TOIP IMPLEMENTATION PLAN

AN ADDENDUM TO THE WISDOT TRAFFIC OPERATIONS INFRASTRUCTURE PLAN

October 2009

Introduction and Purpose

In May 2008, the final report of the *WisDOT Traffic Operations Infrastructure Plan* (TOIP) was published. The TOIP outlines methodologies and plans developed to assess the operational needs along Wisconsin's 37 strategic corridors and determine appropriate improvements (ITS) to mitigate these needs. Furthermore, these needs were developed in a quantifiable manner for deployment with traditional highway improvements, enhancing and extending the investment of infrastructure on Wisconsin's roadways. Recently, the TOIP has been approved by WisDOT for implementation with recommendations from the TOIP integrated into Chapter 13 of WisDOT's *Connections 2030* plan. This integration allows traffic operational devices to be deployed with infrastructure improvements per the recommendations set forth by the TOIP.

A major component in developing the TOIP was recommending ITS technology deployment levels on the 37 corridors. These technologies focused on implementing ramp control and surveillance, traveler warning and information systems, and traffic signal systems to corridors that exhibited existing or future operational needs. Locations of individual elements were recommended based on the TOIP Spectrum of Deployment Density. The TOIP spectrum provides a planning-level approach for the deployment of ITS elements. The TOIP, however, neither includes all ITS elements considered in this analysis nor does the TOIP go so far as to propose exact ITS element locations. Therefore, to provide both WisDOT Central Office and Regional staff more precise locations to install ITS technologies cited in the TOIP, an implementation plan was created as an addendum to the TOIP. This implementation plan will focus on ITS element deployments primarily on the thirteen corridors that exhibited the most significant operational needs, as determined from the TOIP (six "priority" corridors and seven "emerging priority" corridors). These corridors are listed below:

- Badger State Corridor (Eau Claire/Chippewa Falls to Madison)
- Capitol Corridor (Milwaukee to Madison)
- Fox Valley Corridor (Milwaukee to Green Bay)
- South Central Connection (Madison to Chicago via Janesville/Beloit)
- Hiawatha Corridor (Milwaukee to Chicago)
- Chippewa Valley Corridor (Minneapolis / Saint Paul to Eau Claire)
- Wisconsin River Corridor (Madison to Hurley/Ironwood)
- Wild Goose Corridor (Madison to Fox River Valley)
- Peace Memorial Corridor (Eau Claire/Chippewa Falls to Duluth/Superior)
- Cornish Heritage Corridor (Dubuque to Madison)

- Titletown Corridor (Milwaukee to Green Bay)
- Southern Tier Corridor (Janesville/Beloit to Racine/Kenosha)
- Glacial Plains Corridor (Janesville/Beloit to Milwaukee)

It should be noted that the thirteen corridors encompass the vast majority of Wisconsin's freeway and Interstate Highway system. However, a section of Interstate Highway 90 (IH 90) from La Crosse to Tomah is not among the thirteen "priority" corridors, based on criteria established by the TOIP, but has emerging needs. Based on discussions with WisDOT staff, this particular corridor (also known as the Coulee Country Corridor) will be analyzed and included as part of this project as an "emerging priority" corridor.

In addition to providing more site-specific locations to installing ITS elements, the TOIP Implementation Plan also achieves the following tasks, which are described below:

- Inclusion of the following devices/technologies that were not discussed in the TOIP
  - Portable changeable message sign (PCMS) pads
  - Roadside-mounted, dynamic message signs (DMS)
  - Ramp closure gates
  - Crash investigation sites (CIS)
  - Law enforcement pads (LEP)
  - Intellidrive
  - Communication infrastructure to connect to existing automated traffic recorder (ATR) stations
  - Statewide communications infrastructure

- Review current WisDOT technology practices to ensure that deployment of operational devices reflect "state-of-the-practice" equipment being utilized

Resources

The primary source of information used to determine the deployment of devices along a particular corridor was the May 2008 TOIP. Appendices A and B of the TOIP list the type and frequency of devices to be implemented on the aforementioned fourteen corridors while Appendix C of the TOIP generates infrastructure recommendations for traffic signal systems along the analyzed corridors. Cost estimates were developed in both appendices to provide a preliminary assessment of the capital investment needed to fund the installation, operation, maintenance, and replacement (for traffic signal systems only) of these devices.

In addition to the TOIP, several studies have been completed that provide a more in-depth analysis of the use of operational technologies on particular corridors. From the analyses, recommendations were made that provide the type and intensity of operational devices to be deployed as well as a more specific location for installation of recommended equipment. These studies were obtained and their recommendations were utilized as part of this document. The following lists the studies and roadway(s) analyzed as part of the project:

- Benefit/Cost Analysis for U.S. 41 Corridor ITS "New Start" – Winnebago, Outagamie, and Brown Counties USH 41 (Oshkosh to Green Bay)
- Southwest Region Freeway ITS Benefit/Cost Analysis, IH 39, IH 90, IH 94 (Tomah to Beloit), and Madison Beltline
- Southeast Region I-94 N/S Corridor ITS Benefit/Cost Analysis, IH 94 (North-South Corridor)
- North Central Region Wausau Area ITS Benefit/Cost Analysis, IH 39 and USH 51 (Wausau)

Several WisDOT directives have also been recommended for implementation that will affect the intensity and deployment of operational devices. These directives are described below:

- Ramp closure gates are recommended to be installed at all service interchanges along Wisconsin's Interstate Highway system and several non-interstate freeway corridors (e.g. USH 41, USH 45, and USH 53). This condition gives WisDOT the ability to prohibit traffic entering the aforementioned freeways due to an event that would significantly reduce or stop traffic flow along the highway (e.g. severe accidents, inclement weather, flooding).

- Roadside-mounted, dynamic messages signs (DMS) have been encouraged for installation to increase traveler information of approaching events (e.g. work zone congestion, alternate route implementation, entertainment event traffic information) as a more cost-effective measure than traditional, overhead, DMS installations.

- WisDOT's *ITS Design Manual* was also utilized to provide guidance on preferred locations to install operational equipment.

It should also be stated that WisDOT Regional staff was consulted to apply local knowledge about these corridors to the implementation plan and that existing as-built plans were cross-referenced to include existing devices into the implementation plan.

Implementation

Using the aforementioned resources, illustrations of the fourteen analyzed corridors were generated denoting the locations of proposed operational (ITS) devices. A complete set of figures for each corridor is located in the Appendix. Several assumptions were made about the type, frequency, and location that ITS components would be deployed, as well as their inclusion in the illustrations and/or document. These assumptions are summarized based on the TOIP technology classifications and are listed below. It is understood that the Regions, in coordination with the STOC, will determine the feasibility and exact locations in the field for TOIP implementation.

Surveillance

- *Automatic Traffic Recorder (ATR) stations.* In many rural and suburban locations, ATR stations do not have the ability to transmit data to source locations in real-time or near

real-time. Rather, data is collected infrequently (monthly, quarterly, or yearly) by technicians downloading the data at the ATR station.

Given that ATR stations function similarly to mainline detection stations, WisDOT is pursuing upgrading ATR stations along freeways statewide to provide more real-time data to the Statewide Traffic Operations Center (STOC) for monitoring purposes. Each ATR station would need a communications link (e.g. fiber optic, leased line, or wireless network) and power source (e.g. solar power or connection to local utilities) to achieve this task. For purposes of this plan, defining the detailed design of the combination of communications and power for each ATR station is not feasible in this addendum due to varying geographic and topographic variances. However, costs for the installation, maintenance, and operation of these upgraded ATR stations were assumed in this plan to allocate monies for this task.

- *Law Enforcement Pads.* Law enforcement pads allow for law enforcement vehicles to monitor traffic operations without stationing themselves within, or in close proximity to, the traveled way. For the Southwest Region Freeway ITS Benefit/Cost Analysis project, a survey of law enforcement officials was conducted to determine appropriate devices and locations to provide for traffic surveillance. The survey indicated that existing median crossovers, when available, are a preferred location for law enforcement officials to monitor traffic operations and vehicular speeds. Therefore, the deployment of law enforcement pads was based on whether the roadway segment provided a divided cross-section with median crossovers. In rural areas, law enforcement pads were not recommended due to the prevalence of median crossovers along the freeway system; however, in several urban and suburban areas, law enforcement pads are recommended on freeways where concrete medians generally separate the through travel lanes and median crossovers are not available.

Detection

- *Mobile Probes.* Mobile probe technology allows for the detection of wireless devices (e.g. cellular phones, laptop computers, and GPS devices) to gather traffic data. While the TOIP recommends its use on many rural or lower-volume segments and corridors, the exact location of their deployment is unknown due to communications availability from the physical environment. Therefore, mobile probes were neither assigned specific locations for the analyzed corridors nor assessed as a capital investment cost for the corridors.

Incident Management

- *Incident Management Trailers.* Incident management trailers provide mobile deployment of incident management devices (e.g. barricades, cones, beacons, signs) when required. However, the acquisition, ownership, and storage of these trailers vary by region and their potential usage. Therefore, incident management trailers were not included as part of this project.

- *Crash Investigation Sites.* Crash investigation sites are designated areas along a roadway or interchange ramp that allow for parties involved in a crash to quickly remove themselves from the traffic stream. Typically, determining the location to deploy crash investigation sites relies on detailed, operational knowledge of the corridors from both a safety and operations standpoint; however, for purposes of this project, crash investigation sites were assumed for deployment along urban or suburban freeway interchange locations in which a medium or high-level of technology intensity for incident management was recommended, as cited by the TOIP.

Traffic Flow Management

- *Dynamic Message Signs.* As a more cost-effective measure of increasing traveler information, portable, changeable message signs (PCMS) and roadside-mounted DMS are recommended in addition to traditional overhead DMS for deployment as part of this project. All DMS sites should have power available to the site and, if possible, a communication connection (preferably fiber optic) to provide real-time communication with the Statewide Traffic Operations Center (STOC).

  PCMS pads are gravel or concrete areas that are used for positioning and deploying PCMS devices. PCMS pads can be located along the ditch-side or median-side of a roadway, further increasing its flexibility to service both directions of traffic. Locations for PCMS deployment were based on recommendations cited in Appendix B of the TOIP as well as input with local WisDOT officials.

  Roadside-mounted DMS devices are similar to standard overhead DMS devices in that they both are permanently-installed, dynamic message signs that relay real-time information to motorists. However, unlike overhead and cantilever-mounted DMS that places the message board over the roadway, roadside-mounted DMS devices place the message board on the ditch-side of the roadway. While roadside-mounted DMS equipment is more cost-effective in terms of installation and maintenance, it may be less effective in areas that provide three or more lanes of directional travel or higher percentages of truck-traffic as these conditions increase the probability of vehicles blocking the view of the signs for motorists in the leftmost lane(s). Therefore, roadside-mounted DMS was recommended for deployment in primarily lesser metropolitan and suburban areas where the corresponding roadway provides a favorable cross-section for increased visibility. Locations for these devices also relied on Appendix B of the TOIP to update locations that call for PCMS pads or overhead DMS to roadside-mounted DMS.

- *Intellidrive.* Intellidrive (formerly known as Vehicle Infrastructure Integration or VII) is a vehicle-based technology that allows for real-time information to be relayed to and from a communication source and vehicles that pass by. It is believed that information such as travel times and traffic incidents, as well as signal phase changes and emergency signal pre-emption would be accessible to motorists through in-vehicle devices.

Several test locations have experimented utilizing Intellidrive, most notably a test performed in the San Francisco metropolitan area. At this test location, communication infrastructure was installed along several corridors that relayed information about vehicle characteristics, such as speed, heading, windshield wiper usage, and speeds approaching traffic signals. While it is believed that significant value can come from implementing Intellidrive, it requires further research and will likely require significant financial resources to implement. Currently, no devices/equipment have been developed for widespread commercial use for deployment of Intellidrive. Therefore, Intellidrive was not taken into consideration as part of this plan; however, the operational devices and communications systems should not preclude the deployment of this technology when it is fully matured for commercial use.

As previously stated, a directive of the TOIP was to incorporate the installation of ITS devices in conjunction with highway improvement projects. When appropriate, ITS deployment with highway improvement projects will be cost-effective as personnel and equipment will likely be onsite for the highway improvement project. This, in turn, will lead to accelerated deployment of ITS technology on the analyzed corridors. Deploying ITS devices with highway improvement projects may also assist in monitoring traffic conditions within the work zone for current and future highway projects. Therefore, included in these illustrations are planned highway improvement projects which indicate where the installation of ITS devices could be linked to a particular project. The planned projects, their termini, and proposed scheduling dates are based on WisDOT's Six-Year Highway Improvement Plan as of October 2009.

Where ITS devices are illustrated with proposed highway improvement projects, approximately 55 percent of devices are recommended for deployment. With this amount of ITS equipment scheduled for deployment within project termini, it is recommended that discussions with design staff be conducted for the inclusion of ITS construction.

Although many corridors have ITS equipment deployments that can be linked to highway improvement projects for installation, it should be noted that this situation may not necessarily be the course of action for ITS deployment. In many areas of the studied corridors, equipment is recommended in locations that do not have highway improvement projects in its vicinity. Therefore, when necessary, WisDOT should consider deploying equipment on a system-wide basis and creating standalone operations projects to do so. This condition is based upon legislation adopted in SAFETEA-LU, Subtitle B, Section 1201, which advises state agencies to establish surveillance systems that can monitor traffic and travel conditions in real-time.

Costs

Cost estimates for each device were derived from the cost summary tables of the TOIP, cost assumptions from the aforementioned corridor studies, and estimates derived by WisDOT. These assumptions are illustrated in Table 1 of the Appendix. With these assumptions, cost estimates for the installation, operation, maintenance and replacement (for traffic signal systems only) of recommended ITS equipment was compiled to assess the capital investment and yearly maintenance and operations costs needed to fund their implementation. Tables 2A and 2B of the

Appendix illustrate statewide deployment costs, which are estimated to be approximately $100,000,000 in initial capital investment (installation and deployment) and approximately $7,600,000 in yearly operational, maintenance, and replacement costs. It should be noted that many of the ITS devices recommended for deployment is existing equipment currently deployed (primarily in WisDOT Southeast and Southwest Regions). Therefore, a significant portion of the capital investment and yearly maintenance costs outlined in Table 2A and 2B include existing equipment. Tables 3 through 16 of the Appendix illustrate deployment costs by corridor. Because the life cycle of ITS components varies, the costs are annualized over each device's useful life. The cost estimate tables reflect the installation costs of new devices deployed in the field.

Non-ITS Costs

Two deployment measures identified in this study, crash investigation sites and law enforcement pads, are not generally considered a "traditional" ITS device. These deployments consist of the application of a gravel surface or a paved surface with little to no equipment required for operation. As these deployments are more similar to highway construction than ITS, the costs of these devices were extracted from the grand total of costs and identified as a separate cost. The deployment of these devices should be further discussed within WisDOT's Traffic Incident Management Enhancement (TIME) Committee, as these devices aid as much, if not more, in incident management.

Network Communications Devices

Currently, WisDOT utilizes a statewide fiber optic network (comprised of a combination of state-owned and leased fibers) that relays data from devices and other information hubs. Typically, these fiber optic trunk lines are located within the right-of-way of various freeways (e.g. IH 43, IH 94, and USH 151). In an effort to extend the fiber optic network, WisDOT is considering adding additional trunk lines along other freeways (e.g. IH 39, USH 41, USH 51, USH 53, USH 151) to reach other locations for communication as well as redundancy to their existing system. However, WisDOT has indicated that the deployment of these fiber optic trunk lines is not of high priority when compared to the various ITS devices discussed in the TOIP and the TOIP implementation plan; therefore, costs for installing these network communication trunk lines were separated from the total cost estimate and identified as a separate cost.

Technology Validation

To ensure that devices recommended for deployment for WisDOT use currently meet "state-of-the-practice" technologies, a validation of operations technology was performed. This technology validation focused on both field devices and the communication infrastructure that connects field device to operations center. Procuring devices that meet "state-of-the-practice" standards allows for equipment to be deployed that is widely used and can be effectively maintained.

The results of this technology validation indicate that current WisDOT devices used for field use and communication to field devices fall within current "state-of-the-practice" standards used for operations deployment. This condition is due to the fact that a technology scan of many of the ITS devices discussed in this implementation plan occurred as part of the TOIP and were documented in Appendix E of the TOIP.

Action Steps

The following describes action steps to be taken by WisDOT to deploy operations technologies on the studied corridors:

- Consult with project designers for highway improvement projects in the six-year plan to investigate the possibility of including the installation of operations technologies in tandem with the highway improvement project, providing a cost-effective approach to deployment.

- Provide outreach to WisDOT Regional staff regarding the implementation of technologies cited in the TOIP so that staff is aware of including these recommendations to projects, when achievable.

- Check the statewide six-year plan regularly to monitor significant changes in the scheduling dates of projects along the analyzed corridors so that actions can be made to implement operations equipment, when necessary.

List of ITS Deployment Maps

List of ITS Deployment Cost Estimate Tables