPaT) capabilitiesAssessing whether larger traffic cabinets capable of housing CV equipment are needed in the futureAddress electrical code issues for conduit separation for electrical conductors and ethernet cabling required for future CV equipmentDeveloping standards for assessing small cell installations and other communications technology on MnDOT infrastructure	<ul style="list-style-type: none">Build CAV readiness into existing and planned construction projects where it is most cost-effective				
		LEAD Traffic Engineering			
		MNDOT STAKEHOLDERS <ul style="list-style-type: none">CAV-XDistrict OfficesMnITRTMC			

STRATEGY 2

GOAL ALIGNMENT

Assess and Prepare Pavements and Bridges for CAV

CAVs may impact the way roads and bridges are designed. The increased size and weight of vehicle platooning may impact roads and bridges. AVs are specifically programmed not to wander within lanes which may lead to rutting or other pavement impacts. CAV impacts may not be understood for a decade or more but the long life-span of road and bridge construction means MnDOT should update design standards to extend the life of current investments.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 3 — Continue Research Scan of Platooning Impact on Pavements and Bridges

DESCRIPTION

Continue to research and assess the potential impacts of vehicle platooning and limited vehicle wheel wander stresses on pavement and bridges.

VALUE TO MNDOT

- Understand available research to anticipate action or further research needs

INITIATE



CAPITAL



STAFF EFFORT



LEAD

Materials and Road Research and Bridge (co-leads)

MNDOT STAKEHOLDERS

- CAV-X
- Project Management and Technical Support
- Research and Innovation

Recommendation 4 — Update Design Standards to Accommodate Platooning

DESCRIPTION

If necessary, update design standards for pavement and bridges to address anticipated changes in loading characteristics. When possible, follow national guidance and emerging standards (e.g. AASHTO).

VALUE TO MNDOT

- Prepare to incorporate new standards into project designs

INITIATE



CAPITAL



STAFF EFFORT




LEAD

Materials and Road Research and Bridge (co-leads)

MNDOT STAKEHOLDERS

- District Planners and Engineers
- Project Management and Technical Support

Recommendation 5 — Develop Truck Platooning Network Plan				
DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Develop a Truck Platooning Network Plan for MnDOT freeways and expressways to:</p> <ul style="list-style-type: none">• Identify freeways and expressways that are candidates for safe truck platooning• Identify which corridors can safely sustain truck platooning based on safety, operations, and infrastructure readiness• Map which corridors are open to truck platoons when platooning is authorized by law• Identify strategies to enhance bridge and pavement conditions on platoon corridors that cannot currently accommodate platooning• Assess costs to implement these changes• Ensure coordination with public safety, law enforcement, and freight communities• Assess how to improve truck platooning corridor pavements and bridges in the District Freight Plan to improve and maintain oversize-overweight corridors and Critical Urban and Rural Freight Corridors	<ul style="list-style-type: none">• Identify safety and operational impacts prior to platooning• Identify priority locations for retrofitting• Market Minnesota to freight industry	<div><div>1-3</div></div>	<div>\$\$\$</div>	<div></div>
		LEAD CAV-X		
		<div>MNDOT STAKEHOLDERS</div> <ul style="list-style-type: none">• Bridge• District Operations• Freight and Commercial Vehicle Operations• Materials and Road Research• RTMC		

STRATEGY 3

GOAL ALIGNMENT

Develop and Implement Enhanced Pavement Marking and Signage Program

Pavement markings and signage are needed to help CAVs safely navigate. This in turn places increased pressure to maintain existing infrastructure. MnDOT should develop and implement an updated pavement marking and signage strategy using the most current guidance to enhance safety for both AVs and human drivers.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 6 — Pilot Pavement Marking to Support Automated Vehicles and Human Drivers

DESCRIPTION

Install advanced pavement markings recommended by the Manual on Uniform Traffic Control Devices (MUTCD) to support CAV and enhance visibility for both human drivers and automated vehicles.

Test areas on freeways, expressways, and arterials. When possible, install test segments along designated CAV Connected Corridors on Trunk Highway 55, Trunk Highway 52 and Interstate 94.

VALUE TO MNDOT

- Evaluate the cost, maintenance and efficiency of new CAV standards
- Test and validate safety advancements before updating statewide standards

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Traffic Engineering

MNDOT STAKEHOLDERS

- CAV-X
- Construction
- District Offices
- Maintenance

Recommendation 7 — Support Industry in Researching and Advancing Signing to Support CAV

DESCRIPTION

Create partnerships to allow industry to install and test static signage at MnROAD facility and on MnDOT roads to support CAV. Allow industry to equip MnDOT fleet vehicles to support testing. In exchange, require industry to provide progress updates, share information, promote industry adoption, and understand requirements to install and maintain the technology. When possible, test along designated CAV Connected Corridors on Trunk Highway 55, Trunk Highway 52 and Interstate 94.

VALUE TO MNDOT

- Obtain early knowledge of signing requirements, allowing MnDOT to proactively prepare and budget

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- District Offices
- Maintenance
- Materials and Road Research
- Traffic Engineering

STRATEGY 4

GOAL ALIGNMENT

Develop and Implement Electric Vehicle (EV) Strategy

Many AVs are being built on electric platforms but it is not yet known whether the industry will broadly adopt EV technology. Battery technology is rapidly improving; however, limited ranges and cold weather impede performance. MnDOT should strategically build out charging infrastructure on MnDOT's trunk highway system to address range limitations and accelerate CAV adoption. Advancing electric vehicles also promotes Minnesota's climate change reduction and air quality goals.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 8 — Develop EV Infrastructure Deployment Strategy at State Facilities

DESCRIPTION

Develop an EV infrastructure deployment strategy for state facilities on major highways. Consider gaps in public and private charging stations, distance between stations, rest area locations, other state facilities which could house infrastructure, access to power, and other factors. Consider alternative business models such as public-private partnerships and licensing agreements to offset costs for installation, operation and maintenance of the infrastructure.

VALUE TO MNDOT

- Identify charging infrastructure gap areas which could accelerate EV and CAV adoption

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Sustainability and Public Health

MNDOT STAKEHOLDERS

- CAV-X
- District Offices
- Maintenance/Building Services Section
- Project Management and Technical Support/
Rest Area Program Manager
- Traffic Engineering

Recommendation 9 – Implement EV Infrastructure Deployment Strategy at State Facilities

DESCRIPTION

After a deployment strategy is developed, begin a phased build-out of charging infrastructure. Identify number of installations and locations. Negotiate public-private partnerships, lease agreements and utility agreements if applicable. Design and construct infrastructure.

VALUE TO MNDOT

- Close charging infrastructure gaps to accelerate EV and CAV adoption

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Maintenance

MNDOT STAKEHOLDERS

- District Offices
- Land Management
- Maintenance/Building Services Section
- Project Management and Technical Support/ Rest Area Program Manager
- Traffic Engineering

STRATEGY 5

GOAL ALIGNMENT

Lead National Research and Innovation

MnDOT is seen as a leader in CAV. CAV technologies are rapidly evolving, making it difficult for transportation departments to plan for CAV advancements. MnDOT can advance national CAV research in safety, cold weather testing, pavement impacts, equity and mobility. MnDOT should actively steer collaborative national research, encourage private-sector innovation, and work with the state's academic institutions to promote research important for Minnesota.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 10 — Continue the Minnesota CAV Challenge

DESCRIPTION

Continue the Minnesota CAV Challenge open, rolling request for proposals to promote innovative solutions to identified MnDOT priorities. Focus on applied research and implementation, with results that either: (1) broaden MnDOT's knowledge on how to design, operate, and maintain these systems; or (2) result in an immediate public benefit.

Ensure the portfolio of selected projects covers a variety of Minnesota's transportation needs, including automated and connected vehicle testing, public engagement, freight, transit, bikes and pedestrian safety, work zones, worker safety, and public policy.

MnDOT should secure long-term funding for the program to continue applied research and policy activities.

VALUE TO MNDOT

- Delivers private-sector and academic innovation to help address key MnDOT priorities
- Engages the public to help shape future policy
- Reduces the staff and time needed to prepare requests for proposals.

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- District Offices
- Leadership
- Research and Innovation
- RTMC
- Traffic Engineering

Recommendation 11 – Leverage TRIG and LRRB to Research CAV Long-Term Impacts

DESCRIPTION

Use MnDOT's Transportation Research Innovation Group (TRIG) and Local Road Research Board (LRRB) programs to research long-term impacts (10+ years) of CAV safety and operations.

VALUE TO MNDOT

- Establish research objectives
- Guide national research to align with MnDOT priorities

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Research and Innovation
- Traffic Engineering

Recommendation 12 – Seek Research Panel Assignments Aligned with MnDOT Interests

DESCRIPTION

Continue to seek panel assignments through cooperative research initiatives such as the National Cooperative Highway Research Program (NCHRP), the CV Pooled Fund Study, and others. Ensure research initiatives align with MnDOT priorities to help set objectives and guide research efforts.

VALUE TO MNDOT

- Help establish objectives and guide national research efforts to align with MnDOT priorities

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Research and Innovation
- Traffic Engineering
- Other Districts and Offices As Needed

Recommendation 13 – Further Collaborative Research with Minnesota Academic Institutions

DESCRIPTION

Share research objectives and identify partnering opportunities with academic and research institutions. Research winter weather impacts on CAV technology and ways MnDOT can mitigate impacts to facilitate CAV adoption. Partnerships may be self-funded or include in-kind support.

VALUE TO MNDOT

- Address research priorities for MnDOT not currently addressed by national research efforts or the private sector

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Research and Innovation
- Other Districts and Offices As Needed

Recommendation 14 – Research Data Use and Models

DESCRIPTION

Research CAV data collection, storage and maintenance models to support MnDOT operations. Identify the types of data available which could support MnDOT business functions. Research and assess third party and private sector models for CAV data management and staffing.

VALUE TO MNDOT

- Identify solutions to cost-effectively support MnDOT's data needs

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Asset Management
- Chief Counsel
- District Offices
- MnIT
- Research and Innovation
- RTMC
- Traffic Engineering
- Transportation System Management

Recommendation 15 – Monitor Research on CAV Dedicated Lanes

DESCRIPTION

Monitor national research and market trends on prioritizing CV or AVs on Minnesota roadways, such as dedicated lanes or converting MnPASS and high-occupancy vehicle (HOV) lanes.

VALUE TO MNDOT

- Prepare for potential long range impacts
- Research the safe integration of CAV into the transportation system

INITIATE



CAPITAL



STAFF EFFORT



LEAD | RTMC

MNDOT STAKEHOLDERS

- CAV-X
- District Offices
- Traffic Engineering

STRATEGY 6

GOAL ALIGNMENT

Continue and Expand CV Pilot Activities

MnDOT has established connected vehicle testing corridors to evaluate CV technologies. This program should be expanded to address additional research objectives including cold weather applications and vulnerable road users who are often overlooked or adversely affected by technology developments.

-  SAFETY
-  EFFICIENCY
-  EQUITY AND ACCESSIBILITY
-  ECONOMIC BENEFITS
-  TRUST AND UNDERSTANDING
-  READINESS
-  SUSTAINABILITY

Recommendation 16 – Continue Strategic Investments in CV Test Corridors

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Invest in test corridors to advance connected technologies such as DSRC and C-V2X. This includes:</p> <ul style="list-style-type: none">Continued investment in Trunk Highway 55 Connected Corridor in Minneapolis to evaluate signal phasing and timing (SPaT) and other urban applications.Continued investment in Trunk Highway 52 from Rochester to St Paul.Investment in other corridors for additional applications and use cases. <p>Document lessons learned to help plan the long-term design, construction, operation and maintenance of these systems.</p>	<ul style="list-style-type: none">Gain experience in deploying, operating and maintaining CV equipmentProvide test sites to pilot applicationsProvide opportunities for testing partnerships	<p>1-3</p> <p>LEAD CAV-X</p> <p>MNDOT STAKEHOLDERS</p> <ul style="list-style-type: none">District 6Electrical Services SectionMnITMetro DistrictRTMCTraffic EngineeringTransit and Active Transportation	<p>\$\$\$</p>	<p>3</p>

Recommendation 17 – Conduct Pilot of CV Technologies for Rural Applications

DESCRIPTION

Pilot commercially available CV safety and weather applications across Minnesota to promote safety, public engagement and public trust.

Pilots should include both conventional infrastructure-based systems (such as dynamic message signs, flashing beacons, etc.) and vehicle-to-infrastructure (V2I) applications to show direct public benefits of CV technologies.

VALUE TO MNDOT

- Gain experience in deploying, operating and maintaining CV equipment
- Provide test sites to pilot applications
- Provide opportunities for testing partnerships

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- District Offices
- Electrical Services Section
- MnIT
- Public Engagement and Constituent Services
- RTMC
- Traffic Engineering

Recommendation 18 – Pilot Alternative Communications Technologies and Business Models

DESCRIPTION

Test DSRC alternative communications technologies including cellular vehicle to everything (C-V2X) and 5G technologies. Conduct testing directly or through partnerships with industry because of the lack of nationwide industry consensus around DSRC, 5G and C-V2X communications technologies, business models and interoperability. Evaluate feasibility of partnerships with telecommunications providers to use small-cell technology in MnDOT rights-of-way (e.g., traffic signal pole), or testing C-V2X roadside units to understand how these applications are different from DSRC technology.

Conduct assessment of infrastructure standards and needs to pilot these technologies.

VALUE TO MNDOT

- Gain experience and understanding of the impact of different communications technologies
- Explore business models which may reduce public cost of deployment

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Administration
- District Offices
- Electrical Services Section
- MnIT
- RTMC
- Statewide Radio Communications
- Traffic Engineering

Recommendation 19 – Conduct Pilots of CAV Technologies on MnDOT Fleet Vehicles

DESCRIPTION

Develop a plan to pilot and validate CV technologies in fleet vehicles. The plan should include:

- Snow plow signal priority
- Work zone and maintenance vehicle communications
- Probe data gathering (e.g., pavement condition and weather data)
- Validating CV testing corridor applications
- Long-term maintenance and operations impacts to CV technology in fleet vehicles
- Retiring technology from fleet vehicles
- Evaluating the success of the technology in the fleet

VALUE TO MNDOT

- Gain experience and understanding of the impact of different communications technologies
- Explore business models which may reduce public cost of deployment

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Administration
- Construction
- District Offices
- Maintenance
- Traffic Engineering

STRATEGY 7

GOAL ALIGNMENT

Encourage Third-Party Research and Development in Minnesota

There are many entities testing CAV technologies in Minnesota. MnDOT should partner with third-party researchers in Minnesota to advance CAV goals and economic development. MnDOT should facilitate industry research and development to achieve mutual objectives, leverage Minnesota facilities and climate conditions and efficiently use MnDOT resources.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 20 — Encourage Third-Party Testing to Validate Deployed CV Systems

DESCRIPTION

Interoperability is a key objective of all CV systems. In order to validate deployed CV infrastructure and understand interoperability challenges, it is recommended to seek partners to bring DSRC-equipped vehicles or devices to test interoperability on MnDOT's deployed corridors, and to cooperatively identify necessary changes or standards issues which impact interoperability.

VALUE TO MNDOT

- Validate CV investments and understand deployment challenges

INITIATE

1-3

CAPITAL

\$ \$ \$

STAFF EFFORT

3

LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- District Offices
- Electrical Engineering Section
- RTMC
- Traffic Engineering

Recommendation 21 — Designate and Market On-Road CAV Test Corridors

DESCRIPTION

Designate and market CAV testing corridors to encourage third-party testing. Work with industry to design applications, potential use cases, infrastructure (e.g., CV communications, enhanced markings and signage), and test new traffic control technologies.

VALUE TO MNDOT

- Focus investment on testing and piloting technologies
- Create partnerships and third-party testing opportunities

INITIATE

1-3

CAPITAL

\$ \$ \$

STAFF EFFORT

3

LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- District Offices
- Electrical Services Section
- Liaison Services
- Materials and Road Research
- Traffic Engineering

STRATEGY 8

GOAL ALIGNMENT

Facilitate Statewide CAV Stakeholder Collaboration

As the state's transportation agency, MnDOT has a unique opportunity to convene and facilitate conversations on CAV. MnDOT should establish a statewide working group to promote engagement and collaboration with the public and private industry. These efforts should focus on transportation equity and reducing disparities.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 22 – Continue I-CAV Team

DESCRIPTION

MnDOT should continue to work with the I-CAV team to promote safe testing of CAV. The I-CAV team should continue to provide technical expertise to the Advisory Council and discuss public engagement priorities.

VALUE TO MNDOT

- Collaboratively promote priorities

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- Government Affairs
- Liaison Services
- Transit and Active Transportation
- Transportation System Management
- Senior Leadership

Recommendation 23 – Continue the CAV Advisory Council

DESCRIPTION

MnDOT should continue to work with the CAV Advisory Council to review CAV and ITS advancements, explore partnerships to remain prepared for the widespread adoption of CAV and propose policies for safe testing and deployment. Support the Council in implementing the 2018 CAV Executive Report, consulting with communities experiencing transportation barriers, preparing an annual report and working with DPS to support the safe testing and deployment of CAVs.

VALUE TO MNDOT

- Promote safe testing of CAV and shared mobility
- Statewide collaboration and partnerships
- Leverage expertise of public and private sector to promote MnDOT priorities

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- Government Affairs
- Liaison Services
- Transit and Active Transportation
- Transportation System Management
- Senior Leadership

Recommendation 24 – Develop Statewide CAV Workshop

DESCRIPTION

Work with key partners to continue the work of the CAV Advisory Council and 2018 CTS VISIONING WORKSHOP to regularly collaborate with the public, private and academic sectors to share information, build relationships and strategically plan for CAV. Work will also focus on public engagement, testing and demonstrations. The workshop will be coordinated with Advisory Council, I-CAV, the Advisory Council policy subcommittees and other statewide stakeholders to leverage the interest of the public and technical experts. MnDOT will identify a lead organization to convene the workshops.

VALUE TO MNDOT

- Provide a forum for public engagement and industry outreach
- Build relationships and industry partnerships
- Promote economic development

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel
- Government Affairs
- Liaison Services
- Transit and Active Transportation
- Transportation System Management
- Senior Leadership

Recommendation 25 – Prepare for Grant Opportunities and Partnerships

DESCRIPTION

Identify a list of potential projects and public and private partners for federal CAV grant opportunities to proactively prepare for solicitations.

VALUE TO MNDOT

- Proactively prepare for funding opportunities
- Position Minnesota as a leader in federal grants

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- Finance
- District Offices
- Research and Innovation
- Transportation System Management

Recommendation 26 – Promote Industry Partnerships

DESCRIPTION

Build Minnesota CAV knowledge base by building partnerships with private industry:

- Include automobile and technology companies on Advisory Councils, conferences, and in developing policy
- Leverage expertise of existing Minnesota CAV industry
- Work with Minnesota businesses interested in CAV

VALUE TO MNDOT

- Collaborate with industry and solicit feedback into policy and investment decisions
- Create cost-sharing opportunities on pilot projects
- Grow Minnesota businesses

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Advisory Council
- Liaison Services

STRATEGY 9

GOAL ALIGNMENT

Support Small and Disadvantaged Business Capacity Building

CAV technologies raise concerns about transportation equity and communities experiencing transportation barriers. In advancing CAV benefits, MnDOT does not want to widen disparities. To promote equity, MnDOT should work with the Targeted Group/Economically Disadvantaged/Veteran-Owned (TG/ED/VO) Small Business Procurement Program to expand CAV industry opportunities. MnDOT should proactively engage small businesses to help grow CAV opportunities and expertise.

-  SAFETY
-  EFFICIENCY
-  EQUITY AND ACCESSIBILITY
-  ECONOMIC BENEFITS
-  TRUST AND UNDERSTANDING
-  READINESS
-  SUSTAINABILITY

Recommendation 27 – Conduct CAV Workshop for Small Business Community

DESCRIPTION

Conduct a CAV workshop for small and disadvantaged business enterprises (DBE) to learn about CAV, MnDOT procurement, CAV skills gaps, training programs, and potential partnership opportunities.

VALUE TO MNDOT

- Grow CAV small business community
- Promote local talent and economic development

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Civil Rights

MNDOT STAKEHOLDERS

- CAV-X
- Equity and Diversity
- MnDOT DBE and Workforce Collaborative

Recommendation 28 – Develop Small Business and Workforce CAV Mentorship Program

DESCRIPTION

Develop a CAV small business mentorship program to engage the state's targeted group business (TGB), disadvantaged business enterprise (DBE) and workforce communities. Include funding for on-the-job training to share expertise and resources, build staff capacity and broaden small business knowledge of the CAV market.

VALUE TO MNDOT

- Grow small business community
- Promote local talent and economic development
- Build relationships among small businesses and CAV industry

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Civil Rights

MNDOT STAKEHOLDERS

- Administration
- CAV-X
- Equity and Diversity
- MnDOT DBE and Workforce Collaborative
- Public Engagement and Constituent Services

STRATEGY 10

GOAL ALIGNMENT

Update State Laws and Administrative Rules

Current Minnesota statutes and policies never contemplated CAV technology. Laws and agency rules need to reflect changing technologies and mobility trends. The state must proactively engage with policy makers and the public to ensure state law is clear regarding whether automated vehicles are legal and how other laws need to adjust for changing infrastructure needs.

 SAFETY

 EFFICIENCY

 EQUITY AND ACCESSIBILITY




 ECONOMIC BENEFITS

 TRUST AND UNDERSTANDING

 READINESS

 SUSTAINABILITY

Recommendation 29 — Authorize in State Law the Safe Testing of Automated Vehicles

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Work with policy makers and the public to enact state law that authorizes the safe testing of automated vehicles. Conduct engagement with the public, policymakers and stakeholders on how automated vehicles operate and promote public safety.</p> <p>Develop an awareness campaign for legislation and automated vehicle testing safety to engage policy makers and the public on the benefits of safe CAV testing and the risks of not enacting clear state policy.</p>	<ul style="list-style-type: none">Build trust in safe CAV technologiesGrow relationships with policy makers, public and industry			
LEAD CAV-X				
MNDOT STAKEHOLDERS				
<ul style="list-style-type: none">Chief CounselEquity and DiversityGovernment Affairs				

Recommendation 30 – Update the Minnesota Government Data Practices Act to Address CAV data

DESCRIPTION

Work with MnIT, data privacy, and cyber security stakeholders to update Chapter 13 (the Minnesota Government Data Practices Act) to address collection, storage and retention of CAV data. Create temporary classifications for CAV data until updated laws are passed. Consider financial and privacy impacts of CAV data.

VALUE TO MNDOT

- Leverage local expertise on data privacy and cyber security
- Grow relationships with policy makers, public and industry
- Expand CAV pilot applications

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- CAV-X
- Chief Counsel
- Government Affairs
- MnIT
- RTMC

Recommendation 31 – Assess State Utility Laws for Connected Vehicle Infrastructure Opportunities

DESCRIPTION

Assess whether updates to state utility locating laws and administrative rules are needed to address broadband/fiber optic partnerships.

Assess whether to amend state utility law to strike language requiring MnDOT to reimburse utilities during relocations in cases where P3s are in-place to avoid MnDOT paying relocation costs under a P3 agreement.

Consider alternative models for utility relocation payment. Use CAV goals to authorize public-private communications infrastructure partnerships.

Leverage support in connected vehicle technologies to update utility reimbursement statutes in partnership with telecommunications industry.

VALUE TO MNDOT

- Build trust in safe CAV technologies
- Grow relationships with policy makers, public and industry
- Become more flexible and nimble with evolving technology changes

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Land Management

MNDOT STAKEHOLDERS

- CAV-X
- Chief Counsel
- Government Affairs
- Land Management
- MnIT

STRATEGY 11

GOAL ALIGNMENT

Update Internal MnDOT Policies

MnDOT policies never contemplated CAV technologies and emerging mobility trends. MnDOT must proactively update internal policies to address CAV transportation to build public trust, grow relationships with private industry and become more flexible and nimble with rapidly changing technology trends.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 32 — Review Agency Utility Accommodation Policy to Address CAV Partnerships

DESCRIPTION

Review MnDOT's [Utility Accommodation on Highway Rights of Way Policy](#) to address opportunities for fiber optic public-private partnerships and to address requests to install small cell telecommunications technology on MnDOT infrastructure. Update policy language which currently prohibits utility installations on controlled access freeways.

VALUE TO MNDOT

- Build relationships with industry and public
- Become more flexible and nimble with evolving technology changes
- Explore opportunities to expand telecommunications infrastructure

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Land Management

MNDOT STAKEHOLDERS

- CAV-X
- Chief Counsel
- Electrical Services Section
- Government Affairs
- Land Management
- MnIT
- RTMC

Recommendation 33 — Assess Whether Automated Delivery Vehicles are Permissible under State Law

DESCRIPTION

Review and assess current state law and administrative rules on automated delivery vehicles (ADV). Assess whether ADVs may be operated on MnDOT jurisdictional roads, rights of way or sidewalks. Coordinate with research institutions and local government to share research and recommendations on whether state laws need amending.

VALUE TO MNDOT

- Build trust in safe CAV technologies
- Become more flexible and nimble with evolving technology changes
- Coordinate with local governments

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Chief Counsel

Recommendation 34 – Develop Policy on CAV Priority

DESCRIPTION

Create a statewide MnDOT policy (or technical guidance) to address priority models for traffic signals to address CAV, including transit, snow plow priority, and pedestrian and cyclist priority.

Collaboratively work to integrate signal timing framework and Statewide Pedestrian Plan updates to prioritize safety for vulnerable road users.

VALUE TO MNDOT

- Build trust in safe CAV technologies
- Grow relationships with local government, policy makers, public and industry
- Support bicyclist and pedestrian safety

INITIATE



CAPITAL



STAFF EFFORT



LEAD

Transit and Active Transportation and Traffic Engineering (co-leads)

MNDOT STAKEHOLDERS

- Chief Counsel
- District Offices
- Government Affairs

Recommendation 35 – Update Agency Data Stewardship and Records Retention Policies to Address CAV Data

DESCRIPTION

Work with data stewards, Records Management and Data Practices Unit to update MnDOT's [Data Stewardship Policy](#) and [Records Retention and Disposal Policy](#) to address the collection, storage and retention of CAV data.

Coordinate efforts with updates to state data practices laws and Recommendation 30 (update the Minnesota government data practices act to address CAV).

Develop CAV data sharing policy with third parties, industry, research institutions, transportation organizations (e.g. Metro Transit, City of Minneapolis) and transportation network companies.

VALUE TO MNDOT

- Build trust with public and industry that MnDOT is safely managing personal and proprietary data
- Leverage opportunities to share data with researchers

INITIATE



CAPITAL



STAFF EFFORT




LEAD

Chief Counsel

MNDOT STAKEHOLDERS

- CAV-X
- MnIT
- Senior Leadership

Recommendation 36 – Support Local Government Shared Mobility Policy				
DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
Support local governments in developing a model shared mobility policy to promote statewide consistency.	<ul style="list-style-type: none">Build trust in safe CAV technologiesBecome more flexible and nimble with evolving technology changesCoordinate with local governments	<div>5+</div>	<div>\$ \$ \$</div>	<div></div>
		LEAD State Aid		
		<div>MNDOT STAKEHOLDERS</div> <ul style="list-style-type: none">CAV-XState AidTraffic Engineering		

STRATEGY 12

GOAL ALIGNMENT

Use CAV Data to Streamline MnDOT Operations

CAV data can streamline MnDOT operations, including snow plowing and traffic management. Today CAVs are not a significant data source. MnDOT can take measures to streamline operations and maintenance through asset management, assessing pavement condition, using weather probe data and others.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 37 — Identify Data Needs and Data Sources to Support MnDOT Operations

DESCRIPTION

Identify ways CAV data may improve operations and streamline business processes. Potential examples include:

- Traffic management
- Snow and ice management
- Pavement conditions
- High-resolution data to support system planning, such as anonymized origin-destination data
- LIDAR

Evaluate which CAV data is valuable to MnDOT (e.g., work zone maps) and what data MnDOT needs from third parties to identify partnership opportunities.

Monitor potential impacts to Minnesota Continuously Operating Reference Stations (MnCORS) for connected and automated vehicle applications. MnCORS is a statewide network that provides GPS positioning data. MnCORS data can be used for many applications, including surveys, weather and geopositioning. If MnCORS use increases due to AVs, assess whether modifications or upgrades to the system are needed.

VALUE TO MNDOT

- Streamlining business and maintenance operations

INITIATE



CAPITAL



STAFF EFFORT






LEAD | CAV-X

MNDOT STAKEHOLDERS

- District Offices
- Land Management
- Maintenance
- Materials and Road Research
- Metro District Traffic
- RTMC
- Transportation System Management

Recommendation 38 – Develop a Framework for a CAV Data Management System

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Develop a framework to collect, manage and analyze CAV data received by third parties (including basic safety messages) from vehicles. This includes:</p> <ul style="list-style-type: none">• Pilot projects on MnDOT CV test corridors to collect anonymized data from vehicles. Evaluate:<ul style="list-style-type: none">– Benefits, risks and costs associated with collecting and storing CV data– Security models and privacy risks– Benefits and limitations of edge computing compared to cloud or other storage options• After pilot projects, develop a long-range data management system plan for CAV• Identify MnDOT data that can benefit third parties in advancing CAV. Develop plans and processes to efficiently share this data with third parties.	<ul style="list-style-type: none">• Build foundation for management and use of new data sources• Pilot data management projects to improve operations• Promote data sharing and partnerships			
		LEAD RTMC		
		<p>MNDOT STAKEHOLDERS</p> <ul style="list-style-type: none">• CAV-X• Chief Counsel• District Offices• MnlT• Traffic Engineering• Transportation System Management		

STRATEGY 13

GOAL ALIGNMENT

Develop IT Network Management and Security Policies for CAV

The introduction of connected vehicle technologies creates networking challenges and cyber security risk. Planning for these risks is a key step in preparing Minnesota roads for CAV. In the future, MnDOT may consider outside business models and partnerships with the private sector to address network security. MnDOT will partner with MnIT staff to develop strategies to integrate and secure devices on the state network and develop cyber security strategies.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 39 – Develop CAV Network Integration Guidance and Security Policy

DESCRIPTION

After developing a data management system framework (Recommendation 38), create a best practices guidance document to integrate connected vehicle infrastructure with the state's networking system. MnDOT should consider how networks are built, including security, architecture, firewalls and configuration.

Develop a security policy to centrally manage user and password administration for CAV devices deployed in MnDOT vehicles and on the MnDOT network.

Policies should consider wired/wireless security architecture with advanced threat detection and prevention, vulnerability management, security logging and monitoring, and incident response plan capabilities to protect public safety and privacy. Integrate NTCIP 1218 national security credential management system standards.

VALUE TO MNDOT

- Establish guidelines to secure CV infrastructure network

INITIATE



CAPITAL



STAFF EFFORT






LEAD | CAV-X and MnIT (co-leads)

MNDOT STAKEHOLDERS

- Chief Counsel
- District Offices
- RTMC
- Traffic Engineering
- Transportation System Management

Recommendation 40 – Pilot a CAV Network Management System

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Pilot a health and monitoring plan to remotely monitor, manage, and configure CV infrastructure.</p> <p>Consider system reliability measures, staffing commitments, and use of third parties to operate or maintain the systems.</p> <p>Develop system plan to address long-term maintenance and network management.</p>	<ul style="list-style-type: none">Ability to efficiently manage CV infrastructure and operations			
		LEAD CAV-X		
		<p>MNDOT STAKEHOLDERS</p> <ul style="list-style-type: none">CAV-XChief CounselDistrict OfficesRTMCMnITTraffic EngineeringTransportation System Management		

STRATEGY 14

GOAL ALIGNMENT

Improve Work Zone Safety by Leveraging CAV Technologies and Data

Work zones present significant safety challenges and opportunities to leverage CAV technology. Work zone locations can move frequently, which may make it difficult for automated driving systems to locate them and safely operate. Automated vehicles need real-time information to safely navigate and minimize intrusions. CAV technology can also improve worker safety. CAV can be used to automate some work zone functions to protect workers and avoid the dangers of speeding and distracted and inattentive driving.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 41 — Pilot Work Zone Data Collection Project and Data Sharing System

DESCRIPTION

Pilot technologies to provide real-time information on work zone locations to third parties. Real-time information should include which road is closed, directional and lane information, and the beginning and end of the work zone.

After the pilot project, develop a system to provide real-time information to the public and third parties. Consider collaboration with other states, federal programs, and local government.

Build off previous research and consider impacts to work zone contractors, work zone employees and the long-term operations and maintenance of these pilots.

VALUE TO MNDOT

- Provide real-time information for short-term work zone locations
- Build public trust and promote safety with more accurate, real-time work zone information

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Construction
- Maintenance
- MnIT
- RTMC
- Traffic Engineering

STRATEGY 15

GOAL ALIGNMENT

Evaluate and Plan for CAV-Related Operations and Maintenance

In the future, CAVs may provide opportunities to save money or bring in new revenues. Preparing for CAV, however, may take additional capital, operating and maintenance costs. MnDOT will research and quantify these costs to understand how CAV will impact current programs, business models and staffing to assess how the agency needs to re-evaluate its current operations and maintenance practices to account for these changes.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 42 – Develop Strategy to Maintain CAV Infrastructure

DESCRIPTION

Establish short-term and long-term strategies to operate and maintain CV infrastructure and TSMO priorities. Consider required skills, staffing, and training needed to operate and maintain infrastructure safely and efficiently.

Identify gaps in current resources. If necessary, consider models to design, build, operate, and maintain CV infrastructure by private parties. Consider life cycle costs to maintain infrastructure, replacement costs, and who is responsible for funding.

Identify minimum levels of experience needed to oversee any third parties developing, operating or maintaining infrastructure.

VALUE TO MNDOT

- Properly maintain CV infrastructure
- Proactively plan to design, build, operate, and maintain these systems

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- District Offices
- Electrical Services Section
- Maintenance
- MnIT
- RTMC
- Traffic Engineering

STRATEGY 16

GOAL ALIGNMENT

Evaluate Organizational Capabilities to Support CAV

To build and manage CAV infrastructure, MnDOT may need to hire new staff and grow new skills for current staff. MnDOT will evaluate minimum qualifications needed to support CAV and assess whether CAV staffing and skills should be directly hired, consulted out to third parties or privately managed. MnDOT will develop short-term and long-term strategies for hiring, training, and leveraging third party skills.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 43 – Develop Employee Engagement Plan

DESCRIPTION

Develop an employee engagement plan that:

- Seeks opportunities to improve worker safety and operations using CAV
- Collaborates with staff on identifying and mitigating the risks and impacts of CAV
- Develops strategies including surveys to continually solicit feedback

VALUE TO MNDOT

- Promote worker safety through CAV
- Proactively prepare for workforce impacts
- Build trust with staff to anticipate changes

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Human Resources and CAV-X (co-leads)

MNDOT STAKEHOLDERS

- Communications
- District Management
- Human Resources
- Market Research
- MnIT
- Public Engagement and Constituent Services

Recommendation 44 – Evaluate CAV Staffing Abilities

DESCRIPTION

Evaluate organizational capabilities within MnDOT to support CAV using the FHWA Capability Maturity Model (CMM), which addresses issues that challenge an organization's success in implementing technology-oriented programs.

VALUE TO MNDOT

- Assure organizational ability to lead and support CAV implementation

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Human Resources

MNDOT STAKEHOLDERS

- CAV-X

Recommendation 45 — Develop Plan to Address Skill Gaps				
DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Develop a systematic response plan to address staffing, hiring, and training throughout the organization. Assess whether CAV staffing and skills should be directly hired, consulted out to third parties or privately managed. Identify minimum qualifications needed to manage CAV programs and technologies.</p> <p>Skills that may be needed include:</p> <ul style="list-style-type: none">• Cyber security experts• Data scientists• Electrical engineers• Electricians• Equipment operators• Mechanics• Mobility managers• Network architecture, directory, server and database administrators• Permits and right-of-way staff• Radio frequency engineers	<ul style="list-style-type: none">• Identify organizational needs to hire, train, and organize staff to support CAV			
		LEAD Human Resources		
		MNDOT STAKEHOLDERS <ul style="list-style-type: none">• CAV-X• Districts and Functional Offices• Equity and Diversity		

STRATEGY 17

GOAL ALIGNMENT

Staff Recruitment, Training and Retention

CAV technology will likely require advanced skill sets to analyze data and operate and maintain equipment. These skill sets may be in high demand and MnDOT will need to compete with the private industry to recruit, hire, and retain individuals with these skills.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 46 — Review and Update Civil Service Requirements

DESCRIPTION

After evaluating organizational capacity and needs, work to update civil service classifications and other requirements to hire CAV skills. Additional classifications may need to be created to support CAV and other technology needs. Work with technical and vocational schools, colleges and universities and training programs to evaluate skills and compensation structures.

VALUE TO MNDOT

- Leverage MnDOT workforce talent
- Plan for CAV skills through updated, flexible hiring

INITIATE

CAPITAL

STAFF EFFORT

LEAD | Human Resources

MNDOT STAKEHOLDERS

- CAV-X
- Civil Rights
- Equity and Diversity

Recommendation 47 — Develop a CAV Talent Pipeline

DESCRIPTION

Work with university, community college and technical college partners in Minnesota to share information on skillsets needed for Minnesota's CAV future workforce needs. Work with the following vocations:

- Data science
- Cyber security
- Project management
- Radio technologies
- STEM and systems engineering
- Planning
- Policy

Partner with schools to develop curriculum to train students in skills needed to implement CAV at MnDOT and throughout the state.

VALUE TO MNDOT

- Collaboration with colleges and technical schools for curriculum development that meets MnDOT needs
- Create a CAV talent pipeline

INITIATE

CAPITAL

STAFF EFFORT

LEAD | CAV-X

MNDOT STAKEHOLDERS

- District and Functional Offices
- Human Resources

STRATEGY 18




GOAL ALIGNMENT

Pilot a Greater Minnesota Transit Agency CAV Program

Greater Minnesota transit agencies have limited resources and staff to leverage CAV benefits but CAV could greatly expand transportation and mobility in these communities. MnDOT will support these agencies to establish a pilot program to plan for CAV and identify how communities can support long-term planning and technology investments.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 48 — Develop a Greater Minnesota Transit Agency CAV Program

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Leverage state and federal transit funding to create a CAV pilot project grant program for transit agencies in greater Minnesota.</p> <p>Consider greater Minnesota communities experiencing transportation barriers. Use the pilot projects to:</p> <ul style="list-style-type: none">Educate and engage the public on CAVSolicit feedback on how CAV could enhance transit and other transportation servicesDiscuss the risks and opportunities associated with CAVBuild public trust <p>Consider updating procurement and contract requirements to pilot existing automated driver assist (ADS) features already commercially available on the market. Assess which ADS features are most appropriate for transit vehicles and develop targets to increase the number of transit vehicles with ADS features.</p>	<ul style="list-style-type: none">Develop a base level of understanding for transit agencies and communities to prepare for CAVBuild public trust through hands-on demonstrations			
<p>LEAD Transit and Active Transportation</p>				
<p>MNDOT STAKEHOLDERS</p> <ul style="list-style-type: none">CAV-XDistrict OfficesTransportation System Management				

Recommendation 49 – Convene Workshops and Develop Guidance to Share Lessons Learned

DESCRIPTION

Host interactive meetings with greater Minnesota transit agencies to share the experience and lessons learned from the Greater Minnesota Transit Agency CAV Pilot Program.

Create one-pagers summarizing lessons learned and share with statewide partners.

VALUE TO MNDOT

- Share best practices and lessons learned
- Leverage statewide knowledge
- Build partnerships

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Transit and Active Transportation

MNDOT STAKEHOLDERS

- CAV-X
- District Offices
- Transportation System Management

Recommendation 50 – Update Greater Minnesota Transit Investment Plan

DESCRIPTION

Continue planning and public engagement workshops to gather feedback for the Greater Minnesota Transit Investment Plan. Address how CAV can improve transit service in greater Minnesota communities. Address CAV trends, including connected and automated technologies, new on-demand service models, micro transit and others.

VALUE TO MNDOT

- Improve transit service delivery in Greater Minnesota
- Leverage expertise

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Transit and Active Transportation

MNDOT STAKEHOLDERS

- CAV-X
- District Offices
- Transportation System Management

STRATEGY 19




GOAL ALIGNMENT

Promote Pedestrian, Bicyclist, and Road User Safety

Interactions among CAVs, people who bike and walk and vulnerable road users (VRUs) continue to evolve. CAVs create safety challenges for VRUs. MnDOT is committed to supporting bicyclist and pedestrian safety, transportation equity and accessibility. MnDOT will engage with stakeholders to understand their needs and develop models to allow VRUs to safely move in CAV environments.

-  SAFETY
-  EFFICIENCY
-  EQUITY AND ACCESSIBILITY
-  ECONOMIC BENEFITS
-  TRUST AND UNDERSTANDING
-  READINESS
-  SUSTAINABILITY

Recommendation 51 — Conduct Pedestrian and Bicyclist Stakeholder Outreach








DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Conduct public engagement, CAV demonstrations and pilot projects to engage roadway users and solicit feedback on the safe integration of CAV.</p> <p>Engage people who bike and walk in automated vehicle demonstrations, to understand the current benefits and limitations of the technology.</p> <p>Collaborate with bicyclist, pedestrian and road user safety organizations in engagement and outreach efforts.</p> <p>Identify connected vehicle pilots to improve safety and efficiency for VRUs in CAV environments, such as signal warnings, Bluetooth applications or signal priority.</p>	<ul style="list-style-type: none">Understand the perspective of VRUs through research and surveysEducate and engage bicyclists and pedestrians on the benefits and risks of CAVsDevelop strategies to promote CAV and VRU safety			
		LEAD CAV-X		
		MNDOT STAKEHOLDERS <ul style="list-style-type: none">CommunicationsMarket ResearchPublic Engagement and Constituent ServicesTraffic EngineeringTransit and Active Transportation		

STRATEGY 20

GOAL ALIGNMENT

Research CAV Technologies to Support Rail Crossings and Freight Network Safety

CAVs present several potential points of interaction with truck and rail freight. With respect to trucks, CAVs present opportunities for greater efficiency through platooning and automation. With respect to rail, CAVs will need to operate safely at rail grade crossings. MnDOT will seek to partner with key industry stakeholders to research and pilot these technologies to strengthen the safety and efficiency of the state's multimodal network.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 52 — Research and Pilot CAV Freight Technologies

DESCRIPTION

After the development of a Truck Platooning Network Plan (Recommendation 5), conduct industry outreach to encourage the research and testing of CAV freight platooning and automation in Minnesota. Monitor state and federal legal challenges to freight automation.

VALUE TO MNDOT

- Advance the state of the practice for CAV freight technologies
- Support freight efficiencies

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X and Freight and Commercial Vehicle Operations (co-leads)

MNDOT STAKEHOLDERS

- Electrical Services Section
- Liaison Services
- Research and Innovation

Recommendation 53 — Monitor Research on CAV Technologies to Support Safety at Rail Grade Crossings

DESCRIPTION

Monitor research activities aimed at promoting safe interaction of CAVs at rail crossings. Evaluate systems that provide direct in-vehicle warnings to CAVs to alert them of train position to supplement infrastructure-based crossing warning systems.

VALUE TO MNDOT

- Maintain and promote safety at rail crossings
- Build partnerships with freight industry

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X and Freight and Commercial Vehicle Operations (co-leads)

MNDOT STAKEHOLDERS

- Research and Innovation

STRATEGY 21




GOAL ALIGNMENT

Promote Internal Awareness of CAV

Awareness and understanding is critical to ensuring that MnDOT speaks and acts with one voice. There is often misunderstanding of what CAV is, its timelines for adoption, and why MnDOT needs to prepare for these changes in transportation. It is important for MnDOT employees across the organization to have the most accurate, up-to-date information to understand how CAV may impact them, to build trust that MnDOT is adequately preparing, and to create ambassadors to help share information.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 54 — Create a CAV Email Newsletter

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Create a monthly email newsletter to provide updates on CAV activities and information. Share similar CAV updates each quarter in MnDOT's Newslane publication.</p> <p>Updates will include Advisory Council work, policy, strategic planning, public engagement, demonstrations and resources. The newsletter will include project highlights, educational pieces and public opinion research and refer back to the CAV website.</p> <p>Leverage the work of the internal MnDOT AV/CV Committee to promote understanding, awareness and education.</p>	<ul style="list-style-type: none">Engage and inform MnDOT about CAV and how the agency is preparingCreate CAV ambassadors to share informationBuild trust			
		LEAD CAV-X		
		MNDOT STAKEHOLDERS		
		<ul style="list-style-type: none">CommunicationsDistrict OfficesMnDOT AV/CV CommitteePublic Engagement and Constituent Services		

Recommendation 55 – Host CAV Brown Bag Discussions and Create CAV Ambassadors

DESCRIPTION

Host brown bag discussions on CAV to discuss the benefits and challenges of CAV and develop a deeper understanding for interested staff. Convene face-to-face discussions with opportunities to provide feedback. Discussions will be led by CAV-X staff and may include outside speakers, interactive discussions, and demonstrations.

Use a "train the trainer" model to develop "CAV Ambassadors" to empower MnDOT employees, stakeholders and community members to discuss the benefits and challenges of CAV and how MnDOT is preparing for the future.

VALUE TO MNDOT

- Develop deeper understanding for interested staff
- Opportunities to solicit feedback
- Grow relationships within MnDOT
- Create CAV ambassadors to share information
- Build trust

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- Public Engagement and Constituent Communications
- Equity and Diversity/Employee Resource Groups

STRATEGY 22




GOAL ALIGNMENT

Public Engagement and Education

As the state transportation agency, MnDOT has an important role educating and engaging the public on CAV. This is important because research shows nearly three-quarters of Americans are afraid of fully automated vehicles and are concerned about safety. With education, engagement, and opportunities to test the technology, however, individuals are more likely to accept the technology and support research. MnDOT will collaborate with partners to create a public engagement and communications plan to provide information on CAV convene public meetings and listening sessions, gauge public feedback, and gather broad public input on CAV policy and programs.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 56 — Develop CAV Public Engagement and Communications Plan

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Create a CAV Public Engagement and Communications Plan to strategically identify CAV engagement goals, audiences, messaging and events. A Public Engagement and Communication Plan efficiently uses state resources to ensure CAV policy and program decisions consider Minnesota needs and that communities are involved in the decision-making process. Strategically planning for engagement and communications helps to manage expectations, build community trust, and develop meaningful relationships to influence policy and programs.</p> <p>Develop an evaluation plan to develop successful communications and engagement tools.</p> <p>Segment audiences and messaging in the Communications Plan to meet the needs of each community, with a focus on communities experiencing transportation barriers and vulnerable road users.</p> <p>Target outreach and messaging specific to each community.</p>	<ul style="list-style-type: none">Promotes understanding and supportsBuild public trustConsistent messaging and outreachEfficiently use MnDOT resources through strategic planning			
		LEAD CAV-X		
		MNDOT STAKEHOLDERS		
		<ul style="list-style-type: none">CommunicationsDistrict and Functional OfficesPublic Engagement and Constituent Services		

Recommendation 57 – Rebrand the CAV-X Website

DESCRIPTION

Leverage MnDOT’s new “Destination CAV” brand to update the MnDOT CAV-X website to provide timely and accurate information on CAV programming, policy and events. Develop a website management plan so information is regularly updated and accurate. Post resources, opportunities to attend public meetings and demonstrations, and ways the public can sign up to receive the CAV Monthly Newsletter.

VALUE TO MNDOT

- Promotes understanding and supports acceptance by keeping CAV activities in the public eye, with a focus on public benefit

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- District and Functional Offices
- Public Engagement and Constituent Services

Recommendation 58 – Conduct Public Demonstrations throughout Minnesota

DESCRIPTION

Hold public demonstrations in urban, rural and suburban areas throughout Minnesota to allow the public to see, feel, and use CAV technology. Host static demonstrations and service pilots in different communities focusing on communities experiencing transportation barriers. Hold public engagement activities alongside demonstrations to engage communities, build trust and create CAV “ambassadors.”

Host regular demonstrations at the State Fair, Minnesota Auto Show and other recurring events where MnDOT may participate to build predictability and trust in the public engagement process.

VALUE TO MNDOT

- Build public trust and understanding in CAV
- Engagement with Greater Minnesota communities
- Advance equity through engagement and outreach

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications

Recommendation 59 — Create and Implement a Survey to Gauge Public Opinion				
DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
<p>Create a regular (e.g., quarterly) survey similar to the American Automobile Association’s CAV survey to gauge Minnesotans’ feelings on CAV.</p> <p>Create an annual CAV public engagement survey to assess public understanding, concerns, and recommendations on policy and programming. Build from the MnDOT omnibus survey, CAV Advisory Council survey and the University of Minnesota’s Human Factors lab to collaborate and efficiently leverage existing resources.</p>	<ul style="list-style-type: none">• Gauge public understanding and track progress• Identify educational and public demonstration needs• Build public trust	<div><div>1</div></div>	<div>\$ \$ \$</div>	<div><div></div><div></div><div></div></div>
		LEAD CAV-X		
		<div>MNDOT STAKEHOLDERS</div> <ul style="list-style-type: none">• Communications• District Public Affairs• Market Research• Public Engagement and Constituent Services		

STRATEGY 23

GOAL ALIGNMENT

Industry Outreach

Private sector businesses are rapidly developing CAV technology. If the auto and technology industries do not collaborate with government, the private sector may drive CAV advancements without assessing public sector policy risks, equity and accessibility, or operational and maintenance needs. Working with the industry is critical to achieve MnDOT's CAV goals.

MnDOT will partner with industry to share information and solicit feedback on CAV policy and programs. Industry outreach will focus on discussing MnDOT CAV priorities, partnership opportunities, and policy updates to advance the safe testing and deployment of CAV in Minnesota.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 60 — Conduct Regular Industry Outreach

DESCRIPTION

Regularly reach out to private partners to share information, solicit feedback and find partnership opportunities to:

- Build public trust through public engagement and communications
- Attend conferences and events to leverage industry expertise
- Grow partnerships to advance CAV testing and deployment
- Collaborate on communications and social media campaigns to amplify messaging from public and private partners

VALUE TO MNDOT

- Share information and leverage industry expertise
- Economic development
- Advance testing and deployment

INITIATE



CAPITAL



STAFF EFFORT



LEAD | CAV-X

MNDOT STAKEHOLDERS

- Communications
- District Offices
- Liaison Services
- Public Engagement and Constituent Services

STRATEGY 24

GOAL ALIGNMENT

Review Planning Measures, Assumptions and Methods

The potential changes that CAV and emerging transportation technologies will bring will alter how MnDOT plans for the state's transportation system and the tools the agency and its partners use to do so. MnDOT will consider how planning tools may be updated to better measure alignment with preferred outcomes of this technology shift, explore the potential for new data sources to support planning activities, and assess modeling tools and the methodology with which they are applied to reflect this uncertain future. Implementation of the recommendations below will be coordinated with the Twin Cities Metropolitan Council and other Metropolitan Planning Organizations (MPOs) in the state, as relevant. The recommendations below may be conducted as part of the plan update process or outside of it.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 61 — Review Performance Measures to Address CAV

DESCRIPTION

Review performance measures and targets used to evaluate the transportation system to address CAV. Review performance indicators that may help achieve the benefits of CAV. Identify and track emerging data sources including CAV market trends that may impact long range planning and evaluation of transportation system performance.

VALUE TO MNDOT

- Update performance measures and targets to address CAV impacts

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Planning

MNDOT STAKEHOLDERS

- Programming and Performance Management

Recommendation 62 – Evaluate Ways to Forecast CAV Trends

DESCRIPTION

Monitor the number of connected and automated vehicles in Minnesota to assist in forecasting future CAV trends. Use tools such as benefit-cost analysis, safety and crash modification analysis, and travel demand forecasting to predict travel behavior, the value of time, congestion and other factors impacted by CAV.

Conduct sensitivity analysis (ways to predict future outcomes with a wide range of variables) to understand if long range planning methods and forecasting need to change. Use a scenario planning approach (possibly using the four scenarios referenced in Section II. Planning Process) to consider CAV technology trends.

VALUE TO MNDOT

- Develop forecasting tools to anticipate changing trends and uncertainty
- Consider a range of future outcomes

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Planning

MNDOT STAKEHOLDERS

- CAV-X
- Traffic Engineering

STRATEGY 25

GOAL ALIGNMENT

Incorporate CAV Considerations into MnDOT Plans

Over time, CAV has the potential to influence planning and design of the state transportation system and the policies and investments that guide both. MnDOT statewide plans include modal and system plans as well as investment and operations plans. As part of the plan update process, both plans and underlying strategic direction should be reviewed to account for CAV as needed.

	SAFETY
	EFFICIENCY
	EQUITY AND ACCESSIBILITY
	ECONOMIC BENEFITS
	TRUST AND UNDERSTANDING
	READINESS
	SUSTAINABILITY

Recommendation 63 — Review Planning Strategies to Account for CAV

DESCRIPTION	VALUE TO MNDOT	INITIATE	CAPITAL	STAFF EFFORT
Review current long range planning policies to address MnDOT CAV Strategic Plan Scenario Planning Workshop feedback. Assess how to create policies that support a future of integrated and shared mobility (scenario 4). Address the key opportunities and concerns discussed in the workshops, address regional variation and adjust policies when necessary.	<ul style="list-style-type: none">Develop guidance on how to create policies that support shared mobility and CAV			
		LEAD Planning		
		MNDOT STAKEHOLDERS		
		<ul style="list-style-type: none">Districts and Functional Offices		

Recommendation 64 — Review and Update MnDOT Plans to Account for CAV

DESCRIPTION

Review the following transportation plans for potential CAV impacts:

- Statewide Multimodal Transportation Plan (SMTP): *Overall strategic direction, performance measures*
- State Highway Investment Plan (MnSHIP): *Changes to investment mix related to changes in usage patterns, modes, new devices, etc.*
- Greater Minnesota Transit Investment Plan: *Transit vehicle types, technologies and service models*
- Freight Plan: *Truck platooning and related behavior, patterns, vehicle types*
- Rail Plan: *Interface with CV/AV at crossings; signal technologies*
- Transportation Asset Management Plan (TAMP): *New asset types, costs, expertise to install and maintain*
- Strategic Highway Safety Plan (SHSP): *Potential shift in program emphases (e.g., reduced driver incidents with CAV?)*
- Transportation System Management and Operations (TSMO) Plans: *Potential for connected technology to improve, change implementation*
- Intelligent Transportation Systems (ITS) Plan and Statewide ITS Architecture: *Review new CAV technology for conformance with plans; update plans to account for changes in technology*
- Bicycle Plan and Pedestrian Plan: *Understand CAV interaction with vehicles and potential need for stakeholder communication*
- Other Plans (including Aviation Plan, Ports and Waterways Plan): *Monitor for future needs (e.g., growth in unmanned aerial systems)*

VALUE TO MNDOT

- Develop a plan-specific approach to address CAV
- Capture CAV benefits and mitigate potential challenges
- Address program cost impacts

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Planning

MNDOT STAKEHOLDERS

- Districts and Functional Offices

STRATEGY 26

GOAL ALIGNMENT

Provide CAV Resources and Support to Local, Regional and Tribal Governments

MnDOT has planning partners around the state in the form of local (city, county), tribal and regional governments. With respect to CAV, not only are these entities responsible for transportation planning on their own systems, but local governments have authority over land use planning, an area with particular susceptibility to CAV impacts. The purpose of this strategy is to provide for coordination and support regarding CAV between MnDOT and local, regional and tribal partners.



SAFETY



EFFICIENCY



EQUITY AND ACCESSIBILITY



ECONOMIC BENEFITS



TRUST AND UNDERSTANDING



READINESS



SUSTAINABILITY

Recommendation 65 — Provide CAV Resources and Support to Local, Regional and Tribal Governments

DESCRIPTION

Coordinate with and provide support to local, regional and tribal governments regarding issues related to CAV, in particular as it relates to points of transportation system coordination. Topics of interest may include delineation of responsibilities (local vs. regional vs. state) and technical assistance regarding regulatory issues, transportation infrastructure and investment, planning tools and methods, and local issues such as land use, parking or curb space. Consider continued use of scenario planning to address uncertainty and develop shared understanding of CAV issues.

VALUE TO MNDOT

- Support local, regional and tribal governments to address CAV issues that may also have statewide implications

INITIATE



CAPITAL



STAFF EFFORT



LEAD | Planning and State Aid (co-leads)

MNDOT STAKEHOLDERS

- CAV-X
- Equity and Diversity
- Government Affairs

**APPENDIX A:
SUMMARY OF STRATEGIES AND RECOMMENDATIONS**

Appendix A: Summary of Strategies and Recommendations

MnDOT CAV Strategic Plan Focus Areas, Strategies and Recommendations		MnDOT Lead	Initiate	Capital	Staff Effort	Strategic Plan Themes			SOP Goals		
						Strategic Investment	Innovation	Knowledge Sharing	Customer Trust	Workforce Excellence	Operational Excellence
FOCUS AREA 1: CAPITAL INVESTMENT											
► Strategy 1: Assess Connected Vehicle Infrastructure Needs											
1	Assess Communications Infrastructure and Public-Private Partnership Feasibility Study to Support CV Technologies	CAV-X	1 Year	\$\$\$	MED	✓			✓		✓
2	Build Traffic Signal Infrastructure for CV Readiness	Traffic Engineering	1 Year	\$	LOW	✓					✓
► Strategy 2: Assess and Prepare Pavements and Bridges for CAV											
3	Continue Research Scan of Platooning Impact on Pavements and Bridges	Materials/Bridge	1 Year	\$	LOW	✓					✓
4	Update Design Standards to Accommodate Platooning	Materials/Bridge	3-5 Years	\$\$\$	MED	✓	✓				✓
5	Develop Truck Platooning Network Plan	CAV-X	1-3 Years	\$\$	MED		✓	✓	✓		✓
► Strategy 3: Develop and Implement Enhanced Pavement Marking and Signage Program											
6	Pilot Pavement Marking to Support Automated Vehicles and Human Drivers	Traffic Engineering	1-3 Years	\$\$	HIGH		✓		✓		✓
7	Support Industry in Researching and Advancing Signing to Support CAV	CAV-X	1-3 Years	\$	LOW		✓	✓	✓		✓
► Strategy 4: Develop and Implement Electric Vehicle (EV) Strategy											
8	Develop EV Infrastructure Deployment Strategy at State Facilities	Sustainability and Public Health	1-3 Years	\$	MED	✓	✓				✓
9	Implement EV Infrastructure Deployment Strategy at State Facilities	Maintenance	1-3 Years	\$\$	MED	✓	✓		✓		✓
FOCUS AREA 2: RESEARCH AND DEVELOPMENT											
► Strategy 5: Lead National Research and Innovation											
10	Continue the Minnesota CAV Challenge	CAV-X	1 Year	\$\$\$	MED		✓	✓	✓		✓
11	Leverage TRIG and LRRB to Research CAV Long-Term Impacts	CAV-X	1-3 Years	\$\$	LOW			✓	✓		✓
12	Seek Research Panel Assignments Aligned with MnDOT Interests	CAV-X	1-3 Years	\$	LOW			✓			✓
13	Further Collaborative Research with Minnesota Academic Institutions	CAV-X	3-5 Years	\$\$	MED			✓	✓		✓
14	Research Data Use and Models	CAV-X	1-3 Years	\$\$	HIGH		✓	✓			✓
15	Monitor Research on CAV Dedicated Lanes	RTMC	5+ Years	\$	LOW			✓			✓

MnDOT CAV Strategic Plan Focus Areas, Strategies and Recommendations	MnDOT Lead	Initiate	Capital	Staff Effort	Strategic Plan Themes			SOP Goals		
					Strategic Investment	Innovation	Knowledge Sharing	Customer Trust	Workforce Excellence	Operational Excellence

► **Strategy 6: Continue and Expand CV Pilot Activities**

16	Continue Strategic Investments in CV Test Corridors	CAV-X	1-3 Years	\$\$	HIGH	✓			✓	✓
17	Conduct Pilot of CV Technologies for Rural Applications	CAV-X	1-3 Years	\$\$\$	HIGH		✓		✓	✓
18	Pilot Alternative Communications Technologies and Business Models	CAV-X	1-3 Years	\$\$	HIGH		✓			✓
19	Conduct Pilots of CAV Technologies on MnDOT Fleet Vehicles	CAV-X	1 Year	\$\$	MED	✓	✓		✓	✓

► **Strategy 7: Encourage Third-Party Research and Development in Minnesota**

20	Encourage Third-Party Testing to Validate Deployed CV Systems	CAV-X	1-3 Years	\$	MED		✓	✓	✓	✓
21	Designate and Market On-road CAV Test Corridors	CAV-X	1-3 Years	\$	MED			✓	✓	

FOCUS AREA 3: PARTNERSHIPS

► **Strategy 8: Facilitate Statewide CAV Stakeholder Collaboration**

22	Continue I-CAV Team	CAV-X	1 Year	\$	LOW			✓	✓	
23	Continue the CAV Advisory Council	CAV-X	1 Year	\$	LOW			✓	✓	
24	Develop Statewide CAV Workshop	CAV-X	1 Year	\$	LOW			✓	✓	
25	Prepare for Grant Opportunities and Partnerships	CAV-X	1 Year	\$	LOW		✓	✓	✓	✓
26	Promote Industry Partnerships	CAV-X	1 Year	\$	LOW			✓	✓	✓

► **Strategy 9: Support Small and Disadvantaged Business Capacity Building**

27	Conduct CAV Workshop for Small Business Community	Civil Rights	5+ Years	\$	LOW		✓	✓	✓	✓
28	Develop Small Business and Workforce CAV Mentorship Program	Civil Rights	5+ Years	\$\$	MED		✓	✓	✓	✓

FOCUS AREA 4: REGULATION AND POLICY

► **Strategy 10: Update State Laws and Administrative Rules**

29	Authorize in State Law the Safe Testing of Automated Vehicles	CAV-X	1 Year	\$	MED		✓	✓	✓	✓
30	Update the Minnesota Government Data Practices Act to Address CAV Data	CAV-X	3-5 Years	\$	HIGH		✓	✓	✓	✓
31	Assess State Utility Laws for Connected Vehicle Infrastructure Opportunities	Land Management	3-5 Years	\$	MED	✓		✓	✓	✓

MnDOT CAV Strategic Plan Focus Areas, Strategies and Recommendations	MnDOT Lead	Initiate	Capital	Staff Effort	Strategic Plan Themes			SOP Goals		
					Strategic Investment	Innovation	Knowledge Sharing	Customer Trust	Workforce Excellence	Operational Excellence

► **Strategy 11: Update Internal MnDOT Policies**

32	Review Agency Utility Accommodation Policy to Address CAV Partnerships	Land Management	1 Year	\$	MED		✓	✓	✓	✓
33	Assess Whether Automated Delivery Vehicles are Permissible under State Law	CAV-X	1 Year	\$	MED			✓	✓	✓
34	Develop Policy on CAV Priority	Transit and Active Transportation/ Traffic	3-5 Years	\$	HIGH		✓		✓	✓
35	Update Agency Data Stewardship and Records Retention Policies to Address CAV Data	Chief Counsel	3-5 Years	\$	MED		✓	✓		✓
36	Support Local Government Shared Mobility Policy	State Aid	5+ Years	\$	MED			✓	✓	

FOCUS AREA 5: OPERATIONS AND MAINTENANCE

► **Strategy 12: Use CAV Data to Streamline MnDOT Operations**

37	Identify Data Needs and Data Sources to Support MnDOT Operations	CAV-X	1 Year	\$	LOW	✓				✓
38	Develop a Framework for a CAV Data Management System	RTMC	1-3 Years	\$\$\$	HIGH	✓	✓		✓	✓

► **Strategy 13: Develop IT Network Management and Security Policies for CAV**

39	Develop CAV Network Integration Guidance and Security Policy	CAV-X/MnIT	3-5 Years	\$	MED	✓			✓	✓
40	Pilot a CAV Network Management System	CAV-X	3-5 Years	\$\$\$	MED	✓				✓

► **Strategy 14: Improve Work Zone Safety by Leveraging CAV Technologies and Data**

41	Pilot Work Zone Data Collection Project and Data Sharing System	CAV-X	1-3 Years	\$\$	MED		✓		✓	✓
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Strategy 15: Evaluate and Plan for CAV-Related Operations and Maintenance

42	Develop Strategy to Maintain CAV Infrastructure	CAV-X	3-5 Years	\$	MED	✓		✓		✓
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FOCUS AREA 6: STRATEGIC STAFFING

► **Strategy 16: Evaluate Organizational Capabilities to Support CAV**

43	Develop Employee Engagement Plan	HR/CAV-X	1 Year	\$	MED	✓			✓	✓
44	Evaluate CAV Staffing Abilities	Human Resources	3-5 Years	\$	MED	✓			✓	
45	Develop Plan to Address Skill Gaps	Human Resources	3-5 Years	\$	MED	✓			✓	✓

MnDOT CAV Strategic Plan Focus Areas, Strategies and Recommendations	MnDOT Lead	Initiate	Capital	Staff Effort	Strategic Plan Themes			SOP Goals		
					Strategic Investment	Innovation	Knowledge Sharing	Customer Trust	Workforce Excellence	Operational Excellence

► **Strategy 17: Staff Recruitment, Training and Retention**

46	Review and Update Civil Service Requirements	Human Resources	3-5 Years	\$	MED	✓			✓	✓
47	Develop a CAV Talent Pipeline	CAV-X	3-5 Years	\$	MED	✓			✓	✓

FOCUS AREA 7: MULTIMODAL

► **Strategy 18: Pilot a Greater Minnesota Transit Agency CAV Program**

48	Develop a Greater Minnesota Transit Agency CAV Program	Transit and Active Transportation	1 Year	\$	MED		✓	✓	✓	✓
49	Convene Workshops and Develop Guidance to Share Lessons Learned	Transit and Active Transportation	3-5 Years	\$	MED			✓	✓	
50	Update Greater Minnesota Transit Investment Plan	Transit and Active Transportation	5+ Years	\$	MED	✓			✓	✓

► **Strategy 19: Promote Pedestrian, Bicyclist and Road User Safety**

51	Conduct Pedestrian and Bicyclist Stakeholder Outreach	CAV-X	1 Year	\$\$\$	MED			✓	✓	
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► **Strategy 20: Research CAV Technologies to Support Rail Crossings and Freight Network Safety**

52	Research and Pilot CAV Freight Technologies	CAV-X	1 Year	\$	LOW		✓		✓	✓
53	Monitor Research on CAV Technologies to Support Safety at Rail Grade Crossings	CAV-X	3-5 Years	\$\$	MED			✓		✓

FOCUS AREA 8: COMMUNICATIONS

► **Strategy 21: Promote Internal Awareness of CAV**

54	Create a CAV Email Newsletter	CAV-X	1 Year	\$	LOW			✓	✓	✓
55	Host CAV Brown Bag Discussions & Create CAV Ambassadors	CAV-X	1-3 Years	\$	MED			✓	✓	✓

► **Strategy 22: Public Engagement and Education**

56	Develop CAV Public Engagement and Communications Plan	CAV-X	1 Year	\$\$	MED			✓	✓	
57	Rebrand the CAV-X Website	CAV-X	1 Year	\$	LOW		✓		✓	
58	Conduct Public Demonstrations throughout Minnesota	CAV-X	1 Year	\$\$\$	HIGH		✓		✓	
59	Create and Implement a Survey to Gauge Public Opinion	CAV-X	1 Year	\$\$	MED			✓	✓	

MnDOT CAV Strategic Plan Focus Areas, Strategies and Recommendations	MnDOT Lead	Initiate	Capital	Staff Effort	Strategic Plan Themes			SOP Goals		
					Strategic Investment	Innovation	Knowledge Sharing	Customer Trust	Workforce Excellence	Operational Excellence

► **Strategy 23: Industry Outreach**

60	Conduct Regular Industry Outreach	CAV-X	1 Year	\$	LOW			✓		
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FOCUS AREA 9: LONG RANGE PLANNING

► **Strategy 24: Review Planning Measures, Assumptions and Methods**

61	Review Performance Measures to Address CAV	Planning	1-3 Years	\$	MED	✓		✓		✓
62	Evaluate Ways to Forecast CAV Trends	Planning	1-3 Years	\$\$	MED		✓			✓

► **Strategy 25: Incorporate CAV Considerations into MnDOT Plans**

63	Review Planning Strategies to Account for CAV	Planning	1-3 Years	\$	MED		✓	✓		✓
64	Review and Update MnDOT Plans to Account for CAV	Planning	1-3 Years	\$\$	MED		✓	✓		✓

► **Strategy 26: Provide CAV Resources and Support to Local, Regional and Tribal Governments**

65	Provide CAV Resources and Support to Local, Regional and Tribal Governments	Planning/State Aid	1-3 Years	\$	MED			✓	✓	✓
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