October 2009

ENTERPRISE

http://enterprise.prog.org

# Work Plan for FY 2009


Prepared by:

**Castle Rock Consultants**

CASTLE ROCK

# 1. Executive Summary

## *1.1 Program Overview*

The ENTERPRISE Program is a pooled-fund organization with member agencies in the United States, Canada, and the Netherlands. The main purpose of the Program is to use the pooled resources of its members, private sector partners, and the United States federal government to develop, evaluate, and deploy Intelligent Transportation Systems (ITS).

As part of its mission, ENTERPRISE seeks to facilitate the sharing of technological and institutional experiences gained from its own ITS projects and the projects of its individual members.

## *1.2 Mission*

By sharing funding, resources, and risks, the ENTERPRISE Program provides a forum for multi-agency international and public-private initiatives to conduct member-supported research, development, and demonstration activities to advance innovative solutions that improve the quality of transportation service.

## *1.3 Ongoing Projects*

Ongoing projects are defined as those projects that were approved in prior fiscal years and which are still in progress. The ENTERPRISE Program currently has five ongoing projects, as follows:

1. Intersection Collision Avoidance Phase 2 - Monitoring traffic on minor roads to warn travelers of potential dangers at upcoming intersections. The original project budget was $70,000, with $50,000 for the testing in phase two.

2. Renewable Energy for Rural ITS Applications - Using solar and wind energy to power ITS devices in remote areas. The project budget was $65,000, all of which was funded for this project year.

3. Nationwide ATIS – Looking at ways states and other agencies can share traveler information across larger regions. The project will research potential design and legal implications for such a system, create a concept of operations, feasibility study, and a recommended deployment approach. The project budget is $25,000.

4. Autonomous Monitoring Station Phase 2 – Learning from the findings of phase one, this project will upgrade the AMS equipment and design a new more user-friendly interface for the software application.

5. IP Cameras – Deploying low-cost Satellite IP Cameras (SIPC) – incorporating video capture, solar power and internet communications – to remove the need for expensive power and communications infrastructure costs.

### 1.4 New Projects

New projects are defined as those projects that have been approved for the current fiscal year, which starts on January 1, 2009 and ends December 31, 2010 (referred to as FY2009) as part of the work program. The ENTERPRISE Executive Board has approved two new projects for funding during the FY2009 period, as follows:

1. ITS Warrants Phase 2 –Continuing the testing and outreach of warrants developed under phase 1, this project will develop warrants for traffic detection, dynamic speed display signs, curve warning signs, and ramp meters

2. Virtual TMC – Creation of a mobile traffic management center that can be accessed through PDA and other capable cell phone technology. The software application will be standards compliant and available for testing in several states.

3. Third Party Mapping - Focusing on the needs of transportation agencies to form partnerships with private sector mapping providers. The project will explore the issues involved in establishing such a partnership between 2-3 mapping providers.

4. Intelligent Highways Phase 1 - Looking at the concept of intelligent or "thinking" highways using miniature, low cost, and maintenance free sensors in the road surface.

## Program Overview

The ENTERPRISE Program represents a forum for collaborative ITS research, development, and deployment ventures reflecting the interests of governmental entities and industrial groups. This forum also facilitates the sharing of technological and institutional experiences gained from individual ITS projects conceived and initiated by each participating entity.

ENTERPRISE is a group of states and provinces joined by the mechanism of a pooled-fund program. The intent is to use the pooled fund to support jointly-sponsored ITS projects of shared interest. These projects form the annual ENTERPRISE work plan.

The scope of the ENTERPRISE Program promotes North American ITS development, reflecting the active involvement of U.S. and Canadian member agencies. ENTERPRISE also seeks to take advantage of technologies being developed outside North America. ENTERPRISE's European member is the Dutch Ministry of Transport, Rijkswaterstaat.

### *1.5 Goals & Objectives*

The vision for the ENTERPRISE Program is to be a recognized leader in delivering proven, useful, solutions to the transportation community. To achieve this vision, ENTERPRISE members have developed the following mission statement (most recently updated during the May 2004 Board meeting) to guide the program's activities: By sharing funding, resources, and risks, provide a forum for multi-agency international and public-private initiatives to conduct member-supported research, development, and demonstration activities to advance innovative solutions that improve the safety, mobility and functionality of transportation services for all modes.

The goals for ENTERPRISE aim to define areas of benefit that the group intends to pursue. ENTERPRISE goals include the following:

- Increase highway safety;
- Reduce highway congestion;
- Increase highway efficiency;
- Reduce environmental impacts of travel;
- Increase comfort and convenience of travel; and
- Support research and development of promising advanced technologies for use in solving transportation problems.

The ENTERPRISE objectives cite activities or areas of work that will support realization of the above goals. General objectives for ENTERPRISE include:

- Support the individual ITS program plans of ENTERPRISE participants;
- Provide a mechanism to support multi-state and international project cooperation and technical information interchange;

- Facilitate the formation of public-private partnerships for appropriate program activities;
- Pursue emerging ITS project opportunities in areas of interest to the group;
- Provide test beds in a variety of environments and locations for emerging ITS technologies; and
- Identify common needs within the group and proceed with appropriate technical activities.

### *1.6 Program Participants*

As of September 2008 the following transportation agencies are represented on ENTERPRISE's Executive Board with full voting rights:

- Arizona Department of Transportation
- Dutch Ministry of Transport, Rijkswaterstaat
- Federal Highway Administration
- Iowa Department of Transportation
- Kansas Department of Transportation
- Michigan Department of Transportation
- Ministry of Transportation of Ontario
- Minnesota Department of Transportation
- Transport Canada
- Virginia Department of Transportation
- Washington State Department of Transportation
- Maricopa County Department of Transportation, Arizona

There are other agencies from North America and overseas that continue to follow ENTERPRISE's activities. However, only those organizations listed above are members of the program's Executive Board.

### *1.7 Program Structure*

The ENTERPRISE organizational structure is arranged to maximize the group's ability to meet its objectives and to minimize bureaucratic impediments that sometimes result from the management of a large group. The figure below shows the organizational structure of ENTERPRISE.

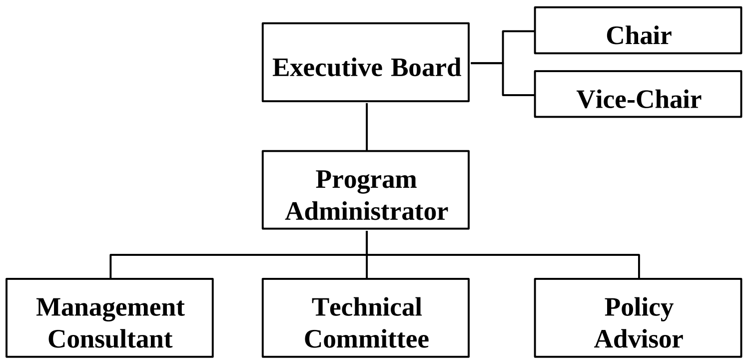


*Figure 1: Organizational Structure*

## 1.8 Executive Board

The Executive Board consists of one voting representative from each active member agency. All of ENTERPRISE's operating authority derives from the Executive Board. It is responsible for overall policy direction and budget approval as well as for organizing itself, establishing operating rules and conducting other business. The Board gave voting membership to the two federal agencies in ENTERPRISE: FHWA and Transport Canada. FHWA, however, does not vote on matters involving the expenditure of federal funds over which it has approval authority, such as State Planning and Research (SP&R) funds.

### 1.8.1 Program Chairs

The Program Chair serves as the head of the Executive Board for a two-year period. The duties of the Chair include developing meeting agendas, chairing meetings, and representing ENTERPRISE in discussions with other organizations.

The Program Vice Chair is elected by vote of the Executive Board and also serves this position for a two-year period. The Vice Chair is responsible for supporting the Chair, including temporarily assuming the duties of the Chair during periods of absence. The vice chair ultimately assumes the position of chair by vote after the chair serves his or her two year term.

At the August 2004 meeting, Bill Legg was elected Chair of the Enterprise Board. The new Chair and was formalized at the December 2004 meeting. Gene Martin was elected Vice Chair at the April 2006 meeting, which was formalized in August 2006.

Chair
Mr. Bill Legg
Washington State DOT
310 Maple Pk Ave, S.E.,
Olympia , WA 98501
leggb@wsdot.wa.gov

Vice Chair
Mr. Gene Martin
Virginia DOT
1401 East Broad Street,
Richmond, VA 23219
E.Martin@VDOT.Virginia.gov

### 1.8.2 Program Administrator

The Program Administrator operates under delegated authority from the Executive Board and is responsible for day-to-day management of ENTERPRISE. The administrator is an employee from the lead administrative state that controls expenditures from the program's pooled funds. The Program Administrator is responsible for contract administration. The Administrator is also responsible for quality control and evaluation, recommendations on contract preparation, change order requests, authorizing payments, and for informing the Executive Board of all contract progress. Finally, the Administrator is responsible for administering the ENTERPRISE management budget and approving all travel authorizations.

**Program Administrator**
Mr. John Whited
Iowa Department of Transportation
800 Lincoln Way
Ames, Iowa 50010
(515) 239-1411
jwhited@dot.state.ia.us

### 1.8.3 Technical Committees

ENTERPRISE Technical Committees are established to study, in detail, those areas of group interest identified by the Executive Board. Potential committee activities include problem definition, analysis of alternative approaches, RFP development, project selection recommendations, project oversight, and future program planning. Voting authority on the technical committees is limited to Executive Board member agencies. This authority may be given to an agency's full Board member or a designated representative.

### 1.8.4 Management Consultant

The role of the Management Consultant is to provide general and specific support to the Chair, Program Administrator, and program participants on an ongoing basis. These duties may range from preparing meeting agenda and minutes to coordinating complex technical studies and activities.

**Management Consultant**
Castle Rock Consultants
6222 SW Virginia Ave, #2
Portland, Oregon, 97239
(303) 449-4242
james.davies@crc-corp.com

## *1.9 Project Definition*

The following three approaches discuss how ENTERPRISE defines and develops projects:

### 1.9.1 Review of state and provincial plans

On an ongoing basis, the Management Consultant remains appraised of the activities, interests, and state/provincial ITS plans of the ENTERPRISE members. The Management Consultant identifies common themes among program participants, which can be used as guidelines by others in preparing project outlines. These common themes may be used as the basis for developing further project outlines for group consideration.

### 1.9.2 Proposals by ENTERPRISE members

ENTERPRISE members propose projects that are developed through discussions with colleagues in the participants' state/provincial transportation agencies. Although proposed projects may initially reflect the interests of the proposing state or province, it is in their best interest to suggest activities with broad group appeal. This increases the chances of support by other Executive Board members. To facilitate this, a summary of identified areas of common interest is prepared and distributed to the members by the Management Consultant.

In many cases, the specific interest of a member is expanded into a project that incorporates the interests of other members. Members are encouraged not to propose projects that represent proprietary interests of private sector agencies, as the project may be modified by the Executive Board and/or selection of contractors may involve a competitive bid.

### 1.9.3 FHWA & Transport Canada

ENTERPRISE offers its services to FHWA and Transport Canada for the coordination of appropriate ITS activities that address national and North American interests. These activities could include projects that might otherwise be performed by individual agencies, but are more ideally suited for delegation to ENTERPRISE because it represents a broad spectrum of ITS stakeholders.

## *1.10 Project Selection*

In general, ENTERPRISE projects are considered on an annual basis. This supports development of an annual work plan with a consistent schedule. However, if a member identifies a project that offers significant immediate benefits or takes advantage of short-term opportunities, the member may suggest it to the group for early consideration. The group can then choose to accept such projects for fast-tracked initiation, reject them, or delay a decision until the start of the normal work plan development process.

### 1.10.1 Selection Process

Project outlines, no more than two pages long, are submitted to the members, who use them to narrow down activities for the coming fiscal year. ENTERPRISE then convenes a meeting, if necessary, to discuss and select projects. Telephone, Internet or facsimile polling is also an option. At this time, the members narrow down the number of projects for further consideration. These projects form the initial basis of the annual work plan.

The projects still under consideration are elaborated into more detailed work scopes. Based on these detailed work scopes, the members select those projects that, based on funding and other considerations, are undertaken by ENTERPRISE.

Following project selection, the work scopes are refined based on previous discussions and are prepared for final vote and approval. Once approved, the work scopes are included in the annual work plan and submitted to FHWA as an indication of ENTERPRISE's plans for the coming year.

For the projects in the annual work plan, Requests For Proposals (RFP) and other contract documents are developed and mailed to prospective bidders. The Program Administrator reviews proposals and determines compliance. All compliant proposals are mailed to the appropriate ENTERPRISE committee members. Evaluation criteria are used by the members to facilitate the proposal selection process. The evaluation criteria are developed to match each study and are included in the appropriate RFP. Members use rankings based on these criteria to identify a short-list of preferred proposals. Short-listed teams give presentations, upon which ENTERPRISE members make final selections.

Since ENTERPRISE's legal authority to solicit proposals and award contracts lies with the lead state, the lead state's procurement process takes precedence over ENTERPRISE's Charter and Operating Rules when soliciting for and awarding contracts.

Each U.S. State DOT's procurement procedures are approved by the Federal Highway Administration. Under the procurement rules of the current lead state Iowa, solicitation lists produced by other American states may be used to award contracts for the state of Iowa provided that the award is within the soliciting state's scope of work.

### 1.10.2 Selection Criteria

The selection process for projects is designed to quantify the relative importance and value of proposed initiatives based on the group's requirements. Each member ranks each proposed project and the most useful projects are chosen for inclusion in the annual work plan.

The five selection criteria used to assess individual projects (as updated and approved by members at the May 2004 Board meeting) are as follows:

- Value to members efforts (0–20 points) – members rank the project based on the value they will receive from the completion of the project.
- Suitability to ENTERPRISE (0–20 points) - determines whether or not a project is appropriate for ENTERPRISE to pursue based on its goals and objectives, timing, and consistency with group needs.
- Project feasibility (0–20 points) – asks whether the project could be effectively implemented by the group, considering such things as external developments, timing and overall direction of the industry.
- Validity of approach (0–20 points) – establishes whether the methodology is logical includes all of the proper elements for a complete project.

- Cost realism (0–20 points) – Assesses the anticipated costs for the proposed project to determine whether they seem reasonable and appropriate.

Once the individual agencies rank the proposed projects, the Program Administrator combines the results, and identifies the contenders by their rankings.

When the final project descriptions have been expanded into work scopes, they go through a final ranking process by the Board. While several may be included in the annual work plan they do not necessarily receive full or even partial funding. The Board attempts to fully fund the highest ranked projects. If there are additional funds, the Board allocates them to the remaining projects. This allocation is normally based on a project's ranking and its need for initial seed money to further develop and expand the concept and scope.

Each agency is afforded the opportunity to choose not to participate in a project. This decision means that the non-participating agency does not take part or fund an effort with which other agencies may choose to proceed. The lack of allocation of funding by any one agency does not prevent projects from being undertaken if they are considered important enough, and sufficiently highly ranked, by the other participants.

## *1.11 Work Plan Development Schedule*

The FY2009 Annual Work Plan was developed based on the process described above. New project proposals were distributed to all Board members for their review. A conference call followed that allowed members to put questions to the proposers about their respective project ideas. Following brief presentations at the August meeting, Board members submitted their evaluations of the projects (i.e., scoring sheets) to the Program Administrator.

Board members indicated their willingness to "champion" the different project proposals. Based on the review and feedback received from all Board members, a draft version of the project scopes was developed and distributed to all members. The final comments and revisions were incorporated by the management consultant team, and the final Annual Work Plan for FY2009 was submitted to FHWA for review.

## *1.12 Project Management*

Technical Committees serve to manage projects from a technical perspective. The Management Consultant provides technical support to the committees on an as-needed basis. The Program Administrator serves as the contract manager and is responsible for all specific and performance-related contract compliance.

## 2. Ongoing Projects

This chapter summarizes the Enterprise projects that are currently ongoing. These projects have been approved by the Executive Board for implementation during previous years. A brief description and status is provided for each of the projects currently ongoing. The next chapter provides a description of the new projects that have been approved for the FY2007 period.
The following projects are ongoing:

**Intersection Collision Avoidance Phase II** - Monitoring traffic on minor roads to warn travelers of potential dangers at upcoming intersections. ENTERPRISE will fund $50,000 this year, to cover the project's phase two.

***Status/Update:*** This project was delayed until the publication of a Swedish Department of Transportation report, and for the test site installation in Michigan. It is expected to conclude during the 2009 cycle.

**Renewable energy for rural its applications** - Using solar and wind energy to power ITS devices in remote areas. The project budget was $65,000, all of which was funded for this project year.

***Status/Update:*** This project has been delayed due to installation issues but is expected to conclude in the first half of 2009 with a final report

**Nationwide Advanced Traveler Information System (ATIS)** – Create a Concept of Operations, feasibility study, and recommend deployment approach for ATIS. The project budget is $25,000

Status/Update: This project is in development and expected to conclude during the 2009 cycle.

**Autonomous Monitoring Station Phase 2** – Learning from the findings of phase one, this project will upgrade the AMS equipment and design a new more user-friendly interface for the software application.

Status/Update: The test station is functional and was installed in the fall of 2008. Data collection will take place until March 2009, giving the project one full winter season of data to use in the final report.

**IP Cameras** – Deploying low-cost Satellite IP Cameras (SIPC) – incorporating video capture, solar power and internet communications – to remove the need for expensive power and communications infrastructure costs.

Status/Update: Difficulties were experienced with the solar power part of the project. The pilot now includes a backup power source and was set up in a different location from the original plan. Data collection is currently underway, with a final report to follow.

## 2.1 Intersection Collision Avoidance Phase II

Intersection crashes account for almost 44% of total vehicle crashes in the United States. According to a University of North Carolina study, there are approximately three million intersection-related crashes and 8,500 fatalities at intersections each year. Intersection collision avoidance is particularly important in rural, non-signalized intersections, since 85% of fatal intersection crashes occur at junctions without signals. The primary reported causes for intersection collisions include misjudgment of the situation, failure to correctly observe the situation, and inability to accurately perceive the degree of danger at the intersection. These factors should be taken into account in order to develop a successful collision avoidance system.

Several European countries have developed and implemented successful intersection collision avoidance measures, including the United Kingdom and Finland. The Swedish National Road Administration (SNRA) is launching a five year trial project on variable speed limits. This will involve equipping 18 non-signalized intersections with sensors at the cross-street to detect vehicles. Upon detection of an approaching vehicle, signs are illuminated on the main route to recommend or enforce a temporary speed reduction. This method has been proven to provide an easy, low-cost solution for reducing the number of intersection-related crashes.

Although an intersection collision avoidance system has been successfully implemented and has proven to reduce intersection-related crashes in parts of Europe, the approach has yet to be deployed in North America.

### 2.1.1 Project Summary

The primary goal of this project is to investigate the applicability of the European method of intersection collision avoidance and to help ease the deployment of this solution within North America. The scope of this project would be to first gather information on the collision avoidance methods that are successfully employed in Europe, and to document the proven benefits and costs (cost benefit ratio) of these approaches. The intent of this is to develop a 'Toolbox' description of this approach that describes each aspect of the approach as well as the anticipated benefits. This phase of the project will perform outreach and technology transfer information sharing to transportation professionals (such as statewide traffic engineers and other key decision makers). An outreach plan will be developed to perform the coordinated outreach activities, and is anticipated to include presentations at key conferences (e.g. the Rural ITS Conference, ITE, AASHTO) as well as briefings made to one or more representatives within ENTERPRISE member states. With the technology already being established for the most part, it is likely that phase one of the project will primarily address the legal and risk-management sides of the issue of applying a European system to an American road network.

The next phase of the project would involve developing and deploying the proposed collision avoidance system at a trial location(s) in order to test the effectiveness of the solution. The test would be run over a twelve month period, to allow statistics to be gathered during all weather conditions. A radar could be set up after the warning signs to establish the extent to which drivers heeded the warnings.

A final report will be written to explain the findings of both the research and deployment. This will serve as a "best practices" document and as such a manual for DOT's to reference when considering collision avoidance solutions.

### 2.1.2 Scope of Work

This project originally proposed two phases, Phase 1 being the technology transfer and information outreach, and Phase 2 being the deployment of the trial project.

Phase 2 will aim to take the recommendations provided in Phase 1 and deploy the proposed intersection collision avoidance system at one or more trial locations in member states. The ideal scenario would be that the results of Phase 1 will provide sufficient evidence of the benefit/cost relationship of this solution so that the ENTERPRISE funds set aside for the Phase 2 trial could be leveraged against additional funds from an outside source. One of two approaches is likely for Phase 2 of this project:

1. If no outside funding from other agencies is assembled, a limited deployment of 1-2 sites will provide evidence of the ease of deployment of the system coupled with the low-cost and potentially high-return associated with the reduction in intersection-related crashes.
2. 2. If sufficient cost/benefit support is gathered from previous trials in Europe to support a request for additional safety related funds, the ideal scenario would be the creation of a large scale deployment for Phase 2 of the project.

### 2.1.3 Project Schedule

The estimated duration of phase two of this project is:
January 2008 – December 2009

### 2.1.4 Project Deliverables and Costs

**Task Cost**
Task 1: Phase one **Completed**
Task 2: Phase two $50,000
**Total $50,000**

### 2.1.5 Project Participants

Michigan Department of Transportation

### 2.1.6 Project Contact

**Joe Finch**
Michigan Department of Transportation
1420 Front Ave, N.W.
Grand Rapids, MI 49504

## 2.2 Development and Field Evaluation of Renewable Electric Power Station for Rural ITS Applications

### 2.2.1 Background

Recent advances in sensing, communication and computing technologies have produced various Intelligent Transportation Systems (ITS) devices that can be used for directly improving traffic safety and efficiency in rural areas [1-5]. The types of ITS technologies that are ready for deployment in rural areas include traffic-activated advisory signs, advance warning signals/flashers for hazardous locations, variable message signs, animal crossing detection and road/weather condition detection/dissemination systems. However, the lack of easily accessible power source and/or the high cost of brining electric utility to remote rural areas make the deployment of such ITS technologies economically not justifiable to most transportation agencies. In Minnesota, the cost of bringing a utility power line to a rural intersection is approximately $3 per foot. Therefore for a location 20 miles away from a power distribution center it would cost $316,800.

To address the electric power issues for rural ITS deployment, a research group at the University of Minnesota Duluth (UMD) has developed a prototype renewable power station using a hybrid technology that integrates a small wind-turbine and a photovoltaic (PV) solar panel. The prototype power station has been applied to operate a street lighting system as shown in Figure 1. As it can be seen from the figure, a wind turbine is positioned at the highest point of the pole to utilize the fact that a higher wind speed is available at a higher altitude. A PV panel is located just above the light arm to avoid any shade formed by the light arm. The converted electric power is then stored into a battery bank, which currently consists of six 240Ah maintenance-free Absorbed Glass Matt (AGM) batteries providing a total 8,640Wh. This amount of stored power is sufficient to operate the attached lighting system for about 10 days. This is based on an assessment of the worst case scenario in Minnesota, where the number of consecutive days without any sun or wind may reach up to 10 days. Figure 1 also includes the picture of the prototype system, installed at Duluth, Minnesota, in operation at night.

The proposed research extends the UMD prototype technology to develop a renewable power station that can address the electric power needs for typical ITS applications in rural areas. Unlike conventional PV only based technologies, the new system has been designed to generate electricity under all weather conditions by taking advantage of a common weather fact that bad weather, i.e., lack of sun light, is usually accompanied with windy conditions. Further, most of mid/north-west states in US have strong winds during winter that has reduced daylight hours compare to summer periods.

### 2.2.2 Project Summary

First, the power requirements of typical rural ITS applications will be analyzed and a simple classification chart will be developed. A formulation based on this chart along with US wind/solar-radiation maps will be developed to determine the specifications of PV, wind turbine, and the size of battery bank for the given ITS application needs. Secondly, a prototype renewable power station will be designed and built to support the power requirements for typical ITS applications in rural areas. The prototype system will be installed at a remote rural site in Minnesota and its operational performance will be assessed during the project period. For the evaluation of the prototype system performance, the power system will be linked to an intersection lighting system which will be operated continuously during nighttime periods. The performance data to be collected include the actual production of electric power and the number of hours failed to provide electricity. These data will be used to draw a realistic estimation of power supply capability of the hybrid power station. After the evaluation is completed, a set of the design specifications for the renewable power station will be developed and made available to the ENTERPRISE member states.

### 2.2.3 Scope of Work

The major activities of the proposed project are as follows:

- *Review of renewable energy technologies.* Existing wind and photovoltaic technologies will be reviewed through literature and web search.
- *Analysis of power requirements for rural ITS applications.* Power requirements of typical rural ITS applications will be studied and analyzed. Based on the analysis results, different classes of renewable power stations will be defined in terms of watt-hour (Wh) requirements. The specification of the daily power usage for given ITS applications and local weather conditions will be used to determine the design specifications of a power station for a subject area.
- *Development of a prototype renewable power station.* An improved version of PV and wind-turbine integrated power station will be developed based on the UMD PV/wind-turbine technology. This task includes procurements of all components needed for the power station.
- *Controller design.* The controller manages the charge/discharge cycles of the battery bank and controls the actuation of applications. It will also determine when to turn on or off the inverter to conserve the energy. A controller will be designed to work fully autonomous, so that no human intervention or maintenance visit is required.
- *Installation of the prototype system at a remote rural intersection.* An intersection site located at a remote rural area in Minnesota, where the conventional electric utility is not easily accessible, will be selected for installation and testing of the prototype power station. Installation includes developing concrete foundations for anchoring the pole and cabinet, underground installation of conduit between the pole and cabinet, grounding of 8' grounding rod, and wiring.
- *Data collection and performance evaluation of the prototype system.* History of power generation by solar and wind energy will be recorded separately, and the data will be analyzed against the power consumption to evaluate sustainability of power supply for given applications.
- *Development of the design and procurement specifications.* This part is to create a knowledge base that can directly benefit the ENTERPRISE member states by utilizing the field

test results of the renewable power station. Specifications and guidelines will be developed for utilizing this new technology for powering up rural ITS applications.

### 2.2.4 Project Schedule

The estimated duration of the proposed project is 18 months as shown below:

- Literature search and review: 2 months
- Development of a renewable power station: 6 months
- Installation/integration of the prototype: 2 months
- Field operation testing and performance assessment: 6 months
- Final report: 2 months

### 2.2.5 Project Deliverables and Costs

| | |
|---|---|
| • Development and installation of a prototype system: | $ 45,000. |
| • Operational testing, Report: | $ 20,000. |
| Total | $ 65,000. |

### 2.2.6 Project Participants

- The Minnesota Department of Transportation
- University of Minnesota Duluth
- Other interested ENTERPRISE members

### 2.2.7 Project Contact

Minnesota Department of Transportation,
395 John Ireland Blvd., St. Paul, MN 55155
Phone: 651 296 1615

## 2.3 Nationwide Advanced Traveler Information System (ATIS)

Many states and regions have web-based and/or telephone-based traveler information systems. Some information is rapidly changing and is only of interest to travelers in that region, such as congestion and incident information. Some information is more slowly changing and is of interest to distant travelers who will be passing through the area in the near time frame, such as lane or road closures due to construction or weather.

A truck driver heading northwest out of Chicago does not care about the current travel time on a road segment in the Minneapolis area, but the driver does care that I-90 across southern Minnesota is closed completely due to extreme snow conditions. The truck driver needs to know that information before reaching Tomah, WI, where the choice is made whether to take I-90 or I-94. Currently, in order to gain information about a cross-country trip, the traveler must access each state or region's individual traveler information systems along the route and piece together the big picture. This is made more difficult by the fact that no standard exists for naming web sites to ensure that the traveler can easily find each site reporting on the route.

There would be value in having a single nationwide traveler information system that provides information that is of interest to the cross-country travelers. This system would not provide information that is only of regional interest, such as current congestion or incident information. Each state or region would provide their information of nationwide significance to this single system in the standardized format of the nationwide system. A traveler could access this single system and find out information affecting their entire cross-country trip from one system. Another scenario would be that multiple private systems be created.

States and regions may additionally provide information of regional interest on their own separate systems. The nationwide system could provide a link to the state or region's local system. Each state or region's separate systems do not have to be standardized across regions since one region's information of regional interest is not of value in a different region.

Because a nationwide ATIS crosses state lines, the USDOT would be a candidate for deploying and operating such a system. However, the USDOT does not have authority to operate systems on state roads. Therefore, ENTERPRISE, as a pool of multiple states, should consider the best means to bring a nationwide ATIS into existence.

### 2.3.1 Project Summary

The objective of this project would be to do preliminary analysis for a nationwide ATIS and recommend the best approach for implementing the system.

#### 2.3.1.1 Task 1: Define a concept of operations

Define a concept of operations for a nationwide ATIS, including documenting who would use the system for what purpose and what the outcome would be.

#### *2.3.1.2 Task 2: Define information*

Define information that should be considered to be a nationwide significance (as opposed to of regional interest only).

#### *2.3.1.3 Task 3: Analyze Feasibility*

Analyze the feasibility of a nationwide ATIS, including benefit/cost, technical feasibility and nontechnical considerations.

#### *2.3.1.4 Task 4: Analyze Possible Approaches*

States and regions may additionally provide information of regional interest on their own separate systems. The nationwide system could provide a link to the state or region's local system. Each state or region's separate systems do not have to be standardized across regions since one region's information of regional interest is not of value in a different region.

Because a nationwide ATIS crosses state lines, the USDOT would be a candidate for deploying and operating such a system. However, the USDOT does not have authority to operate systems on state roads. Therefore, ENTERPRISE, as a pool of multiple states, should consider the best means to bring a nationwide ATIS into existence.

### 2.3.2 Deliverables

The following products will be delivered from this project:

- Draft and final Concept of Operations working document
- Draft and final Feasibility Analysis working document
- Draft and final Implementation Recommendations working document
- Draft and final Report Incorporating working document

These products will help ENTERPRISE member states individually and collectively to pursue improvement to traveler information for cross-country travelers.

### 2.3.3 Project Schedule

This project has a nine month timeline.

### 2.3.4 Budget

**Task Cost**
Task 1: Creation of Concept of Operations document $6,250
Task 2: Creation of Feasibility Analysis document $6,250
Task 3: Creation of Implementation Recommendations document $6,250
Task 4: Creation of Report Incorporating document $6,250
**Total $25,000**

### 2.3.5 Project Participants

Federal Highway Administration

Other interested member agencies
Castle Rock Consultants

### 2.3.6 Project Contact

**Ray Starr**
Minnesota Department of Transportation
Mail Stop 725
1500 W. County Rd. #B2
Roseville, MN 55113
ray.starr@dot.state.mn.us

## *2.4 Autonomous Monitoring Station Phase 2*

The Total Monitoring Station demonstration project, during the winter of 2005 and 2006 at three locations along Highway 21 near Kincardine Ontario, successfully demonstrated; the use of 1xRTT commercial data radio communications, the use of solar power and illustrated a definite co-relation between quantifiable visibility readings from the road side sensors and driving conditions.

The conclusions of the project are that the technology worked well and that the TMS's are a useful tool for research into the co-relation between visibility, traffic conditions and human observations of road conditions. However, it was also concluded that the system was not ready for operational deployment due to a user interface which was not designed to provide a user friendly operator interface with integrated video. As well, in order to continue the research aspects an additional sensor, specifically an anemometer to measure wind speed was required. It was recommended that an algorithm be developed in order to calculate a "visibility index" using data from a variety of sensors.

It was recommended that the system be upgraded to meet the operational requirements; replace "loaned" equipment and incorporate the recommended additional sensors in order to continue research during the winter of 2007 and 2008. As well as providing a base for additional visibility research; this will allow the Ontario Ministry of Transportation (MTO) and the Ontario Provincial Police (OPP) to investigate whether the TMS would be a valuable component to a modern motorist advisor and road closure system.
Background

The TMS Demonstration Project was sponsored by ENTERPRISE with contributions by Transport Canada and the Ministry of Transportation of Ontario. In kind contributions were also provided by Delcan, Sony and Bell Mobility.

The purposes of the demonstration project were:

- to determine the suitability and reliability of the 1xRTT communications network for rapid and effective ITS deployments,
- to assess the use of solar power using conventional ITS controllers and sensors,
- to conduct research to determine the co-relation between visibility sensor readings and observations from trained observers on site,
- to evaluate co-relations between traffic behaviour and visibility, and
- to assess temporal and spatial correlations as visibility deteriorates.

Three TMS locations were selected along Highway 21 where poor winter conditions could be guaranteed. At each location a standard advance traffic controller (Hwy 401 standard ATC) were installed with:

- solar panels and batteries for power,
- 1xRTT modem and antenna for communications,
- RTMS detector for traffic monitoring,

- visibility detector for quantifying visibility levels, and
- IP camera for sending video clips.

The TMS communicated with a server at Delcan offices where the central database is housed. Users could access the server or individual field controllers using a standard browser via the Internet. Users were able to query the database and enter data associated with manual observations.

The demonstration project showed that the technology met the requirements with the exception of the video player which was not fully compliant with standard MPEG IV video thus requiring the use of an awkward custom player.

The MTO and the OPP determined that the system could meet their operational requirements however enhancements to operational user interface were required. The analysis of the visibility data, traffic data, video data and wind speed data (from an adjacent road weather information station (RWIS)) showed a co-relation with observations by the OPP and maintenance patrollers on site.

It was recommended that an operational system be deployed prior to the winter of 2007 and 2008 in order to:

- continue the research into the co-relation between visibility data, traffic data, and wind speed in order to provide an automatic assessment index of actual visibility conditions at the road level, and
- to develop an operational system which could be a model for a motorist advisory and road closure system.

### 2.4.1 Proposed Program

In accordance with recommendations from the TMS Demonstration Project Team a proposal has been developed to upgrade the existing TMS and central server in order to deploy a system which meets the operational requirements of MTO South West Regions (SWR) and OPP, includes anemometers, and supports additional research objectives.

The program has a rapid deployment schedule in order to complete the installation and final commissioning and testing prior to the onslaught of winter weather in the Kincardine region. The program will utilize the existing TMS locations and as much as possible the existing components. As the existing TMS consists of equipment procured via the ENTERPRISE Program; as well equipment and services provided "in kind" ownership needs to be transferred and new equipment purchased in order to deploy an operational system.

### 2.4.2 Work Activities

The following activities will be conducted by the Consultant:

**Project Management**
This activity includes:

- Liaison with MTO SWR, MTO ITS Office and Transport Canada
- Prepare progress reports for ENTERPRISE
- Co-ordination with suppliers
- Management of Delcan staff
- QA/QC according to ISO requirements
- Scheduling and financial management

**System Design**
System design includes two main components. The first is to update the design of the system in terms of hardware and software configuration, relative to the demonstration project. The other component is to define the users / operators requirements in terms of screen layout and functionality. This will involve review by; and discussions with MTO SWR Operations centre as well as the OPP.

**Procurement**
The final equipment required to meet the new requirements will be selected. This will be procured by Delcan and integrated with the existing ATC's. This setup and hardware integration will be conducted by Delcan in its equipment lab.

Additional equipment required includes equipment which was previously on loan and has been returned; and new equipment required to meet the new functionality. Specifically the equipment required is:

- low light dome cameras
- video encoders to convert the analog camera output to digital IP
- anemometers at each location to measure wind speed
- a digital power meter at one of the locations to measure the actual power used in order to accurately size the batteries and solar cells in the future
- additional serial input / outputs to connect the additional sensors
- real time operating system for the controllers (QNX)
- a new wireless modem to replace the one which was previously damaged.

**Software Development**
The existing software in the field controller and in the server needs to be updated to: provide a new graphical user interface, interface with the new sensors and the development of the algorithm which will determine the "visibility index". The activities include:

Software design for the new components
Software development and testing of the updated ATC software
Development of a new browser based graphical user interface to incorporate the requirements of an operational system (refer to Operational Requirements below) and provide a link from MTO's RWIS Server's web page
Software updates for the central server and development of the algorithm to co-relate wind speed and visibility to generate the "visibility" index. A link to the RWIS Server will also

allow weather and pavement conditions from appropriate RWIS to be considered. The algorithm will consider the rate of change of the data as well as the current measured values. The parameters of the visibility index can be adjusted through the GUI to improve performance over time. To develop the algorithm data collected during the demonstration project will be utilized.
Software integration and testing
Provide support to the implementation team during system integration and testing.

**Field Work Supervision**
This activity includes providing instructions to the electrical contractor and assistance to SWR's maintenance and operations forces. It also includes inspection during the field installation and documentation of the installation.

**Integration and Testing**
Integration and testing involves testing the entire system in Delcan's lab, integration with the components in the field and testing in the field. It is composed of the following steps:

- Factory acceptance testing which will test all of the functions and the hardware in Delcan's lab
- Integration of the three stations and central computer once the field equipment is installed
- Site acceptance testing which ensures that the hardware and software operates correctly in the field.

**Data Collection and Evaluation**

Once Integration and Testing are completed data can be collected and the algorithm tested and adjusted under winter conditions. This activity consists of the following tasks:

- Develop evaluation criteria in consultation with MTO and OPP
- Review the output of the algorithm, the visibility index, and compare it with the recorded images and field observations
- Meet with users to obtain observations and inputs
- Adjust parameters to refine the output of the algorithm to reduce false alarms and missed events
- Prepare a report to document the results of the project.

### 2.4.3 Operational Requirements

The following operational requirements have been identified by the users and discussed with the project team and stakeholders. Emphasis is placed on a user friendly graphical user interface which focuses on providing users with current information on road conditions. The existing user interface functionality; with its research and report focus will also be maintained to support ongoing data collection and research activities.

Graphical User Interface:

- Map based GUI
- Real time display of visibility, traffic, wind speed and wind direction data
- Single click video stream
- Alerts based on visibility, traffic, wind speed
- Input field for field reports and road closure data

Report Generation:

- Current TMS functionality with additional wind speed and direction
- Provide reports of traffic statistics

Operational Features:

- Multiple Log On authority levels
- Accessible from Internet browser
- Adjustable alarm thresholds
- Adjustable data collection rates to manage communication costs
- Remote configuration capability
- Future capability to interface with DMS or sign control system

The operators need a tool which does not require multiple steps to use and impact upon their existing work load. In particular a single log in at the start of shift is required and there should be no need to activate additional tools or programs.

### 2.4.4 Research Activities

The data collected during the winter of 2005 / 2006 showed a co-relation between visibility readings and observed conditions. However, it was observed that wind speed, wind direction and blowing snow were also strong contributing factors.

It was postulated that by using wind speed and direction data in combination with visibility and traffic data a road visibility index could be developed. Data available from local RWIS, in particular temperature and snow conditions, will also be considered if appropriate. The index would be calculated through an algorithm which would consider the known parameters. The value of the index could then be used to generate intelligent alerts for operations personnel to make a visibility assessment and road closure decisions using the cameras, weather reports and; if necessary, direct observations. Although it is not anticipated that the index could be used to automatically drive traveller advisor systems or road closure signs it could be used by the responsible agencies to consistently provide information and take action. In addition a record of the action taken would be available for future operational reviews and enhancements.

The research required is to develop and tune the necessary algorithm to develop a reliable visibility index. The algorithm will consider visibility measured, wind speed, wind direction and traffic speed. In order to tune the algorithm video images will be analysed. Images will be correlated to observed conditions at the relevant station at the time.

### 2.4.5 System Deployment

In order to deploy an operational system and undertake the research activities the following system enhancement and deployment activities are required.

Field Upgrades

- Replace equipment and software on loan
- Install additional sensors and monitors
- Replacement for video encoder
- Adjust equipment and sensor height
- Software upgrades

Server Upgrades

- hardware & commercial software upgrades
- software upgrade
- algorithm development

GUI & Operational Enhancements

- User Interface Enhancements
- Algorithm development

System Integration & Training

- Factory Acceptance Tests
- Site Integration Tests
- Training

Evaluation, Maintenance & Support

- Evaluation and algorithm tuning
- Six Month Maintenance and Support after system acceptance by the MTO
- As well a service contract is required from Bell Mobility to supply the 1xRTT service.

### 2.4.6 Schedule and Costs

An estimate for the improvements above excluding, Consultant's in kind contributions taxes and the monthly communication charges is shown in Table 1 below.

Table 1: Cost Estimate

| Item | Description | Estimate |
|---|---|---|
| 1.0 | Field Upgrades | $ 64,056 |
| 2.0 | Server Upgrades | $ 9,564 |
| 3.0 | GUI & Operational Enhancements | $ 22,842 |
| 4.0 | System Integration & Training | $ 17,735 |
| 5.0 | Evaluation, Maintenance & Support | $ 41,368 |

| | Total | $ 155,565 |
|---|---|---|

A compressed project schedule has been developed to allow the system to be operational during the winter of 2007 and 2008. This considers that the majority of the field components are already in place. The key dates are provided in Table 2, below.

Table 2: Proposed Schedule

| | |
|---|---|
| September to November 2007 | Consultation MTO ITS Office, SWR /Region<br>Develop Proposal and Cost Estimate |
| January 7, 2008 | Approval to Proceed & Initiate Procurement |
| February 18, 2008 | Procurement & Field Software Development Complete |
| March 3, 2008 | Field Installation & Commissioning Complete |
| March 10, 2008 | Operational Test Period & Initial Data Collection Complete |
| March 17, 2008 | Acceptance & On Line Operations |
| April 13, 2008 | 2007/08 Winter Data Collection Complete |
| April 21, 2008 | Progress Report Complete |
| December 23, 2008 | Final Data Collection Complete |
| February 17, 2009 | Final Evaluation Report Complete |

### 2.4.7 Summary

The TMS Demonstration Project has shown the suitability of using 1xRTT communications and solar power to support the rapid deployment and reliable operation of Total Monitoring Stations in remote locations. In order to capitalize on this experience and continue with additional research and deploy a system which meets the operational needs as well as the research requirements, this proposal to upgrade the TMS system has been prepared.

The existing infrastructure has been included, careful consideration has been given to the operational needs and a schedule has been prepared. Although the schedule has been compressed, there is adequate time to utilize the system during the winter of 2007/2008.

## *2.5 IP Cameras*

Perhaps the most significant challenge in using existing transportation infrastructure effectively is the lack of up to date road condition information for the broader roadway network. In large urban centers, dedicated traffic sensors and cameras are deployed on major freeways (e.g. COMPASS and RESCU systems in the Toronto area) enabling traffic managers to obtain information on road conditions in near real-time. But little real-time information is currently available for other roadways, least of all in remote areas.

Installing cameras on a network scale would incur prohibitive levels of costs for power and communication lines, and so more creative solutions are called for. This project proposes a demonstration of innovative technology, to deploy a low-cost Satellite IP Camera (SIPC) Pilot Project, incorporating video capture, solar power and internet communications, thereby removing the need for expensive power and communications infrastructure costs.

Further economies will be realized because the particular communications technology incorporates a user-adjustable bandwidth capability. In practice, this means that the number of video frames transmitted can range from low levels, like one every one to five minutes when traffic is light or normal, to 20 frames per second or higher during heavier or unusual traffic activity.

This technology also affords flexibility inherent in quick set-up times.

The project will incorporate two cameras. One will be mounted at the Highway 400- Highway 9 interchange. The purpose of the second camera is to demonstrate sharing of communications bandwidth, and will not necessarily be installed in a remote location. The video quality will be 640x480 pixel resolution. The project duration is 9 months, and the total estimated cost of this project is $80,000 including a $5,000 provision for contingencies.

### 2.5.1 Problem and Need

Increasingly, the broader Intelligent Transportation Systems (ITS) vision incorporates real-time information to both manage roadway operations and provide decision support to travellers who are planning a trip or updating one already in progress. Because capture of information from cameras is prohibitively expensive, not much has been done until now to implement this broader vision.

This technology has the potential to reduce costs considerably. Essentially, the Pilot will demonstrate the ability to pick strategic locations for capturing video information anywhere in our transportation network.

This technology will result in several forms of operational efficiencies:

- We can increase coverage across the province because new installations can be added at a fraction of the cost of conventional technology
- We can reduce time lines in both installation of new stations and the rehabilitation of existing stations where operations have been disrupted
- With current technology we do not have the comprehensive video coverage that we need for wide area traffic management.

- We will share these efficiencies with our partners such as the OPP, emergency services, municipalities and Ontario tourism
- Another possible application of this technology is the provision of real-time updates of conditions on routes approaching Canada-US border crossings and in the vicinity of the crossings themselves.

This technology will also promote saving of non-renewable energy:

- Substitution of solar power for conventional power consumption off the regional power grid
- The savings from substitution for conventional installation technology such as trenching, erection of hydro poles, communications and transformers
- To the extent that such installations help Ontario traffic managers to reduce congestion, fuel consumption will be reduced.

### 2.5.2 Project Goals, Deliverables and Anticipated Benefits

The overall goal of the project is to deploy a SIPC pilot installation on an Ontario highway in a remote area within a three month time frame. The purpose is to demonstrate the ITS application using low-cost satellite communication and renewable solar power to capture real-time video data of interest to both traffic managers and interested parties.

If this technology and the pilot are acceptable to operating agencies, it will constitute a breakthrough of ITS implementation in several ways. It will demonstrate fast, flexible and a low-cost comprehensive ITS deployment. It is technically feasible to add video incident detection, vehicle detector and on-site variable message signs to the system configuration, together constituting **FAST, LIGHT** and **LOW-COST** Advanced Traffic Management System deployment **anywhere** on the transportation network. These advanced features are technically feasible, but are not in the scope of the current project.

### 2.5.3 Project Activities – Preliminary Work Plan

- A Detailed Work Plan. Within 4 weeks of the start of the project a detailed work plan will be developed. A number of stakeholders will work with the guidelines provided by the System Integrator to develop this coordinated plan.

- The pilot site is expected to be in place 3 months after the start of the project, and will then be in operation and maintained for a period of 6 months, to give traffic managers and interested parties a chance to get accustomed to, and evaluate the results of the pilot project.

- A Final Report outlining what was done, results and recommendations for future work, prepared by MTO and System Integrator.

### 2.5.4 In-kind Contribution and Project Cost Estimates

Partners' contribution is estimated at $120,000 for a nine months pilot project.

| Partner | Deliverables | Contribution |
|---|---|---|
| Vikon International<br>(Satellite Communication) | Satellite system service provider from concept to completion of pilot project.<br>Satellite access from remote site to www internet connection.<br>Satellite system transmitter receiver hardware & software.<br>Preliminary and detailed design, system testing, installation, integration, 9 months on-call operation and maintenance. | Hardware and software cost for one field satellite station, and one other station; out of town travel expenses<br><br>$55,000 |
| Alfa Tech<br>(IP Camera) | Hardware and software customization. Electrical interconnect wiring & cables.<br>Host web broadcasting server.<br>Host media publishing point server.<br>Preliminary and detail design, testing, installation, integration, 9 months on-call operation and maintenance. | Software application and system tools, 2 IP cameras & housing, zoom pan tilt unit<br><br>$30,000 |
| Fortran Traffic<br>(System Integrator) | Overall system integrator from concept to preliminary design, detailed design to completion of the 9 months pilot project.<br>Issue final report. | Project management and coordination<br><br>$25,000 |
| Ontario Ministry of Transportation (Champion, project management, field installations and coordination) | Electrical & civil works.<br>Project management – concept to detail design, bench testing, dry run, field installation, performance, testing, integration and commissioning, and 9 months pilot operation | Field installation, Power supply - solar panels, batteries.<br>Traffic cabinet.<br>Pole.<br><br>$10,000 |

The total project expenditure estimate is Can $80,000.00.

Expenditure allocation:

| Partners | Allocation |
|---|---|
| Vikon International - Satellite communications | $25,000 |
| Alfa Tech - IP Camera | $25,000 |
| Fortran Traffic - System Integrator | $15,000 |

| | |
|---|---|
| Electrical and Civil Site preparation | $10,000 |
| Contingency | $5,000 |

Therefore, the total funding required is $80,000, of which, the MTO portion is $20,000.00 and proposed Transport Canada portion is $60,000.00

### 2.5.5 Operations and Maintenance Cost Estimates

If, after a successful pilot, MTO embarks on installations at remote sites, the anticipated operations and maintenance costs for one year for one camera are estimated at $20,000:

| Subsystem | Activities | Annual Cost Estimate |
|---|---|---|
| Satellite communications | Portal, data stream and still images one frame every 3 to 5 minutes - $70/month or $840/yr<br>Video (8 to 25 frames/sec) - $6.00/min for a minimum of 15 sec per broadcast, if allowing 20 broadcasts/day (5 minutes of video) - $30/day or $900/month or $10,800/year<br>Field visit once a year – $300.00 | $12,000 |
| IP Camera | Web server collocation ($250/month for up to 10 IP cameras) or $3,000/year<br>Media publishing point (310/month for up to 10 cameras) or $3,720/year<br>Two site maintenance visits per year - $900.00 | $8,000 |
| Total | | $20,000 |

### 2.5.6 Risk

This technology is at the creative edge of ITS, and so buy-in by conventional engineers might take some time. But the low-cost and increased coverage, desk-top demonstrations of live video images received via the internet and the user adjustable bandwidth feature are all very strong selling points that might overcome the novelty effect among conservative engineers and managers.

### 2.5.7 Project Management

The project manager will be:
Ataur Bacchus, P.Eng.
Senior Intelligent Transportation Systems Engineer
Ministry of Transportation of Ontario
1201 Wilson Avenue, 3rd Floor, Building B

Downsview, Ontario, M3M 1J8

The integrator of the technology implementation will be: Fortran Traffic

The Project Advisory Committee will consist of members from Transport Canada and MTO, to provide advice on technical and managerial aspects of the work and its results, and to serve as a forum for information exchange.

### 2.5.8 Summary

Satellite IP Camera (SIPC) Pilot Project, total duration of 9 months. 3 months for engineering, installation and integration. 6 months for operation of pilot.

## 3. New Projects

For the Fiscal Year 2009 period, the Executive Board has selected four new projects, based on the project selection process described in Section 1. This section of the work plan provides a description of each approved project for FY 2009:

1. ITS Warrants Phase 2 –Continuing the testing and outreach of warrants developed under phase 1, this project will develop warrants for traffic detection, dynamic speed display signs, curve warning signs, and ramp meters

2. Virtual TMC – Creation of a mobile traffic management center that can be accessed through PDA and other capable cell phone technology. The software application will be standards compliant and available for testing in several states.

3. Third Party Mapping - Focusing on the needs of transportation agencies to form partnerships with private sector mapping providers. The project will explore the issues involved in establishing such a partnership between 2-3 mapping providers.

4. Intelligent Highways Phase 1 - Looking at the concept of intelligent or "thinking" highways using miniature, low cost, and maintenance free sensors in the road surface.

## 3.1 Warranting ITS Devices, Phase 2

In recent years, state DOTs continue to mainstream the deployment of ITS into traditional infrastructure projects. As a result, ITS deployments are typically not selected as Field Operational Tests or demonstrations as they were in the 1990s, but rather as fundamental components of larger transportation improvement projects. Within this mainstreamed approach, ITS deployments are increasingly subjected to benefit/cost analyses, much in the way that pavement or structural projects are.

There has been a significant number of ITS benefit and cost analyses performed, and several tools exist to estimate the benefits and costs of ITS deployments. While these results are all useful, ENTERPRISE member agencies have expressed a need for an efficient and effective methodology to determine if ITS deployments are appropriate, and to support any internal justifications needed to decide whether ITS technologies should be deployed. Simply put, members have expressed a need to determine if the value that an ITS solution brings to a project warrants the costs of deployment and ongoing operation of the solution.

The manual on Uniform Traffic Control Devices (MUTCD) defines 8 warrants for traffic control signals. These warrants allow State DOTs to investigate the need for a traffic control signal by completing an engineering study of the traffic conditions, pedestrian characteristics, and physical characteristics. The results of the engineering study are then compared against the traffic signal warrants as an initial analysis to determine whether installation of a traffic control signal is justified. Meeting the requirements of a warrant do not mandate that a traffic control signal be installed, but rather indicates that other factors and circumstances should be considered further to determine if a traffic signal control should be deployed.

The concept for this project is to build upon the 'model' of the MUTCD warrants and to investigate and develop warranted installation parameters to guide initial decisions for the deployment of ITS solutions. If it is deemed to be appropriate, the project will attempt to work with the MUTCD. A recommended 'owner and maintainer' of the ITS warranted installation parameters would be determined within the project, and could perhaps be the ENTEPRISE Program. The use of the ITS warranted installation parameters would be voluntary, and entirely intended to serve those State DOTs that wish to use them in their ITS deployment decision making process.

### 3.1.1 Status Update on Phase 1 of the Project

Phase 1 of this project is currently nearing completion and has developed initial warrants for 4 ITS devices -- Dynamic Message Signs (DMS), Closed Circuit TV (CCTV), Highway Advisory Radio (HAR), and Road Weather Information Systems (R/WIS).

The results of Phase 1 are benefiting ENTERPRISE member states as well as other states. Virginia DOT has been using the ITS Warrants for selecting R/WIS locations for deployment. North Dakota DOT has used the ITS Warrants on numerous occasions to consider ITS deployments requested by partnering agencies.

The outreach portion of Phase 1 has also been successful. Presentations have been made at the 2007 NRITS conference, and Gene Martin of VDOT will present feedback from a state actually using the warrants at the 2008 NRITS conference.

The ITS Warrants will be presented at the ITS Canada Annual meeting in June 2008, and at the ITS World Congress / ITS America Annual meeting.

The on-line website allows on-line use and testing of the ITS Warrants. Each time a warrant is executed, the results (warranted, not warranted, partially warranted) are logged in a database with information about the test site. This has allowed analysis of the use and results of each warrant.

Finally, the ITS Warrants is on the agenda at the 2008 AASHTO Subcommittee on System Operations and Management (SSOM). At this meeting, ENTERPRISE representatives will present the concepts, share the testing and use statistics to date, and request feedback from the SSOM on whether the ITS Warrants is a topic that AASHTO could support and ultimately host.

### 3.1.2 Project Summary

Phase 2 of this project will continue the testing and outreach of warrants developed under phase 1, and will develop, test, and provide outreach for warrants for the following additional ITS devices:

- Traffic detection (infrastructure and/or probe based);
- Dynamic speed display signs ("Your speed is …");
- Curve (or downhill speed) warning signs; and
- Ramp Meters.

In addition, Phase 2 will examine the concepts of 'Corridor-wide' consideration of devices. In other words, if the location in question is part of a large corridor (either entirely within the state or a multi-state corridor) the warrant considerations may differ. Corridor-wide considerations will be developed for each of the current warrants and the additional warrants planned in Phase 2.

For the additional warrants, the consultant will develop initial purposes for each of the devices along with an initial warrant for each unique purpose. Once the warrants have reached a certain level of maturity, the consultant will work with ENTERPRISE members and possibly other states also to test the use of the new warrants. The web site developed under phase 1 will continue and will support phase 2. The outreach begun under phase 1 will continue in phase 2 to broaden the exposure of the warrants and to encourage support from a nationally recognized standards body.

### 3.1.3 Scope of Work

#### *3.1.3.1 Task 1: Literature Search/State of the Practice Review*

This task will investigate if there is any current or past work that has been done that is relevant and applicable to the new devices. Any relevant discovered work will be accounted for in the remainder of the project.

#### *3.1.3.2 Task 2: Define ITS Deployment Needs*

In this task a matrix of the additional ITS field devices and the purpose of their installation will be developed. This effort will attempt to document the different reasons that particular ITS field devices are deployed with the understanding that different deployment objectives will possibly require the development of unique warranted installation parameters.

It is envisioned that this task will focus on the ITS devices identified in the Project Summary above. Additional field devices could be added to the list if appropriate. The focus of this project is to develop and test some real warranted installation parameters that are immediately useable. This task will recommend which warranted installation parameters focused on will be fully developed for testing and application

#### *3.1.3.3 Task 3: Develop and Test Warranted Installation Parameters*

Based on the findings of Task 2, a minimum of two warranted installation parameters will be completely developed and tested for real ITS installations. The development of these warranted installation parameters will require the coordination of ENTERPRISE members and others outside of ENTERPRISE . The goal of this project is to gain broad support for the ITS installation parameter concept within the transportation community both on the public and private sides.
This task will also develop guidelines for practitioners on the use of the warranted installation parameters.

#### *3.1.3.4 Task 4: Defining Future Direction and Outreach*

Under this task the project team will continue to "shop" the ITS warranted installation parameters concept to the greater national ITS community with two objectives in mind:

- Inform the community of our efforts
- Find future funding to continue to develop this concept to cover a larger set of ITS field devices.

### 3.1.4 4. Project Schedule

This project would have a one year timeline.

### 3.1.5 5. Project Deliverables and Costs

| **Task / Deliverable** | **Cost** |
|---|---|
| Literature Review | $2,000 |
| Define ITS Deployment | $15,000 |
| Develop and Test of ITS Warrants | $25,000 |
| Outreach and Future Steps | $8,000 |
| Total Contract Cost | $50,000 |

Additional anticipated travel costs for ENTERPRISE member states to participate in this effort is $2500.

### 3.1.6 6. Project Participants

Washington State Department of Transportation
Minnesota Department of Transportation
Other interested member agencies

### 3.1.7 7. Project Contact

Ray Starr
Minnesota Department of Transportation
(651) 634-5264

Bill Legg
Washington Department of Transportation
(360) 705-7994

## 3.2 Mobile Advanced Traffic Management Systems (ATMS)

Now that mobile and handheld devices are being used by increasingly broader segments of the population, "Mobile ATMS" and "Mobile ATIS" solutions are being explored by several transportation agencies.

A Mobile ATMS is a streamlined traffic management software application, similar to the software that runs in TMCs but designed specifically for mobile phones and PDAs. A Mobile ATMS would provide key traffic management functions needed by TMC operators, such as viewing CCTV, changing DMS displays, accessing RWIS data, and creating and viewing incident reports/events. These functions would be able to be accessed at any location where a particular operator's mobile device can access data wirelessly, either using cellular technology or wireless Internet.

The Mobile ATMS concept is also a potentially attractive solution for transportation agencies that are struggling to fund TMC operations on a 24/7 schedule, particularly those in rural areas. A Mobile ATMS solution could enable staff to respond to traffic incidents from any location, during off-hours, on an as-needed basis.

A Mobile ATIS is a traveler information system that can be accessed from a mobile or handheld device. An example of a Mobile ATIS was recently deployed by the New York State Department of Transportation. NYSDOT's new service (which can be accessed at www.informny.com/mobile-r1) enables the public to view live traffic cameras in the Albany region from their web-enabled cell phones or other mobile devices. Similarly, Oregon Department of Transportation has released a Mobile ATIS (www.tripcheck.com/Mobile) that offers traffic alerts, incidents, road conditions, a Portland-area speed map, and cameras to users of mobile devices.

### 3.2.1 Project Summary

It is proposed that the Enterprise group investigate the best practices in creating a Mobile ATMS/ATIS through a pilot deployment pursued jointly by Enterprise, the Iowa Department of Transportation (IADOT), and the Idaho Transportation Department (ITD). This project was initially proposed at an Enterprise meeting by the Michigan Department of Transportation (MDOT), who expressed an interest in developing a "TMC for a Blackberry." However, MDOT is currently in the process of procuring an ATMS to run in three of its state TMCs. The procurement underway in Michigan offers an opportunity for MDOT to build an ATMS system that is ITS standards-compliant and could eventually tie in with a Mobile ATMS.

To get the pilot project started, it is proposed that Michigan partner with the Iowa DOT (IADOT) and Idaho (ITD) to deploy an initial prototype. In 2003-2004, IADOT invested in building centralized, ITS standards–compliant traffic detector, DMS, and CCTV systems. These systems make information about and control of their ITS devices available to external applications using C2C standards from TMDD (Traffic Management Data Dictionary). This environment makes Iowa an ideal test bed for a Mobile ATMS. Using the ITS standards to connect a Mobile ATMS to the existing TMC software is essential to keep the two systems in synch. Also, the ITS standards make possible the development of a vendor-neutral Mobile ATMS that could be used with any TMC software that supports the applicable standard messages. The software will be piloted in Iowa but documentation will also be produced that assists Michigan and other states in adding support for the applicable ITS standards to their TMC software, which will pave the way for building and using Mobile ATMS.

On the Mobile ATIS side, ITD is currently planning to fund the development of a mobile website that allows both agency staff and the general public to view Idaho traffic events and cameras on web-enabled mobile devices. Using combined funding from ITD and the Enterprise group, the Idaho ATIS mobile concept could be expanded into a more feature-rich web application, bringing the ATMS and ATIS functions together into a common mobile platform.

The deliverables of this project will be a pilot Mobile ATMS/ATIS application that will be deployed in Idaho and Iowa, as well as interface control documents that can be used by MDOT and other agencies interested in Mobile ATMS/ATIS. The ATMS portion of the system will be accessible only to authorized DOT staff, who will need a password to log on. The ATIS portion of the system will be designed for the public, requiring no log on.

The proposed pilot system could include one or more of the following functions:

***ATMS (DOT and Public Access)***

- *View current DMS messages*
- *View CCTV images*
- *View RWIS data*
- *View traffic events*

***ATMS (DOT Access Only)***

- *Modify DMS messages and message queue*
- *Control individual CCTV cameras using pre-set views*
- *View traffic volume*

A final report shall also be written that summarizes the development and outcome of the project.

### 3.2.2 Scope of Work

**Task 1: Concept of Operations, Functional Requirements, and System Design Document**
A Concept of Operations, Functional Requirements, and System Design Document will be drafted for the Mobile ATMS/ATIS, building upon the documentation developed for the Idaho-funded mobile traveler information website. The Concept of Operations will be updated to describe how the Mobile ATMS/ATIS fits within broader TMC operations. The updated Functional Requirements will specify the particular features that the pilot Mobile ATMS/ATIS will be designed to support. The System Design Document is a detailed design specification, describing how the software will satisfy the functional requirements.

**Task 2: Interface Control Document**
An Interface Control Document will be drafted that specifies in detail the specific Center-to-Center (C2C) messages from TMDD (Traffic Management Data Dictionary) that the Mobile ATMS/ATIS will use to interact with the DMS and CCTV central servers, which in turn "talk" to the field

devices. This ICD may be used by MDOT or other agencies that wish to procure standards-compliant traffic management systems that will be able to integrate with Mobile ATMS/ATIS.

**Task 3: Software Development and Deployment (Alpha Release)**
An alpha version of the combined Mobile ATMS/ATIS software will be built, configured, and deployed in Iowa and Idaho. The software will be designed and built to support at least one of the most popular mobile web browsers. The task will be completed once the alpha version has been transformed into a beta version that can be made operational and ready for testing.

**Task 4: Testing and Final Operational Release**
The beta release will be formally tested against the functional requirements produced in Task 1. An acceptance test plan will be prepared that includes tests and procedures for each functional requirement. After testing, the final software release will be issued and installed at IADOT and ITD..

**Task 5: Final Report**
A final report will be drafted to document the results of the pilot deployment of the combined Mobile ATMS/ATIS software. The report will address the initial concept of and need for developing a Mobile ATMS/ATIS application; the challenges involved in creating, designing, and building such an application; the use of the national ITS standards; and the "lessons learned" for other states or agencies that wish to create similar applications. The report will include an executive summary that summarizes the findings. Following review by ENTERPRISE and other interested parties, a final report will be produced. The final report will be presented both electronically and in hard-copy formats. A PowerPoint presentation of the project findings will be created for public presentation.

### 3.2.3 Project Schedule

The estimated duration of this project is shown below:

Task 1: 2 months
Task 2: 1.5 month
Task 3: 3.5 months
Task 4: 2 months
Task 5: 1.5 month

### 3.2.4 Project Deliverables and Costs

This cost proposal assumes that the IADOT ITS standards-compliant DMS and CCTV central servers and interfaces will be available for use in this project. IADOT shall be responsible for the coordination necessary to ensure that the interfaces are available.

| Deliverable | Cost |
|---|---|
| Task 1: Concept of Operations, Functional Requirements and System Design Document | $22,500 |
| Task 2: Interface Control Document | $18,750 |
| Task 3: Software Development and Deployment (Alpha Release) | $15,000 |

| | |
|---|---|
| Task 4: Testing and Final Operational Release | $11,250 |
| Task 5: Final Report | $7,500 |
| **Michigan Contribution** | **$25,000** |
| **ENTERPRISE Total** | **$50,000** |
| | |
| Idaho Funding for Mobile Traveler Information Website | **$45,000** |
| Louisiana funding for Mobile Traveler Information Website | **$45,000** |
| **Total Funding Available for Combined Software** | **$165,000** |

The Enterprise share of the project will be $75,000, with $25,000 being funded directly from Michigan.

### 3.2.5 Project Participants

Iowa Department of Transportation
Michigan Department of Transportation
Idaho Transportation Department
Other interested ENTERPRISE agencies
Other interested non-ENTERPRISE agencies

### 3.2.6 Project Contact

Annjanette Kremer,
Michigan DOT

John Whited,
Iowa DOT

Alison Lantz,
Idaho DOT

Carryn Ferrier

## *3.3 Creating Partnerships with Third-Party Mapping Providers*

Transportation agencies have historically utilized many different types of map-based software applications in support of their work in managing transportation systems. Most recently, many agencies have been charged with providing up-to-date, accurate highway and transit information to the public. Finding ways of displaying traveler information to the public in a geographically meaningful and user-friendly manner has been a major challenge in this area. Many mapping approaches have been attempted, with varying degrees of success. More generally, state governments as a whole have many more uses for map-based public outreach.

In the very recent past, the private sector has been producing Internet-based, mapping technologies on open platforms that have a high degree of user friendliness and visual appeal. Many transportation agencies are now looking into forming relationships with these third-party mapping providers, such as Windows Live, Google and Yahoo!, in order to utilize the map bases for their own applications, both internal and public.

Google, Yahoo!, and other private sector map providers generally require expensive licenses for third parties to use their mapping platforms with highly available, ad-free service. That is, if an acceptable level of service is to be maintained, and to eliminate any clause that advertisements may be incorporated into the maps in the future, the licenses must be in place–and they do not come cheaply. Google, for example, charges around $85,000 per year for a basic Enterprise License.

At the same time, transportation agencies have information that the private sector map providers both want and need—specifically, 1) the latest road network geometries; and 2) real-time traffic data. Most mapping providers are interested in receiving the latest details of roadway realignments, re-numberings, etc., as well as corrections to their not-always-perfect geo-location databases. Even more so, they are eager to get hold of real-time traffic and incident information from government agencies for their own traffic applications. Because both sides of the negotiating table have something of value to offer the other, it is probable that a synergy can be found for establishing a resource-sharing partnership (rather than the DOTs getting stuck with paying large Enterprise license fees for use of the maps).

Three initial meetings have now been held with one of the potential map providers—Google. Google has confirmed its willingness to trade Enterprise licenses for traffic event and camera data. Google also offers to go further, sharing all its statewide/national traffic speeds and travel data (derived from cellular phone vehicle probes) with states willing to exchange RWIS and urban traffic speed/volume data with Google on a non-exclusive basis. This opportunity of acquiring statewide speed and travel time data at zero annual cost is a remarkable development that arguably should not be missed.

This project will focus on the needs of transportation agencies to form partnerships with private sector mapping providers such as Windows Live Maps, Google Maps and Yahoo! Maps. The project will explore the issues involved in establishing such a partnership between a minimum of 2 and a maximum of 3 mapping providers. The experiences gained and lessons learned through this process will be documented and shared with other ENTERPRISE members who are also seeking to establish partnerships with private sector mapping providers. Should any actual agreements be formed as part of this project, they will also be shared with the group.

### 3.3.1 Scope of Work

**Task 1: Select Agency and Establish Communication with Map Provider(s)**
A state or local agency within the ENTERPRISE group will be selected based on willingness to devote time and resources to moving the project forward and a willingness to share data collected by the state with the private mapping company, preferably using the national ITS standards. (Initial communication with mapping providers has indicated that they wish to receive information from public agencies in a uniform format. The national ITS standards naturally lend themselves to this type of application.) The details of any contacts that are established at the mapping companies will be shared with the group.

**Task 2: Data Exchange Discussions**
The selected agency will open discussions with a minimum of 2 and a maximum of 3 map providers (e.g., Google, Yahoo!, Microsoft) to explore how a partnership could be established through the sharing of resources. The goal of obtaining a free or reduced-cost Enterprise license for the state agency in exchange for real-time traffic information will guide these discussions.[1] If successfully negotiated, the final agreement(s) will be shared with the Enterprise group. The costs for this task include a budget for attorney fees to draft and/or review the agreements.

**Task 3: Final Report**
A final report will be drafted to document the results of the discussions. The report will address the methods of creating the partnership, obtaining the map license, and the format of the data to be shared. The report will include an executive summary of lessons learned. Following review by ENTERPRISE and other interested parties, a final report will be created. The final report will be presented both electronically and in hard copy formats. A PowerPoint presentation of the project report will be created for public presentation.

### 3.3.2 Project Schedule

The estimated duration of this project is shown below:

Task 1: 4 months
Task 2: 4 months
Task 3: 2 months

### 3.3.3 Project Deliverables and Costs

| **Deliverable** | **Cost** |
|---|---|
| Task 1: Establish Relationship | $10,000 |
| Task 2: Data Exchange Discussions | $15,000 |
| Task 3: Final Report | $5,000 |
| **Enterprise Total** | **$30,000** |
| | |

1 Actually setting up the data exchange itself is outside the scope of this Enterprise project.

| | |
|---|---|
| IADOT and ITD—Technical standards for data exchanges | **$15,000** |
| Idaho (ITD) Data Exchange Implementation | **$45,000** |
| New Hampshire DOT Data Exchange Implementation | **$45,000** |
| **Overall Total** | **$135,000** |

### 3.3.4 Project Participants

ENTERPRISE member state(s)
Map Provider(s)
Iowa Department of Transportation
Idaho Transportation Department
New Hampshire Department of Transportation

### 3.3.5 Project Contact

John Whited, Iowa DOT

## *3.4 Feasibility Study Intelligent Highways*

### 3.4.1 Project Background

Each year traffic continues to increase on our highways and byways, so there is a need to better control and manage this increasing mobility and enhance safety. Governmental organizations should focus their attention on influencing and directing the collective growth in mobility whereby the importance of Advanced Traffic Management (ATM) is growing. Effective traffic management requires new state-of-the-art data collection systems that provide traffic indicators - e.g. speed, position, acceleration - at a high level of detail using distributed data and models.

With today's traffic management and traffic monitoring systems that is difficult to do. Partly because of the large intervals between the inductive loops or camera's that are used for data collection and because of the delay between an event and the moment the management information becomes available. Solutions can be found in a more profound and intense vehicle-to-vehicle and vehicle-to infrastructure interaction and from the road administrator's point of view should offer the possibility to dynamically determine the state of the available road capacity.

With car-to-car communication that will not be possible on the short or intermediate term; because of the required penetration rate and because the developments within the automotive industry have their own – consumer driven - dynamics. It is therefore important to look for solutions that provide adequate information using a vehicle independent monitoring tool and that overcome the present deficiencies (for example easy maintenance with minimum hindering of the traffic). With this more detailed information we can more effectively manage and direct the traffic and we might also be bridging the cap towards real cooperative systems by making this information available to intelligent vehicles that are equipped with state-of-the art in car technology.

### 3.4.2 Project Summary

The project is looking at the concept of Intelligent or Thinking highways using miniature, low cost and maintenance free sensors in the road surface. With a few sensors every square meter a large percentage may - during its lifetime - become dysfunctional without affecting the robustness and reliability of the system when it comes to providing information on all individual vehicles. Every vehicle is detected the moment it enters the network and can be followed accordingly without the need for on-board units in the vehicle. Given the high sensor density, several vehicle parameters (presence, speed, lateral position) or road parameters (occupation, traffic jam position) can be determined very accurately. This boosts the information on what is happening on the road. The systems features should include the vehicle independency, a high accuracy, robustness and reliability as well as scalability (by density and size).

The aim of the project is to review and research the implications of such a new state-of-the-art data collection system for effective operational traffic management and to perform a technological feasibility study for short term implementation.

### 3.4.3 Scope of Work

#### *3.4.3.1 Task 1: Literature Search/State of the Practice Review*

Literature study into the state-of-the art knowledge and technologies (i.e. for example the research done by University of Minnesota Duluth, Newcastle University, MIT, TNO, PATH etc.)

#### *3.4.3.2 Task 2: Defining potential applications*

Based on the concept we will define potential and novel applications for intelligent highways within the ITS scope. We will ask the partners within ENTERPRISE to input their own ideas for applications and to define criteria for prioritization, for example contribution to traffic management, novelty etc. and look for short term wins.

These applications should be real problems deducted from the day-to-day operations of the road operators and should go beyond the concept of inductive loops. Intelligent Highways can open up new ways of traffic management and solve existing problems.

This task will amongst others consist of sending out a questionnaire for input from the members relating to applications and criteria.

#### *3.4.3.3 Task 3: Analyzing expectations and maturity of technology*

This task focuses on the crucial challenges related to deploying the technology, i.e. what are the requirements for the sensors and how do you construct, place and position them? Looking at the potential applications what is the required information, where and when is this information needed and how do we organize these information flows (also if the outlook towards the future incorporates in-car information).

#### *3.4.3.4 Task 4: Reporting*

Finally we will summarize our findings in a report especially aiming at identification and matching the expectations for deployment with feasible applications from a technology point of view.

### 3.4.4 4. Project Schedule

The project will run from January 1st up to July 1st 2009. During the annual meeting in spring we will present the prelimanary findings of task 1 and 2 and the final report will be presented during the meeting in September.

### 3.4.5 5. Project Deliverables and Costs

| **Task / Deliverable** | **Cost** |
|---|---:|
| Literature Review | $2,000 |
| Defining showcases | $8,000 |
| Expectations and feasibility | $12,000 |
| Report and future outlook | $2,000 |

Total required funds from Enterprise: $ 24,000 (i.e. EUR 15,000)

### 3.4.6 Project Participants

Dutch DOT- in cooperation with TNO (Netherlands Organization for Applied Scientific Research)

### 3.4.7 Project Contact

Pieter Blokland (DDOT/Rijkswaterstaat)