NATIONAL EVALUATION OF THE FY 2003 EARMARKED ITS INTEGRATION PROJECT:

MINNESOTA TRAVELER INFORMATION GUIDANCE AND EMERGENCY ROUTING (TIGER) PROJECT

Final Phase II Evaluation Report

May 14, 2008

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16. Abstract

This report presents the Phase II (Baseline) results for the national evaluation of the FY 2003 Earmarked ITS Integration Project: Minnesota Traveler Information Guidance and Emergency Routing (TIGER) project. This Phase II Report builds upon the *Minnesota TIGER Final Evaluation Plan and Detailed Test Plan* by providing a preliminary assessment of the Minnesota TIGER project. The report is intended to provide the U.S. Department of Transportation (USDOT) ITS Joint Program Office (JPO) with: an update on the current deployment status of the project; a summary of available data and baseline (pre-deployment) performance measures; an identification of preliminary lessons learned from the deployment; and an assessment of the opportunity for continued evaluation of the project.

The TIGER project is intended to provide traffic management and traveler information strategies and tools that can be used on a daily basis and to support emergency routing during evacuation conditions. The project is being deployed on the Interstate 94 and the parallel Highway 10 corridor, and is characterized by both urban and rural elements. Mn/DOT is seeking to improve the mobility and safety of travel along the corridor via improved monitoring of real-time conditions by operations personnel at the traffic management centers (TMC); the dissemination of enhanced traveler information to travelers; and the integrated operation of the two primary roadways to proactively manage diversion during incident conditions. These capabilities are intended to be provided through the implementation and integration of a number of freeway management, traffic surveillance, arterial signal control, and traveler information (dynamic message signs [DMS]) strategies.

The Mn/DOT TIGER project evaluation consists of a study of system impacts and the development of lessons learned. Through the cooperative efforts and support of the Mn/DOT TIGER Project Program Manager, the Phase II evaluation resulted in the collection and analysis of selected baseline performance measures, preliminary lessons learned from the deployment, and an assessment of the evaluation opportunities and risks. The incident data from November 2006 through November 2007 yielded hundreds of incidents. However, only four met the criteria for severity, direction of travel, time of day, and most importantly, proximity to operational traffic detectors. Fortunately, now that the all TIGER traffic detections are operational, continuous data can be collected from a much more robust coverage of the corridor to capture the behavior of traffic during incident conditions. Historical crash data from July 2005 to July 2007 were analyzed to examine crash frequency by severity in the before deployment period and will form the basis for the comparison with data collected during the "after" period.

It is recommended that the evaluation continue into Phase III but modify the approach for assessing system impacts to eliminate dependency on model-generated performance measures and focus on the identification of diversion behaviors in response to incident conditions. This analysis would be supplemented with the additional data provided by the new detector coverage added in late 2007. Also, proposed is an approach to develop outreach products to target audiences of the final results and findings.

Key Words

Intelligent Transportation Systems, ITS, Minnesota DOT, Safety, Mobility, Lessons Learned, I-94, TMC, Diversion Routes, Emergency Evacuation Routes, Dynamic Message Signs, Crashes, Incidents.

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Table of Contents

List of Tables

List of Figures

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EXECUTIVE SUMMARY

This Phase II Report builds upon the *Minnesota Traveler Information Guidance and Emergency Routing (TIGER) Project Final Evaluation Plan and Detailed Test Plan* by presenting the baseline ("before" deployment) results and risk assessment for the national study of the *Minnesota TIGER* project. The report is intended to provide the U.S. Department of Transportation (USDOT) ITS Joint Program Office (JPO) with:

- An update on the current deployment status of the project.
- A summary of available data and baseline (pre-deployment) performance measures.
- An identification of preliminary lessons learned from the deployment.
- An assessment of the opportunity for continued evaluation of the project.
- Recommendations for Phase III Evaluation and outreach activities.

This evaluation is being conducted in conjunction with the USDOT Integrated Intelligent Transportation Systems (ITS) Deployment Program.

The Interstate-94 (I-94)/Highway 10 corridor serves to connect the Twin Cities region with the St. Cloud region of Minnesota. Both the northwest side of the Twin Cities and the St. Cloud region have been experiencing rapid growth, promoting both increased recurring and incident-related congestion along the corridor. The corridor serves as a daily commuter route, and often experiences the most significant congestion on the shoulders during weekends and holidays. The increased congestion occurs as many Twin Cities residents utilize the corridor to access recreation destinations further north in the Brainerd area or other regions.

The approximate 50-mile corridor is located in the fastest growing region within the State of Minnesota. The corridor is unique in that it consists of urban, suburban, and rural components. I-94 parallels the Mississippi River valley between the Twin Cities to St. Cloud, and comprises four to six traffic lanes in the corridor. Highway 10 parallels I-94 to the northeast on the opposite side of the river, and primarily comprises four lanes of signalized roadway. Although there are some limited grade separated segments within the corridor, the roadways are usually within 5 miles from each other along this entire corridor and serve as diversion routes for each other. The Monticello Nuclear Power Plant is located between I-94 and Highway 10 outside Monticello and the corridor also serves a primary evacuation route for the Twin Cities.

The Minnesota TIGER project seeks to improve travel time, travel time reliability, and safety through the deployment and integration of traffic monitoring, advanced communication, and traveler information components. Traffic monitoring will be provided through closed circuit television (CCTV) surveillance, and loop and radar-based traffic detection. The visual images and volume/speed data provided by these surveillance technologies will be transmitted to traffic operations personnel at the TMCs via wireline and wireless communications.

The Minnesota TIGER evaluation is a study to determine the mobility and safety impacts and to identify the significant lessons learned to assist others who may be considering similar deployments. The evaluation approach was developed with the assistance of Mn/DOT and under the guidance of the USDOT ITS JPO.

Through the cooperative efforts of the Mn/DOT TIGER Project Program Manager in support of the evaluation, the Phase II evaluation resulted in the collection and analysis of selected baseline performance measures, preliminary lessons learned from the deployment, and an assessment of the evaluation opportunities and risks. The incident data from November 2006 through November 2007 yielded hundreds of incidents. However, only four met the criteria for severity, direction of travel, time of day, and most importantly, proximity to operational traffic detectors. Fortunately, now that all the TIGER traffic detectors are operational, continuous data can be collected from a much more robust coverage of the corridor to capture the behavior of traffic during incident conditions. Historical crash data from July 2005 to July 2007 were combined and averaged to represent crash frequency by severity in the before deployment period and will form the basis for the comparison with data collected during the "after" period.

This document is structured as follows:

- **Section 1.0 – Project Background and Deployment Update –** Provides an overview of the TIGER project, the corridor environment, deployment status, and evaluation background.
- **Section 2.0 – Evaluation Overview –** Identifies the identified goals, objectives, and hypotheses to be analyzed; identifies several challenges facing the evaluation; and provides an overview of the evaluation test plans.
- **Section 3.0 – Baseline Conditions –** Identifies the available data for testing baseline as well as post-deployment conditions, and summarizes selected baseline performance measures.
- **Section 4.0 – Lessons Learned –** Summarizes the preliminary lessons learned from the deployment.
- **Section 5.0 – Phase III Evaluation Opportunities and Risks –** Provides an assessment of the evaluation opportunity provided by the deployment based on the information gathered to date, describes the risks, opportunities, and proposed Phase III evaluation approach and outreach activities/products.

In conclusion, it is recommended that the project continue as a Phase III evaluation to assess institutional issues as planned, but modify the approach for assessing system impacts to eliminate dependency on model-generated performance measures and mitigate issues related to the limited baseline detector data. The mobility test would focus on the identification of diversion behaviors in response to incident conditions. This analysis would be based on the framework utilized in the baseline assessment and would be supplemented with the additional data provided by the new detector coverage added in late 2007.

1. PROJECT BACKGROUND AND DEPLOYMENT UPDATE

1.1. INTRODUCTION

The Intelligent Transportation Systems (ITS) integration component of the Federal Highway Administration's (FHWA) ITS Deployment Program is being conducted to accelerate the integration and interoperability of intelligent transportation systems in metropolitan and statewide settings. Projects approved for funding have been assessed as supporting the improvements of transportation efficiency, promoting safety, increasing traffic flow, reducing emissions, improving traveler information, enhancing alternative transportation modes, building on existing ITS projects, and promoting tourism. From the population of ITS Integration Program projects earmarked for Fiscal Year (FY) 2003, a small number of projects have been selected as candidates for National Evaluation. The Minnesota Traveler Information Guidance and Emergency Routing (TIGER) project is one such project.

This Draft Phase II Evaluation Report summarizes the preliminary assessment of the Minnesota TIGER project. The report is intended to provide the U.S. Department of Transportation (USDOT) ITS Joint Program Office (JPO) with:

- An update on the current deployment status of the project.
- A summary of available data and baseline (pre-deployment) performance measures.
- An identification of preliminary lessons learned from the deployment.
- An assessment of the opportunity for continued evaluation of the project.

This information is provided to ITS JPO so it may make an informed decision regarding the opportunity for conducting a Phase III evaluation, which would fully assess the impacts and lessons learned from the TIGER deployment.

1.2. PROJECT BACKGROUND

1.2.1. Statement of the Problem

The Interstate-94 (I-94)/Highway 10 corridor serves to connect the Twin Cities region with the St. Cloud region of Minnesota. Both the northwest side of the Twin Cities and the St. Cloud region have been experiencing rapid growth, promoting both increased recurring and incident-related congestion along the corridor. The corridor serves as a daily commuter route, and often experiences the most significant congestion on the shoulders during weekends and holidays. The increased congestion occurs as many Twin Cities residents utilize the corridor to access recreation destinations further north in the Brainerd area or other regions.

The approximate 50-mile corridor is located in the fastest growing region within the State of Minnesota. The corridor is unique in that it consists of urban, suburban, and rural components. As shown in Figure 1, I-94 parallels the Mississippi River valley between the Twin Cities to St. Cloud, and comprises four to six traffic lanes in the corridor. Highway 10 parallels I-94 to the northeast on the opposite side of the river, and primarily comprises four lanes of signalized roadway. Although there are some limited grade separated segments within the corridor, the roadways are usually within a distance of 5 miles from each other along this entire corridor and serve as diversion routes for each other. The presence of the river crossings between the roadways limits the locations in which travelers can switch roadways, thus, providing several key decision points.

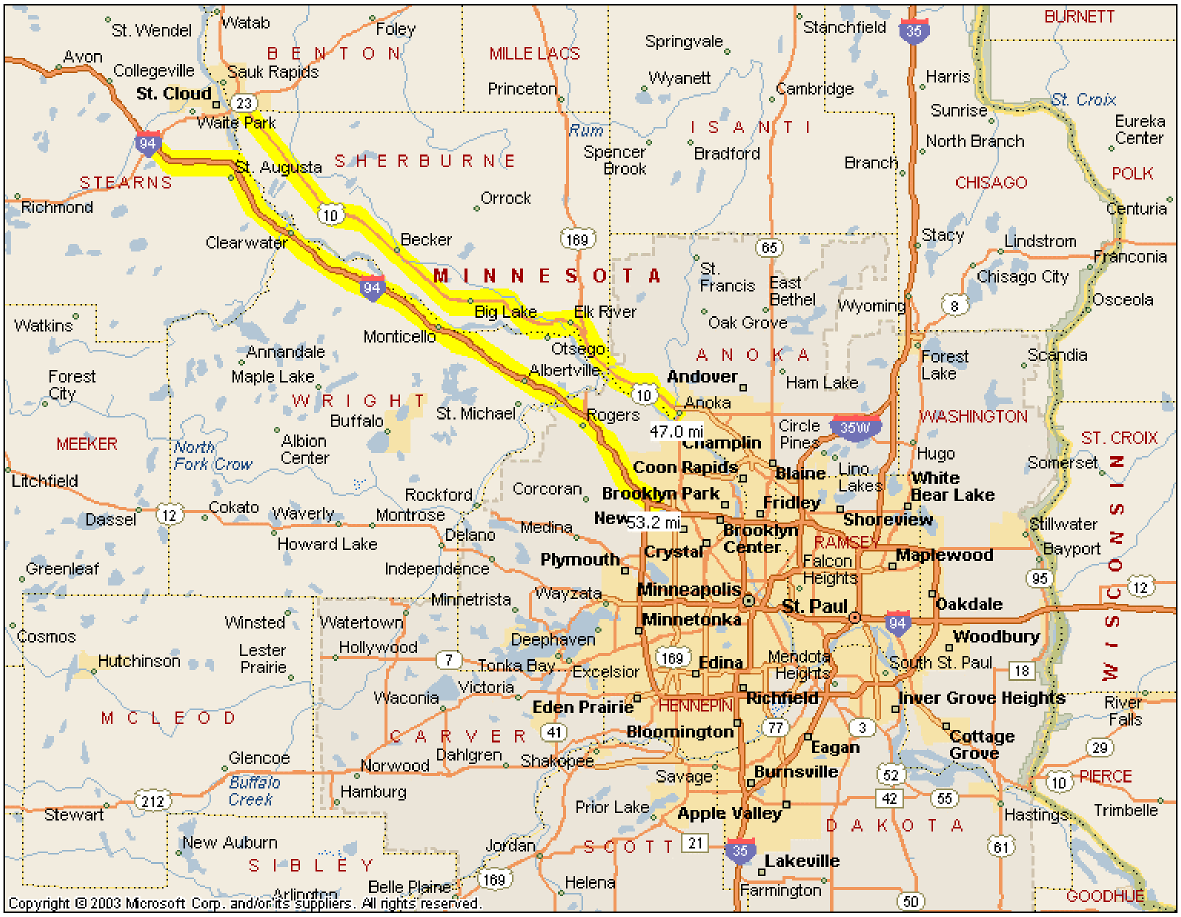

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Figure 1. I-94/Highway 10 Corridor Environs

Segments of the corridor have an average daily traffic (ADT) level exceeding 100,000 vehicles and the overall volumes are expected to more than double by the year 2020. Without additional capacity, the projected population and traffic growth within this corridor is expected to have a significant and negative impact on mobility. The Minnesota Department of Transportation (Mn/DOT) estimated that driving speeds along segments of Highway 10 would be reduced by up to 77 percent by the year 2025. Without action, congestion will increase in the near future, slowing the movement of commuters, tourists, and commercial goods, as well as increasing traveler frustration.

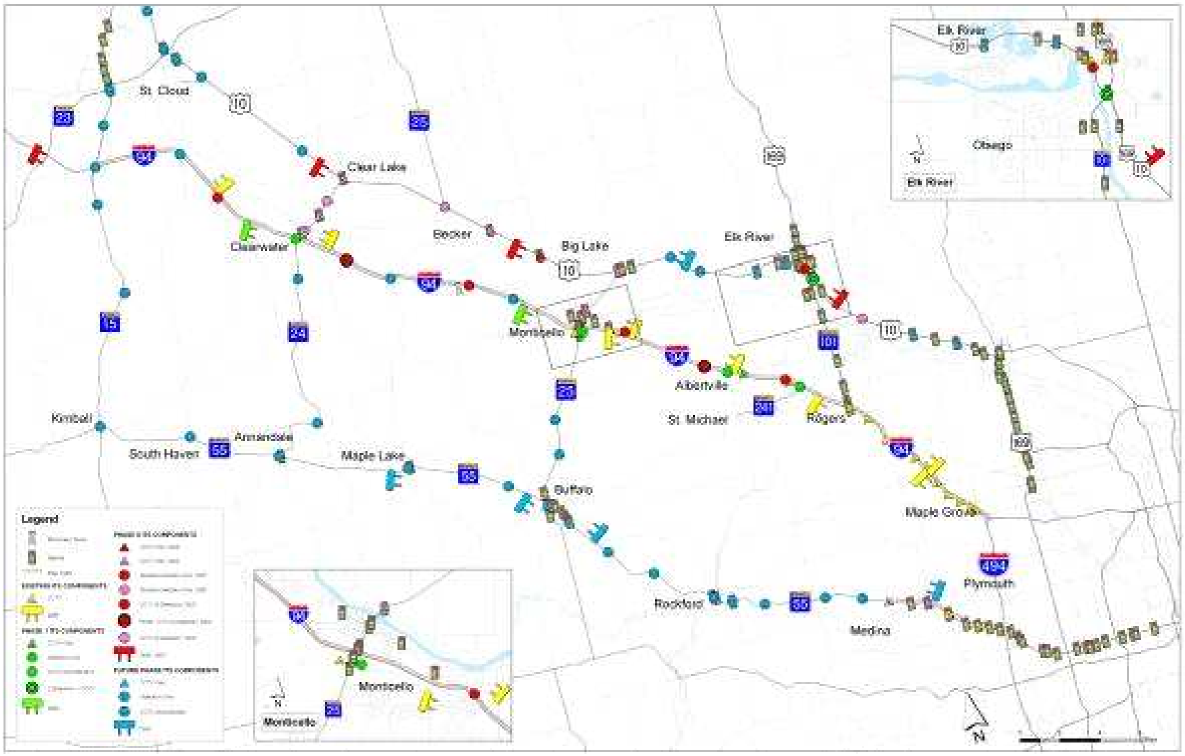
In addition to challenges brought on by increasing travel demand, the corridor also serves a primary evacuation route for the Twin Cities. The Monticello Nuclear Power Plant located between I-94 and Highway 10 outside Monticello (see Figure 2) places further importance on the ability of the corridor to provide safe and efficient travel. In the unlikely event of an incident at the power plant, the corridor could provide critical support for rapidly evacuating regional residents, if necessary.

Figure 2. View of the Monticello Nuclear Power Facility

1.2.2. TIGER Project Description

In response to the challenges in the corridor, the Mn/DOT launched the Traveler Information Guidance and Emergency Routing (TIGER) project. This initiative is intended to provide traffic management and traveler information strategies and tools that can be used on a daily basis and to support emergency routing during evacuation conditions. The innovative project is being deployed on the Interstate 94 and the parallel Highway 10 corridor, and is characterized by both urban and rural elements.

The TIGER project is targeted at improving the efficiency of this travel via improved monitoring of real-time conditions by operations personnel at the traffic management centers (TMC); the dissemination of enhanced traveler information to travelers; and the integrated operation of the two primary roadways to proactively manage diversion during incident conditions. These capabilities are intended to be provided through the implementation and integration of a number of freeway management, traffic surveillance, arterial signal control, and traveler information (dynamic message signs [DMS]) strategies, as shown in Figure 3.



Source: Minnesota Department of Transportation

Figure 3. TIGER Project Deployments

The TIGER project seeks to improve travel time, travel time reliability, and safety through the deployment and integration of traffic monitoring, advanced communication, and traveler information components. Traffic monitoring will be provided through closed circuit television (CCTV) surveillance, and loop and radar-based traffic detection. The visual images and volume/speed data provided by these surveillance technologies will be transmitted to traffic operations personnel at the TMCs via wireline and wireless communications.

This data will be made available to staff at Mn/DOT's Metro Region Regional Traffic Management Center (RTMC), as shown in Figure 4, which serves as the management center for the Twin Cities region, as well as Mn/DOT's District 3 TMC located in St. Cloud. The District 3 TMC is staffed by personnel from the Minnesota Highway Patrol and is responsible for traffic operations on portions of the corridor outside of the Twin Cities metro area. The project capabilities will serve to further enhance Minnesota's robust coordination levels between traffic management and public safety personnel in responding to emergency events.

Figure 4. View of the Mn/DOT Regional Traffic Management Center

Traffic operations personnel at the TMCs will monitor travel conditions and in the event of an incident or unusually congested conditions. Traveler information will be disseminated to corridor travelers through DMS located upstream from key decision points. These DMS consist of large overhead signs on freeway segments in urban and suburban areas, as well as smaller roadside signs in use on more rural freeway segments and along Highway 10.

Figure 5 shows examples of both DMS types. The messages to be displayed on these signs are defined in the traffic operations plan and typically consist of a warning that identifies the source of congestion, location, and duration (when known). In general, the traveler information will not prescribe a recommended diversion route, except in the case of mandatory detours.

Figure 5. Examples of TIGER Corridor Dynamic Message Signs

The TIGER deployments also include traffic signal coordination components that can be used by traffic operations personnel to add operational capacity on Highway 10 in the event of an incident on I-94. Several traffic signal flush plans are available to the operations personnel to coordinate signal timing to either maximize capacity on the Highway 10 mainline or maximize capacity on the cross roadways to enable access between Highway 10 and I-94.

Mn/DOT anticipates using the TIGER components on a day-to-day basis to better manage traffic operations in the corridor and maximize the efficiency of both roadways. The Department also anticipates heavy use of the TIGER components to manage the tourism-related congestion that can occur during weekends, holidays, and other special events (e.g., opening day of fishing season).

Since the corridor also serves as a primary evacuation route for the Twin Cities, the TIGER system components also are designed to be used during emergency situations to enhance the efficiency of the evacuation procedures by maximizing the utilization of both roadways. In the event of a problem at the Monticello Nuclear Power plant, the TIGER components also could be used to support the rapid evacuation of corridor area residents. Currently, the TIGER components are not formally recognized as mitigation strategies within the regional emergency/evacuation plans, but would be expected to have potential critical application in an emergency situation. The traveler information systems also may be used during extreme weather events to warn drivers of upstream road closures or restrictions.

To date, the TIGER project is unique in what has been primarily an application of metropolitan ITS components applied into a more rural environment to provide integrated management capabilities to a corridor consisting of an Interstate and a State Highway. The project also represents Mn/DOT's first attempt to fully integrate the transportation operations, management, and information resources on an inter-district basis that involves two separate TMCs. As such, the project is simultaneously addressing many issues regarding the coordination of urban and rural highway operations within the Department.

Mn/DOT has partnered with the Minnesota Highway Patrol for the deployment and operation of the TIGER project components. This deployment is intended to serve as a model deployment for these types of integrated strategies. If successful, the concept is planned for deployment to other critical corridors.

1.3. DEPLOYMENT UPDATE

The initial project schedule called for the completing the project deployment by December 2006. Due to project challenges, this completion date was delayed, particularly due to problems with establishing communications with all the field units. Feedback received from Mn/DOT during a late 2006 site visit initially estimated a "best-case" scenario for system availability as summer 2007, and a "worst-case" estimate of December 2007. Significant deployment progress has been made during the past year, largely credited to a firmware update by the system integration software providers implemented department-wide in December 2006. This provided access to and use of many of the system's CCTV cameras and DMS beginning in January 2007. Other system components have been incrementally integrated into the system, and final testing and acceptance of the completed system from the contractor occurred in December 2007.

The majority of the cameras and DMS have been available and in use by Mn/DOT throughout the summer of 2007. The detector system was one of the last systems to be fully integrated, and as a result, only a limited number of detectors (2 of 12) have been fully operational during the entire baseline evaluation period (November 2006 to November 2007). Several additional detector stations were periodically reporting data during this period, but the majority of detector stations did not come on-line until November 2007. This is unfortunate for the evaluation, as it limited the amount of baseline data that could be collected from these automated sources prior to full system implementation. In moving forward, however, these detector units should be reliably available to collect long-term data on vehicle volumes and speeds in the corridor.

One additional TIGER component developed during the Phase II deployment was a remote platform that provided a mobile CCTV, DMS, and a detector station that could be positioned as needed in the corridor to provide these temporary capabilities. This platform was successfully developed and tested. This remote unit has been redeployed outside of the corridor to assist in managing traffic caused by the I-35W bridge closure following its collapse in August 2007. Mn/DOT reports that the platform is performing very well in this capacity and is providing critical management capabilities.

With acceptance in December 2007, the TIGER system components are fully operational. The system components are jointly managed by Mn/DOT RTMC staff operating from the Metro District's headquarters in the Twin Cities and by Minnesota Highway Patrol staff operating from the District 3 offices in St. Cloud.

Additional future field elements have been proposed to be added in a future deployment phase, though no firm implementation timelines currently exist for their implementation.

1.4. EVALUATION BACKGROUND

An Evaluation Team, under direction from the USDOT ITS JPO, was selected to conduct a national evaluation of the Minnesota TIGER project. The following three areas are being investigated for this evaluation:

- Mobility impacts.
- Safety impacts.
- Lessons learned.

The purpose of this evaluation is to determine whether the corridor mobility and safety are impacted by the deployed strategies, and to identify significant lessons learned to assist others who may be considering similar deployments. Section 2 of this Evaluation Report provides additional detail on the evaluation approach.

1.5. PHASE II EVALUATION REPORT STRUCTURE

This document is structured as follows:

- **Section 1.0 – Project Background and Deployment Update –** Provides an overview of the TIGER project, the corridor environment, deployment status, and evaluation background.
- **Section 2.0 – Evaluation Overview –** Identifies the identified goals, objectives, and hypotheses to be analyzed; identifies several challenges facing the evaluation; and provides an overview of the evaluation test plans.
- **Section 3.0 – Baseline Conditions –** Identifies the available data for testing baseline as well as post-deployment conditions, and summarizes selected baseline performance measures.
- **Section 4.0 – Lessons Learned –** Summarizes the preliminary lessons learned from the deployment.
- **Section 5.0 – Phase III Evaluation Opportunities and Risks –** Provides an assessment of the evaluation opportunity provided by the deployment based on the information gathered to date, describes the risks, opportunities, and proposed Phase III evaluation approach.

2. EVALUATION OVERVIEW

2.1. EVALUATION BACKGROUND

The Evaluation Team is conducting a national evaluation of the Minnesota TIGER project to determine the mobility and safety impacts and to identify the significant lessons learned to assist others who may be considering similar deployments.

The evaluation approach was developed with the assistance of Mn/DOT and under the guidance of the USDOT ITS JPO. Mn/DOT identified broad project goals and objectives included in its original application for ITS Integration Funds. In this application, the primary goal areas identified by Mn/DOT included:

- Improvement in corridor mobility (e.g., travel times and travel time reliability).
- Enhancement to corridor safety.
- Testing of the concept and application of the operations/management strategies to assess their potential for application to additional corridors within the State.

Building on these goals, the Evaluation Team developed a methodology for assessing the TIGER project. The approach and methodology is described in the *Minnesota Traveler Information Guidance and Emergency Routing (TIGER) Project Final Evaluation Plan and Detailed Test Plan* (July 17, 2007). The remainder of this section provides an overview of the evaluation goals, objectives, challenges, and the mobility, safety, and lessons learned test plans.

2.2. EVALUATION GOALS AND OBJECTIVES

Various evaluation objectives have been identified which support the evaluation goals and provide a valid assessment of the TIGER goals. Table 1 summarizes the identified evaluation objectives and corresponding evaluation goals.

Table 1. TIGER Project Evaluation Goals and Objectives

Goals	Evaluation Objectives
Improve corridor mobility	• Identify change in average vehicle speeds during incident conditions • Identify change in travel time during incident conditions • Identify change in travel time variability during incident conditions • Identify change in vehicle delay during incident conditions
Improve corridor safety	• Identify change in the number of crashes • Identify change in the severity of crashes
Document lessons learned	• Document significant lessons learned regarding the application of integrated corridor management strategies in a rural environment • Document significant lessons learned regarding the integration of operations and management strategies in multiple inter-district traffic management centers • Document additional deployment lessons learned

Table 2 presents the evaluation hypotheses and performance measures identified for each evaluation objective. The hypotheses identified as key to the evaluation are indicated in **BOLD**. These hypotheses were selected by the Evaluation Team as the most likely to show impacts (positive or negative) and those having the greatest relevancy to other agencies considering these types of strategies for deployment.

Table 2. Evaluation Objectives, Hypotheses, and Performance Measures

Evaluation Objective	Hypothesis	Performance Measures
Identify change in average vehicle speeds during incident conditions	TIGER deployments will result in an increase in average vehicle speeds in the corridor	• Vehicle speeds • Incident logs • DMS messages logs
Identify change in travel time during incident conditions	**TIGER deployments will result in a decrease in average travel time in the corridor**	• **Vehicle travel times** • **Incident logs** • **DMS messages logs**
Identify change in travel time variability during incident conditions	**TIGER deployments will result in a decrease in travel time variability in the corridor**	• **Vehicle travel times (standard deviation)** • **Incident logs** • **DMS messages logs**
Identify change in vehicle delay during incident conditions	TIGER deployments will result in a decrease in hours of vehicle delay in the corridor	• Vehicle travel times (standard deviation) • Incident logs • DMS messages logs
Identify change in the number of crashes	TIGER deployments will result in a decrease in vehicle crashes in the corridor	• Number of crashes by severity • Vehicle volumes
Identify change in the severity of crashes	TIGER deployments will result in a decrease in the severity of vehicle crashes in the corridor	• Number of crashes by severity • Vehicle volumes
Document significant lessons learned regarding the application of integrated corridor management strategies in a rural environment	**Documentation only**	• **Documentation only**
Document significant lessons learned regarding the integration of operations and management strategies in multiple inter-district traffic management centers	**Documentation only**	• **Documentation only**
Document system costs	Documentation only	• Documentation only
Document additional deployment lessons learned	Documentation only	• Documentation only

2.3. EVALUATION CHALLENGES

The deployments for the TIGER project do not represent a complete green field implementation of new strategies. Instead, the TIGER project has served to integrate many existing components with new technologies and link these strategies with interconnected traffic management centers to improve the efficiency of corridor operations. As such, several evaluation challenges were noted by the Evaluation Team during the development of the evaluation plan:

1. The incremental nature of the deployment presented a challenge in establishing the baseline "before" traffic conditions since some of the TIGER components, including some of the DMS, have been present in the corridor for several years. The deployment and use of these existing technologies prior to the initiation of the evaluation resulted in a lack of opportunity to observe and measure pre-deployment conditions in the corridor.
2. The lack of opportunity to observe pre-deployment incident conditions when the focus of the deployment is on improving operations during randomly occurring incident conditions requires data collection over long periods to ensure that data representing these incident conditions are gathered. This long-term data collection requires automated data collection systems (e.g., detectors) be present to collect the data. Unfortunately, few automated detector stations existed prior to the deployment and the new automated traffic detector stations were deployed in parallel with the other components. This creates difficulty in conducting a pure "before and after" analysis of traffic conditions since very limited corridor traffic detection data (e.g., automated volume and speed data) exist prior to the implementation and connection of the TIGER traffic detector units. Now that they are connected, other TIGER strategies may be in use, tainting the opportunity to use the data to represent "before" conditions.
3. The growth of traffic demand in the corridor for both the northwest suburbs of the Twin Cities and the St. Cloud region, which bracket the corridor, have experienced rapid growth during recent years. Large-scale housing developments and retail establishments (e.g., Albertville Outlet Mall) have promoted changes in regional travel demand patterns. These changes limit the usefulness of historical data and must be controlled for in the analysis.
4. Many of the strategies are targeted at alleviating congestion during incidents and special events. These are random and often non-recurring events; therefore, it is problematic to capture data on enough comparable events to conduct a meaningful "before and after" study.
5. The geographic scope and land-use diversity of the corridor further provide a challenge, since incidents, occurring in different parts of the corridor, may have significantly different impacts and may not be comparable.

The Evaluation Team carefully considered these challenges when developing the evaluation approach to alleviate or minimize these challenges to the greatest degree possible. An overview of the evaluation test plans is presented in the following sections.

2.4. OVERVIEW OF THE EVALUATION TEST PLANS

The implementation of the TIGER components has resulted in the addition of new procedures and influencing variables in what was already a dynamic operational environment. Travel conditions on I-94 and Highway 10 currently are observed to vary significantly due to cyclical patterns, which include:

- Time of day.
- Day of week.
- Month of year.
- Regularly scheduled holidays and events (e.g., opening day of fishing season).

Travel conditions on the corridor can also be greatly impacted by other less predictable factors, such as:

- Vehicle crashes and breakdowns.
- Inclement weather conditions.
- Special events.
- Enforcement activities.

Further, regional trends and other factors also can influence the travel demand on the corridor over time. Examples of these factors include:

- Changes in land-use patterns and development in and around the corridor.
- Changes in the price of gasoline.
- Regional economic activity and employment growth.

Given the dynamic nature of the traffic conditions within the corridor, the evaluation approach was specifically designed to accommodate and control for these influencing factors, to the degree possible, to isolate the change in conditions directly resulting from the TIGER strategies.

The evaluation test plans presented in this section provide additional detail on the initial recommended approach to collecting and analyzing data. As discussed in Sections 3 and 4, these initial approaches may need to be modified in Phase III to accommodate the realities of the deployment.

Three separate test plans were initially developed based on similarities in the approach and the objectives being analyzed. These test plans include:

- **Mobility Impacts Test Plan –** Describes the approach for analyzing speed, travel time, and travel time reliability impacts.
- **Safety Impacts Test Plan –** Describes the approach for evaluating the impacts to safety.
- **Lessons Learned Test Plan –** Describes the collection and analysis of data related to the lessons learned by the project partners.

These individual test plans are discussed in the subsequent subsections.

2.5. MOBILITY IMPACTS TEST PLAN

2.5.1. Objective

The mobility impacts test plan was developed to provide the framework for assessing the impacts of the TIGER deployment on vehicle speeds, travel time, and travel time reliability.

2.5.2. Approach

Due to the planned use of the TIGER components, the evaluation of speed and travel time needs to assess the impacts occurring during incident conditions when the system would be expected to be in use. Various factors, described in Section 2.3, serve as challenges to the evaluation of mobility-related impacts in the corridor using a traditional before and after approach. These challenges complicate the comparison of mobility performance measures collected before deployment with the same metric collected following deployment to identify the incremental impacts. Primary among these challenges is a relative lack of automated and continuous traffic conditions data sources prior to the deployment of the TIGER traffic detection units in the corridor. These continuous data are required due to the need to capture conditions during incident conditions, and the unpredictable and non-recurring nature of the incidents.

Due to these challenges in completing a meaningful analysis depending on before and after data, the Evaluation Team recommended an alternative approach to assessing the potential mobility impacts of the TIGER components. This approach recommended modeling supplemented with data collection and analysis of traveler behaviors during incident conditions using the TIGER detection capabilities.

To simulate the impact of the TIGER components on the network, it was proposed that field data be collected using the TIGER traffic detection units. Vehicle volumes and speeds observed during incident conditions would be used to calibrate the simulation model to properly represent incident diversion rates and patterns following deployment. Several incident scenarios, based on incidents actually observed in the corridor, then would be simulated. The default diversion parameters in the model would be used to represent the "before" travel conditions and the revised diversion rates and parameters would be used to represent the "after" travel conditions with the TIGER components in place. The various before and after traffic conditions for the various incident scenarios would be compared to identify incremental changes in the vehicle volumes, speeds, travel time, and travel time variability.

Activities completed in the current Phase II of this evaluation effort were limited to the collection and analysis of the field data to estimate preliminary diversion behavior patterns; the compilation and review of the available models and data; and the assessment of model enhancements that would be needed to complete Phase III using modeling techniques. No actual simulation of scenarios was proposed under the current Phase. The results of this analysis, including the assessment of necessary model refinements, evaluation scenarios, and resource requirements are discussed within Section 3 of this report.

2.6. SAFETY IMPACTS TEST PLAN

2.6.1. Objective

The safety impacts test plan was developed to provide the framework for assessing the impacts of the TIGER deployment on the number and severity of vehicle crashes.

2.6.2. Approach

Safety impacts of the TIGER deployments are being evaluated using current and archived data available in a crash database maintained by the Minnesota Department of Public Safety. The detailed crash data in the database allows for a comparison of the number of crashes, by severity, occurring before and after the deployment of TIGER strategies. Additionally, historical volume counts are being used to control for travel demand growth that has been occurring in the corridor.

2.7. LESSONS LEARNED TEST PLAN

2.7.1. Objective

The lessons learned test plan was developed to provide the framework to identify and document significant lessons learned by the project partners that may be informational to other practitioners considering deployment of a similar strategy. Of particular interest for this study, the Evaluation Team will be looking to identify lessons learned regarding:

- The application of integrated corridor management strategies in a rural environment.
- The integration of operations and management strategies in multiple inter-district TMCs.

2.7.2. Approach

While there is little formalized approach to evaluating these lessons learned, the evaluators remain attuned to the experiences of the project partners and attentive to identifying information that may be of interest to other practitioners throughout the evaluation process. The majority of the lessons learned were identified though the ongoing discussions and meetings with the project partners. The Evaluation Team continues to make a focused effort to be inquisitive about these matters and will follow up with more probing questions or requests for information when warranted.

3. SUMMARY OF BASELINE CONDITIONS

3.1. OVERVIEW OF DATA COLLECTION AND ANALYSIS

Data collection and analysis activities completed in Phase II of the TIGER evaluation focused on several key activities intended to assess the ability to carry out the full Phase III activities as detailed in the *Minnesota TIGER Final Evaluation Plan and Detailed Test Plan*. These activities often differed from more traditional "before and after" evaluations as they focused less on the actual identification of baseline, "before" performance measures, but instead focused on assessing the ability of the proposed modeling approach to yield meaningful results if a full Phase III evaluation is conducted. The primary activities conducted in support of this assessment included:

- Analysis of incident data to identify time periods affected by incidents.
- Analysis of automated detector data to assess the ability to detect and analyze diversion patterns during incidents and the resulting impact on volumes, speeds, and travel times.
- Analysis of crash data to identify the frequency and severity of crashes.
- Analysis of available models to assess their suitability to be used to generate performance measures impact estimates in Phase III of the evaluation and the identification of modifications that would need to occur to support this use.
- Identification of institutional issues and lessons learned.

The following sections provide additional detail on the activities performed and the findings from these activities. These discussions include:

- Mobility Impacts Test Findings.
- Safety Impacts Test Findings.
- Suitability Assessment of Available Models.

Section 4 provides a separate discussion of the Lessons Learned that have been identified to date.

3.2. MOBILITY IMPACTS TEST FINDINGS

3.2.1. Methodology

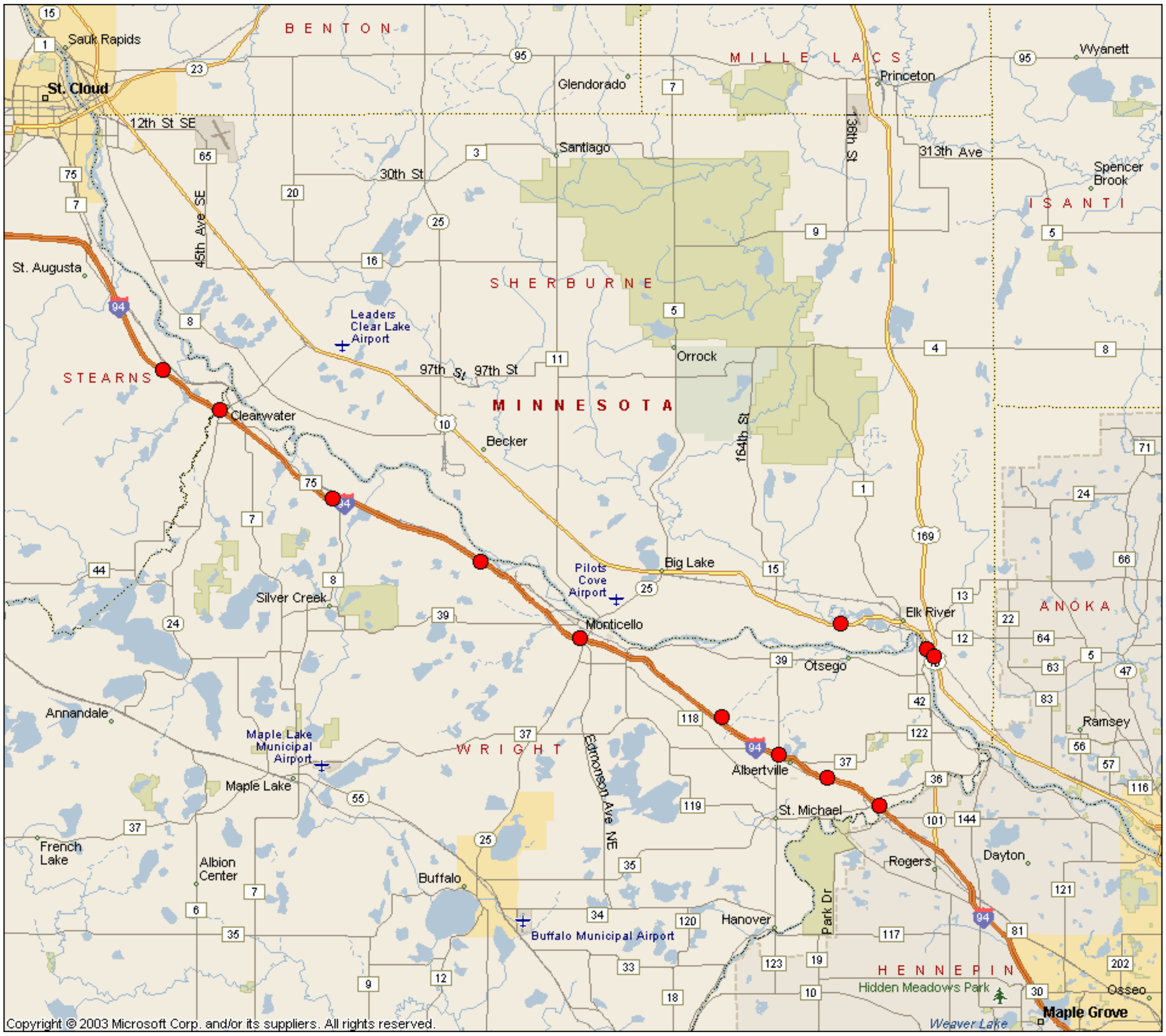
The objective of the Phase II mobility test plan, as detailed in Section 2.5, was to collect and analyze available data to assess vehicle volumes, speeds, and travel times during incidents to identify diversion patterns. The approach to the analysis was to compile available data from automated detectors within and on the fringes of the corridor. Automated data was needed to provide long-term monitoring of conditions and better ensure the observation of conditions during non-recurring and unpredictable incident occurrences. Incident data was also compiled from Mn/DOT incident logs to identify when and where incidents occurred during the baseline evaluation period (November 2006 to November 2007).

The data from the incident logs were then used to categorize data collected from the detectors as occurring during "incident" or "non-incident" conditions. Average volumes and speed data from the incident conditions were then compared with the same metrics representing non-incident conditions – controlling for time-of-day, day-of-week, and other cyclical factors – to assess the ability to detect changes in these performance measures attributable to the incident.

Various factors, detailed in Section 2.3, served as challenges to the evaluation of mobility-related impacts in the corridor using this approach. Primary among these challenges was the situation that many of the automated traffic detector stations, predicted to be available to collect data, did not become fully operational until very late in the baseline evaluation period. Of the TIGER traffic detection stations shown in Table 3 only two stations (one at I-94 and County Road 19 and one at I-94 and County Road 24) were operational during the entire baseline evaluation period (as of December 2007, all 12 detector stations have been brought on line and are providing data). Two additional stations were operational during sporadic times within the baseline evaluation period. This data was combined with data from existing detector stations on I-94 and Highway 10 located slightly beyond the southern limits of the TIGER corridor; however, this still provided a very limited view of conditions on the entire 50-mile corridor, particularly conditions on Highway 10. Figure 3 shows the approximate locations of the detector stations along I-94 and Highway 10.

Table 3. TIGER Traffic Detection Stations

Traffic Detection Location
I-94 and Highway 241
One mile west of I-94 and Highway 241
I-94 and County Road 19
MnROAD RWIS Station
I-94 and Highway 25 (Monticello)
I-94 and County Road 8 (Hasty)
I-94 and RWIS station at mile marker 180.2
I-94 and County Road 24 (Clearwater)
I-94 West of Clearwater
Highway 10/Highway 169 (facing Highway 10)
Highway 10/Highway 169 (facing Highway 169)
One-half mile west of Highway 10/Highway 169



Source: Microsoft Corporation licensed to the Minnesota Department of Transportation.

Figure 6. Location of TIGER Traffic Detection Stations

Although hundreds of incidents were reported in the corridor during the period from November 2006 to November 2007, one challenge for the Evaluation Team was to identify incidents that had a strong likelihood to yield an identifiable response by travelers, given the limited coverage of operational detectors. Corridor incident logs were evaluated to identify incidents that contained combinations of the following characteristics:

- Sufficient severity and/or duration to result in an observable impact.
- Occur in the peak direction.
- Occur during peak or congested time periods.
- Occur in close enough proximity to operational detector stations to provide an opportunity to collect traffic data representing the incident conditions.

The findings from this analysis effort are highlighted in the following section.

3.2.2. Mobility Analysis Findings

Given the limitations of this analysis as discussed in the previous section, only four incidents were identified that met the requirements and were likely to yield identifiable impacts. These incidents included:

1. Tuesday, December 19, 2006 at 7:15 a.m.: Injury accident in eastbound direction closes one lane of I-94 near Monticello.
2. Friday, April 27, 2007 at 5 p.m.: Injury accident in westbound direction closes one lane near Clearwater.
3. Thursday, July 13, 2007 at 7 p.m.: Fatality accident in westbound direction closes one lane near Highway 7.
4. Friday, October 26, 2007 at 3:45 p.m.: Fatality accident in westbound direction closes all lanes near St. Michael.

An analysis of each incident was conducted to compile volume and speed data from available traffic detectors to compare the performance measures from the incident conditions. The analysis was conducted with performance measures representing a similar period (e.g., time-of-day, day-of-week, month-of-year) representing non-incident conditions. Unfortunately, all but one of these analyses failed to result in the identification of impacts to volumes or speeds that were outside of the typical day-to-day variability (noise) of the data. All of the incidents appeared to occur too far from an operational detector station to impact traffic conditions at that location.

The analysis of the fourth incident on October 26, 2007 did result in identifying significant volume and speed impacts as shown in Table 4.

Table 4. Performance Measure Impacts Observed During October 26, 2007 Incident

Detector Location	Relative Location to Incident	Observed Volume Change (%)	Observed Speed Change (%)
I-94 and County Road 24 (Clearwater)	25 Miles Downstream	-25	+12
I-94 and County Road 19 (1)	2 Miles Downstream	-100	N/A
I-94 and Highway 30 (2)	13 Miles Upstream	-15	-5
Highway 10 West of Highway 169 (2)	10 Miles Upstream	+14	-15

(1) Located within closure section.
(2) Located beyond southern/eastern corridor limits.

The observed impacts of this one incident do not provide a reasonable assessment of the diversion patterns in the corridor, particularly because this specific incident resulted in a full closure of the freeway for several hours. Therefore, any diversion impacts observed in these limited data points are the result of mandatory diversions, not just voluntary diversions. This analysis does prove, however, that it is possible to observe these diversion impacts from an incident – albeit an extreme incident situation – using the system detectors. A greater number of incidents would need to occur in closer proximity to detector stations to allow greater confidence in the diversion analysis findings.

Now that the additional TIGER traffic detection units are in operation, there is the potential to collect continuous data from a much more robust coverage of the corridor to capture the behavior of traffic during incident conditions. While this does not support a pure "before and after" evaluation of the impacts associated with the system components, it would allow the better identification of diversion behaviors during incidents as called for in the evaluation test plans. Data from these newly integrated detector stations are currently being continually uploaded and archived to the identical Mn/DOT database as the previously compiled baseline data and are available for potential future use in the evaluation.

3.3. SAFETY IMPACTS TEST FINDINGS

3.3.1. Methodology

Safety impacts of the TIGER deployments are being evaluated using current and archived data available in a crash database maintained by the Minnesota Department of Public Safety, Office of Traffic Safety. The detailed crash data in the database allows for a comparison of the number of crashes, by severity, occurring before and after the deployment of TIGER strategies. In the case of any crashes that occur in Phase III of the evaluation, volume counts will additionally be collected and used to control for travel demand growth that has occurred in the corridor.

The number of crashes by severity will be obtained from the Minnesota Department of Public Safety's crash database. This robust database contains records of all crash reports occurring on State highways compiled from Minnesota Highway Patrol and other local law enforcement personnel. A limitation of this data is that it often takes several months or more for all the crash records to be entered into the system, which results in a time delay in analyzing recent crashes.

To provide a representative sample of crash occurrences for the analysis, 2 years of crash data (July 2005 to July 2007) were used to establish the baseline "before" conditions. Crash data also will be obtained for the after scenario, ideally representing a 1- year period or more.[1]

Data representing the two previous years (July 2005 to July 2007) were combined and averaged to represent crash frequency by severity in the before deployment period. As a precautionary measure, crash data representing the period from January 2007 to July 2007; was first analyzed against the same data from the same period from the previous year to evaluate if there were any significant differences in the data possibly caused by the incremental deployment of several of the TIGER components during this period. No discernable differences could be observed in this data, therefore, all the data from the 2-year period was combined for analysis.

[1] There is often substantial time required to review and process the crash data from all the various sources prior to uploading into the Department of Public Safety crash database. Due to this time delay, there may not be an opportunity to review an entire year of crash data following the implementation within the time constraints of this evaluation effort. If this analysis period is reduced, the baseline period also will be reduced to an equivalent representative period (e.g., using data from the identical months in the before and after periods) prior to comparison.

3.3.2. Safety Analysis Findings

The analysis of the crash data included crashes reported on I-94 as well as Highway 10, and other State highways serving as connectors between the two roadways in the corridor. The results of this analysis are presented in Table 5.

Table 5. Average Number of Annual Corridor Crashes by Severity (July 2005 – July 2007)

Roadway Type	Fatality	Injury	Property Damage
Interstate 94	4.5	31	61
Highway 10 and Other State Highways	5	52	101

The crash metrics shown in Table 5 will form the basis for the comparison with data collected during the "after" period.

3.4. SUITABILITY ASSESSMENT OF AVAILABLE MODELS

Due to the challenges in completing a meaningful analysis depending on the "before and after" data, and due to limited capabilities to collect long-term automated data representing the before period, the Evaluation Team proposed an alternative approach to assessing the potential mobility impacts of the TIGER components in the *Minnesota TIGER Final Evaluation Plan and Detailed Test Plan*. The proposed approach would utilize modeling supplemented with data collection and analysis of actual traveler behaviors observed in the corridor during incident conditions using the TIGER detection capabilities.

The proposed approach recommended the assessment of currently available models to test their suitability to conducting an analysis in the corridor and the identification of modifications that would be necessary to support the analysis. Activities to be completed in the current Phase II of this evaluation effort were limited to the compilation and review of the model files, and identifying the necessary model enhancements that would be required to support the analysis in Phase III. No direct simulation of scenarios was proposed under the current Phase. The results of this analysis, including identification of modeling opportunities and limitations, are presented in this section.

The following three previously developed models were identified and evaluated for their ability to provide analysis of mobility performance measures in the corridor under incident conditions:

1. The Twin Cities regional travel demand model maintained by the Metropolitan Council. This forecasting model utilizing the Tranplan/TP+ platform covers the Twin Cities region including a portion of the southeast segment of the corridor.
2. A macro-simulation model developed as part of bridge crossing study conducted in 2001 for Mn/DOT. This FREQ simulation model was developed by SRF Consulting Group and covers a small segment of the corridor near St. Cloud.
3. A macro-simulation model developed by the University of Minnesota's Center for Transportation Studies (UofM-CTS) in 2004 to study evacuation routing for the Mn/DOT Office of Homeland Security and Emergency Management. This study included the

development of a macrosimulation model of major evacuation routes, including the I-94 and Highway 10 corridors.

Of the three models, the model developed by the UofM-CTS to study evacuation models was initially identified as having the best possibility of supporting this evaluation. The Metropolitan Council's model provided very little detail of the corridor northwest of the Hennepin County line, and as a travel demand model, was assessed to have limited ability to analyze traffic during incident conditions. Meanwhile, the bridge crossing study models were assessed to be too localized to be of use in this evaluation.

To assess the suitability of the third model, the Evaluation Team contacted personnel at UofM-CTS who were involved with simulation model development. The University staff provided information on the model capabilities and provided the Evaluation Team with data files and model documentation. Once the initial review was complete, the Evaluation Team conducted follow-up discussions with UofM-CTS staff to obtain a better understanding of the data and model files.

This analysis yielded the following findings. The model utilizes a GIS-based (ARC/Info) network of the greater Twin Cities region, including Interstate and major State Highways for the surrounding region. This includes representation of I-94 and Highway 10 in the study corridor, but does not contain representation of any of the cross highways in the corridor. The model was developed to evaluate the speed and efficiency of several evacuation scenarios. The model does not contain a dynamic assignment algorithm, and uses a more simplified approach that assigns traffic according to available capacity and parameters defining travelers preferences for various roadway types. The traffic demand (trips) in the model are loaded onto the network at numerous loading points throughout the Twin Cities region. The loaded trips are meant to represent evacuation conditions, so trips are not assigned to represent travel destined to the region.

The Evaluation Team, with advice support from the UofM-CTS staff, critically assessed the model based on the potential to successfully support the needs of the Phase III analysis. The following major limitations were identified to this approach:

- The model does not contain representation of major cross roadways linking I-94 and Highway 10. To successfully evaluate diversion patterns, the network would need to be modified to add these roadways and connections. This would require a relatively significant effort to code the associated roadway data and recalibrate the model. This effort was anticipated in the development of the proposed approach, and by itself would not be cause to abandon the proposed plans.
- Traffic is not assigned dynamically in the model, making it difficult to assess incident conditions. Traffic is assigned based on available capacity. Real-world data collected on diversion patterns observed in the corridor would first need to be converted into a representative network capacity change, greatly complicating the analysis procedure, as well as further separating the output performance measures from the empirical data.
- Travel demand in the model is based on non-typical evacuation patterns and would need to be modified to represent normal traffic conditions. This would require a significant effort to develop the data and recalibrate the model.

Based on the limitations identified through the critical assessment of the model, the Evaluation Team determined that the effort and resulting resources required to modify the model for use in the Phase III analysis would far exceed the resources preliminarily estimated for this effort in previous assessments. The effort required to modify the model would be on par with the effort required to develop a new model for the corridor, and would include a substantial effort to compile roadway configuration and travel demand data.

Due to these limitations and the resources that would be required to mitigate them, the Evaluation Team recommends that the modeling approach not be conducted as proposed in the *Minnesota TIGER Final Evaluation Plan and Detailed Test Plan*. Section 5, which assesses the evaluation opportunities and risks, presents several alternatives and recommendations for examining mobility impacts.

4. LESSONS LEARNED

Several significant lessons learned by the project partners have been identified in the course of the evaluation to date. Many of these lessons learned have revolved around the coordination required for a multi-jurisdictional (Mn/DOT Metro District and District #3) and in this case multi-agency (Mn/DOT and Minnesota Highway Patrol) deployment. Project partners have reported gaining an increased understanding of the needs of the different agencies involved, including:

- Mn/DOT personnel increasing their understanding of the needs of the Highway Patrol during enforcement activities.
- Minnesota Highway Patrol gaining better insight into the traffic implications of their enforcement and accident investigation efforts.

Although not one of the originally stated project goals, the project partners have reported that the TIGER project has produced some unanticipated benefits related to law enforcement. Two specific incidents were anecdotally cited as proving the benefits of the camera surveillance additions to rural areas of the corridor. These example incidents mentioned by stakeholders included:

1. The camera surveillance capabilities of the system were used to monitor the development of a high-speed motorcycle chase along the I-94 corridor. Although patrol vehicles were unable to keep pace with the suspect vehicle, camera images were used to track the vehicle without having to pursue at dangerous speeds. Patrol cars were also able to be pre-positioned in the path of the chase, eventually leading to the successful apprehension of the suspect.
2. A patrol officer pulled over to assist a disabled vehicle on the roadside to find no occupants inside the vehicle. A further check revealed that the car had been reported stolen. No suspects were immediately sighted near the vehicle by the patrol officer; however, when the dispatcher was contacted with the information, the officers checked the camera feed from a nearby interchange and noticed several suspects walking on the shoulder of the off-ramp toward a truck stop. The dispatcher was able to monitor the movements of the individuals until another patrol officer arrived. The suspects were arrested and charged with the vehicle theft as they were attempting to obtain a spare can of gasoline to refuel the car which had run out of fuel.

To date, there have been few institutional challenges reported by the stakeholders as a result of the integration of the deployment across both an urban and a primarily rural district. Some of these issues may have been tempered during deployment as a contractor was available to cover many of the routine operation, repair, and maintenance issues. With the acceptance of the project in December 2007, the staff at the various districts may need to work closer together to resolve issues and define roles and responsibilities in the absence of the project contractor.

One additional lesson learned by stakeholders is that unforeseen circumstances can result in a reassessment of project priorities and require significant changes in a deployment. One TIGER component that was highly anticipated for use in the corridor was a remote platform providing a mobile CCTV, DMS, and a detector station that could be positioned as needed in the corridor to provide these temporary capabilities. Although this platform was successfully developed and tested, this remote unit was unexpectedly redeployed outside of the corridor to assist in managing traffic caused by the closure of the I-35W bridge which collapsed in August 2007. Mn/DOT reports that the platform is performing very well in this capacity and is providing critical management capabilities.

5. ASSESSMENT OF PHASE III OPPORTUNITIES AND RISKS

The Evaluation Team has enjoyed the opportunity to learn more about the TIGER project through discussions with the partners and through the related project data analysis. In conducting these Phase II efforts, the Evaluation Team has continually been assessing the project for strengths and weaknesses that would either support or inhibit the Team from confidently recommending the project for continuation as a Phase III evaluation. These risks, opportunities, and recommendations are discussed in the subsequent sections.

5.1. IDENTIFIED RISKS

Several factors have been identified during the conduct of Phase II of this evaluation that inhibit the conduct of the Phase III effort as initially defined in the *Minnesota TIGER Final Evaluation Plan and Detailed Test Plan*. These risk factors serving as barriers include:

- Difficulties in modifying available models to support the needs of the Phase III analysis at a reasonable level of effort and cost.
- Difficulties in connecting the empirical evidence gained on diversion patterns with the available models to extrapolate the impacts to other performance measures.
- Lack of long-term automated detector data with sufficient coverage to allow for meaningful before and after comparison of mobility performance measures.
- Difficulties in establishing baseline conditions since components of the system were incrementally introduced throughout the data collection period.
- Lost opportunity to utilize the TIGER mobile platform for supplemental data collection due to the redeployment of the traffic management trailer.

Balancing some of these risks are the opportunities identified in the subsequent section.

5.2. IDENTIFIED OPPORTUNITIES

In the conduct of the Phase II evaluation effort, the Team also identified many factors supporting the continuation of the evaluation effort. These opportunities include:

- The deployment is complete and fully operational, so the Phase III evaluation could begin immediately.
- A much more robust detection network is now operational and provides much greater coverage of data in the corridor. This data is actively being archived and would be available for any future evaluation efforts.
- There is a proven framework for assessing the diversion behaviors of travelers. Although only a limited number of incidents were able to be analyzed during the baseline period, the additional detector coverage should provide an enhanced opportunity to analyze these impacts in the future.
- There are robust datasets (e.g., incidents, crashes) available to support the evaluation.

- The project partners have eagerly assisted the Evaluation Team and would like to continue providing this support.
- The integration of the TIGER components on a multi-jurisdictional and multi-agency basis continues to prove opportunities to assess lessons learned to could be valuable to other agencies attempting similar integration projects.

5.3. RECOMMENDATIONS

The evaluation team conducted the assessment of the available baseline data and available models during the Phase II evaluation period (November 2006 to November 2007). This effort also included an analysis of available safety data and documentation of institutional issues and lessons learned reported by the local partners. The findings of the Phase II effort were reported in a briefing to ITS JPO in February 2008, along with an assessment of the opportunities and challenges facing a continued Phase III evaluation.

Based on these challenges, the evaluation team recommended that the mobility study of the Phase III evaluation could not be completed utilizing the initial, innovative modeling approach. The evaluation team did suggest, however, that there remained significant opportunities to collect, analyze and document useful data representing the deployment impacts and lessons learned. The evaluation team suggested that the mobility study approach could be altered to provide useful information on driver behaviors during incident conditions, and that the proposed approach for the evaluating safety impacts and lessons learned could be successfully completed with minimal modifications. ITS JPO agreed with this finding and requested the evaluation team to propose a revised evaluation and outreach approach for conducting a Phase III analysis of the Minnesota TIGER project. This revised approach is presented in the following sections.

5.3.1. Proposed Phase III Evaluation Approach

The proposed modifications to the Phase III evaluation approach primarily impact the proposed conduct of the mobility study; however, minor modifications were also proposed for the safety study and the analysis of lessons learned. These modifications are discussed in subsequent subsections. There are also proposed modifications to the proposed deliverables for the evaluation (expanding the number of the format variety of the output products) and proposed changes to the overall schedule for the evaluation (extending the post-deployment period from 6 months to 2 years) that are discussed in later sections.

Proposed Modifications to the Mobility Study

The most significant changes to the Phase III evaluation approach are in the area of studying the mobility performance measure impacts. The initial approach proposed:

- Customizing an available regional model to conduct corridor analysis.
- Collecting data on changes in speeds and volumes during incident conditions using corridor detectors.
- Incorporating the observed changes in speeds and volumes from the detectors into the model to estimate changes in corridor speeds, travel times and travel time reliability.

This initial approach was determined to be unworkable during an assessment of the available data and models, as highlighted in a previous section. Therefore, the following modifications to the Phase III approach are proposed.

1. The proposed approach to using modeling to estimate before and after conditions will be discontinued.
2. It will not be possible to reasonably compare before and after mobility conditions, thus the evaluation will not attempt to directly estimate the impact of the deployment on corridor speeds, travel times or travel time reliability.
3. The mobility study will be focused on evaluating driver behaviors during incident conditions, specifically, using the analysis framework developed and tested in Phase II to collect and analyze detector data during incident conditions to estimate diversion rates. This analysis will flag incident conditions occurring in the corridor from the incident logs and compile the available detector data for those periods. The detector data representing the incident conditions will be compared with detector data for non-incident days (controlling for time-of-year, day-of-week, and time-of-day variations) to provide estimates of diversion rates during various types and severity of incidents observed.

This revised analysis would not represent a typical before and after evaluation and would not identify many traditional performance measures (e.g., change in speed, travel time, travel time reliability) familiar to laypersons. Instead, this assessment would provide additional insight into the behavior of travelers during incident conditions, primarily what proportion of travelers typically divert when different levels of non-recurring congestion are encountered. This type of behavior impact information is critically needed by practitioners attempting to study the likely impacts of operations strategies in their own regions and also desired by researchers and developers of traffic analysis tools to enhance the ability to assess these impacts. The output from this analysis would therefore be targeted towards a technical audience.

Proposed Modifications to the Safety Study

The initial evaluation approach to the safety study proposed using incident and accident logs maintained by the local project partners to compare the number of accidents occurring before and after the deployment of TIGER components. Assessments completed in Phase II revealed that the available data support this analysis and a similar approach is proposed for the Phase III analysis. This analysis will result in the estimation in any change in overall accident rates observed between the two evaluation periods.

Additionally, ITS JPO suggested the addition of an additional analysis into Phase III. Since the TIGER deployment's greatest impacts on safety would be expected to occur as a result in the occurrence of secondary accidents, a separate analysis is proposed to capture these potential impacts. An additional analysis will be performed to identify the number of accidents occurring during incident conditions caused by a previous incident. The information in the corridor incident logs will be used to flag those incident periods and observed accidents will be tallied from the accident logs. The observed occurrence of these incident period accidents will be compared between the before and after periods to identify any change that may be attributed to the TIGER improvements.

Proposed Modifications to the Documentation of Lessons Learned

As initially proposed, the approach for documenting lessons learned will continue to assess issues surrounding:

- The application of integrated corridor management strategies in a rural environment; and
- The integration of operations and management strategies in multiple inter-district traffic management centers.

As a result of interesting findings from the baseline evaluation, suggestions from ITS JPO, and input from the local partners on what information they would have liked to know prior to initiation of the project, the following three issues are proposed to be further explored in the Phase III evaluation:

1. Mn/DOT personnel increasing their understanding of the needs of the Highway Patrol during enforcement activities, and similarly, Minnesota Highway Patrol gaining better insight into the traffic implications of their enforcement and accident investigation efforts;
2. Study of communication issues that were encountered and how these issues were addressed; and,
3. Issues and outcomes surrounding the re-deployment of TIGER equipment (e.g., mobile traffic surveillance and traveler information platform) as a result of the closure of the I-35W bridge which tragically collapsed in August, 2007.

5.3.2. Proposed Outreach Support

The ITS JPO is interested in disseminating the findings from the TIGER evaluation to transportation practitioners across the country to help accelerate the integration of ITS and applied operations strategies to corridors in order to cost-effectively improve travel time, travel time reliability, and safety. While the I-10 corridor in Minnesota is unique in several aspects, there is likely to be broad interest in the findings from this evaluation among transportation practitioners across the country because many corridors share some aspect of the I-10 corridor's challenges. Like Mn/DOT, all transportation and public safety agencies seek to increase the safety of their roadways and reduce non-recurring delay due to incidents, planned special events, or large-scale emergencies. Nearly every region faces population growth that is expected to outpace roadway capacity. Furthermore, a growing majority of transportation agencies across the country either own or are considering investment in the technologies, or combinations of technologies, implemented by Mn/DOT including traffic monitoring (CCTV), loop and radar-based detection, DMS, signal timing, and traveler information. Finally, because of the unique urban-rural hybrid nature of the I-10, the results of the MN TIGER evaluation are also likely to be of interest to managers of transportation corridors in both urban and rural areas, each of whom may find aspects of this evaluation they can apply directly to their situation.

Investment in an outreach component of this evaluation is critical to advancing the state of the practice in ITS, integrated corridor management, and other operational areas including traffic incident management and emergency management. Target audiences must be given multiple opportunities to learn from the MnDOT TIGER experience. In so doing, the audience will be able to leverage the experiences and lessons-learned from Mn/DOT's leadership with ITS and this Evaluation to broaden their understanding of how strategic application of ITS and integrated operations strategies can help address specific corridor objectives.

Goals for outreach related to this task include the following:

- Generate awareness and interest among transportation practitioners across the country of this initiative and its key findings relative to the desired outcomes of improved travel time, travel time reliability, and safety.

- Motivate and equip transportation practitioners to investigate options to apply these lessons to their corridors.
- Stimulate increased investment in, and successful application of, ITS and integrated operations strategies in other corridors to improve travel time, travel time reliability and safety in other corridors.

To achieve these goals, the outreach effort will develop or tailor a brief communications and outreach strategy that identifies the target audiences by role, core messages, outreach products, outreach channels, and distribution strategies that could be used to achieve the outreach goals. In the case of the TIGER evaluation, an existing outreach strategy, from the Integrated Corridor Management Initiative, will be reviewed and used as a guide. Table 6 provides an example of the Outreach Goals, Supporting Strategies, and Products that will be expanded upon in the outreach strategy document.

Table 6. Sample Outreach Goals, Strategies, and Communications Products

<table>
<tr><th>Outreach Goal</th><th>Supporting Strategies</th><th>Products</th></tr>
<tr><td>1. Generate awareness and interest among transportation practitioners across the country of this initiative and its key findings relative to the desired outcomes of improved travel time, travel time reliability, and safety</td><td>•Identify the appropriate target audiences (roles, seniority range, geographic range, and corridor demographics) on a sufficient scale (number reached) to achieve change.
•Develop outreach products that effectively communicate with range of target audiences and persuasively convey why they should care.</td><td rowspan="3">•Tailored Communications/ Outreach Strategy

<u>Outreach Products</u>
•Brochure
•Presentation
•Case Study product (s)
•Web Site
•Email Lists</td></tr>
<tr><td>2. Motivate and equip transportation practitioners to investigate options to apply these lessons to their corridors.</td><td>•Inform audiences of available knowledge products such as Evaluation Reports, lessons-learned summaries and where they can find it.
•Move audiences from awareness to desire to take action (learn more) and enable them to take the desired action (point them to a website/knowledgebase, points of contact, upcoming conferences).</td></tr>
<tr><td>3. Stimulate increased investment in, and successful application of, ITS and integrated operations strategies in other corridors to improve travel time, travel time reliability and safety in other corridors.</td><td>•Illustrate how the strategies applied in TIGER can inform the range of needed decisions to effect the desired improvements.</td></tr>
</table>

Primary Target Audiences:
Primary target audiences are those audiences whose support is critical to achievement of the desired change outcome. Examples of target audiences for the MN TIGER Evaluation initiative include:

- Managers and staff at USDOT, other related federal agencies (DHS, other) and National associations such as ITS America, TRB, AASHTO, and so forth.
- Executive Directors and Managers of State DOTs, TMCs, MPOs, Local Transportation Agencies, Public Safety and EMS agencies.
- Operations personnel at State DOTs, TMCs and local transportation, public safety and EMS agencies.
- Planning staff at State DOTs and MPOs.

Core Messages:
Core messages will be tailored and defined to be used in all outreach products to convey a clear, accurate and consistent message that resonates with the target audiences. Core messages cross all audience groups and convey high-level, influence points that are substantiated in more detail in supporting products such as a Case Study, presentation and the Evaluation Report itself. Examples of core messages could include:

- ITS (or specific ITS technologies) in combination with integrated operational strategies shown to reduce travel time, increase travel time reliability and safety.
- Transportation and public safety agencies glean value through shared ITS (or specific ITS technologies) in combination with integrated operations of a corridor.
- Mn/DOT ITS strategies bridge rural and urban transportation safety and mobility challenges.
- Integrated corridor operations are key to achieving return on your ITS investment.
- Individual agencies report benefits from operational collaboration and shared ITS.

Outreach products:
At this time, a minimum of three outreach products are proposed for this task; a brochure, a presentation slide deck and a case study. The ITS JPO will be consulted to consider telling additional 'stories' of the Mn/DOT TIGER experience through case studies that help illustrate different outcomes of specific aspects of the deployment to interested audiences. Table 7 highlights the goals and format for the brochure, slide deck, and case study.

Table 7. Brochure, Slide Deck and Case Study Focus

Outreach Product	Focus
Brochure	Goal: Stimulate interest among target audiences in ITS and the Mn/DOT experience. Format: High-level, visually-oriented introduction to the significance of the Mn/DOT TIGER evaluation project and key outcome-influencing findings, and where to learn more. Likely trifold glossy brochure, easily carried by audiences. Applicable to all target audiences.
Presentation Slide Deck	Goals: (1) Stimulate interest among target audiences in ITS and the Mn/DOT experience and (2) inform of significant findings and lessons-learned. Format: Executive version and more detailed technical version. Both are visually-oriented. Executive version focuses on outcome-influencing findings and includes 1-3 vignettes also illustrated in Case Study products. Technical version includes more detail on Mn/DOT's requirements, ITS approach, Evaluation approach, challenges and lessons-learned, and key findings and where to learn more. Likely applicable or easily tailored to all target audiences.
Case Study	Goals: (1) Stimulate interest among target audiences in ITS and the Mn/DOT experience and (2) provide detailed examples that illustrate specific aspects and outcomes of keen interest to target audiences from Mn/DOT's ITS implementation (compelling stories) such as the mobile surveillance detection's role in the tragic I-35 bridge collapse. Format: Highly visual format that is also more information intensive. Likely a 2-sided fact sheet or 4-8 page brochure that may include 1-3 case study profiles. Very specific target audiences.

Outreach Channels:
The outreach strategy will also identify specific outreach channels that could be used to reach each target audience. Identifying and utilizing all the outreach channels is not expected due to budgetary constraints. However, these outreach channels will be reviewed by the ITS JPO and those with the highest priority may be used under this task, budget permitting. Examples that could be employed to disseminate the outreach products and information about this Evaluation include:

- Conferences
- Webinars
- Targeted email lists
- Newletters
- Web sites
- Industry publications
- Podcasts
- OTHER

Finally, the outreach strategy will include the distribution or implementation strategy to assure that target audiences receive the messages in the desired timeframes. The distribution strategy will identify specific, time-based outreach opportunities to reach the target audiences and applies these to an implementation plan or schedule. The goal is to assure that each audience set receives the core messages at least seven times in three different formats, the rule of thumb in marketing to assure that a message is retained. Table 8 provides an example distribution strategy for one target audience.

Table 8. Distribution Strategy Example

Target Audience	Distribution Opportunity	Timeframe	Outreach Channel
ITS transportation practitioners	ITS America Conference	Summer 2009	• Present on panel forum and distribute outreach products (Brochure, Case Studies); • Stage outreach products in ITS JPO Exhibit space; • Co-host reception

5.3.3. Proposed Outcomes and Products

The initial evaluation approach proposed the development of a single Phase III evaluation report, documenting all evaluation findings, following the completion of the evaluation period (previously anticipated as August 2008). Due to the modifications proposed the evaluation approach, the evaluation team suggests that multiple products be developed, each specifically tailored to a specific audience. These products are also proposed to be delivered during a longer evaluation timeline to provide additional time to assess certain impacts (as discussed in the subsequent schedule section).

The products proposed as deliverables for Phase III include:

1. An interim Evaluation briefing providing an overview of progress and interim results at the half-way point of the evaluation (proposed December 2008). This briefing will summarize all evaluation efforts to date and allow ITS JPO insight into progress made in order to assess the likelihood of additional success that could be gained by extending the evaluation period an additional year.
2. A Communications and Outreach Strategy defining the goals, strategies, target audience, core messages, outreach products, outreach channels, and distribution strategies.
3. A final Evaluation Report summarizing the evaluation findings at the ultimate conclusion of the evaluation period (proposed December 2009)
4. A glossy, high-level brochure summary of the lessons learned from the TIGER deployment that could be distributed at conferences and to interested practitioners.
5. A deck of presentation slides (appropriate for an approximate 20 minute presentation) summarizing the lessons learned by the local partners. This presentation will be structured so that it may be delivered by the local partners, FHWA representatives, or the evaluation team members at future meetings or conferences. An executive version of the presentation can also be developed if desired.

6. A glossy double-sized, single page case study telling the story of how the mobile surveillance and traveler information platform was successfully utilized in addressing the emergency conditions following the I-35W bridge collapse. The ITS JPO may choose to develop additional case study products to support outreach objectives for this initiative within budget. If so, alternate formats such as a brochure format could be considered that could package them together as a set.

5.3.4. Proposed Schedule

The initial evaluation schedule called for the completion of the evaluation by approximately August 2008. The evaluation team concluded during the conduct of Phase II activities that a longer timeline would provide greater opportunity to observe a greater number (and variety) of incident conditions. Therefore, it is proposed that the evaluation timeline be extended approximately two years – taking the schedule to 3/1/2010. Due to the expansion of the evaluation timeline, however, an interim evaluation briefing is proposed in December 2008 to allow the ITS JPO to assess progress. In addition, deliverables not contingent on long-term data collection are proposed to be completed earlier in the schedule providing the ability to disseminate the findings sooner. Table 9 shows the proposed deliverables schedule.

Table 9. Proposed Deliverables and Schedule

Deliverable	Schedule
1. Mobile Platform Redeployment Case Study	September 2008
2. Interim Evaluation Briefing	December 2008
3. Communications/Outreach Strategy	February 2009
4. Lessons Learned Brochure	October 2009
5. Final Evaluation Report	December 2009
6. Presentation Slide Deck	January 2010
7. Section 508 Remediation	March 1, 2010

5.3.5. Proposed Budget

The schedule and the number of deliverables under the proposed evaluation approach will increase from what was originally planned. However, by reallocating resources from the originally planned modeling analysis of mobility impacts the evaluation team believes that the originally proposed Phase III budget of $289,000 will be sufficient for conducting the proposed evaluation and developing several outreach products. It is estimated that approximately 70 percent (or $202,000) would be expended in the first year of the Phase III analysis, with the remaining 30 percent ($87,000) expended in the following year.