Intelligent Transportation Systems (ITS)

Statewide Plan

Final Report

October 2004

(Updated September 2005)

Prepared for:
North Dakota Department of Transportation

Prepared by:
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This report was prepared based on extensive input from the NDDOT ITS Core Group members as well as other ITS stakeholders in North Dakota. The contents of the report (inventory, findings, and recommendations) were written by a research team from the Advanced Traffic Analysis Center of the Upper Great Plains Transportation Institute at North Dakota State University which assisted the NDDOT in completing the plan.

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[1] Report updated in September of 2005 based on comments and recommendations from NDDOT management during the plan approval process. The primary change from the original document published in October 2004 was the modification of the relationship of the ITS plan to the STIP and removal of the STIP tables (originally Appendix A)

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EXECUTIVE SUMMARY

This Intelligent Transportation Systems (ITS) Plan is the product of a multi-year effort undertaken by the North Dakota Department of Transportation (NDDOT) to guide ITS deployment in North Dakota. The plan was developed through participation from various NDDOT sections. The NDDOT leadership provided support for the plan development and encouraged participation among staff.

Given the scale of the geographic area included in the plan, extensive work went into identifying existing systems, assessing needs, developing ITS projects, and suggesting locations for deployment. It should be noted that the main focus of the plan is on statewide projects in non-urban areas. The three metropolitan areas in the state already have developed metropolitan ITS Plans to meet their respective needs. Therefore, the statewide ITS Plan does not duplicate those efforts.

The pace of ITS deployment in North Dakota has picked up significantly over the last couple of years. Several reasons contributed to that growth, including a number of major construction projects, positive experiences with early ITS traveler information projects, an increased focus on customer service and the need to meet increased demands with limited staff.

As part of this ITS planning effort, an inventory of existing ITS and systems that support ITS was conducted. It is clear that the NDDOT has made tremendous progress in the areas of traveler information to improve mobility and enhance safety for travelers. North Dakota's 511 system has received considerable positive feedback from users and is often cited in the news media.

In describing these existing ITS technologies, it is important to point out that many of these technologies have largely been deployed in a fragmented manner. As needs and opportunities arose, field devices have been installed. However, there are only one or two applications that may truly be considered systems (where a system refers to an integrated set of technologies, functions, etc). Therefore, this ITS planning effort strives to address how existing and future technology deployment can be grown into well-integrated systems guided by the National ITS Architecture.

For the future, the NDDOT is looking at enhancing traveler information services to travelers by covering more areas and providing timely and accurate information through a variety of outlets. The NDDOT is also looking at automated systems that would detect problems because of extreme weather conditions and instantly remedy those conditions without operator intervention. More dynamic message signs at key locations will guide motorists and provide information to allow them to take action while en route to avoid dangerous conditions.

There are, of course, challenges and limitations. Perhaps the greatest challenge is to meet increasing ITS needs while maintaining funding for other programs. Given the state's relatively recent experience with ITS, there are significant limitations in supporting infrastructure, namely communications. Although advances in wireless communications are expanding the reach of ITS to rural areas, certain applications require more reliable and higher bandwidth communications.

NDDOT ITS Projects

#	Project Title	Deployment Horizon
1	Automated Treatment (Anti-icing) Systems	High Priority
2	Statewide ITS Communications Plan and Network	
3	Incident Reporting Information System	
4	Fleet Management for Maintenance/Construction Vehicles (Support MDSS)	
5	Road Weather Information Sensors (RWIS)	
6	Addition of Cameras to Existing RWIS	Medium Priority
7	Flood Detection/Warning Systems	
8	Freeway Surveillance/Monitoring	
9	High-Wind Warning Systems	
10	Over-height Detection Systems	
11	Non-Intrusive Traffic Data Collection System	
12	Permanent DMS	
14	Snow Plow Collision Avoidance System	
15	Weigh-in-Motion	
16	Automated Road Closure Gates	Low Priority
17	Kiosks	
18	Portable DMS	
19	Portable Traffic Management System	
20	Regional Transit Management and Security	

ITS Implementation Strategy

Recommendations for effective implementation of ITS Plan:

1. Increase staff resources available for ITS planning, design, and deployment
2. Create a NDDOT ITS Implementation Team
3. Reach-out to other agencies to join in implementing NDDOT ITS Plan
4. Participate in regional consortiums that could expand funding, allow for peer-to-peer exchange, and increase staff training in ITS

5. Develop an awareness campaign for elected officials and political appointments in the state to explain the role ITS play in improving transportation safety and mobility
6. Emphasize a systems approach to ITS deployment rather than fragmented deployment of technologies
7. Develop NDDOT ITS Design Manual
8. Integrate existing ITS with new systems and with legacy systems
9. Complete North Dakota's statewide ITS Architecture development
10. Develop a process for maintaining and updating NDDOT's ITS Architecture
11. Provide training on the NDDOT's ITS Architecture to staff
12. Coordinate ITS with STIP

1.0 STRATEGIC DOCUMENT

The purpose of this plan is to guide Intelligent Transportation Systems (ITS) deployment in North Dakota. During the last 10 years, ITS technologies have been successfully deployed across the nation to facilitate traffic operations, reduce traffic delays, improve safety and enhance the ability of transportation agencies to manage their transportation systems. However, the majority of ITS deployment has been limited to the largest metropolitan areas in the United States and other high traffic priority corridors.

ITS technologies refer to electronic sensing technologies that continuously monitor the system's operations, computer systems that process system performance data , electronic devices that can deliver critical information to travelers and communication networks that carry data flows between the field processing points. ITS, therefore, emphasizes system operations in an efficient and safe manner through integrated management of various components of the transportation system and its services.

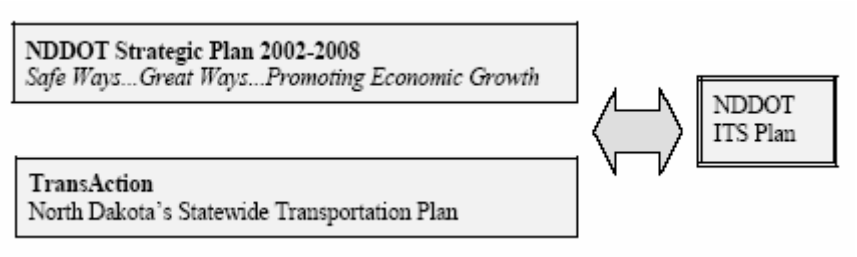
One of the key elements of successful deployment of ITS technologies is effective planning. Both federal and state agencies have recognized the need for a planned and strategic approach to ITS deployment. This approach recognizes the state's unique characteristics and enable it to develop a plan that accomplishes the greatest benefit from targeted ITS technologies as well as be embraced by various stakeholders. Further, this approach establishes a direct link between ITS planning and other transportation and strategic planning efforts. Ideally, the outcomes of ITS planning are activities (projects) incorporated and programmed into statewide, regional, and metropolitan transportation plans.

The purpose of this document is to describe the strategic direction for the ITS planning process, highlight the priority areas to the state, identify relevant trends and discuss possible roles and responsibilities of various stakeholders. A brief discussion of two related efforts recently undertaken by the NDDOT is also provided. First, the NDDOT’s Strategic Plan for 2002-2008 updated the 1997 plan and developed revised statements on the mission and goals for the department. The Strategic Plan was developed through participation from a wide segment of NDDOT staff. The second activity, TransAction, which represents the state’s long-range transportation plan, was developed with participation from a wide segment of public and private partners.

The development of North Dakota's ITS Plan recognizes the geographic and socio-economic characteristics of the state that impact North Dakota's transportation system and the deployment of ITS. It further recognizes emerging transportation and technology trends both nationally, regionally and in the state. The plan is developed through a coordinated effort that builds on input from internal NDDOT stakeholders, as well as other private and public stakeholders in the state. The NDDOT has a leadership role in ITS planning and deployment in the state and has the primarily role for coordinating the plan with other activities as well as other partners.

1.1. ITS Goals and Objectives

This section addresses the goals and objectives for ITS in North Dakota. The goals refer to ultimate outcomes that are coordinated with statewide goals of the transportation systems. The objectives represent specific deliverables from the ITS planning process.



1.1.1. ITS Goals

Setting goals for ITS follows the general areas outlined in the national ITS program. Those goal areas include:

1. Traveler safety
2. Traveler mobility
3. Transportation system efficiency
4. Productivity of transportation providers
5. Conservation of energy and protection of the environment

Although these goal areas would probably encompass many areas of interest for a state or region, they need to be refined to address specific needs. There may also be additional areas that may be appropriate to unique features of a state, region or project. Further, one of the keys to successful ITS planning and deployment is the integration of ITS with the transportation planning process. Therefore, ITS goals should be closely coordinated with transportation goals for the state as well.

Part of developing the NDDOT Statewide Transportation Plan, the following vision was adopted[1]:

> "*North Dakota's transportation system is an important part of regional, national and global systems, developed strategically to help grow and diversify the economy and enhance our quality of life*."

[1] TransAction: North Dakota's Statewide Transportation Plan, North Dakota Department of Transportation, Bismarck, North Dakota 2002

Related to this mission, the NDDOT identified five transportation goals:

1. Create a safe and secure transportation for residents, visitors and freight (ITS goal area 1 - safety)
2. Create a transportation system that allows optimum personal mobility (ITS goal area 2 - mobility)
3. Create a transportation system that allows the efficient and effective movement of freight (ITS goal area 3 - efficiency)
4. Create a transportation system that enhances economic diversity, growth and competitiveness (ITS goal area 4 - productivity)
5. Create funding sufficient to protect North Dakota's transportation investment and address future transportation needs

1.1.2. ITS Plan Objectives

The main objectives of the plan include the following:

1. Develop an ITS vision and strategic direction for North Dakota
2. Develop a framework for coordinating ITS activities with the mission and strategic direction of the NDDOT, other relevant agencies, as well as among various stakeholders
3. Identify high priority ITS projects (technologies to be deployed, location of deployment and plan for deployment)
4. Identify the needed organizational changes and required resources for meeting the ITS Plan objectives in the state
5. Coordinate ITS activities at the state level with local and regional ITS initiatives
6. Coordinate ITS activities in North Dakota with neighboring states as well as the national ITS program, ITS Architecture, and ITS standards
7. Raise the awareness of ITS in the state, including internal NDDOT as well as other stakeholders
8. Develop a process to continually share information both internally within the NDDOT as well as with external stakeholders to keep the plan up to date (ITS Core Group)

1.2. Guiding Principles

The development of the North Dakota ITS Plan embraces a need-based approach rather than a technology-based approach. Often a problem with new technologies is that the technology is selected before a clear need is identified. Given the limited funding sources, especially for a rural state such as North Dakota, which has low population density, large expenditures on ITS technologies may not be possible. Instead, ITS technologies targeted for deployment are identified through careful analysis of needs and an examination of potential benefits. Technologies and systems which address most critical needs and yield the maximum benefits are targeted for deployment. Further, future implementation will follow a phased schedule that would take advantage of planned construction activities at various locations in the state.

Another consideration for planning ITS is to recognize the changing needs and transportation system characteristics in different areas of the state. The largest urban areas, such as Bismarck,

Fargo and Grand Forks, continue to experience population and economic growth. These areas attract many rural residents for various economic, medical, social and cultural opportunities. They certainly experience a different set of transportation problems than in rural areas across the state. Traffic congestion and customer service expectations in the urban areas are among the top priorities. In contrast, the main priorities for rural residents may include safety and access to transportation services.

In North Dakota, for example, Fargo and Cass County experienced the largest growth in population among North Dakota cities and counties between 1990 and 2000 (See Figure 1.1). While the state's population remains almost the same, more people migrated from rural areas of the state to the urban centers. Further, the number of vehicle-miles traveled in North Dakota increased by 22.1% during the same period (Highway Statistics 1990, 2000). That may reflect the increased economic activity as well as the changing travel characteristics of the state residents as they travel longer distances to access socioeconomic opportunities. Therefore, the state's urban centers will also have a major role in any statewide ITS deployment since they affect a large segment of travelers. These centers also have a more suitable communications and information infrastructure which could support various ITS services and provide gateway services to statewide travelers.

Table 2.1 Population Trends for Selected North Dakota Cities and Counties (1990-2000)

Location	Population		Population Change	
	1990	2000	Change	Percent
Fargo	74,111	90,599	16,488	22.3%
Bismarck	49,256	55,532	6,276	12.7%
Grand Forks	49,425	49,321	(104)	-0.2%
Minot	34,544	36,567	2,023	5.9%
Burleigh County	60,131	69,416	9,285	15.4%
Cass County	102,874	123,138	20,264	19.7%
Grand Forks County	70,683	66,109	(4,574)	-6.5%
North Dakota	638,800	642,200	3,400	0.5%

North Dakota's ITS Plan recognizes the differences discussed above by addressing ITS in several contexts. The purpose of organizing ITS needs and projects into distinct groups is to facilitate priority identification, ensure residents from various segments are served and take advantage of various funding programs and opportunities. These contexts are discussed in detail in Section 1.4 of this document.

1.3. North Dakota Issues and Needs

A kickoff meeting for potential ITS stakeholders in North Dakota was held in the spring of 2000. The meeting was held in conjunction with another ITS meeting that focused on commercial vehicle operations (CVO). The purpose of the ITS Plan meeting was to establish a framework to guide the development of the ITS Plan and create a mechanism for continuing input from stakeholders. However, there was some reluctance among several participants about participation in the ITS planning effort and their potential involvement. That may have been attributed to the lack of familiarity among some participants about ITS and an underestimation of its impacts on their organizations. During the last two years, there have been several developments that contributed to a changed environment- an environment which realizes the benefits of ITS and encourages innovative solutions to some of the state's transportation problems. There also has been a growing emphasis on customer service through a more pronounced and elaborate effort led by the NDDOT. NDDOT participation has been continued and has contributed to developing the main ITS concepts as well as some initial ITS projects across the state.

1.3.1. Stakeholders Input Mechanism

Although the initial stakeholder meeting didn't accomplish all of its goals, it did succeed in identifying some of the underlying issues that impact ITS in North Dakota. Figure 1.2 shows a list of stakeholders who participated in the kickoff meeting.

Table 2.2 ITS Stakeholders Participating in the ITS Plan Kickoff Meeting	
NDDOT Office of Operations	Gary Berreth, Ed Ryen
NDDOT Project Development	Francis Ziegler
NDDOT Planning and Programming (Traffic)	Al Covlin, Jane Wetsch
NDDOT Bismarck District	Kevin Levi
NDDOT Fargo District	Kevin Gorder
NDDOT Information Technology	Ron Richter
NDDOT Motor Vehicles	Frank Laqua
FHWA North Dakota Division	Mike Bowen, Steve Busek
ND Highway Patrol	Doyle Schulz
ND Information Technology Division	Curtis Wolfe
ND Emergency Management	Susan Reinertson, Pat Scott
UND ATWIS (and Meridian #SAFE)	Leon Osborne, Kathy Osborne, Mark Owens
Fargo-Moorhead Council of Governments	Brian Shorten

Stakeholders were asked to react to a list of possible issues as they relate to their own agency/organization objectives and priorities. Further, breakout sessions of smaller groups focused on more specific ITS issues, such as information needs, urban needs, safety, etc. Follow up interviews were setup with key stakeholders to further develop an understanding of the functions and priorities of their agencies as well as possible involvement in ITS. A summary of issues gathered from these activities is provided below.

1.3.2. Common Issues

Input from steering committee and interviews completed with NDDOT units and other stakeholders suggest several issues could have an impact on ITS implementation. These issues were organized under main areas as follows:

1. Socio-economic/geographic
    a. Funding
    b. Weather
    c. Freight flows through state/across international border
    d. Service economy becoming more prominent
    e. Tourism points of interest
    f. Low population density and long distances between population centers (services)
    g. Population shift to cities
    h. Limited choice of transportation sources
    i. Aging rural population

2. Institutional/organizational
    a. Leadership and a long range vision
    b. Coordinated information sharing among agencies
    c. Lack of communication between and within agencies
    d. Coordination among various stakeholders in the state
    e. Coordination with and among adjoining states and provinces
    f. Involvement of private sector in strategic planning
    g. Level of awareness of individual system capabilities (public and private)
    h. Customer service – whose responsibility, how much, and how to measure?

3. Physical transportation infrastructure
    a. Aging infrastructure
    b. Rebuilding or repairing transportation infrastructure after natural disasters (i.e. flooding)
    c. Impacts of weather extremes on local, state, and Interstate system
    d. Damage to rural roads due to spring flooding

4. Information/data infrastructure
    a. Integration of existing data systems
    b. IT resources to support ITS
    c. Communication infrastructure

d. Exchange of agency information across networks
e. Data availability to support decisions and services
f. Limited infrastructure (i.e., RWIS)

5. Transportation system operations/services
   a. Winter operations
   b. Road closures due to weather or incidents
   c. Road/travel advisories and condition reports
   d. Urban traffic congestions (especially event traffic)
   e. Construction activities
   f. Load/weight restrictions
   g. Increase in commercial truck traffic, especially higher concentration due to large agricultural processing plants

1.4. Contexts for ITS Deployment

The purpose of this section is to explore the possible contexts for ITS deployment. Although the statewide ITS Plan will focus on activities that have statewide significance, it is important to identify possible relationships (and interfaces) with regional and local ITS initiatives. Three general groups are used to classify ITS deployment: area type, customer group and function. These groups are not meant to be exclusive, but rather to provide different frameworks for appreciating ITS planning.

1.4.1. Area Type

Relative to location or area type, ITS needs and potential projects may be segmented into three different area types. It should be noted that there will be interface points that would connect ITS elements among the various areas. Also, information will be shared across all area types for specific events when warranted. The responsibility of deploying and operating ITS services will depend on the area type, but will require close coordination among various public/private transportation, law enforcement, emergency and medical services and other entities. Further, the NDDOT initially has the leadership role in coordinating these activities and ensuring their consistency with the state's strategic direction and priorities.

1.4.1.1. Statewide

This group includes issues, needs, and projects that have statewide significance. ITS deployment in this context serves a large segment of transportation system users including state residents as well as travelers from other states. A good way to illustrate this is to use traveler information as an example. Although traveler information systems have been deployed for cities, corridors, regions, and states, each application focuses on varying degrees of information details. For a statewide application, some of the potential information may include: weather (warnings for a large area and expected path), road conditions on major routes for a 50-mile segment, road work (location and activity) and major incidents (such as road closures due to incidents or weather).

For a rural state, statewide projects must recognize the sparse communication infrastructure and the limited access points for various users and develop innovative ways to enhance resource utilization, especially through coordination and partnerships with relevant stakeholders. The most critical issue is the information infrastructure (telecommunications).

1.4.1.2. Urban

ITS may be introduced in an urban context, focusing on urban transportation needs such as traffic congestion and personal mobility. In an urban setting, communication infrastructure may be more available and can reach a large number of users without requiring significant additional investments. It is also important to recognize that users in an urban environment tend to have higher levels of service expectations. For instance, ITS may be required to provide more detailed information, updated more frequently, than in statewide rural applications. Urban issues emphasize short-term traffic operations such as traffic signal control, incident management, transit operations, and special events traffic.

1.4.1.3. Locations of special interest

This group includes points of interest (both activity or transportation infrastructure) that receive special attention in ITS deployment. Although some of these locations may be part of corridor or regional plans, it is important to identify their specific needs and possible interfaces with adjacent systems or the statewide system. Some examples of these locations include: tourist attractions, high-priority security (i.e., military bases, key civil installations) and border crossings.

Examples of transportation infrastructure with additional points of interest include bridges that may be targeted for automated anti-icing systems, locations for high-speed warnings and locations of Weigh-in-Motion (WIM) equipment.

Figure 1 shows the traveler information example for various area types and some of the differences anticipated in the required infrastructure as well as the range of services. Notice the different levels of required ITS infrastructure as well as the level of details required for the three sample applications.

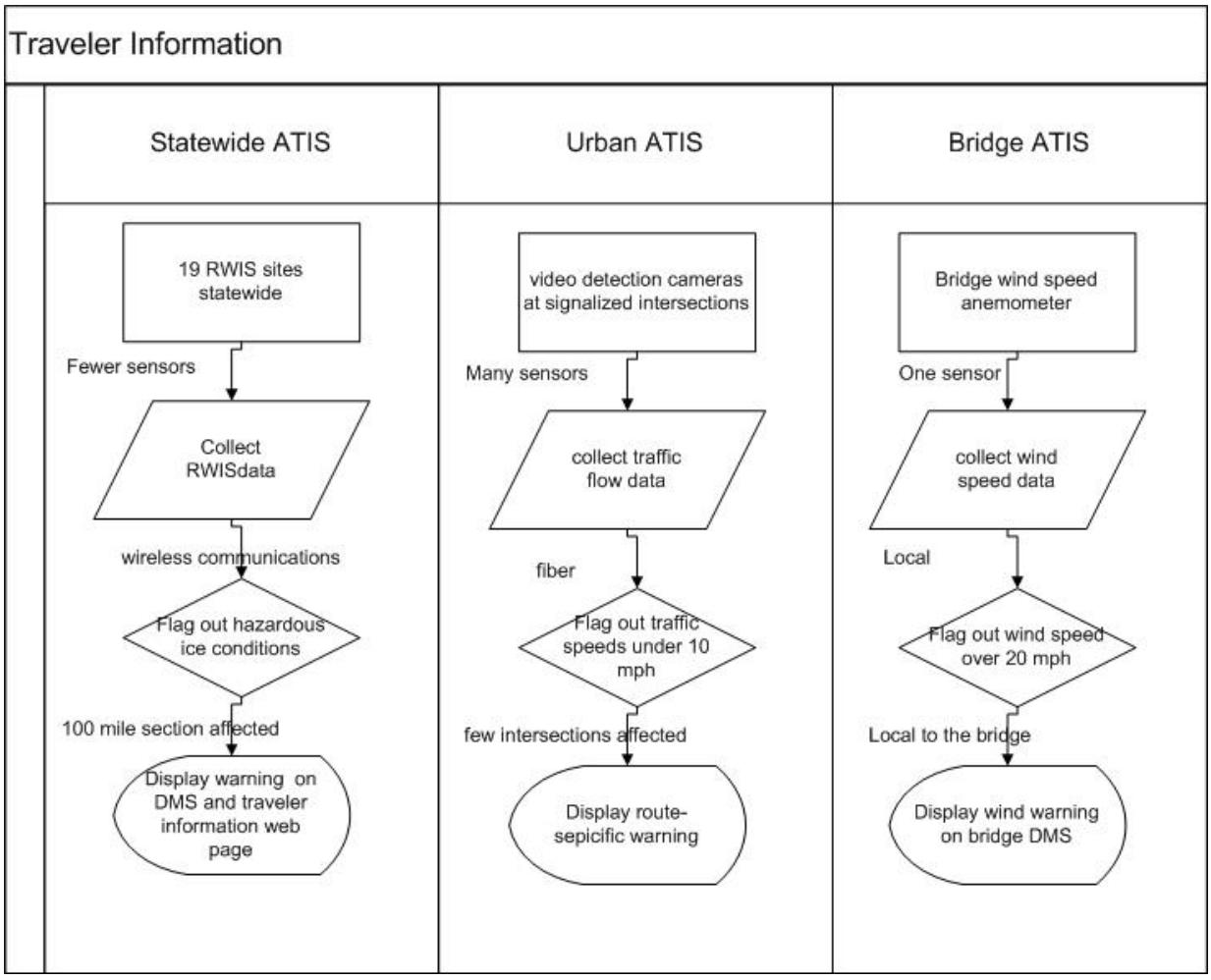


Figure 1 Traveler Information Example

1.4.2. Customer Groups

As mentioned earlier, the main focus of ITS is on improving the operations of existing transportation infrastructure through better information. As a result, ITS is often described using *user services* which correspond to functions that directly support a particular user group. Therefore, it is paramount that the ITS planning process understands and recognizes the distinct needs relevant to several customer groups. This delineation will also assist in identifying system design needs as well as interface requirements. Three main groups encompass potential users of ITS in North Dakota and include: NDDOT internal users, other public agencies and private users (motorists, firms or organizations). Below is a summary of individual users for each group.

1. NDDOT
    a. Management
        i. Legal
    b. Operations
        i. Maintenance and Engineering Services
        ii. Construction Services
    c. Transportation Programs
        i. Planning and Programming
        ii. Local Government
        iii. Traffic Operations
    d. Information Technology
    e. Project Development
        i. Design
        ii. Bridge
        iii. Materials and Research
    f. Driver and Vehicle Services
    g. NDDOT Districts
2. Other agencies
    a. ND Highway Patrol
        i. Motor Carrier
        ii. Traffic Safety
        iii. NDHP Districts
    b. Emergency Management
    c. Information Technology Department
    d. Radio Communications
    e. North Dakota GIS
    f. Tourism
    g. North Dakota cities

3. Private
    a. Interstate motorists
    b. Local drivers (urban)
    c. Commercial vehicle drivers
    d. Farmers
    e. Transit operators
    f. School buses

1.5. Challenges/Opportunities

The main focus of the ITS Plan is how to take advantage of limited resources in order to implement ITS services that yield the maximum benefit to the state. Given the uncertainty of transportation funding, there must be a concentrated effort to take advantage of all funding opportunities and strategies. Furthermore, funding for ITS is often an institutional issue that could be alleviated through effective marketing of key ITS services among both decision makers and the public.

1.5.1. Key Challenges

1. Enhance public awareness of ITS given other pressing and more visible needs across the state such as infrastructure improvements and maintenance.
    a. ITS can enhance customer service with existing physical infrastructure
2. Building a consensus of what ITS means for North Dakota. Critical priorities for the state as identified by NDDOT leadership include:
    a. Systems that provide effective and timely information to users
    b. Systems that enhance how the infrastructure is managed and operated
3. Taking advantage of all funding opportunities, including:
    a. Integration of ITS deployment with other transportation projects
    b. Seeking special federal funding through demonstration projects
    c. Working with local jurisdictions deploying ITS (i.e., Bismarck, Fargo and Grand Forks
    d. Working with regional groups and other states on corridor projects
4. Integrating ITS into the NDDOT business, including various decision points and functional areas
    a. The recently completed NDDOT's Business Plan and Trans Action Statewide Transportation Plan offer some key guidance on how ITS complements other initiatives

1.5.2. Current and Emerging Opportunities

1. The state is experiencing a significant level of construction activity
    a. ITS infrastructure may be included as part of some of these projects when it meets the state needs
2. Increased focus on traffic operations in urban areas, especially the three largest cities of Bismarck, Fargo and Grand Forks.
    a. ITS focuses on enhancing operations
        i. There is likely to be more support from decision makers and public for ITS deployment
    b. ITS deployment in key urban areas could lead to more exposure to users statewide
        i. Success stories in both urban and rural environments will increase support
3. Wealth of information from other states can be used in developing North Dakota's ITS
4. Technology is getting cheaper and more reliable
5. Communication infrastructure, especially in rural areas of the state, is improving
    a. There will be increased support for ITS deployment in rural areas

1.6. Key Success Factors

Below is a summary of some of the key requirements for successful ITS planning and development. These factors are directly related to goals and objective identified earlier in the strategic document.

1. Effective management of
   a. Resources
   b. Relationships
      i. Internal among sections (organizational)
      ii. External with other entities
         (1) Other state agencies, such as NDHP
         (2) Local transportation agencies
            (a) Transit Providers
         (3) Federal agencies
         (4) Other states
         (5) Private sector
            (a) Telecommunications companies
            (b) Internet service providers
            (c) Travel planning services
            (d) Technology/equipment vendors
            (e) Major Employers
   c. Expectations
      i. Internal stakeholders
      ii. External stakeholders

2. Performance measurement
   a. Non-traditional MOE
      i. Users reached with services
         (1) level of service offered
      ii. Road miles covered
      iii. Type and number of services offered
      iv. Customer satisfaction
         (1) How do customers view services offered
         (2) What influences customers' perception of quality of services
         (3) How do customers support NDDOT initiative
   b. Traditional Measures of Effectiveness (MOE)
      i. Time saved
         (1) Annual
         (2) Per incident
         (3) Per corridor
         (4) Per user group (i.e., trucking)
      ii. Safety
         (1) Improvement in response time

(2) Long-term trend in crash reduction

3. Marketing
   a. Address shortcomings identified from performance measurement to influence customer expectations
   b. Devise mechanisms for periodically gauging customer satisfaction
      i. Public
      ii. Users of particular services (i.e., road/weather information)
      iii. Policy makers

These issues may be addressed by coordination with current NDDOT initiatives such as improving public information efforts and assessing customer satisfaction. It is important to effectively utilize available resources through coordination. It is important for this process to be proactive, i.e., positively influence customer perceptions rather than simply measuring them. The South Dakota DOT conducted a customer satisfaction assessment in 1999 that revealed some interesting findings1. The study found that customers' overall satisfaction with SDDOT services were not related to their perceptions of driving conditions. What influenced customer satisfaction most was information access factors. These factors included: ease of obtaining information from proper sources; information on current SDDOT plans of highway construction and maintenance; and information on delays and alternate routes. Customers who felt they had adequate access to this information had a higher rating of service (and a more positive opinion of SDDOT).

1.7. Organization

The accompanying sections, provide more specific information about the progress of ITS planning in North Dakota as well as some of the supporting documentation. Following is an outline of the material contained in this report:

1. Strategic Document: summarizes the approach and key elements of the ITS Plan
2. ITS Stakeholders: identifies various agencies and entities with relevant role in ITS planning, deployment, and operations
3. Needs Assessment: summarizes state transportation needs relevant to ITS
4. ITS Primer: provides a primer on ITS, major services, technologies and requirements
5. ITS Architecture: provides a brief overview of the ITS Architecture and illustrates how the architecture may be used to identify interfaces, develop functionality requirements and assist in project planning
6. Existing ITS in North Dakota: briefly identifies existing ITS systems or technologies deployed across the state
7. Priority ITS Services: describes ITS services appropriate for the state's needs

1 David Bender and John Schamber, SDDOT *1999 Customer Satisfaction Assessment*, Final Report, SD98-17-F, February 2000.

8. Priority Deployment Areas/Corridors: provides a criterion for selecting ITS projects as well as an initial set of early candidate locations
9. Priority ITS Projects: outlines selected ITS projects
10. ITS Implementation Strategy: discusses possible deployment strategies, coordination of ITS projects with STIP, and recommendations for successful implementation.
11. Appendix A: provides a list of acronyms used in the plan.

2.0 ITS STAKEHOLDERS

This section identifies potential stakeholders relevant to ITS in North Dakota as well as their role in various stages of ITS planning, deployment, and operations. These stakeholders include internal NDDOT sections as well as other agencies and private entities. A brief discussion of possible roles for each stakeholder is provided in the summary below.

1. NDDOT
    a. *Administrative/Management*:
        i. Provide guidance
        ii. Facilitate integration of ITS with DOT strategic plans
        iii. Set the priorities
        iv. Establish relationships with other stakeholders and jurisdictions
        v. Allocate resources
            (1) Director
            (2) Deputy Director for Business Support
            (3) Deputy Director for Engineering
            (4) Deputy Director for Driver and Vehicle Services
            (5) Legal

    b. *Office of Operations*
        i. Coordinate ITS activities within the NDDOT
        ii. Oversee ITS planning
        iii. Coordinate ITS project development
        iv. Coordinate ITS project architecture and ITS standards
        v. Collect, process, and disseminate road and weather information
            (1) Maintenance and Engineering Services
            (2) Construction Services

    c. *Office of Transportation Programs*
        i. Coordinate funding for ITS activities with the statewide transportation plan
            (1) Planning and Programming
            (2) Local Governments
                (a) coordinate ITS with North Dakota cities and planning organizations
            (3) Transit
            (4) Traffic Operations
                (a) coordinate ITS applications in traffic control and management

    d. *Office of Project Development*
        i. Incorporate ITS in project designs where appropriate
            (1) Design
            (2) Bridge
            (3) Materials and Research

e. Information Technology
    i. Support ITS infrastructure needs including communication, data processing, electronic sensing, and support for these systems
    ii. Ensure compatibility of ITS with other technology systems
    iii. Assist in integrating legacy systems

f. Districts
    i. Coordinate ITS activities in the districts with statewide efforts as well as support statewide information and ITS infrastructure needs
    ii. Assist in operating ITS in their districts
    iii. Coordinate ITS in their districts with cities/MPOs
        (1) Bismarck
        (2) Valley City
        (3) Devils Lake
        (4) Minot
        (5) Dickinson
        (6) Grand Forks
        (7) Williston
        (8) Fargo

g. Driver and Vehicle Services
    i. ITS/CVO
    ii. Shared ITS infrastructure
    iii. E-commerce to enhance customer service
    iv. Information outlets

2. North Dakota Highway Patrol
    a. General
        i. Shared ITS infrastructure
        ii. Information collection (incidents/road conditions)
        iii. Assist in operating ITS
    b. Motor Carriers
        i. ITS/CVO
    c. Safety/security
        i. Amber Alert
        ii. Road closure

3. Counties
    a. Public Works/Maintenance
    b. Law enforcement
4. Urban areas
    a. Cities
        i. Implement ITS in urban area
        ii. Coordinate with statewide ITS
        iii. Assist in operating ITS
        iv. Provide operational information

(1) Bismarck
(2) Fargo
(3) Grand Forks

b. MPOs (Bismarck-Mandan, Fargo-Moorhead, and Grand Forks-East Grand Forks)
   i. Coordinate regional ITS plans
   ii. Assist in integrating ITS in transportation improvement plans (TIP)

5. Emergency Management
   i. Assist in incident management
   ii. Disasters/evacuation plans

6. State Radio
   a. Coordinate communication needs/projects

7. Tourism
   i. Provide service information
   ii. Share ITS infrastructure

8. Private organizations
   a. Universities
      i. Provide support and technical assistance
      ii. Provide training
      iii. Assist in performance measurement
      iv. Assist in ITS architecture and design
         (1) NDSU
         (2) UND
   b. American Automobile Association (AAA)
      i. Assist in marketing ITS
      ii. Shared infrastructure for information dissemination
   c. ND Motor Carrier Association (NDMCA)
      i. Assist in marketing ITS to trucking companies and commercial vehicle
   d. Communications (Cable, telephone, cellular)
      i. Support ITS operations
      ii. Shared infrastructure
   e. Local media
      i. Radio
      ii. Television
      iii. Cable (public access channels)

   f. Internet service providers
   g. Technology vendors
   h. Weather
      i. Process weather information and provide forecasts
      ii. Operate 511
         (1) Meridian Environmental Technology

3.0 NEEDS ASSESSMENT

The purpose of this section is to outline the general needs that will be addressed in the ITS planning process. These needs will guide the development of ITS strategies that will enhance safety, operational efficiency and effective management of the transportation system. The process of needs assessment is conducted in phases, starting with initial stakeholder reactions, then carried through by the newly formed ITS Core Group that will have the primary responsibility of developing specific ITS projects to address various needs.

The following discussion addresses transportation service needs most relevant to ITS and classify them into four main categories: enhancing safety, enhancing operations, enhancing information for effective management and improving customer satisfaction.

3.1. Safety

North Dakota has an excellent transportation safety record. Discussions with various transportation and law enforcement agencies indicate there is no obvious area that experiences a significantly high number of crashes. However, there are some interesting trends that could be impacted by ITS deployment. Effective information through ITS may improve safety and address some of these issues.

The NDDOT's Drivers License and Traffic Safety Division has a well-developed process for highway safety performance measurement. The division produces an annual report on crash data as well as the North Dakota Highway Safety Plan which identifies planned, non-infrastructure safety activities and desired outcomes.

An analysis of 2002 vehicle crash data indicates that the crash experience in North Dakota continues to fall below national averages. The data from 2002 suggests the following trends[1]:

1. 16,114 traffic crashes occurred in North Dakota
    a. 97 persons were killed in 84 traffic crashes
        i. 56% of the fatal crashes occurred during daylight hours
        ii. 76% of the fatal crashes occurred on dry surface with clear/cloudy weather conditions
        iii. 12% of fatal crashes occurred in urban areas
        iv. 88% of fatal crashes occurred in rural areas
    b. 4,886 persons were injured in traffic crashes
2. Based on the 84 fatal crashes (see Figure 3.1)
    a. Alcohol was a factor in 37
    b. Speed was a factor in 27
    c. Weather was a factor in 8

[1] Drivers License and Traffic Safety Division, *North Dakota Vehicle Crash Facts for 2001*, North Dakota Department of Transportation, Bismarck, North Dakota, April 2002

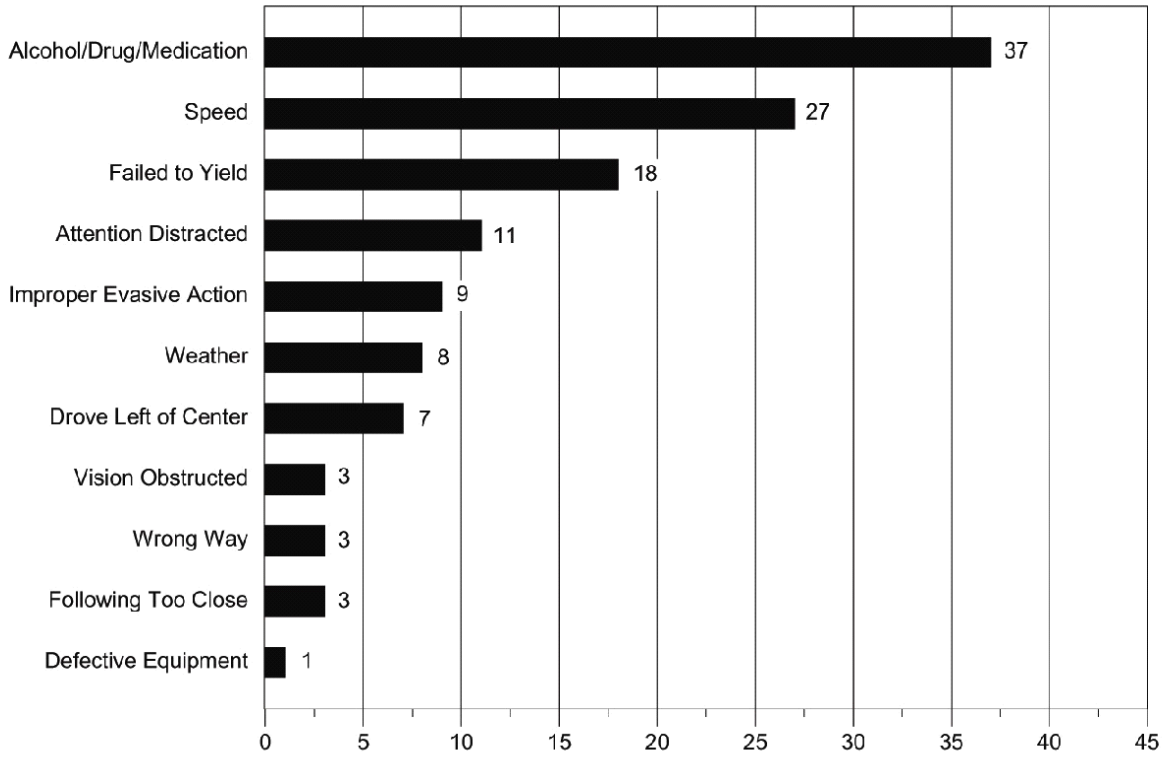


Figure 1 Fatal Crash Contributing Factors (source: ND Vehicle Crash Facts for 2002)

It should be noted that several factors usually contribute to a crash, therefore it is difficult to isolate a single factor. An additional area that is of importance is crashes in work zones. Law enforcement crash reports do not identify work zones as being present or not. However, there has been recent concern about effects of crashes in work zones in busy urban areas, particularly as they relate to congestion and secondary impacts.

Finally, many believe that crash severity in rural areas, which tends to be higher than urban crashes due to higher speeds, is further exaggerated by the longer response time of emergency and medical services (EMS). In fact, improving EMS response time in rural areas is one of the goals for the national ITS rural program. Data from NDDOT's Drivers License and Traffic Safety Division suggest the EMS response time is a critical issue in North Dakota. Review of reported response times based on 1999 data suggests that the median time from the moment a call is received until arrival of an EMS team at the site is about 7 minutes. However, that number varies significantly and reaches a 95th percentile value of 31 minutes.

Several ITS technologies have been developed to combine vehicle locations and notification systems to alert EMS services about crashes. Although these developments have been largely in the private sector (i.e., automobile manufacturers), public agencies need to be aware of these systems. Further, having an adequate telecommunications infrastructure is paramount to incident detection and response. For example, increased wireless telephone service in rural areas will improve EMS response.

3.2. Traffic Operations

North Dakota's transportation system provides adequate service to its users. Except for the busiest urban areas, traffic congestion is not an issue on North Dakota roads during normal conditions. However, the performance of the system can quickly change with changing weather conditions, especially during inclement winter weather. Accurate and timely information, as well as effective information access, are critical to improving winter operations and reducing potential safety risks to motorists. Another way to improve road operating conditions during inclement weather is by using automated systems for controlling ice in trouble spots (ie., bridges known to have an ice problem). Use of such systems would reduce the staff resources required to implement ice control strategies at the sites and improve service to motorists because of significantly reduced response time.

System operations during natural disasters (i.e., flooding) is another area that could benefit from ITS. In recent years, North Dakota has experienced severe flooding problems during the spring in the eastern part of the state, as well as longer lasting flooding in the Devils Lake area. These problems cause severe interruptions to the state's transportation system and require careful management. There is a need to provide accurate information about affected areas, alternative routes and other precautionary information depending on the event. This is especially important for commercial trucks as they could experience significant additional operating costs due to unexpected delays and detours.

There also has been an increase in traffic levels in urban areas which produces periods with high level of traffic congestion when combined with road work activities (i.e., Fargo, Bismarck, Grand Forks). Although this concerns local residents, it also impacts commuters who rely on these roadways for employment. In addition, visitors who seek these urban centers for various socioeconomic activity are also affected.

Finally, special user groups such as commercial trucking, fleet operators, and transit operators have distinct needs relating to targeted information and enhancement of the commercial vehicle administrative process. The North Dakota ITS-CVO Business Plan addressed many of the trucking needs and identified several projects related to improvement of registration and permitting systems, enhancement of commercial vehicle enforcement, and improvement of information to commercial drivers (i.e., load restrictions). However, transit operator informational needs should be addressed in this plan since the services they provide to rural residents could directly be impacted by operational problems and other restrictions.

3.3. Information for System Management

Effective system management is supported by accurate and timely information about the performance of its components, including the physical infrastructure (roads and bridges) and mobile assets (maintenance fleets, emergency response vehicles, and transit vehicles)

3.3.1 Infrastructure

This category of information includes infrastructure condition and any restrictions that may be placed on the system. Restrictions may include construction/maintenance work, environmental (weather) conditions, temporary incidents, and seasonal limitations (weight restriction). The information should also include the level of use of the system (i.e., traffic levels). This information is used in a variety of ways to help manage system operations, address problem areas, and aid in planning efforts.

It should be noted that data collection can be a resource-intensive activity and may often be cut when budgets are reduced. That is even more serious in a rural state where traffic densities may not always justify data collection devices that would support performance measurements of systems operations (i.e., system speeds for various segments). There is, however, great potential in improving this information through ITS technologies. Systems that monitor the weather conditions may be supplemented to include traffic detection sensors which would also collect traffic operational data. The key is integration and coordination of various functions to yield the maximum benefit.

3.3.2 Mobile Assets (Fleets)

Another important area that benefits from better information is related to mobile assets (or fleets). State, county, and local transportation agencies operate several types of vehicles fleets for supporting road maintenance, snow removal, and ice control. Similarly, transit systems must manage their fleets in order to meet service demands. Emergency response agencies must also manage their vehicles to optimize incident response with limited resources. Therefore, accurate and timely information about vehicle location and status is key to supporting effective management. The system users also benefit from this information by having accurate information about the system performance which allows them to make informed decisions.

3.4. Customer Satisfaction

The NDDOT is embarking on several strategic initiatives aimed at measuring and improving customer satisfaction. Although there are many factors that influence customer satisfaction, providing users with accurate and timely information is most critical. When motorists are presented with changes in driving conditions they are often more accepting of these changes if they are provided with information about them. The key is to develop information systems that provide adequate information and can be easily accessed by a wide segment of users. User information needs may be classified into two types:

1. Pre-trip information
    a. Road and weather conditions
    b. Warnings of adverse conditions
        i. Weather related closures or delays
        ii. Delays resulting from severe crashes
    c. Advisories of possible adverse conditions
        i. Road work and maintenance activities
    ii. Traffic at special events that could affect normal operations

2. En route information
    a. Information on changing road and weather conditions
    b. Information on incidents
    c. Information on traffic delays
    d. Information on alternative routes

4.0 ITS PRIMER

The purpose of this section is to provide a summary of ITS technologies and explain various classification schemes used in the national program. The section will also illustrate the relationships of various services and how they use the intelligent transportation infrastructure. Finally, the section provides links to some of the available resources of additional information about ITS that can be used to supplement information provided here.

4.1. ITS Defined

Intelligent Transportation Systems (ITS) in the most general terms are the integrated applications of advanced sensor, computer, electronics and communication technologies and management strategies to provide information to travelers and increase the safety and efficiency of the surface transportation system. It is often said that the "I" in ITS is for information. Another concept related to ITS is management strategies. These strategies directly influence operations of the transportation system and hence are more user-oriented than traditional infrastructure improvement strategies.

ITS is not only about new technology, but also how technologies are used to develop effective information that is integrated to enhance operations. Integration of ITS services with each other, as well as other systems, is key to seamless and effective operations.

4.2. National ITS Program

The development of the national ITS program may be traced back to the early 1990s. Several national program plans have been developed, each typically valid for a five-year period, with the Year 2000 Program Plan being the most recent plan. The national program may be thought of in two distinct components. First, the ITS Infrastructure addresses required systems to support ITS deployment at local, regional, and national levels. The second is the intelligent vehicle initiative which addresses advances of on-board vehicle navigation, communication and control systems. As it stands today, the national ITS program may be described by the following outline of the four main program areas[1].

4.2.1. Metropolitan ITS Infrastructure Program Area

The metropolitan component of the National ITS Program is focused on meeting the goals for integrated deployment of ITS including advanced traffic management, traveler information, and public transit systems in the largest metropolitan areas in the United States. Under this effort, which was known as "Operation TimeSaver," the United States Department of Transportation's (U.S. DOT) objective is to facilitate integrated deployment of basic ITS services in 78 metropolitan areas by 2006. At present, 61 sites are considered to have medium to high levels of

[1] ITS Joint Program Office, *National ITS Program Plan: Five Year Horizon,* U.S. DOT, August 2000

deployment and integration and additional sites show the clear beginnings of integrated systems. This program could potentially grow to include 340 major metropolitan areas nationwide that could benefit from advanced technologies. North Dakota's Bismarck, Fargo, and Grand Forks areas would potentially be part of that effort.

4.2.2. Rural and Statewide ITS Infrastructure Program Area

ITS deployment in rural areas has not progressed as quickly as in metropolitan areas. That is due largely to perceived needs in rural areas, availability of infrastructure and lack of a dedicated federal funding program. Additionally, rural and statewide ITS applications are not yet as well defined as metropolitan and commercial vehicle applications.

The majority of rural ITS focuses on information technologies applied to help improve the safety and mobility of rural travelers. Recent advances in 511 as the national transportation information source for travelers across the United States have resulted in great enhancements that may encourage additional deployment.

The rural ITS infrastructure may be described using the following components:

1. Crash Prevention and Security
    a. Surveillance/monitoring
        i. Roadway onditions
        ii. Environmental
        iii. Rail intersections
        iv. Vehicle intrusion
    b. Information dissemination

2. Emergency Services
    a. Detection
        i. Call centers
            (1) E911
            (2) Mayday
            (3) Call boxes
        ii. Surveillance
            (1) Loop detectors
            (2) Closed circuit television
    b. Mobilization & response
        i. Vehicle tracking
        ii. Coordination
            (1) Interagency
    c. Information dissemination
        i. Dynamic Message Signs (DMS)
        ii. Highway Advisory Radio (HAR)

3. Travel and Tourism
    a. Traveler information
        i. Travel services
            (1) Hotels, restaurants
            (2) Tourist information
        ii. Route advisory
            (1) Pre-trip
            (2) En route
        iii. Travel conditions
    b. Revenue collection
        i. Electronic payment

4. Traffic Management
    a. Surveillance
        i. Traffic conditions
        ii. Road conditions
        iii. Weather conditions
    b. Traffic control
        i. Lane control
            (1) Speed limits
            (2) Lane use
        ii. Work zone
        iii. Signals
    c. Information dissemination
        i. Dynamic Message Signs (DMS)
        ii. Highway Advisory Radio (HAR)

5. Transit Mobility
    a. Transit management
        i. Operations
        ii. Maintenance
        iii. Planning
    b. Traveler information
    c. Electronic payment
    d. Ride sharing and matching

6. Operations and Maintenance
    a. Fleet management
        i. Automated vehicle location
        ii. Computer aided dispatch
    b. Infrastructure management
    c. Weather maintenance
    d. Work zone management
    e. Information dissemination

7. Road Weather Management
    a. Surveillance & monitoring
        i. Traffic conditions
        ii. Road surface conditions
        iii. Weather conditions
    b. Control
        i. Speed limit
        ii. Signals
        iii. Lane use
    c. Response & treatment
        i. Winter maintenance
            (1) Mobile
            (2) Fixed
        ii. Automated Vehicle Location (AVL)
        iii. Interagency coordination
    d. Information dissemination

4.2.3. Commercial Vehicle ITS Infrastructure Program Area

The commercial vehicle ITS infrastructure program focuses on increasing safety for commercial drivers and vehicles while improving operating efficiency for government agencies and motor carriers. The main effort in this program is the deployment of Commercial Vehicle Information Systems and Networks (CVISN), which link existing information systems thereby enabling the electronic exchange of information. North Dakota has been working to achieve Phase-1 of CVISN implementation by developing the ITS/CVO Business Plan (2001), undergoing training and linking systems.

4.2.4. The Intelligent Vehicle Initiative (IVI) Program Area

The focus of this program area is to develop crash avoidance, in-vehicle information systems, and automated highway systems pointed to new safety approaches and promising solutions that could significantly reduce motor vehicle crashes. These integrated technologies can be linked to in-vehicle driver displays that adhere to human factor requirements. The IVI is focused on working with industry to advance the commercial availability of intelligent vehicle technologies and ensuring the safety of these systems within vehicles.

4.3. ITS User Services

ITS user services are defined, not along lines of common technologies, but rather by how they meet the safety, mobility, comfort and other needs of transportation users and providers. They represent essential, but not exclusive, ITS products and services. These services are often grouped into related functions called “bundles.” Below is a discussion of the major ITS user service bundles and the specific user services they cover:

1. Travel and Traffic Management

1.1 Pre-trip Travel Information
1.2 En route Driver Information
1.3 Route Guidance
1.4 Ride Matching and Reservation
1.5 Traveler Services Information
1.6 Traffic Control
1.7 Incident Management
1.8 Travel Demand Management
1.9 Emissions Testing and Mitigation
1.10 Highway Rail Intersection

2. Public Transportation Management

2.1 Public Transportation Management
2.2 En-route Transit Information
2.3 Personalized Public Transit
2.4 Public Travel Security

3. Electronic Payment

3.1 Electronic Payment Services

4. Commercial Vehicle Operations

4.1 Commercial Vehicle Electronic Clearance
4.2 Automated Roadside Safety Inspection
4.3 On-board Safety Monitoring
4.4 Commercial Vehicle Administrative Processes
4.5 Hazardous Material Incident Response
4.6 Commercial Fleet Management

5. Emergency Management

5.1 Emergency Notification and Personal Security
5.2 Emergency Vehicle Management

6. Advanced Vehicle Safety Systems

6.1 Longitudinal Collision Avoidance
6.2 Lateral Collision Avoidance
6.3 Intersection Collision Avoidance
6.4 Vision Enhancement for Crash Avoidance
6.5 Safety Readiness
6.6 Pre-Crash Restraint Deployment
6.7 Automated Vehicle Operation

7. Information Management

7.1 Archived Data Function

8. Maintenance and Construction Management

8.1 Maintenance and Construction Operations

5.0 ITS ARCHITECTURE

This section provides an overview of the ITS Architecture and provides insights on it's use to develop ITS plans and project designs. The main motivation to the ITS architecture is to ensure interoperability of deployed ITS systems across jurisdictional lines. The ITS architecture contains a comprehensive database of functional requirements, process descriptions, data flows, interfaces and other relevant information for various ITS services.

5.1. What is the ITS Architecture?

The National ITS Architecture provides a common framework for planning, defining and integrating intelligent transportation systems. It was developed through broad participation from transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc. over the last ten years. The architecture defines[1]:

1. The functions that are required for ITS (i.e., collection of traffic information)
2. The physical entities or subsystems where these functions reside (i.e., the roadside or the vehicle)
3. The information flows and data flows that connect these functions and physical subsystems together into an integrated system

There are several ways to view and use the National ITS Architecture, including:

1. User Services and User Service Requirements
2. Logical Architecture
3. Physical Architecture
4. Equipment Packages
5. Market Packages

Each of these concepts will be discussed briefly in the following sections. The discussion is adapted from the National ITS Architecture.

5.2. User Services and User Service Requirements

User services represent what the system will do from the perspective of the user, who may be a motorist, a transit rider, a system operator, etc. Currently there are 33 user services which were discussed earlier in Section 4.0 (ITS Primer). The concept of user services allows the process of system or project definition to begin by thinking about services that will be provided to address identified problems and needs. New or updated user services may be added to the National ITS Architecture over time.

[1] National ITS Architecture, Version 5.0, U.S. DOT

A number of functions are required to accomplish each user service. To reflect this, each of the user services was broken down into successively more detailed functional statements called user service requirements, which formed the fundamental requirements for the National ITS Architecture development effort. It should be noted that each entity developing ITS Architecture must decide on the number of user service functional requirements appropriate for its circumstances.

5.3. Logical Architecture

A logical architecture is best described as a tool that assists in organizing complex entities and relationships. Developing a logical architecture helps identify the system functions and information flows, and guides development of functional requirements for new systems and improvements. A logical architecture should be independent of institutions and technology, i.e., it should not define where or by whom functions are performed in the system, nor should it identify how functions are to be implemented.

The logical architecture of the National ITS Architecture defines a set of functions (or processes) and information flows (or data flows) that respond to the selected user service requirements. Processes and data flows are grouped to form particular transportation management functions (i.e., manage traffic) and are represented graphically by data flow diagrams (DFDs) or bubble charts, which can be broken down into several levels of detail. In these diagrams, processes are represented as bubbles and data flows as arrows. See Figure 5.1 below for an example of user service logical flows for the function of managing traffic.

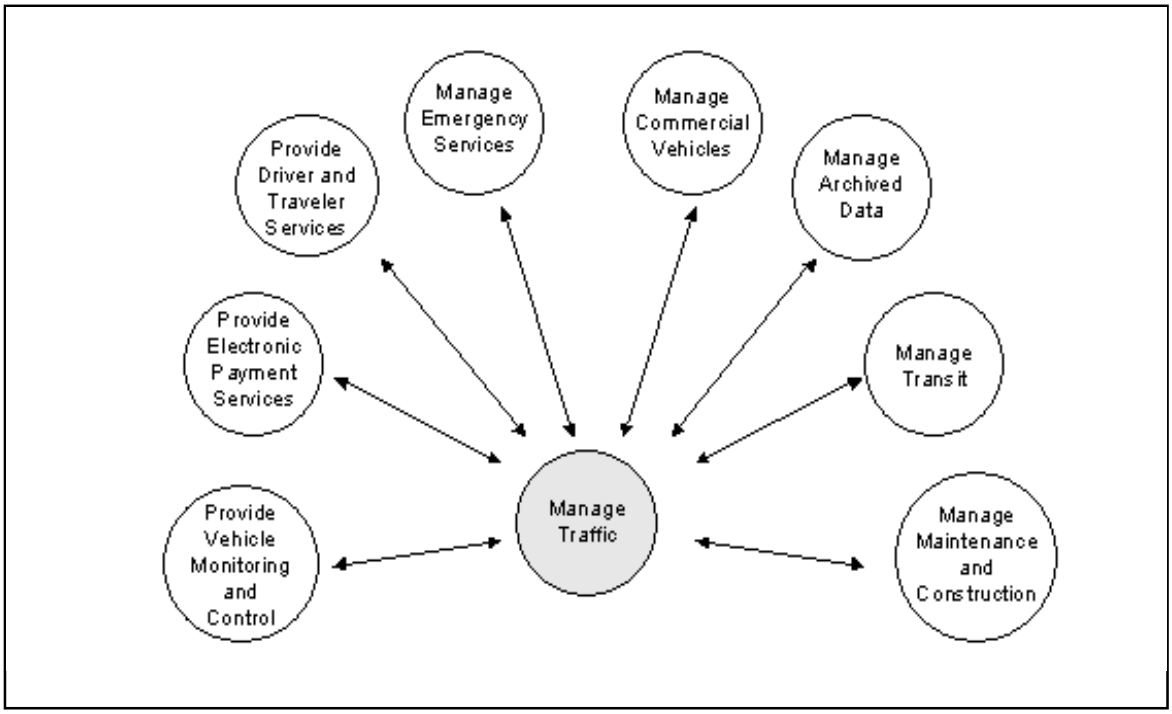


Figure 5.1 User Service Logical Flows for Managing Trafic

5.4. Physical Architecture

A physical architecture is the physical view of a system which provides agencies with a physical representation, though not a detailed design of how the system should provide the required functionality. A physical architecture takes the processes identified in the logical architecture and assigns them to physical entities called subsystems in the National ITS Architecture. In addition, the data flows from the logical architecture that originate from one subsystem and end at another are grouped together into physical architecture flows. In other words, one architecture flow may contain one or more detailed data flows. These architecture flows and their communication requirements define the interfaces required between subsystems, which form the basis for much of the ongoing standards work in the ITS program. Development of a physical architecture will identify the desired communications and interactions between different transportation management organizations.

5.5. Equipment Packages

The term "equipment package" was used in the National ITS Architecture development effort to group like functions of a particular subsystem together into an "implementable" package of hardware and software capabilities. Documented as part of the Physical Architecture, the grouping of functions also took into account the user services and the need to accommodate various levels of functionality within them. The equipment packages are associated closely with market packages (which will be discussed in Section 5.6) and were used as a basis for estimating deployment costs (as part of the evaluation that was performed). The specific set of equipment packages defined is merely illustrative and does not represent the only way to combine the functions within a subsystem. The National ITS Architecture has defined approximately 176 equipment packages in total.

An example of an equipment package that is relevant to traffic signal control is Traffic Management Center Signal Control, which is comprised of five process specifications:

1. Process Traffic Data
2. Provide Traffic Operations Personnel Traffic Data Interface
3. Select Strategy
4. Determine Indicator State for Road Management
5. Output Control Data for Roads

5.6. Market Packages

Market packages are defined as sets of equipment packages required to work together to deliver a given transportation service and the major architecture flows between them and other important external systems. In other words, they identify the pieces of the National ITS Architecture required to implement a service. As such, they are directly grounded in the definition of the Architecture. Most market packages are made up of equipment packages from two or more subsystems. Market packages are designed to address specific transportation problems and needs and can be related back to the 33 user services and their more detailed requirements.

6.0 EXISTING ITS IN NORTH DAKOTA

This section provides a detailed description of existing and currently planned ITS components throughout North Dakota. In addition to providing an inventory of existing components, this information will be used to develop the ITS deployment plan and identify potential integration needs.

The NDDOT has been active in ITS for several years, especially in the area of winter road travel information. North Dakota was among the first states to develop site-specific road and weather information to travelers while en route. The #SAFE system started operations in 1996 to provide road and weather information to travelers using cellular telephones.

Weather naturally plays a major role in influencing the types of technologies that have seen early deployment in North Dakota. Examples of these technologies include: road weather information systems (RWIS), dynamic message signs (DMS), traveler information web page and automated bridge anti-icing systems.

In the last couple of years there has been increased focus on urban transportation issues with continuing growth in the state's urban centers. Applications targeting urban travelers include video technologies for traffic signal operations, dedicated web pages and highway advisory radio for construction projects and video surveillance available for viewing on the web for area drivers.

In describing these existing ITS technologies, it is important to point out that many of these technologies have largely been deployed in a fragmented manner. As needs and opportunities arose, field devices have been installed. However, there are only one or two applications that may be considered a true system (where a system refers to an integrated set of technologies, functions, etc). Therefore, this ITS planning effort strives to address how existing and future technology deployment can be grown into well-integrated systems as guided by the National ITS Architecture.

The information in this section was compiled primarily from feedback obtained from various NDDOT sections. One of the difficulties of getting a complete inventory is how different technologies are viewed and whether they are considered to be ITS. Therefore, the information in this section is not intended to be an exhaustive list of all existing technologies.

The organization of information on existing ITS technologies will follow the user service bundles. Under each user service bundle, each technology provides a description showing location, scope, status and other project-specific information. A GIS database has also been developed to better use this information.

6.1. Travel and Traffic Management

6.1.1. CCTV and other Surveillance Camera's

A 4-camera system at the I-29/I-94 interchange in Fargo was among the first video surveillance installations in the state. The system used wireless communication to transmit video feed to the NDDOT Fargo District located just over one mile north of that location. Snap shots from the four cameras were made available on a web page developed specifically for providing traveler information during the I-29 reconstruction project in Fargo, which started in 2000. The NDDOT's main road and weather information web page is also linked to the cameras.

Last year the I-29/I-94 interchange surveillance system was replaced with four machine vision (video) detectors plus one surveillance camera. This upgrade was designed to allow the NDDOT to collect traffic data (traffic volume, occupancy, and speed on a lane-by-lane basis) using the video detectors, while preserving the surveillance function. The new system is supported by recently installed fiber optic cable along a section of I-29 up to the I-94 interchange. The great bandwidth of fiber optics allows full-motion video to be displayed on three monitors at the NDDOT Fargo District. The old system is being moved to the interchange of I-29 and Main Avenue in Fargo to provide surveillance and pictures for the public to view on the web during the 2004 reconstruction of the interchange.

The NDDOT controls traffic signals on most interstate ramps in Fargo. After completing the re-construction of both I-29 and 13th Avenue S in 2002, the NDDOT Fargo District and the City of Fargo worked to install video detectors that support three intersections. Video detection allows for the monitoring of conditions at the intersection, data collection, and the ability to change signal timings and detector locations without having to be in the field. The NDDOT Fargo District receives video feed from two intersections controlled by video detectors in the I-29/13th Avenue S area of Fargo.

The NDDOT also operates a video camera on the Buxton Bridge along I-29, south of Grand Forks. The bridge features North Dakota's first automated bridge anti-icing system. The camera is used to verify bridge conditions and also provides an image available for viewing at the NDDOT web page. The NDDOT is planning to add surveillance cameras as a standard practice for all new RWIS installations in the state. This would allow the NDDOT to verify conditions at these locations and potentially provide live video images of conditions to travelers.

6.1.2. Signal Coordination

The NDDOT owns and operates traffic signals on state highways in the smaller urban areas and on the interstate system mainly for management of ramp operations. The NDDOT has agreements in Grand Forks and Bismarck that allow the cities to operate and maintain NDDOT owned traffic signals (i.e., timing plans). However, the NDDOT retains these functions in the Fargo district on the interstate system. The NDDOT is working with Fargo to develop coordinated traffic signal corridor plans that will improve traffic operations. Most of the signals operate on preprogrammed coordination plans according to the time of day. Communications to the controllers consist of either a phone drop or fiber connections to the District office, allowing timing plans can be changed from either the District office or the Central Office in Bismarck.

6.1.3. Portable Dynamic Message Signs (DMS)

The NDDOT owns approximately 15 portable dynamic message signs throughout the state. They are primarily used for construction and maintenance purposes during summer months and for winter storm warnings and road closures during winter months. DMS locations during the winter season were identified through coordination with the NDDOT districts in order to provide the most practical information to drivers about road closures. Concrete pads were constructed outside road shoulders to provide appropriate surfaces for the signs during the winter months.

All portable DMS rely on solar power and wireless (cellular) communications for their operations. Originally, the signs had to be called individually in order to display messages using software from three different vendors. However, earlier this year, the NDDOT integrated DMS operations by using a third-party vendor software and adding communications hardware (NTCIP compatible) to the signs. That project was funded partly through a federal grant to coordinate DMS operations in support of the AMBER Alert Program. The new software allows NDDOT personnel to control all or a sub-set of the statewide DMS from a single point and display the required message.

A statewide winter storm road closure operational plan was developed to guide DMS operations. The plan identifies the location of each sign and specifies which message shall be activated on each board during a specific closure. Figure 6.1 shows the locations where these signs are utilized during the winter months.

Due to limitations with portable DMS operations, the NDDOT is actively looking at permanent DMS installations. The size and location of portable DMS currently used, limits the effectiveness of delivering information to the drivers. Additionally, the portable DMS can only display very small messages, therefore may not be appropriate for detailed warning information. Permanent DMS, on the other hand, provide more surface to display messages, offer a better view from the driver's perspective, and is more reliable.

6.1.4. 511 Telephone Traveler Information System

"511" is a nationally designated number for traveler information on road and traffic conditions. North Dakota's 511 grew from the state's previous #SAFE system which provided information to travelers via cellular phones. The new 511 became operational in February 2003 and covers the entire state with route-specific weather/road information. A voice-recognition feature was later added to the system and serves as the primary interface with callers. Because of concerns about the safety impacts of using a cell phone while driving and some technological voice recognition limitations, the system now relies on the users selecting between standard number-driven or voice-recognition menu operations.

Recognizing the potential of 511 as an effective information outlet to travelers, the NDDOT is working on enhancing the system by adding new features. The system currently provides road construction reports and seasonal load restriction information in addition to weather and road information. AMBER Alert announcements are also broadcast to 511.

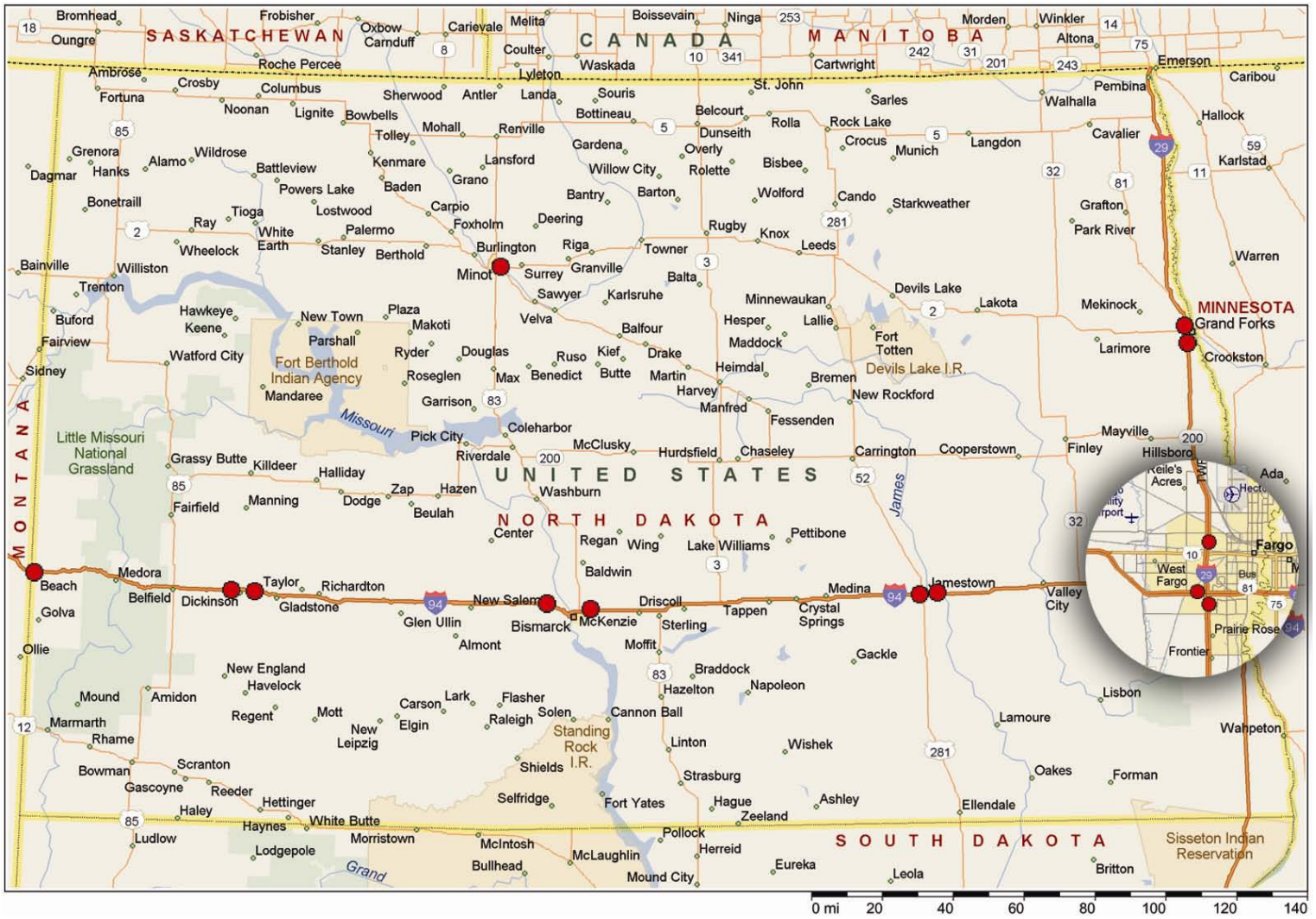


Figure 1 Winter Location for Portable DMS

6.1.5. Web Page

The NDDOT has provided traveler information on its web page for several years. Both the design of the web page and the information available have been greatly enhanced. Travelers can now find the Road and Traveler Information web page easily and they have more options for retrieving relevant information. The main source of information is a color-coded state map (also available in black and white) that shows road and driving conditions statewide. Information on operational conditions range from good driving conditions (or no restrictions) to road closed due to ice or snow.

Recently the NDDOT added an interactive feature that allows travelers to navigate a GIS map of the state to obtain detailed and route-specific information. Users can zoom in to view an area and select a route to display its condition. The route condition report shows route information (highway number and section), current surface/weather conditions, traffic operating speeds and advisories about the route (i.e., travel not advised when applicable). Figure 6.2 shows a snapshot of this interactive map.

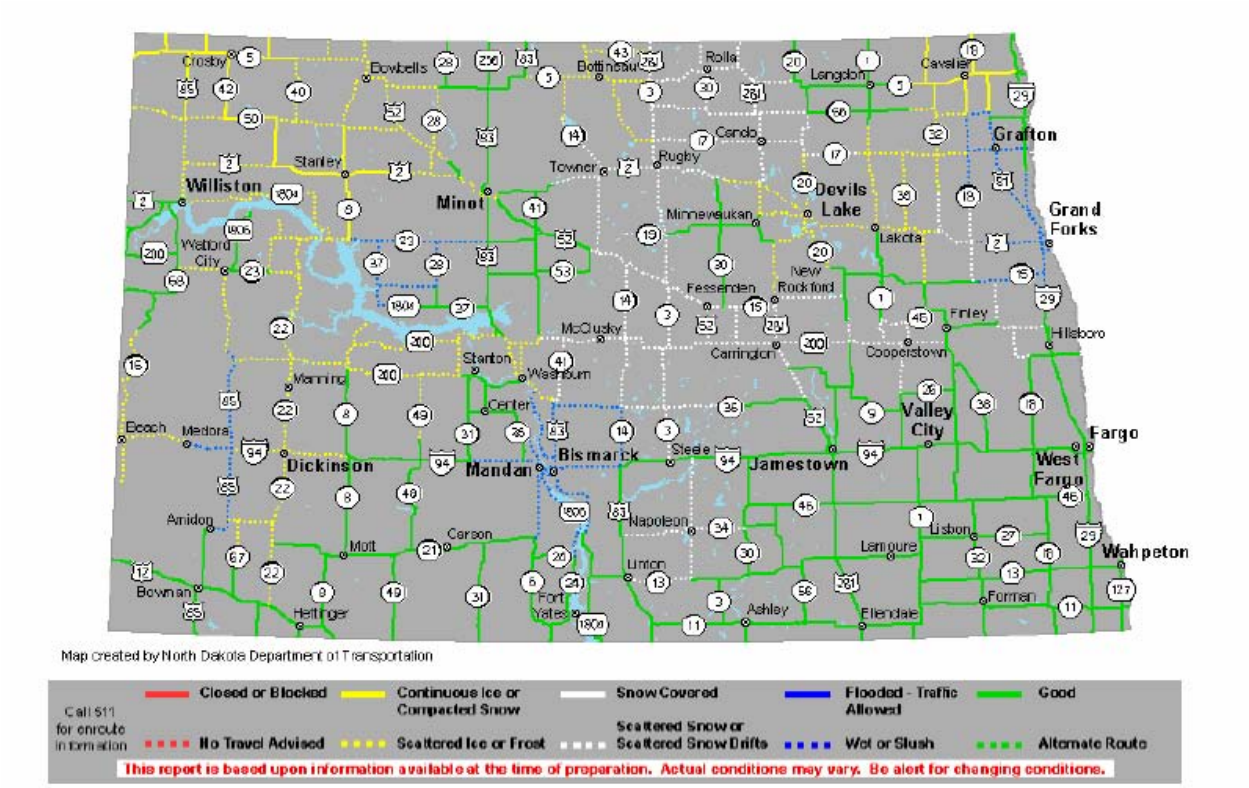


Figure 2 NDDOT Traveler Information Web Page

6.1.6. Kiosks

The NDDOT has allowed a private company to install traveler service kiosks at the state Visitor Centers (rest areas). The kiosks provide a variety of travel services information and allow the users to view road and weather conditions on the NDDOT web page. Currently there are 13 kiosks across the state as shown in Figure 6.3.

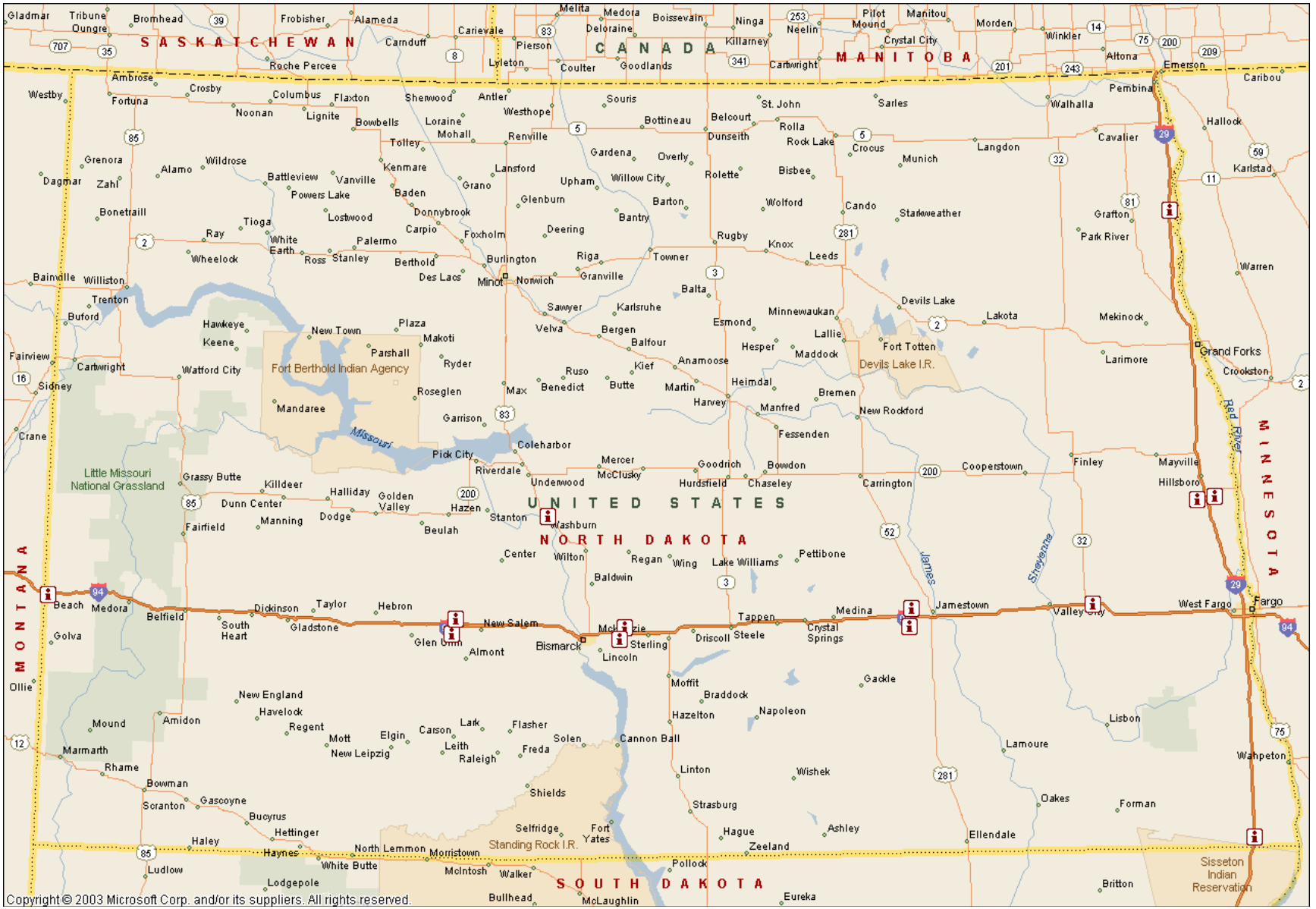


Figure 3 Location of Kiosks

6.1.7. Highway Advisory Radio (HAR)

Highway Advisory Radio is a low power AM radio transmitter strategically deployed to provide information to motorists through an AM radio station. HAR messages provide more information than what can be displayed on a DMS, and the station can be received within a couple miles of the transmitter. Signs are placed along roadways to inform drivers of the station's AM location. NDDOT currently has one portable HAR unit which is used across the state in construction zones. The messages convey construction-related roadway conditions such as detours and lane closures.

6.1.8. Traffic Data Collection

The NDDOT currently operates more than 50 Automated Traffic Recorders (ATRs) across the state. Several of these ATRs are quite old, requiring continuous maintenance and providing limited data collection functionality.

The state has been exploring new technologies to support traffic data collection including video and Weigh-in-Motion (WIM). There are currently 4 video cameras located at the interchange of I-94 and I-29 in Fargo that are capable of data collection such as traffic volumes, occupancy, and speeds on a lane-by-lane basis.

Four new WIM sites were installed early this year while eight more are planned for installation later this year. The WIM sites were planned in coordination with the North Dakota Highway Patrol (NDHP) to facilitate roadside enforcement. Existing and planned WIM sites are shown in Figure 6.4. The NDHP began concentrating its efforts on truck weight and safety enforcement at non-fixed sites. The NDDOT assisted the NDHP in constructing turn-out areas to allow for a safe area for the inspections to take place.

The new WIM sites are connected by land-line telephone and wireless (cellular) communications. Data for NDDOT uses are transmitted over the phone lines. NDHP enforcement officers can communicate with WIM using wireless communications to screen truck weights and select trucks for enforcement within a short distance from the WIM site.

6.2. Maintenance and Construction Management

6.2.1. Bridge Deck Anti-Icing Spray System

NDDOT has installed one bridge deck anti-icing spray system with many more desired throughout the state. The existing system is located on the Buxton Bridge along I-29 between Fargo and Grand Forks. Currently the NDDOT is working with the Minnesota Department of Transportation (Mn/DOT) to install an automated bridge anti-icing system on the Red River Bridge on I-94 between Fargo and Moorhead. The implementation of the system on the Buxton Bridge has been a very positive experience for the NDDOT and has led to the exploration of installations in many other locations.

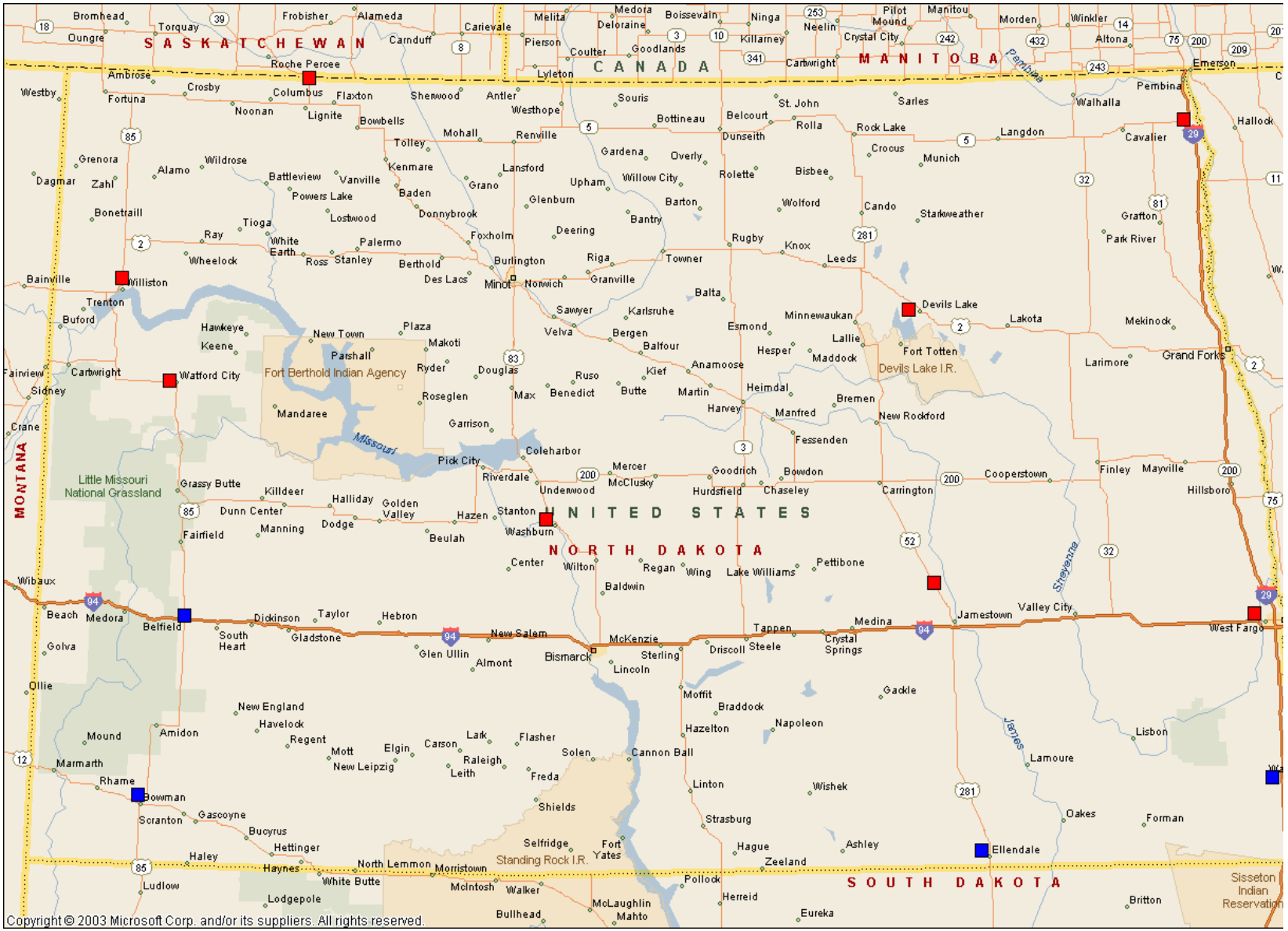


Figure 4 Existing (shown in blue) and Planned (shown in red) WIM Locations

6.2.2. Roadway Weather Information Systems (RWIS)

NDDOT currently has 30 RWIS stations that are either installed and operating or planned for the near future. These stations measure and report site-specific meteorological conditions including wind speed and direction, temperature, relative humidity, dew point temperature, precipitation and pavement temperature. These measurements are used by maintenance personnel to effectively manage road anti-icing and de-icing efforts. Figure 6.5 shows the locations of the existing RWIS throughout the state.

6.3. Regional ITS Efforts

The NDDOT participates with neighboring states in efforts to improve travel in the region and enhance the services provided to travelers. One of these efforts is the North/West Passage Coalition which aims at streamlining ITS on I-94 and I-90 from Wisconsin to Washington. North Dakota, along with Minnesota and Wisconsin, is one of the 3 states currently participating in the pooled-fund study to coordinate traveler information systems.

As part of this study, the NDDOT is looking at a pilot deployment of a statewide condition reporting system developed by Meridian Environmental Technologies (which supports NDDOT's 511 system). The limited deployment will be compared to a system used in Minnesota and Arizona.

Additionally, the NDDOT is working with Mn/DOT to develop a jointly owned automated anti-icing system across the Red River Bridge in Fargo/Moorhead. The two states are working under the Northwest Passage program to jointly design and build the system.

In the areas of traveler information, the North/West Passage Coalition is planning DMS installations that would create a seamless flow of traveler information. Mn/DOT is installing a DMS at I-94 and Hwy 336 which will provide information to North Dakota bound travelers. The operations of the DMS will be coordinated with the NDDOT Fargo District as well as the central office in Bismarck. The NDDOT in turn is planning to install a DMS for Minnesota bound traffic along I-94 in Fargo.

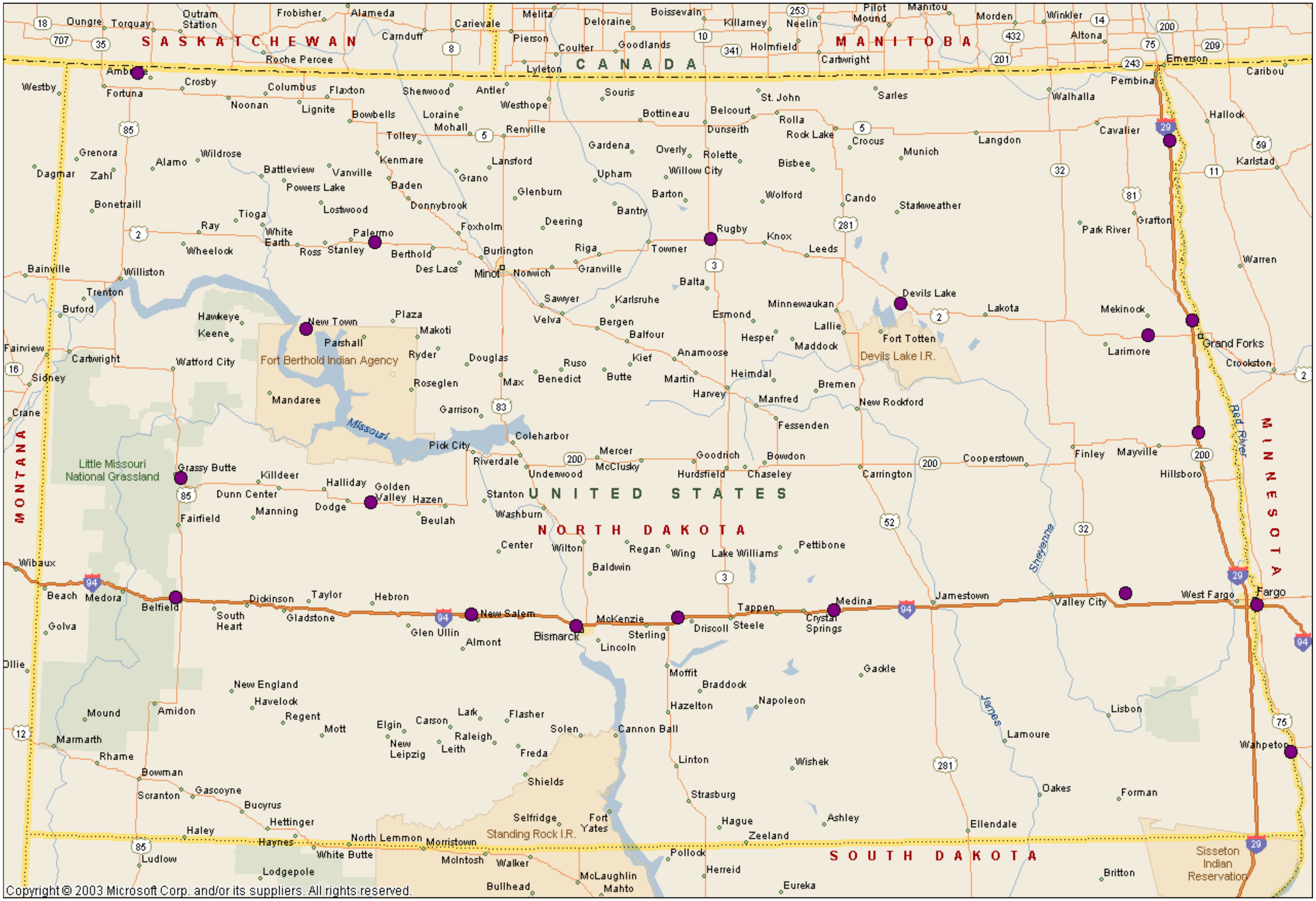


Figure 5 Existing RWIS Locations

7.0 PRIORITY ITS SERVICES

This section identifies high priority ITS services initially identified by working with stakeholders. The list on the following pages was developed using the National ITS Architecture format (user services and user service requirements). It also identifies applicable ITS Market Packages to support these user services. This information will be used in developing the statewide ITS Architecture in the future.

7.1. North Dakota ITS User Services

1. **Travel and Traffic Management**

1.1. **Pre trip Travel Information**: Includes pre-trip travel information capability to assist travelers in making mode choices, travel time estimates and route decisions prior to trip departure.

1.1.2. Provides the capability for users to access the current situation information on transportation systems.

1.1.4. Provides the capability for user access.

1.2. **En Route Driver Information**: Includes an en route driver information function. It provides vehicle drivers with information, while en route, which will allow alternative routes to be chosen for their destination.

1.2.1. Should be implemented in a manner that is beneficial to the transportation system and the public.

1.2.2. Includes a driver advisory function, which will be implemented in two phases first with short term capability and later with long term capability.

1.6. **Traffic Control**: Includes a traffic control function that provides the capability to efficiently manage the movement of traffic on streets and highways.

1.6.2. Includes a traffic surveillance function.

1.6.4. Provides traffic control information to other elements of the ITS.

1.7. **Incident Management**: Includes an incident management function that will identify incidents, formulate response actions and support initiation and ongoing coordination of those response actions.

1.7.1. Provides an incident identification function to identify incidents.

1.7.2. Provides a response formulation function to formulate appropriate response actions for each identified incident and revise those actions when necessary.

1.7.3. Includes a response implementation function to provide services needed to implement a response coordinated with all appropriate agencies.

1.7.4. Provides the capability to predict hazardous conditions, including the time and location of hazardous conditions that may cause an incident.

4. **Commercial Vehicle Operations**

4.1. **Commercial Vehicle Electronic Clearance:** Provides commercial vehicle electronic clearance capability.

4.1.1. Provides a fixed facility consisting of structures and equipment to include ports of entry, inspection stations, weigh stations and toll booths.

4.1.2. Includes a vehicle system capability such as two-way communications with fixed facilities.

4.4. **Commercial Vehicle Administrative Processes:** Includes a commercial vehicle administrative process function consisting of 3 sub-services to include electronic purchase of credentials, automated mileage and fuel reporting and auditing, and international border electronic clearance.

4.4.1. Includes an electronic purchase of credentials function with capabilities that include electronic credentials, electronic permits and electronic payment.

4.4.2. Includes an automated mileage and fuel reporting and auditing function that includes electronic vehicle log, tax reports etc.

4.4.3. Includes an international border electronic clearance function.

4.5. **Hazardous Material Security and Incident Response:** Includes a hazardous materials (HAZMAT) security and incident response service.

4.5.1. Includes a HAZMAT incident notification function.

4.5.2. Provides an operation focal point for initiating appropriate responses.

4.5.3. Includes a communications function.

4.5.4. Includes a HAZMAT security function.

5. **Emergency Management**

5.1. **Emergency Notification and Personal Security:** Includes an emergency notification and personal security function that provides for faster notification when travelers are involved in an incident.

5.1.3. Includes a remote security and emergency monitoring function to create an environment of safety in remote areas.

7. **Information Management**

7.1. **Archived Data Function**: Provide an archived data function to control the archiving and distribution of ITS data. The archived data user service provides the historical data archive repositories and controls the archiving functionality for all ITS data. It collects data, analyzes historical performances, improves operation data integrity and provides historical data to transportation communities, in turn assisting with planning, research and safety management activities.

7.1.1. Provides a historical data archive system that collects ITS data from various field equipment and devices.

7.1.2. Includes an operational data control function to ensure integrity of operational data as received from field equipment or data collection devices.

7.1.5. Provides a data warehouse distribution function as the ITS data source to support the ITS community user functions.

7.1.6. Provides ITS community interface to all ITS users for the specification and retrieval of data products. The interface may be an online (web-based) archive facilitating the community to analyze and download ITS data.

8. **Maintenance and Construction Management**

8.1. **Maintenance and Construction Operations**: Provides maintenance and construction operations functions to support monitoring, operating, maintaining, improving and managing the physical condition of roadways, the associated infrastructure equipment and the required resources.

8.1.1. Provides a maintenance vehicle fleet management function to schedule and dispatch, monitor and track location and monitor operational condition and maintenance requirements of public and contracted fleets of maintenance, construction and specialized service vehicles.

8.1.2. Provides a roadway management function to monitor traffic, road surface and environmental conditions and forecast traffic and road surface conditions to

support management of routine and hazardous road condition remediation and to communicate changes in conditions.

8.1.3. Provides a work zone management and safety function, which provides support for the effectiveness, safety and efficiency of roadway operations during all work zone activities.

8.1.4. Provides a roadway maintenance condition and work plan dissemination function to provide intra- and inter-agency coordination of work plans.

7.1. North Dakota ITS Market Packages

Market Package	Functions	User Services
AD1-ITS Data Mart	- Archives collected data from different entities such as traffic signal systems. - Provides basic data quality, data privacy and meta data management to all ITS archives. - Facilitates and enhances the quantitative support for transportation planning, research and analysis.	7.1
ATIS1-Broadcast Traveler Information	- Collects traffic conditions, advisories, general public transportation, parking information, incident information, roadway maintenance and construction information, and air quality and weather information, then broadly disseminates this information through existing infrastructures and low-cost user equipment such as FM sub-carrier and cellular data broadcast.	1.1, 1.2
ATIS2-Interactive Traveler Information	Provides tailored information in response to a traveler request. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511 portal, personal computer or a variety of in-vehicle devices.	1.1, 1.2, 1.7
ATMS01-Network Surveillance	- Transmits data back to the traffic management subsystem using traffic detectors, other surveillance equipment, supporting field equipment and fixed-point to fixed-point communications. - Enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations and collect census data for traffic strategy development and long range planning.	1.6, 1.7

ATMS06- Traffic Information Dissemination	- Provides driver information using roadway equipment such as Dynamic Message Signs (DMS) or Highway Advisory Radio (HAR). - Disseminates a wide range of information including traffic and road conditions, closure and detour information, incident information, emergency alerts and driver advisories.	1.2, 1.6, 1.7
ATMS08- Traffic Incident Management System	- Manages both unexpected incidents and planned events so the impact to the transportation network and traveler safety is minimized. - Includes incident detection capabilities through roadside surveillance devices and regional coordination with other traffic management, maintenance and construction management and emergency management as well as rail operations and event promoters.	1.7
CVO03- Electronic Clearance	- Provides for automated clearance at roadside check facilities. -Allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated roadside short- range communications.	4.1, 4.4
CVO04- CV Administrative Processes	- Provides for electronic application, processing, fee collection, issuance and distribution of CVO credential and tax filing.	4.1, 4.4
CVO05- International Border Electronic Clearance	- Provides for automated clearance at international border crossings. This package augments the electronic clearance package by allowing interface with customs related functions.	4.1, 4.4
CVO06- Weigh-In-Motion	- Provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. - Provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance market package.	4.1
CVO10- HAZMAT Management	- Integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents.	4.5, 5.1

EM05- Transportation Infrastructure Protection	- Includes the monitoring of transportation infrastructure (e.g., bridges, management centers) for potential threats (e.g. terrorist attacks) using sensors and surveillance equipment and barrier and safeguard systems to preclude an incident, control access during and after an incident or mitigate impact of an incident.	5.1
EM06- Wide-Area Alert	- Alerts the public in emergency situations such as child abductions, severe weather events, civil emergencies and other situations that pose a threat to life and property. The ITS technologies will supplement and support emergency and homeland security alert systems such as the Emergency Alert System (EAS).	5.1
MC01- Maintenance and Construction Vehicle and Equipment Tracking	- Tracks the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities such as ensuring the correct roads are being plowed and work activity is being performed at the correct locations.	8.1
MC03- Road Weather Data Collection MC04- Weather Information Processing and Distribution	- Collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway (or guide way in the case of transit related rail systems). - Processes and distributes the environmental information collected from the Road Weather Data Collection market package. - Detects environmental hazards such as icy road conditions, high winds, dense fog, etc.	8.1 8.1
MC05- Roadway Automated Treatment	- Automatically treats a roadway section based on environmental or atmospheric conditions (i.e., fog dispersion or anti-icing chemicals). - Includes the environmental sensors that detect adverse conditions, the automated treatment system itself and driver information systems that warn drivers when the treatment system is activated (i.e., DMS) .	8.1

MC06- Winter Maintenance	- Supports winter road maintenance including snow plow operations, roadway treatments (i.e., salt spraying and other anti-icing material applications) and other snow and ice control activities. - Monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response and track and manage response operations.	8.1
MC07- Roadway Maintenance / Construction	- Supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way.	8.1
MC08- Work Zone Management	- Directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (i.e., ISP, traffic management and other maintenance and construction centers) for better management of coordination.	8.1
MC09- Work Zone Safety Monitoring	- Includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. - Detects vehicle intrusions in work zones and warns crew and drivers of imminent encroachment or other safety hazards. - Supports stationary and mobile work zones.	8.1
MC10- Maintenance & Construction Activity Coordination	- Supports the dissemination of maintenance and construction activity to centers that can utilize it as part of their operations, or to the Information Service Providers (ISP) who can provide the information to travelers.	8.1

8.0 PRIORITY DEPLOYMENT AREAS/CORRIDORS

One of the important outcomes of the ITS Planning process is a set of ITS projects to be implemented over various time frames. A common approach is to identify projects that will be programmed in the short- (1-3 years), medium- (3-7 years), and long-term (7+ years) time frames. Further, it is crucial that these projects are integrated with transportation plans (STIP and TIP). This section outlines the criteria proposed for selecting ITS projects in North Dakota and identifies a list of possible priority areas to be included in the short- and medium-range time horizons.

8.1. Criteria

One of the guiding principles in developing North Dakota's ITS Plan is to emphasize projects which address a critical transportation need and result in maximum return on investments. The NDDOT has reflected this principle in its Statewide Transportation Plan (TransAction). Initiative 9 of NDDOT's TransAction explicitly calls for using appropriate ITS technologies. Therefore, formulating criteria for developing ITS projects of statewide significance is a basic component of the ITS planning process. The guiding principles for developing the criteria include:

Strategy:

Use Intelligent Transportation System (ITS) applications that enhance passenger and freight mobility and improve safety and security (North Dakota TransAction, P. 14)

1. Recognize the geographic and socio-economic characteristics of the state
   a. Low traffic/population density
      i. Priority corridors
   b. Transportation key to economic viability and development
      i. Special needs of commercial transportation system users (trucking)
      ii. Personal mobility and connectivity among various areas in the state and with other states
         (1) Consider rural transit in addition to personal automobile
   c. Extend the benefits from limited transportation investments available to the state
      i. Projects that yield the maximum return on investment
         (1) Projects with high benefit-to-cost ratio
         (2) Projects which enhance service for most stakeholders

Outcomes of the ITS Planning process include identifying candidate projects, criteria for selecting projects and a timetable for implementation

ii. Projects which enable the state to take advantage of additional funding opportunities
iii. Projects which have low marginal costs (cost savings from coordinating ITS projects with programmed improvements)
(1) Take advantage of planned activities
iv. Project life-cycle-cost is used for evaluation when appropriate
(1) Consider operating and maintenance costs

2. Recognize the technological environment in the state
   a. Requirements for additional ITS infrastructure
      i. Communications
      ii. Available/planned information support systems
      iii. Availability of technical expertise (IT, systems engineers/integrators, etc)
3. Coordinate North Dakota projects with regional and national efforts
   a. Regional corridors (North/West Passage, I-29 trade corridor, etc.)
   b. Cooperation with bordering states/provinces (MB, MN, MT, SD, SK)
   c. Federal requirements and national initiatives
      i. 511
      ii. CVISN
      iii. AMBER Alert
4. Select projects which address most critical needs
   a. Enhances safety (people and freight)
   b. Improves mobility (people and freight)
   c. Supports economic development (people and freight)
   d. Enhances customer service (people and freight)
5. Program projects for incremental implementation
   a. Must follow regional plans and architecture
6. Recognize changing needs/transportation system characteristics
7. Address ITS into different contexts
   a. Economic development
   b. Tourism
   c. Homeland security

North Dakota ITS Priority Areas

- ☞ Travel and Traffic Management: traveler information, incident management, traffic control
- ☞ Commercial Vehicle Operations: CV traveler information, automated routing, electronic clearance
- ☞ Emergency Management: emergency notification and personal security
- ☞ Maintenance and Construction Management: maintenance vehicle fleet management, roadway management, work zones

8.2. Targeted Deployment Areas

The following sections identify starting points for possible project locations. They include corridors as well as single points of interests. These listings are intended to generate more detailed projects that will be included in the three implementation horizons (short-, medium- and long-term). Further, once approved, some of these projects will be incorporated in the STIP and metropolitan TIP when appropriate.

8.2.1. Priority corridors (including key bridge structures)

1. I-29 from Canadian border to South Dakota border
2. I-94 from Minnesota border to Montana border
3. US 2 from Minnesota border to Montana border
4. US 52 between Jamestown and Minot
5. US 83 between Minot Air Force Base and South Dakota border
6. ND 13 from Minnesota border to ND 18
7. Bridge structures
    a. Red River Bridge in Fargo (I-94)
    b. Four Bears Bridge (ND 22)
    c. Buxton Bridge (I-29)
    d. Grant Marsh Bridge in Bis(I-94)

8.2.2. Urban centers

(Cities in bold could have local Traffic Operation Centers (TOC) or play a significant role in supporting statewide operations)

1. **Bismarck**
2. **Dickinson**
3. Devils Lake
4. **Grand Forks**
5. **Fargo**
6. **Jamestown**
7. **Minot**
8. Valley City
9. Wahpeton
10. Williston

8.2.3. Border crossings

1. Manitoba borders
    a. I-29 at Pembina
    b. US 281 at Peace Garden
2. Minnesota borders
    a. US 2 at Grand Forks
    b. I-94 at Fargo
    c. US 10 at Fargo
    d. ND 13 at Wahpeton
3. Montana borders

    a. US 2 near Williston
    b. I-94 at Beach
4. South Dakota borders
    a. I-29 near Wahpeton
    b. US 281 near Jamestown
    c. US 85 near Bowman
    d. US 83 near Linton
5. Saskatchewan Borders
    a. US 52 at Portal

8.2.4. Freight Generators

1. Sugar beet plants
    a. Drayton
    b. Grand Forks
    c. Hillsboro
    d. Fargo-Moorhead
    e. Wahpeton
2. Corn processing plants
    a. Wahpeton
3. Potato processing plants
    a. Jamestown
4. Pasta Plants
    a. Carrington
5. Ethanol Plants
6. Refineries
    a. Mandan
7. Manufacturing Facilities

8.2.5. Tourism/special events

1. Alerus Center
2. Englestad Arena
3. Fargo Dome
4. Bismarck Civic Center
5. State Fair - Minot
6. Medora
7. Valley City Winter Show
8. Lake Sakakawea recreational area
9. Devils Lake

8.2.6. Areas of Special Interest (including homeland security)

1. Dams
2. Bridges
3. State Capitol
4. Communication Towers

9.0 PRIORITY ITS PROJECTS

Based on ITS user services and market packages identified in Chapter 7 of this plan, several ITS projects were identifies for deployment over the next 10 years. In identifying these projects, the NDDOT recognizes that funding allocations will have a significant impact on deployment. The NDDOT has established an internal process for including ITS projects with highway projects programmed for funding. Additionally, special funding may be sought for projects with high priority and immediate pay off.

The following table contains a listing of NDDOT ITS projects, categorized by targeted deployment framework (i.e., short-range, medium-range, and long-range). In designating projects with their deployment horizons, several factors were considered, including: project costs, impact on other projects, level of need, and expected benefits.

Table 9.1 NDDOT Statewide ITS Projects

#	Project Title	Deployment Horizon
1	Automated Treatment (Anti-icing) Systems	**High Priority**
2	Statewide ITS Communications Plan and Network	
3	Incident Reporting Information System	
4	Fleet Management for Maintenance/Construction Vehicles (Support MDSS)	
5	Road Weather Information Sensors (RWIS)	
6	Addition of Cameras to Existing RWIS	**Medium Priority**
7	Flood Detection/Warning Systems	
8	Freeway Surveillance/Monitoring	
9	High-Wind Warning Systems	
10	Over-height Detection Systems	
11	Non-Intrusive Traffic Data Collection System	
12	Permanent DMS	
14	Snow Plow Collision Avoidance System	
15	Weigh-in-Motion	
16	Automated Road Closure Gates	**Low Priority**
17	Kiosks	
18	Portable DMS	
19	Portable Traffic Management System	
20	Regional Transit Management and Security	

Each of the projects in Table 9.1 is described in sections 9.1, 9.2, and 9.3. These sections are organized as follows:

9.1 Lists high-priority ITS projects
9.2 Lists medium-priority ITS projects
9.3 Lists low-priority ITS projects

The format for describing ITS projects includes the following information:

1. Project title
2. Project champions: agencies or NDDOT sections with lead deployment roles
3. Project locations (for location-specific projects)
4. Project description
5. Project costs: based on national or local averages (if available)
6. Technologies: a description of devices/technologies used to support project functions
7. Project functions: identify specific functions targeted by the project

9.1. High-Priority Projects (Short-Range Deployment)

9.1.1. *Automated Bridge Anti-icing System*	
Project Champions	NDDOT Maintenance
Project Locations	I-29 RP 141.196 Gateway Drive Interchange I-29 RP 144.711 North Grand Forks Interchange I-29 RP 153.750 Turtle River Bridge I-94 RP 24.000 Little Missouri Bridge I-94 RP 29.000 Peck Hill I-94 RP 67 WB Green River Hill I-94 RP 69 WB Green River Hill I-94 RP 72.000 RR Separation near Gladstone I-94 RP 156.069 Grant Marsh Bridge I-94 RP 222.290 Crystal Springs BNRR Separation I-94 RP 233.343 Halfway Lake I-94 RP 260.304 East of Jct US 52 I-94 RP 294.658 CPRR Separation I-94 RP 351.000 Red River Bridge I-94 RP 920.914 Memorial Bridge US 2 RP 313.200 Petersburg Overhead US 2 Ray Overpass US 12 Gascoyne Railroad Separation US 12 Little Missouri Bridge near Marmouth ND 23 Four Bears Bridge ND 81 RP 0.846 Bismarck Expressway Bridge ND 200 RP 924.974 Walter R. Hjelle Bridge (Washburn) See locations map (following page)
Project Description	Install automated bridge anti-icing and surveillance systems
Project Cost	$25,000 per anti-icing unit for short span bridge (< 320 ft) $50,000 - $495,000 per anti-icing unit for long span bridge (> ½ mile) $50,000 - $120,000 per permanent DMS $10,000 - $50,000 per RWIS
Technologies	1. Road-weather sensors (including ice sensor) 2. Anti-icing unit 3. CCTV 4. Communications 5. DMS
Project Functions	1. Detect ice/snow on bridge deck 2. Trigger anti-icing unit when conditions warrant operation 3. Provide information on deck condition and unit status to maintenance personnel 4. Provide surveillance capabilities of road and traffic conditions 5. Provide information to drivers through DMS

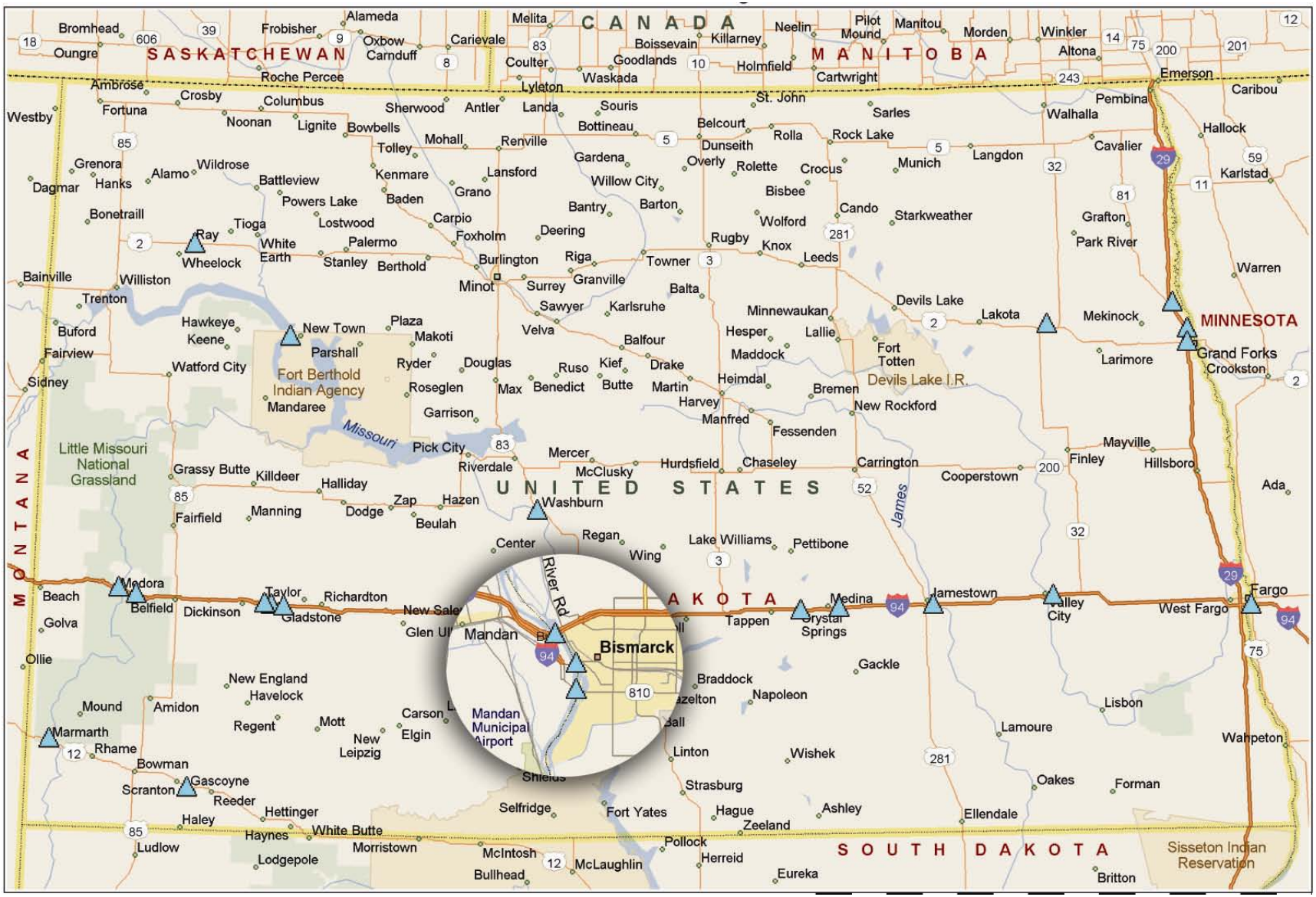


Figure 1Automated Treatment Systems Candidate Locations

9.1.2. *State-wide ITS Communications Plan Network*	
Project Champions	NDDOT Maintenance NDDOT IT NDSU-ATAC State ITD
Project Description	Develop communications alternatives to support statewide ITS projects
Project Cost	$100,000-$200,000
Technologies	1. Fiber optics 2. Landline 3. Wireless and cellular
Project Functions	1. Assess communication requirements for NDDOT ITS projects 2. Examine communication links from Statewide ITS Architecture 3. Assess available communications at ITS project locations 4. Match functionality requirements and communication systems availability for NDDOT ITS projects 5. Develop communication system standards for NDDOT ITS projects

9.1.3.*Incident Reporting Information System*	
Project Champions	NDDOT Maintenance, NDHP, Meridian
Project Description	Develop a system for establishing a statewide road/weather incident information system
Project Cost	$50,000 - $400,000
Technologies	1. Communications 2. Data entry user interfaces 3. Database 4. Internet
Project Functions	1. Streamline NDDOT road and weather traveler information 2. Integrate all traveler and road information databases for ND 511 3. Share condition information with relevant agencies/travelers

9.1.4. *Fleet Management for Maintenance Vehicles*	
Project Champions	NDDOT Maintenance State Information Technology Department (ITD)
Project Description	Install automatic tracking and communication systems on state snow plows and other maintenance vehicles
Project Cost	$500 - $800 per AVL unit $150 - $250 per unit cell/wireless radio with data capacity $5,000 - $10,000 per workstation and supporting software
Technologies	1. AVL hardware and software 2. Two-way wireless communications
Project Functions	1. Real-time information on snow plow location 2. Two-way wireless communications between snow plow and maintenance/construction dispatch

9.1.5. *Roadway Weather Information Systems (RWIS)*	
Project Champions	NDDOT Maintenance
Project Description	Install additional RWIS systems across the state, especially where anti-icing systems and high wind warning systems are to be installed
Project Cost	$10,000-$50,000 per site
Technologies	1. Pavement temperature sensor 2. Subsurface temperature sensor 3. Precipitation sensor (type & rate) 4. Wind sensor (speed & direction) 5. Air temperature and humidity sensors 6. Visibility sensors 7. Remote processing unit (RPU) 8. Camera 9. Communications
Project Functions	1. Detect weather at roadside locations 2. Communicate weather related information to maintenance personnel

9.2 Medium-Priority Projects

9.2.1. *Addition of Cameras to Existing RWIS*	
Project Champions	NDDOT Maintenance
Project Locations	Existing RWIS Stations, see following map
Project Description	Install surveillance cameras to help with maintenance decisions at existing RWIS stations
Project Cost	$2,500 - $5,000 per camera
Technologies	1. High quality color cameras 2. Existing communications and hardware for installation
Project Functions	1. Allow for visual verification of weather and road conditions 2. Provide traveler information on web page

9.2.2. *Flood Detection/Warning Systems*	
Project Champions	NDDOT Maintenance
Project Locations	US 81 RP 181.3 Forest River ND 5 RP 332.0 Red River ND 17 RP 140.3 Red River ND 54 RP 9.9 Red River ND 66 RP 138.7 Red River See following map
Project Description	Install a flood warning system where frequent flooding is a hazard due to spring run-off or major rain events
Project Costs	$42,000
Technologies	1. Sensors (rain, water level, weather, etc.) 2. Communications 3. DMS/blank-out sign
Project Functions	1. Detect conditions where roadway has become flooded 2. Send message to motorists 3. Send warning to maintenance personnel

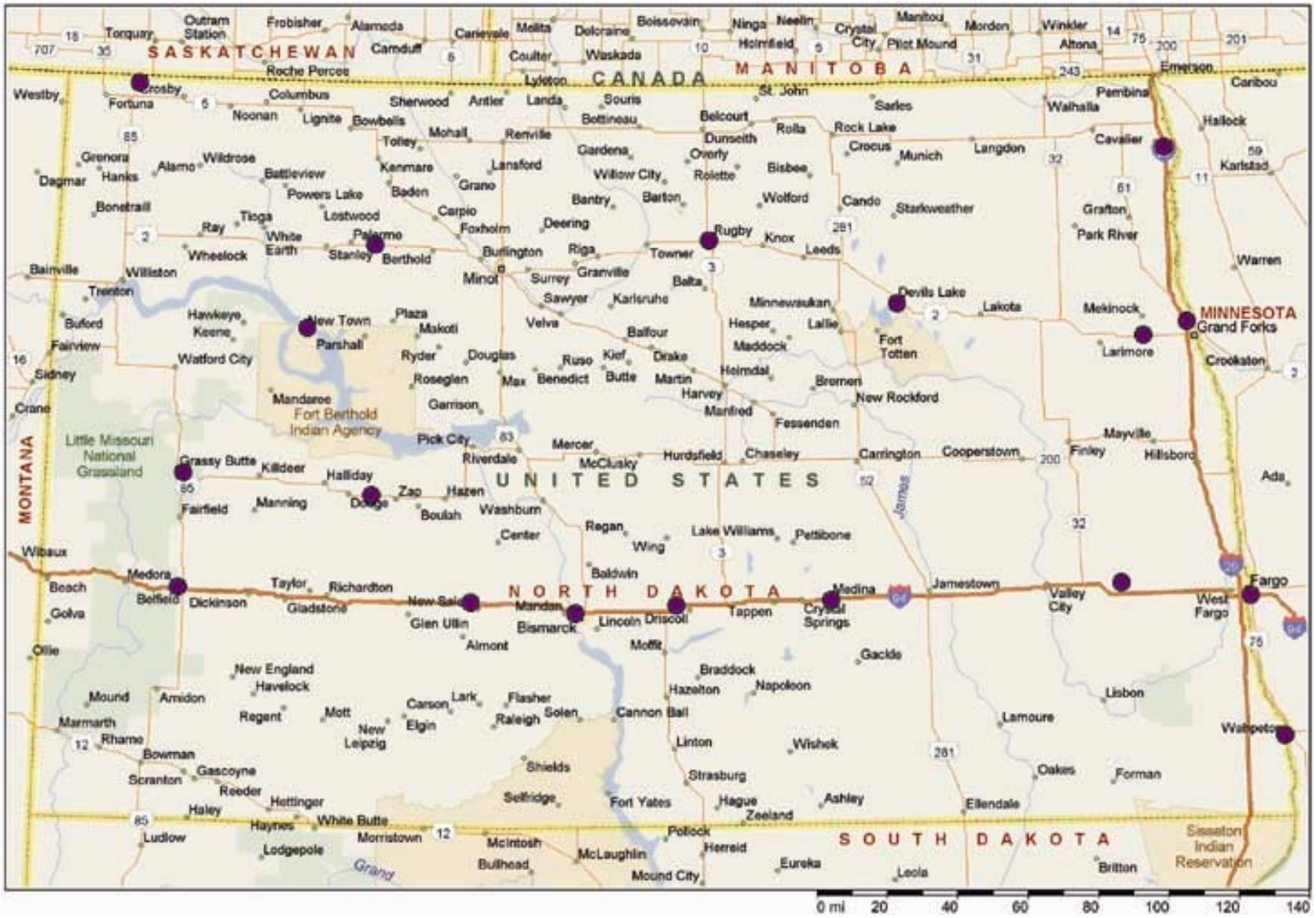


Figure 2 Candidate RWIS Locations for Adding Cameras

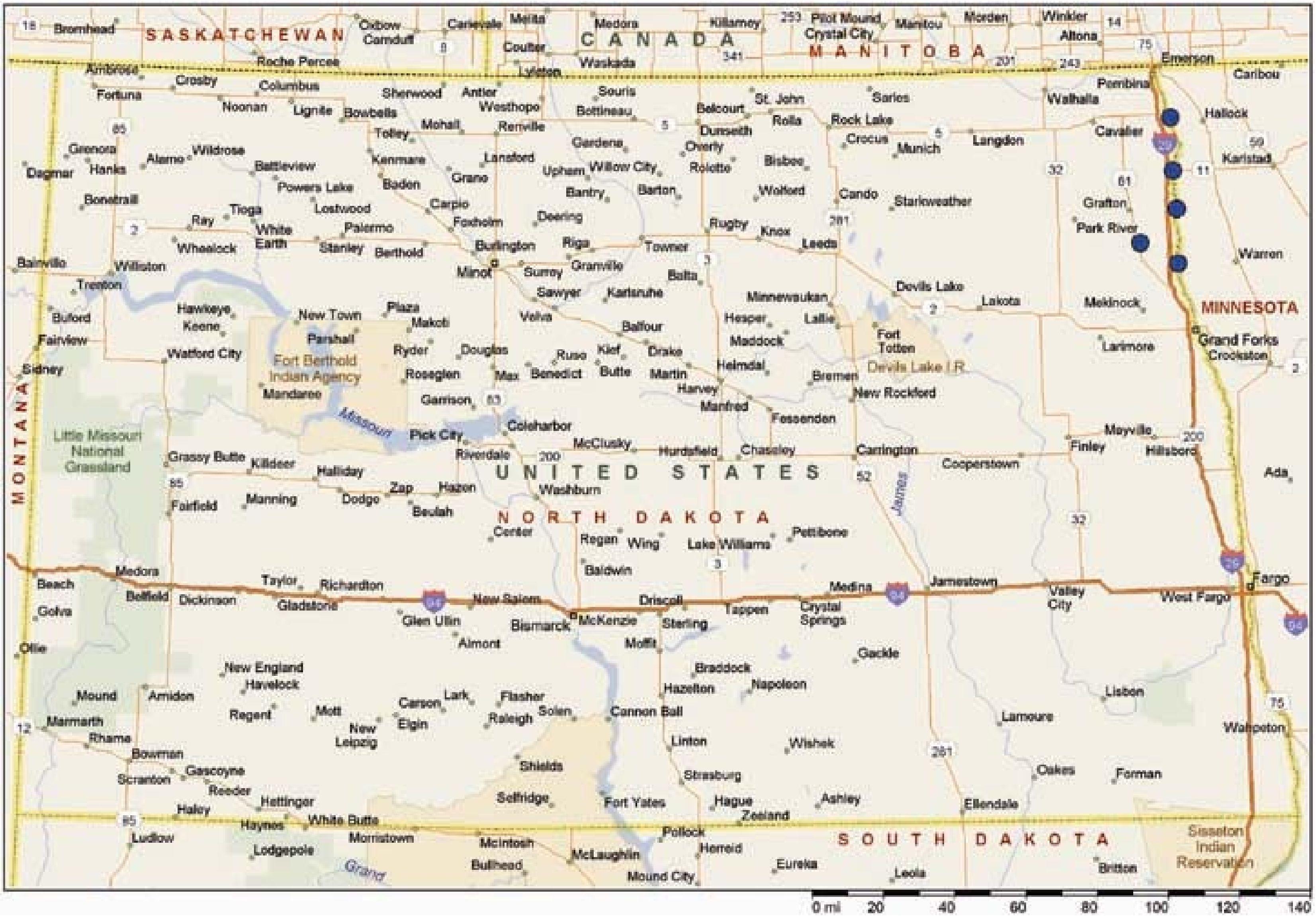


Figure 3 Possible Locations for Flood Detection/Warning

9.2.3. *Freeway Surveillance/Monitoring*	
Project Champions	NDDOT Maintenance
Project Locations	I-29 RP 60 I-29 RP 62 I-29 RP 64 I-29 RP 65 I-29 RP 66 I-29 RP 67 I-29 RP 138 I-29 RP 140 I-29 RP 141 I-94 RP 153 I-94 RP 156 I-94 RP 157 I-94 RP 159 I-94 RP 161 I-94 RP 348 I-94 RP 349 I-94 RP 350 I-94 RP 351 See following map
Project Description	Install CCTV at major interstate interchanges in major urban areas
Project Costs	$8,000 - $17,000 (not including tower for mounting)
Technologies	1. CCTV Camera 2. Communications
Project Functions	1. Surveillance of traffic and roadway conditions 2. Verify incidents for better management

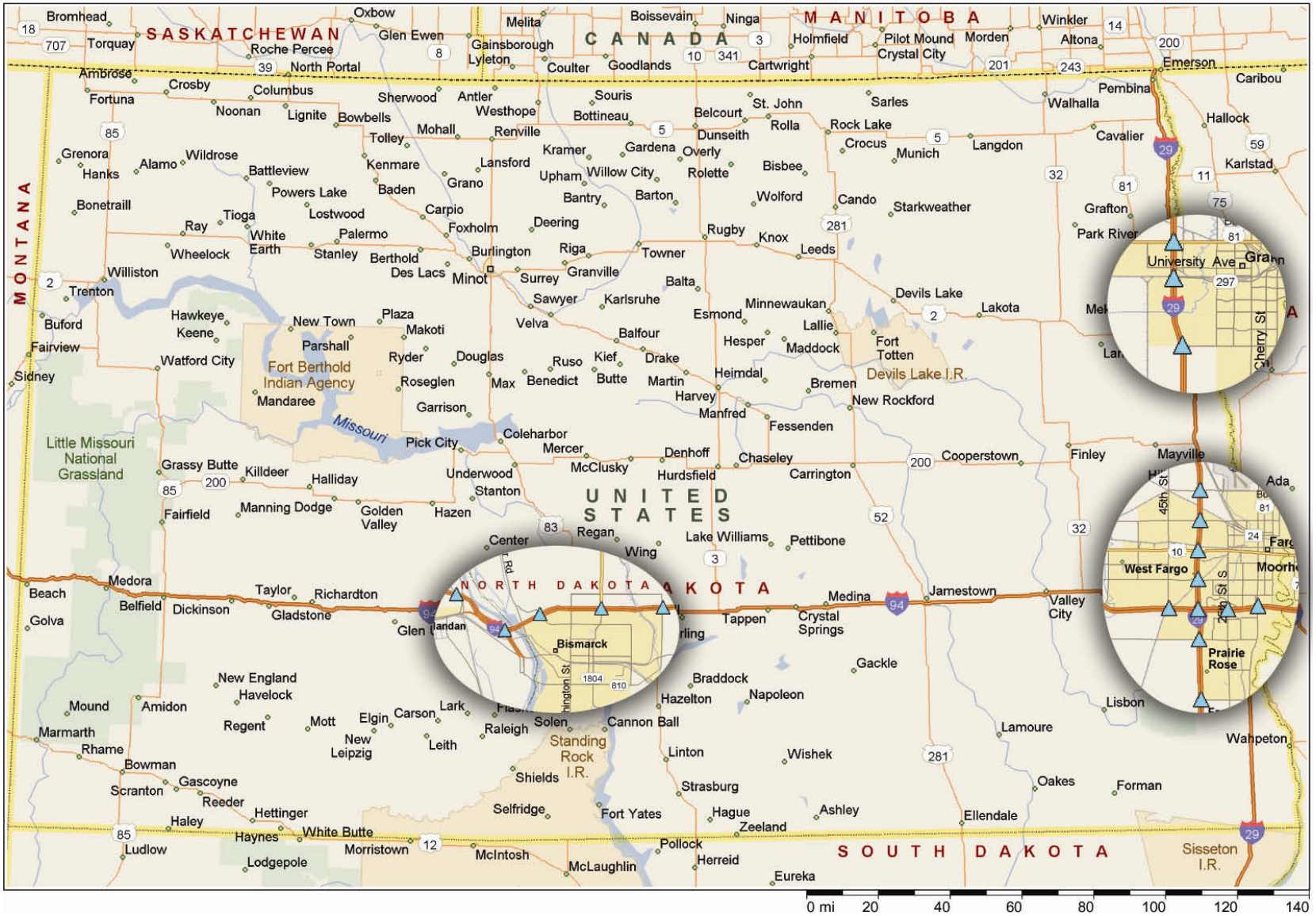


Figure 4 Freeway Surveillance/Monitoring

9.2.4. *High Wind Warning Systems*	
Project Champions	NDDOT Maintenance
Project Locations	US 2 RP 313.2; see following map
Project Description	Install warning system in conjunction with an RWIS station where wind poses a hazard for motorists, especially large trucks and buses
Project Costs	$1,000 - $5,000
Technologies	1. Sensors 2. Communications 3. DMS/blank-out sign
Project Function	1. Detect high wind conditions 2. Provide warnings to travelers of hazardous conditions due to wind velocity

9.2.5. *Over-height Detection System*	
Project Champions	NDDOT Maintenance
Project Locations	I-29 RP 196 to 217; see following map
Project Descriptions	Install sensors to detect when a vehicle height is greater than the clearance of an upcoming bridge
Project Costs	
Technologies	1. Sensors 2. Communications 3. DMS/blank out sign
Project Functions	1. Detect when a vehicle height is greater than that of the upcoming bridge clearance 2. Send a message to a DMS or blank-out sign warning the vehicle and possible providing an alternate route

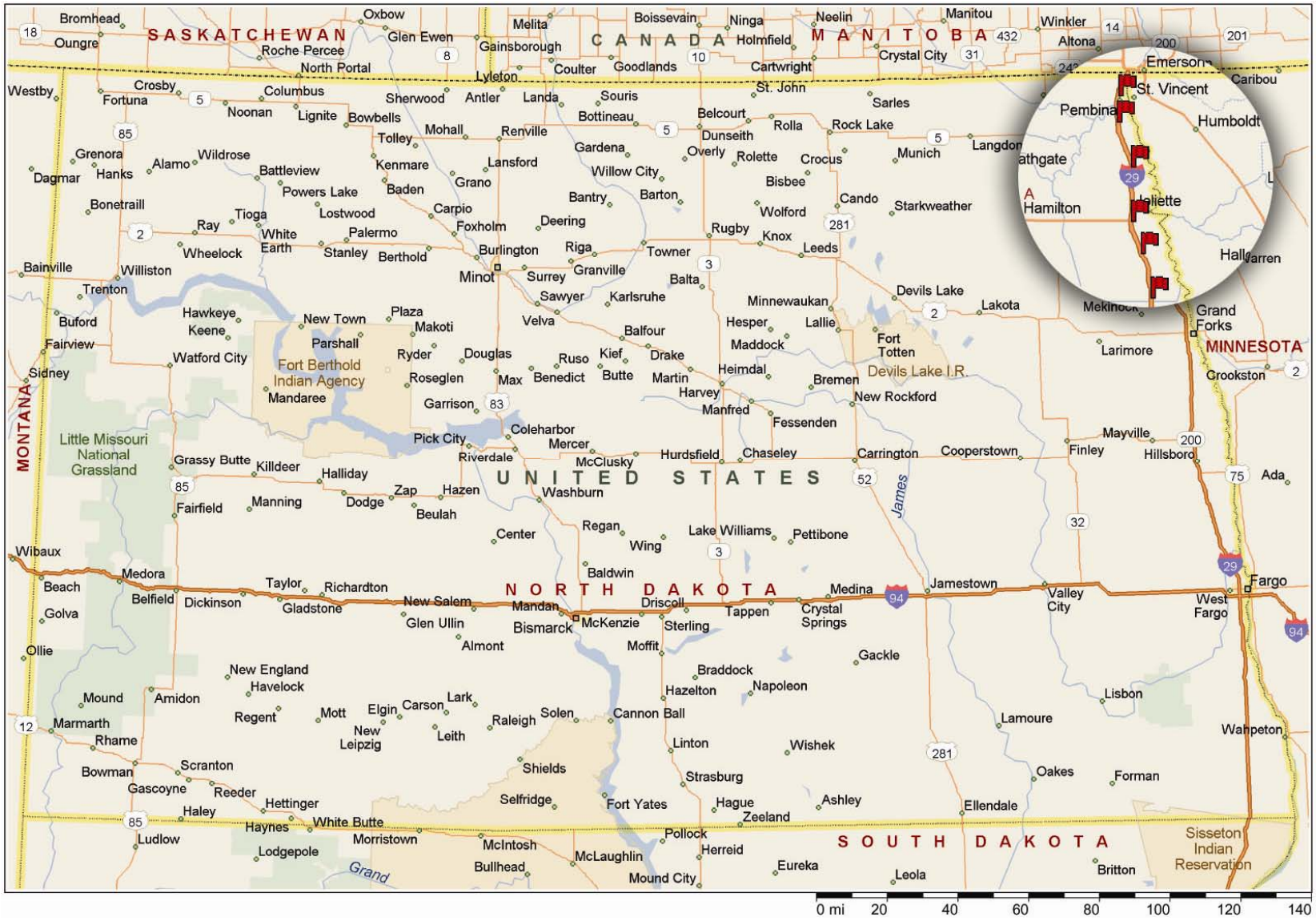


Figure 5 Over-height Detection Systems

9.2.6. *Non-Intrusive Traffic Data Collection System*	
Project Champions	NDDOT Traffic Section
Project Description	Develop a system for collecting data on These sites would be on the Urban Interstate System, Urban Interregional Corridors, and Rural Interregional Corridors. Those sites off the state highway system include Urban Functional Classified roads in the 13 major cities.
Project Cost	$4,000-$8,000 per site
Technologies	1. Radar 2. Video 3. Communications
Project Functions	Count and classify traffic at high-traffic volumes roadway locations

9.2.7. *Permanent DMS*	
Project Champions	NDDOT Maintenance
Project Locations	I-29 NB RP 0.5 Casino Exit I-29 SB RP 1.5 Casino Exit I-29 NB RP 59.5 52nd Avenue S - Fargo I-29 SB RP 62.5 32nd Avenue S - Fargo I-29 NB RP 65.5 12th Avenue N - Fargo I-29 SB RP 67.5 19th Avenue N - Fargo I-29 NB RP 137 32nd Avenue S - Grand Forks I-29 SB RP 138.5 32nd Avenue S - Grand Forks I-29 NB RP 140.5 US 2 - Grand Forks I-29 SB RP 142 US 2 - Grand Forks I-29 NB RP 214.5 Pembina I-29 SB RP 215.5 Pembina I-94 EB RP 0.5 Beach Exit I-94 WB RP 1.5 Beach Exit I-94 EB RP 57.6 Business 94 (13th Ave SW) - Dickinson I-94 WB RP 59.5 Business 94 (13th Ave SW) - Dickinson I-94 EB RP 63.5 Business 94 (Old Hwy 10) - Dickinson I-94 WB RP 65.7 Business 94 (Old Hwy 10) - Dickinson I-94 EB RP 150 Sunset Drive - Mandan I-94 WB RP 152.5 Sunset Drive - Mandan I-94 EB RP 160.5 Business 94 - Bismarck I-94 WB RP 162 Business 94 - Bismarck I-94 EB RP 256.5 Jamestown I-94 WB RP 257.5 Jamestown I-94 EB RP 259.5 Jamestown I-94 WB RP 260.5 Jamestown

	I-94 EB RP 289.5 Valley City I-94 WB RP 290.5 Valley City I-94 EB RP 293.5 Valley City I-94 WB RP 294.5 Valley City I-94 EB RP 347.5 45th Street S - Fargo I-94 WB RP 349 45th Street S - Fargo I-94 EB RP 351.5 Red River Bridge - Fargo US 2 Devils Lake US 2 Minot (see following map)
Project Description	Install permanent DMS along major highways
Project Cost	$48,000 - $120,000 per DMS
Technologies	1. LED, full matrix signs 2. Mounting unit 3. Communications
Project Functions	1. Disseminate information about road conditions and closures, incidents, Amber Alerts, safety campaigns, and special events

9.2.8. *Snow Plow Collision Avoidance System*	
Project Champions	NDDOT Maintenance
Project Description	Install collision-avoidance radar on snow plows across state
Project Cost	$5,000 - $25,000 per unit
Technologies	Radar, infrared, ultrasonic, etc
Project Functions	Provide a system which warns snow plow operators of objects or stalled vehicles in their path that may not be visible due to weather/road conditions.

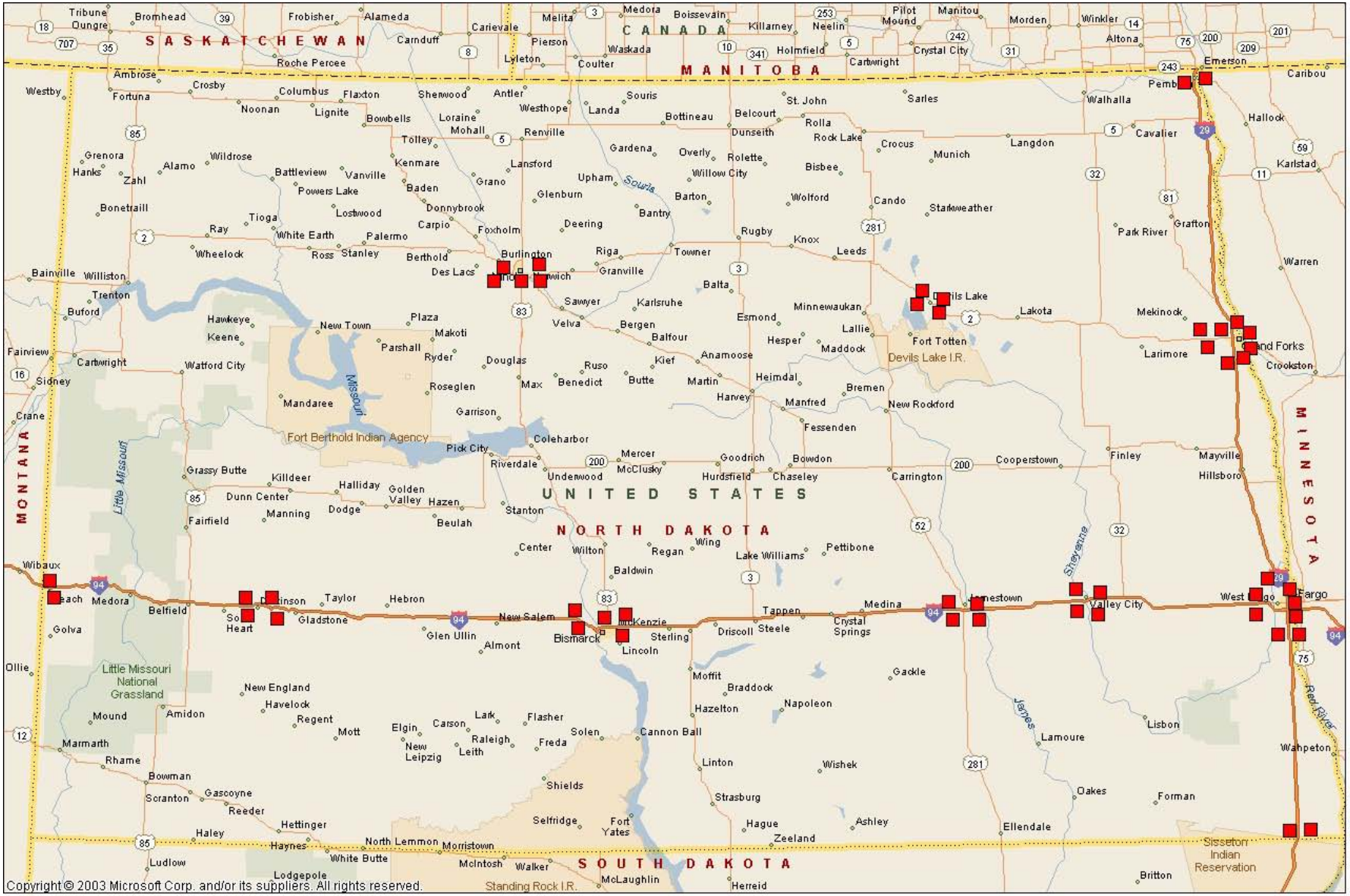


Figure 6 Locations for Permanent DMS

9.2.9. *Weigh-in-Motion (WIM)*	
Project Champions	NDDOT Maintenance Highway Patrol
Project Description	Install WIM at key locations across the state, particularly where manned weigh stations have been closed.
Project Cost	$14,000-$21,000 per site
Technologies	1. Fixed load cell 2. Interface to roadside facility 3. Communications
Project Functions	1. Detect over-weight vehicles for enforcement 2. Provide tuck traffic and weight data for road planning and design

9.3 Low-Priority Projects

9.3.1. *Automated Road Closure Gates*	
Project Champions	NDDOT Maintenance ND Highway Patrol
Project Locations	I-29 Casino Interchange at RP 1 (ramps and loops) I-29 SB near NW ramp at Exit 62 (32nd Avenue S) I-29 SW entrance ramp at Exit 62 (32nd Avenue S) I-29 WB loop at I-94 Interchange I-29 SB at Exit 64 (13th Avenue S) I-29 NW loop and NW ramp at Exit 64 (13th Avenue S) I-29 NB at Exit 66 (12th Avenue N) I-29 NB at Exit 67 ramp gate (19th Avenue N) I-29 EB at Exit 67 (19th Avenue gate) I-29 WB at 19th Ave N and Dakota Drive I-29 NB and SB at Exit 104 I-29 SB at Exit 138 (32nd Ave S) I-29 NB at Exit 145 I-94 EB at Exit 1 I-94 WB at Exit 59 I-94 EB at Exit 64 I-94 WB at Exit 152 I-94 WB entrance ramp at Exit 152 I-94 EB at Exit 161 I-94 EB entrance ramp at Exit 161

	I-94 WB at Exit 257 I-94 EB and WB at Exit 258 (US 281) I-94 EB and WB at Exit 260 I-94 WB at Exit 290 I-94 EB and WB at Exit 292 I-94 On Ramp at Exit 294 I-94 NW and SE Entrance Ramps I-94 WB at Exit 343 (Main Ave) I-94 EB and WB at Exit 346 (Horace Interchange) I-94 NW entrance ramp at Exit 348 (45th Street) I-94 WB at Exit 348 (45th St - Mainline Gate) US 2 EB at Interchange - GF Air Force Base US 2 WB at Co. Rd. 5 and Airport Road US 2 EB at East Jct & WB at West Jct of Burdick Expressway US 2 EB at East of Jct ND 1 US 83 NB at 24th Avenue NW US 83 SB at 31st Avenue SW US 83 NB at Century Avenue ND 13 WB at Jct ND 210 ND 13 WB at RP 389
Project Description	Install automated gate closures to assist maintenance personnel in case of storm closures
Project Costs	$100,000 - $150,00 per automated gate $50,000 - $120,000 per permanent DMS
Technologies	1. Automated road closure gates 1. DMS 3. Communications 4. Video Camera
Project Functions	2. Automate road closure gate operations 3. Warn drivers of closed road with DMS

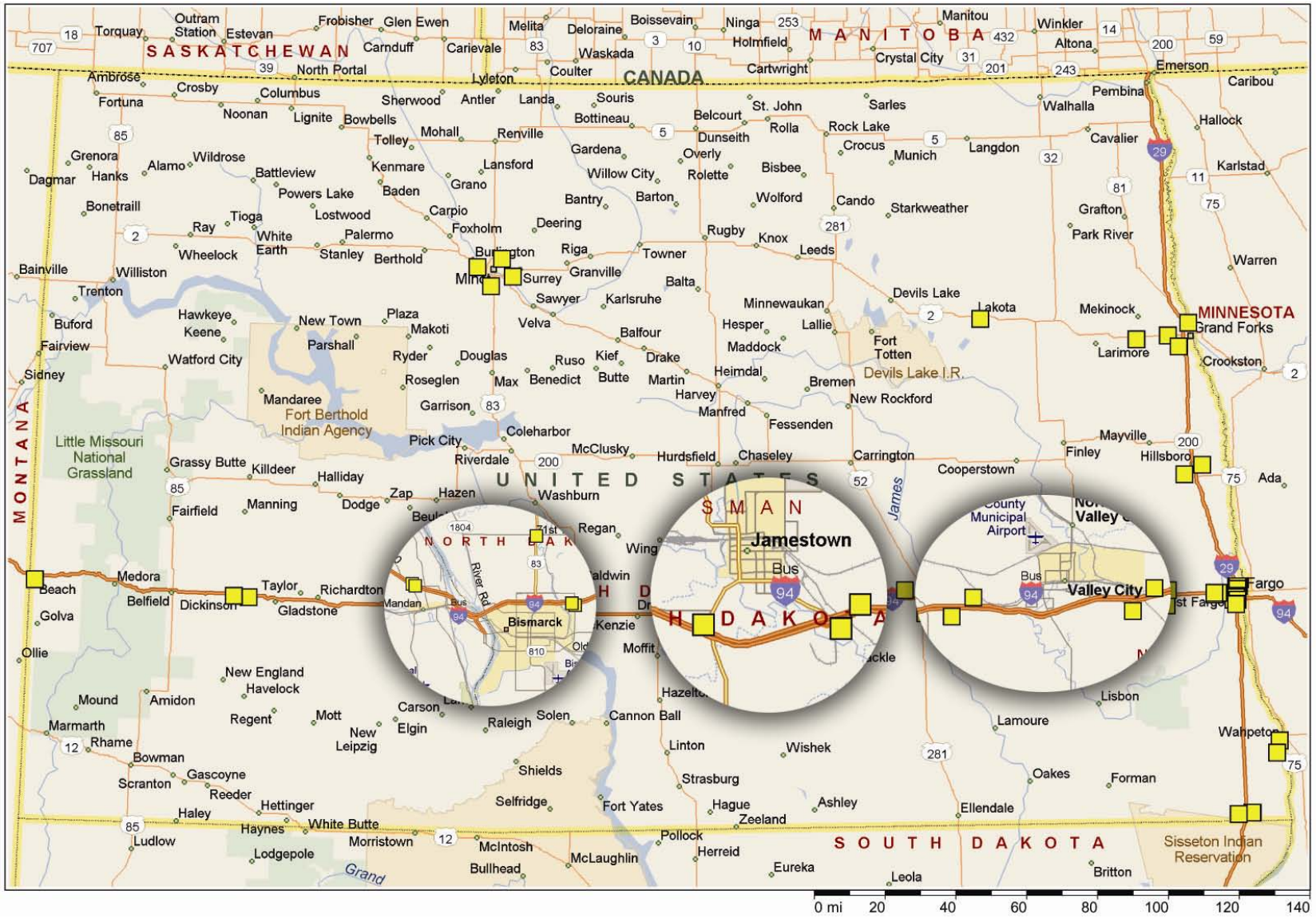


Figure 7 Possible Locations for Automated Gates

Figure 8 Fargo-Moorhead Area Locations for Automated Gates

9.3.2. *Kiosks*	
Project Champions	NDDOT Maintenance ND Tourism
Project Locations	Visitor centers across state
Project Description	Install kiosks at remaining visitor centers across state
Project Cost	$9,500-$50,000 per site
Technologies	1. Hardware 2. Enclosure 3. Installation 4. Modem server 5. Communications
Project Functions	1. Provide information about road conditions, weather, special events and tourist information to travelers 2. Provide public access to internet

9.3.3. *Portable DMS*	
Project Champions	NDDOT Maintenance
Project Description	Purchase portable DMS to replace outdated components
Project Cost	$21,000-$26,000 per sign
Technologies	1. LED sign 2. Solar power units 3. Trailer 4. Communications
Project Functions	1. Supplement at permanent locations until permanent boards can be purchased 2. Use in construction and maintenance projects during the summer

9.3.4. *Portable Traffic Management Systems*	
Project Champions	NDDOT Maintenance
Project Description	Purchase of a portable traffic management system for use during construction and maintenance projects across the state
Project Cost	$90,000
Technologies	1. Structure 2. Tower 3. Cameras 4. DMS 5. Trailer 6. Sensors 7. Wireless communications 8. Vehicle speed radar
Project Functions	1. Gather information and monitor traffic data 2. Manage traffic flow 3. Provide information to drivers

9.3.5. *Regional Transit Management and Security*	
Project champions	NDDOT Transit, Regional Transit Systems
Project description	Install automatic vehicle tracking and communication systems on rural transit vehicles (para-transit) to improve transit fleet management and services to customers
Project costs	$500 - $800 per AVL unit $150 - $250 per unit cell/wireless radio with data capacity $5,000 - $10,000 per workstation and supporting software
Technologies	4. AVL hardware and software 5. Two-way wireless communications 6. Routing/scheduling software
Functions	7. Real-time information on transit vehicles' location and status 8. Dynamic routing and scheduling 9. Two-way wireless communications between transit vehicle and a. Transit dispatch b. Emergency responders (police, fire)

10.0 ITS IMPLEMENTATION STRATEGY

This section presents recommendations for implementing the North Dakota ITS Plan. It offers suggestions for next steps in deployment and discusses potential coordination between ITS projects and the NDDOT STIP.

10.1. Recommendations for ITS Deployment

10.1.1. Organizational

1. Increase staff resources available for ITS planning, design, and deployment
   a. Create a full-time ITS Engineer position to streamline and coordinate ITS activities within the NDDOT
   b. Implement an active ITS training program to increase number of staff with ITS know-how in a wide range of application areas (i.e., safety, traffic operations, design, construction, customer service)

2. Create a NDDOT ITS implementation team
   a. Membership of team representative of NDDOT sections responsible for planning/programming, designing, constructing and funding transportation projects
   b. The team facilitates the ITS review process developed by NDDOT management for deploying ITS as part of other road construction projects

10.1.2. Institutional

1. Reach out to other relevant agencies to join in implementing the NDDOT ITS Plan, including:
   a. North Dakota Highway Patrol
   b. North Dakota Division of Emergency Management
   c. North Dakota's local government, especially the three MPOs located in Bismarck-Mandan, Fargo-Moorhead and Grand Forks-East Grand Forks
   d. Neighboring states/provinces (MB, MN, MT, SK, and SD)

2. Participate in regional consortiums that could expand funding, allow for peer-to-peer exchange and increase staff training in ITS

3. Develop an awareness campaign for elected officials and political appointments in the state to explain the critical role ITS play in improving transportation safety and mobility
   a. Distinguish ITS from information technology
      i. ITS are an integral part of solid transportation engineering tools used to solve today's transportation problems
   b. Provide for user feedback on ITS performance. The best testimony for ITS is the satisfaction and convenience of the users (i.e., positive comments about 511)

10.1.3. Systems Integration

1. Emphasize a systems approach to ITS deployment rather than fragmented deployment of technologies
   a. Use ITS Architecture to outline system functions and requirements
   b. Use systems engineering process to identify optimum design

2. Develop NDDOT ITS Design Manual
   a. Provide information about NDDOT's ITS technologies, priority areas and specifications
   b. Work to develop a short list of pre-qualified vendors for supplying ITS hardware and services

3. Integrate existing ITS with new systems
   a. Use ITS Architecture and standards to ensure compatibility

4. Integrate ITS with legacy systems

10.1.4. ITS Architecture

1. Complete North Dakota's statewide ITS Architecture development
   a. Create a NDDOT ITS Architecture development team
   b. Outline possible involvement from other agencies
      i. Identify potential agreements

2. Develop a process for maintaining and updating the NDDOT's ITS Architecture

3. Provide training on the NDDOT's ITS Architecture to staff

10.2. Coordinating ITS with STIP

Probably one of the most critical success factors in effective ITS deployment is the integration with the transportation planning process. Therefore, it is important to explore opportunities presented in already programmed STIP projects. There are often significant cost savings by including ITS in traditional construction projects. For example, construction costs make up a significant portion of fiber optics communication installation costs. Therefore, installing fiber as part of a programmed construction project would eliminate additional costs.

However, it is not always possible to take advantage of already programmed projects in order to deploy ITS components. The NDDOT is in the process of developing a funding strategy for ITS projects which would take advantage of possible linkages to the STIP, while exploring other funding mechanisms.

ACRONYMS

AAA	American Automobile Association
ATR	Automated Traffic Recorders
ATWIS	Advanced Transportation Weather Information Systems
AVI	Automated Vehicle Identification
AVL	Automatic Vehicle Location
CCTV	Closed Circuit Television
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
DFD	Data Flow Diagram
DMS	Dynamic Message Sign
EAS	Emergency Alert System
EMS	Emergency and Medical Services
GIS	Geographic Information Systems
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
ISP	Information Service Provider
ITD	Information Technology Department
ITS	Intelligent Transportation Systems
IVI	Intelligent Vehicle Initiative
MOE	Measure of Effectiveness
MPO	Metropolitan Planning Organization
NDDOT	North Dakota Department of Transportation
NDHP	North Dakota Highway Patrol
NDMCA	North Dakota Motor Carrier Association
NDSU	North Dakota State University
NTCIP	National Transportation Communications for ITS Protocol
RPU	Remote Processing Unit
RWIS	Roadway Weather Information Systems
SDDOT	South Dakota Department of Transportation
STIP	Statewide Transportation Improvement Program
TIP	Transportation Improvement Program
TOC	Traffic Operations Center
UND	Univerisity of North Dakota
USDOT	United States Department of Transportation
WIM	Weigh-in-Motion