# Twin Cities Ramp Meter Evaluation

# evaluation plan

*prepared for*

**Minnesota Department of Transportation**

*prepared by*

**Cambridge Systematics, Inc.**

*with*

SRF Consulting Group, Inc.
N.K. Friedrichs Consulting, Inc.

*September 25, 2000*

*evaluation plan*

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# Table of Contents

# List of Tables



# List of Figures

# 1.0 Project Background

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The Minnesota Department of Transportation (Mn/DOT) uses ramp meters to manage freeway access on approximately 210 miles of freeways in the Twin Cities metropolitan area. Mn/DOT first tested ramp meters in 1969 as a method to optimize freeway safety and efficiency in the metro area. Since then, approximately 430 ramp meters have been installed and used to help merge traffic onto freeways and to help manage the flow of traffic through bottlenecks.

While ramp meters have a long history of use by Mn/DOT as a traffic management strategy, some members of the public have recently questioned the effectiveness of the strategy. A bill passed in the past session by the Minnesota Legislature requires Mn/DOT to study the effectiveness of ramp meters in the Twin Cities Region by conducting a shutdown study before the next legislative session.

The study is scheduled to occur in the fall of 2000, with the results to be presented to the Legislature and the public by February 1st, 2001. The goal of the study is to evaluate and report any relevant facts, comparisons, or statistics concerning traffic flow and safety impacts associated with deactivating system ramp meters for a predetermined amount of time.

In response to the Legislative mandate, Mn/DOT has formed two committees to represent the public and ensure the credibility/objectivity of the study, including:

- **Advisory Committee –** Provides policy oversight and input into the consultant selection process, the proposed study work plan, measures of effectiveness and evaluation measures.

- **Technical Committee –** Provides technical guidance, expertise, and quality control. Also provides technical input to the consultant selection process, proposed study work plan, measures of effectiveness and evaluation measures.

On June 19th, 2000, Mn/DOT issued a Request for Proposals (RFP) to study and report on the traffic flow and safety results of deactivating ramp meters in the Twin Cities Region. Members of both the Advisory Committee and the Technical Committee served on a selection committee to design and approve consultant selection criteria and evaluate proposals from consultants received in response to the RFP. A consultant team led by Cambridge Systematics, Inc. was selected to conduct the ramp meter evaluation. Joining Cambridge Systematics on the evaluation team are SRF Consulting Group, N.K. Friedrichs Consulting, and a panel of nationally recognized experts in the field of ramp metering and transportation evaluations.

This document represents the Evaluation Plan developed for the study by the Cambridge Systematics (CS) team with significant input from the Technical and Advisory Committees. This Evaluation Plan identifies:

- Evaluation team members and organizational hierarchy (Section 2);
- Evaluation objectives (Section 3);
- Performance measures and evaluation methodologies (Section 4);
- Technical approach for field data collection (Section 5);
- Technical approach for market research tasks (Section 6);
- Technical approach for conducting the benefit/cost analysis (Section 7);
- Technical approach for conducting secondary research (Section 8); and
- Evaluation schedule, meetings and deliverables (Section 9).

This Evaluation Plan will serve as the guideline for conducting the ramp metering evaluation. As such, this document is intended to be sufficiently detailed to provide valuable guidance to the evaluators; however, the plan also maintains flexibility to address project contingencies that may arise.

# 2.0 Evaluation Team

# 2.0 Evaluation Team

The evaluation team assembled for this study is knowledgeable and experienced in the evaluation of traffic management strategies, such as ramp metering. The evaluation team has been carefully selected and structured to provide an independent, credible and objective study.

Two committees have been formed to represent the public in the implementation of the study. The Advisory Committee is comprised of legislators, legislative staff, local government representatives, researchers, industry representatives, and stakeholder representatives. The Advisory Committee provides policy oversight, input and guidance to the study. The Advisory Committee is chaired by David Jennings, President of the Greater Minneapolis Chamber of Commerce. Other organizations represented on the Advisory Committee include:

- Association of Minnesota Counties;
- Department of Public Safety – Minnesota State Patrol;
- Hennepin County Community Health Department;
- Southwest Metro Transit Commission;
- State Legislators (4);
- Federal Highway Administration (FHWA);
- Murphy Warehouse Company;
- American Automobile Association (AAA);
- Metropolitan Council;
- Minnesota Department of Transportation (Mn/DOT);
- Citizens League;
- Metro Transit; and
- City of Eagan.

The Advisory Committee is assisted in the day-to-day technical oversight and project quality control by a qualified Technical Committee. The Technical Committee is chaired by James Grube, Director of the Hennepin County Transportation Department. Other organizations represented on the Technical Committee include:

- Pollution Control Agency;
- Dakota County Highway Department;
- City of Ramsey;

- City of St. Paul;
- Mn/DOT – Metro Division;
- Mn/DOT – Office of Investment Management;
- Metropolitan Council;
- City of Minneapolis;
- Metro Transit;
- Ramsey County Department of Public Works; and
- Federal Highway Administration.

The relation of the Advisory and Technical Committee to the overall evaluation team is shown in Figure 2.1.

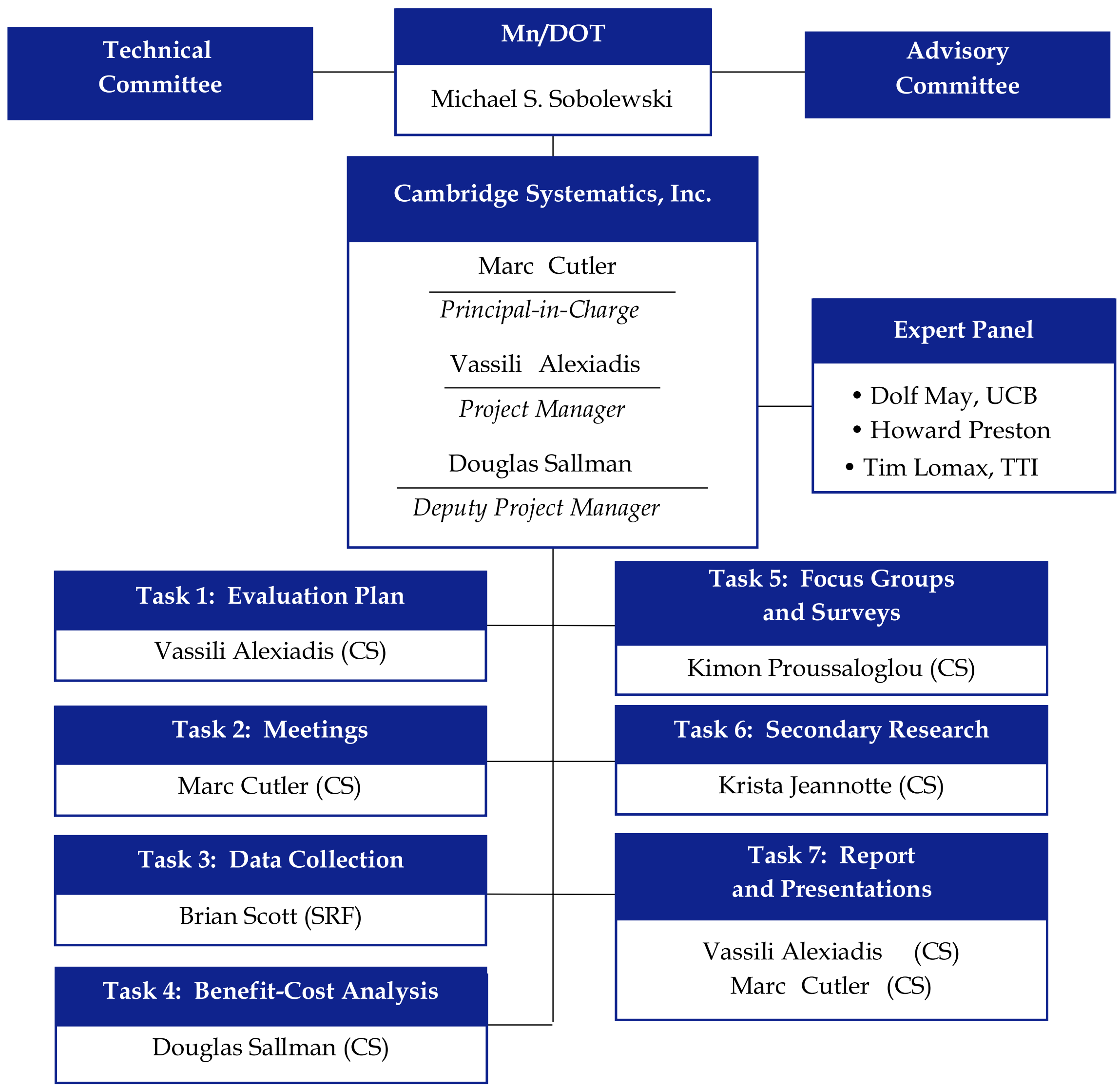
Michael Sobolewski is the Mn/DOT Project Manager selected to provide day-to-day management of the project and provide coordination between the Advisory and Technical Committees and the consultant team.

The consultant team conducting the study is led by Cambridge Systematics, which is responsible for overall project management, as well as the conduct of several specific work tasks (including the development of the evaluation plan, the design and implementation of focus groups and survey market research, the conduct of the benefit/cost analysis, and research of secondary data sources). SRF Consulting is assisting Cambridge Systematics in the traffic data collection design and implementation tasks. N.K. Friedrichs Consulting is assisting with the market research tasks.

Marc Cutler of Cambridge Systematics is serving as the Principal in Charge for the consultant team providing technical direction and quality control of the study. Vassili Alexiadis of Cambridge Systematics functions as the project manager for the consultant team providing day-to-day management of all aspects of the study progress. He is assisted by a Deputy Project Manager and individual Task Managers. These Task Managers provide focused expertise on individual aspects of the work scope. This management approach was developed to adequately support the diverse tasks required of the study while meeting the rigid time schedule presented by the legislative mandate.

The consultant team is also assisted by an expert panel consisting of individuals selected by the consultant team and by the Advisory and Technical Committees. These nationally-recognized experts provide technical input to the study approach, provide critical review of deliverables, and help to ensure a credible and objective evaluation.

## Figure 2.1 Evaluation Team



# 3.0 Evaluation Objectives

# 3.0 Evaluation Objectives

The goals and objectives of conducting the evaluation of ramp meter effectiveness in the Twin Cities Metropolitan Region were designed to meet the mandate of the legislature's bill. Three evaluation goals for the Ramp Meter Study were identified including:

1. Evaluate whether the benefits of ramp metering outweigh the impacts and associated costs;

2. Identify other ramp metering impacts on surface streets and transit operations; and

3. Identify how the Twin Cities' ramp metering system compares and contrasts with other national and international ramp meter systems in terms of ramp meter operation strategy employed and ramp configuration strategy.

For each of the broad evaluation goals, several detailed evaluation objectives were identified. These evaluation objectives provide the framework for conducting the evaluation. Table 3.1 presents the evaluation objectives as they relate to each of the evaluation goals.

The following sections describe in greater detail the tasks required to fulfill each of the evaluation's three main goals and associated objectives.

## Table 3.1 Evaluation Goals and Objectives

| Evaluation Goal | Evaluation Objective |
|---|---|
| Evaluate whether the benefits of ramp metering outweigh the impacts and associated costs. | • Quantify ramp metering safety impacts/benefits (positive and negative) for selected corridors.<br>• Quantify ramp metering traffic flow impacts/benefits (positive and negative) for selected corridors.<br>• Extrapolate ramp metering safety impacts/benefits (positive and negative) to the entire system.<br>• Estimate ramp metering impacts/benefits (positive and negative) on energy consumption and the environment.<br>• Extrapolate ramp metering traffic flow impacts/benefits (positive and negative) for the entire system.<br>• Compare the systemwide ramp metering benefits with the associated impacts and costs.<br>• Identify (both quantitatively and qualitatively) public attitudes toward ramp metering for both the selected corridors and the region as a whole. |
| Identify other ramp metering impacts on surface streets and transit operations. | • Identify ramp metering impacts on local streets.<br>• Identify ramp metering impacts on transit operations.<br>• Document additional ramp metering benefits/impacts observed during the study. |
| Identify how the Twin Cities' ramp metering system compares and contrasts with other national and international ramp meter systems. | • Identify similarities and differences between the Twin Cities' ramp metering system and other metropolitan areas in terms of ramp meter operation strategy employed and ramp configuration strategy.<br>• Identify national and international trends regarding the use of ramp metering as a traffic management strategy.<br>• Identify benefits/impacts of ramp metering systems documented in other national and international studies. |

# 4.0 Performance Measures and Evaluation Methodologies

# 4.0 Performance Measures and Evaluation Methodologies

The evaluation goals and objectives presented in the previous section provide the framework for the evaluation. This section presents the particular measures of effectiveness that will be evaluated during the study. These evaluation measures build on the evaluation objectives and are designed to provide for a comprehensive analysis of the evaluation goals. This section also presents an overview of the methodologies that will be employed to collect and analyze data for the study.

## 4.1 Evaluation Measures

For each of the evaluation objectives identified in Section 3.0, one or more measures of effectiveness have been identified to provide an assessment of the objective. Where possible, these evaluation measures are expressed in quantitative terms; however, many of the measures are more appropriately expressed in qualitative terms.

The evaluation measures selected for each evaluation objective are presented in Table 4.1. The measures of effectiveness are focused on the incremental change observed between the two evaluation scenarios – "with" (meters on) and "without" (meters off). By focusing on the change occurring between the two scenarios, the evaluation team will be better able to isolate the particular benefit/impact. The measures of effectiveness are not mutually exclusive and in some cases the same measure is used to test several objectives. The evaluation measures are also designed to be "neutral" and not presuppose any outcome of the ramp meter test. In all cases, the outcome of the particular measure may be either positive or negative depending on the impacts observed during the two scenarios. Outcomes may also be *both* positive and negative in that results may vary geographically across the selected corridors, market segments, or timeframes.

Appropriate data will be collected related to each of these measures to provide the opportunity for assessment against the evaluation objectives and goals. Section 4.2 presents an overview of the methodology that will be employed in evaluating these measures. The remaining sections of this document provide greater detail on the data collection and analysis methodologies.

## Table 4.1 Evaluation Measures

| Evaluation Objective | Measures of Effectiveness |
|---|---|
| 1. Quantify ramp metering safety impacts for selected corridors. | • Change in the number of crashes occurring in selected corridors.<br>• Change in the severity of crashes occurring in selected corridors.<br>• Change in the number of traffic conflicts (non-crashes ) occurring at specific corridor locations (ramp merge and adjacent intersections).<br>• Change in HOV lane violations.<br>• Perceived change in safety of travel in selected corridors. |
| 2. Quantify ramp metering traffic flow and travel time impacts for selected corridors. | • Change in travel time for primary travel route in selected corridors.<br>• Change in travel time for alternative travel routes in selected corridors.<br>• Change in travel speed for primary travel route in selected corridors.<br>• Change in travel speed for alternative travel routes in selected corridors.<br>• Change in traffic volume for primary travel route in selected corridors.<br>• Change in traffic volume for alternative routes in selected corridors.<br>• Change in travel time reliability for selected corridors.<br>• Change in traffic volume, travel time, travel speed, and travel time reliability for on-ramps in selected corridors.<br>• Perceived change in travel time for selected corridors.<br>• Perceived change in travel time reliability for selected corridors. |
| 3. Extrapolate ramp metering safety impacts to the entire system. | • Change in the number of crashes occurring systemwide.<br>• Change in the severity of crashes occurring systemwide.<br>• Estimated change in the regional crash rate for different facility types.<br>• Estimated regional change in vehicle miles traveled for different facility types.<br>• Estimated change in regional volume to capacity (v/c) ratios.<br>• Perceived change in systemwide safety of travel. |
| 4. Estimate ramp metering impacts/ benefits (positive and negative) on energy consumption and the environment. | • Estimated regional change in emissions by pollutant and by facility type.<br>• Estimated regional change in fuel consumption by facility type. |

## Table 4.1 Evaluation Measures (continued)

| Evaluation Objective | Measures of Effectiveness |
|---|---|
| 5. Extrapolate ramp metering traffic flow impacts/benefits (positive and negative) for the entire system. | • Estimated regional change in travel time.<br>• Estimated regional change in vehicle miles traveled for different facility types.<br>• Estimated regional change in travel speed for different facility types.<br>• Estimated regional change in travel time reliability.<br>• Perceived regional change in travel time.<br>• Perceived regional change in travel time reliability. |
| 6. Compare the systemwide ramp metering benefits with the associated impacts and costs. | • Change in the number and severity of crashes occurring systemwide.<br>• Change in systemwide travel times.<br>• Change in the total number of trips.<br>• Change in travel time reliability.<br>• Change in fuel use and other user paid costs.<br>• Change in vehicle emissions levels.<br>• Estimated change in DOT operating costs.<br>• Estimated change in operating costs of other agencies (e.g., State Patrol, transit agencies, local jurisdictions, etc.)<br>• Capital cost of ramp metering system. |
| 7. Identify ramp metering impacts on local streets. | • Change in traffic volumes on local streets in selected corridors.<br>• Change in the length and severity of ramp queue spillover onto adjacent intersections in selected corridors. |
| 8. Identify ramp metering impacts on transit operations. | • Change in transit travel times for selected corridors.<br>• Change in transit ridership levels for selected corridors.<br>• Estimated change in operating costs for transit providers. |
| 9. Document additional ramp metering benefits/impacts observed during the study. | • Documentation only. |
| 10. Identify similarities and differences between the Twin Cities' ramp metering system and other metropolitan areas in terms of ramp meter operation strategy employed and ramp configuration strategy. | • Documentation only. |
| 11. Identify national and international trends regarding the use of ramp metering as a traffic management strategy. | • Documentation only. |
| 12. Identify benefits/impacts of ramp metering systems documented in other national and international studies. | • Documentation only. |

## 4.2 Overview of Evaluation Methodologies

Data related to the measures of effectiveness will be collected during two periods during the fall of 2000. The first data collection period will be used to assess the baseline or "with ramp meters" scenario. In this scenario, the ramp meters will be operated according to established operating practices. These data will be used to establish a baseline for the purpose of identifying the incremental change occurring in the "without ramp meters" scenario.

A second data collection period will be conducted to evaluate the "without ramp meters" scenario. In this scenario, *all ramp meters will be deactivated systemwide*. The deactivated ramp meters will be set to "flashing yellow" mode – consistent with their normal operation during off-peak periods. Although all ramp meters throughout the system will be deactivated during the test, the data collection effort will be focused on four selected corridors. These corridors were selected as representative of other corridors throughout the metropolitan region. Section 5.0 identifies the selected corridors and provides additional detail on the criteria used to select the corridors. Other systemwide data will be collected during this period to allow for the normalization of data collected in the selected corridors.

In parallel with the field traffic data collection, a series of market research tasks will be conducted. This effort will include both focus groups and surveys conducted during both the "with" and "without" scenarios.

Data collection will occur over a four- to six-week period during both the "with" and "without" scenarios. "With ramp meter" data collection will occur between September 11th (following the Labor Day holiday and the return of normal fall business and school activity) and October 15th, 2000. The public will be informed on October 9th that the ramp meters will be deactivated the following Monday, October 16th. Most of the public knows that this will be occurring sometime in the fall. The goals of the schedule are: 1) to provide adequate time for the collection of the "before deactivation" data; 2) to provide the public with adequate notice of the impending change in traffic operations such that they have time to plan changes in their travel routines should they be interested in doing so; and 3) to not provide so much advance notice that the resulting induced behavioral change would in some way taint the "before deactivation" data collection. It is the intention of the plan to collect the vast majority of data prior to the October 9th public notification, using the final week primarily for contingency purposes. It should be noted that the public will not be formally notified of the selected test corridors; however, it is likely that many travelers will observe the data collection activities in progress on these corridors.

The ramp meters will remain deactivated from October 16th through November 17th, thereby concluding prior to the Thanksgiving Holiday and the onset of the Christmas shopping season. This five-week test period will also enable the evaluation to assess changes over time in travel behavior as travelers adjust to new operating conditions and congestion patterns.

Following the conclusion of the "without" scenario test, the ramp meters will most likely be turned on to operate in their pre-test mode absent a policy decision by Mn/DOT to the contrary. Data analysis will be conducted to isolate the incremental impact observed between the two scenarios during this time. These incremental impacts will then be extrapolated and combined with other data to support the regionwide analysis of ramp meter effectiveness.

To support the evaluation, several individual test plans have been developed to guide the collection and analysis of different types of data. Each test plan provides detailed instructions for conducting a specific aspect of the study. Yet, all the individual test plans have been carefully linked to provide coordination between the different analysis efforts. The individual test plans developed for this study include:

- **Field Data Collection Plan for Selected Corridors –** Defines corridor selection criteria, selected corridors, and the field data to be collected and analyzed for the selected corridors (Section 5.0);

- **Market Research Test Plan –** Defines the focus group and survey data collection tasks to be performed and presents the methodology to be used (Section 6.0);

- **Benefit/Cost Analysis Test Plan –** Identifies how the data collected for the selected corridors will be extrapolated to develop estimates of regionwide impacts and presents candidate methodologies for performing the methodology (Section 7.0); and

- **Secondary Research Test Plan –** Identifies the secondary research to be performed to compare and contrast the ramp metering system in the Twin Cities with systems in other national and international locations (Section 8.0).

The following sections present the various individual test plans that provide specifics on the conduct of the various evaluation tasks.

# 5.0 Test Plan for Field Data Collection

# 5.0 Test Plan for Field Data Collection

Ramp meters throughout the entire system will be deactivated during the test. Collecting field data on the entire transportation system would require an extraordinary amount of resources. However, in order to make better use of evaluation resources and meet the demanding schedule requirements of the project, the evaluation team will instead focus field data collection on several select corridors that are representative of other corridors throughout the entire system. This data will then be extrapolated to the entire system.

The objective of the field data collection portion of this study is to measure the impacts of ramp metering on a host of transportation variables over different types of freeway corridors. The results of the information from this data collection will then be analyzed and applied to the entire metropolitan transportation system to derive the systemwide impacts of ramp metering. The results of the corridor-specific data collection and analysis will also be used to directly report the statistically valid effects of ramp metering on each corridor studied.

## 5.1 Corridor Selection Process

The key to the approach of the evaluation is to select study corridors that are representative of most of the freeway corridors in the Twin Cities Metropolitan Area so that the results can be extrapolated to the entire freeway system. The first task in the corridor selection is to classify the Twin Cities Metropolitan Area freeways into four corridor types. Each freeway corridor type represents a number of freeway sections within Twin Cities Metropolitan Area. This "categorization" of freeway sections allows the CS team to extrapolate the measured impacts of the four study corridors to the rest of the Twin Cities Metropolitan Area freeway system to provide systemwide evaluation results.

The four basic types of freeway corridors are defined as follows:

- **Type A –** Freeway section representing the I-494/I-694 beltline, which has a high percentage of heavy commercial and recreational traffic. The commuter traffic on the corridor type is generally suburb-to-suburb commuters.
- **Type B –** Radial freeway outside the I-494/I-694 beltline with a major geographic constraint that does not allow for alternate routes (i.e., major freeway river crossing).

- **Type C –** Intercity connector freeway corridor that carries traffic moving between major business and commercial zones. This type of freeway has a fairly even directional split of traffic throughout the a.m. and p.m. peak periods.

- **Type D –** Radial freeway inside the I-494/I-694 beltline that carries traffic to/from a downtown or suburban work center.

Next, a three-step process is used to select the four study corridors. Process steps are listed below and defined in greater detail in the following pages:

1. Identify the corridor selection criteria;
2. Identify candidate corridors; and
3. Apply corridor selection criteria and select corridors to be studied.

### 5.1.1 Identify the Corridor Selection Criteria

In coordination with the Technical and Advisory Committees the CS team developed the criteria for corridor selection. The criteria account for the types of freeway corridors, philosophy for metering the different types of freeway corridors, variations in traffic demand on the corridors, lane drops, interchange or geometric constraints, ease of data collection, HOV facilities and transit services in the corridor, unmetered ramps along corridor, etc. The corridor selection criteria were ranked as shown in the following list, with the first four criteria being the primary criteria used for the initial corridor screening:

- Availability and type of alternate routes,
- Level of congestion,
- Geographic representation,
- Construction activity on freeway and alternate routes,
- HOV lanes and bypass ramps,
- Transit service on corridor,
- Geographic balance within the Twin Cities Metropolitan Area,
- Geometric constraints,
- Market segments,
- Geometric constraints, and
- Representative corridor length.

### 5.1.2 Identify Candidate Corridors

Mn/DOT had identified four sample test corridors in the project Request for Proposals (RFP). These corridors represented a good variation of traffic characteristics and ramp meter locations. The CS team applied the corridor selection criteria to freeway sections throughout the Twin Cities Metropolitan Area and identified an initial list of 11 freeway corridors that adequately met the primary selection criteria. These initial corridors are shown in Table 5.1.

Next, the CS team gathered detailed information on the 11 candidate corridors and applied the remaining corridor selection criteria to these corridors, resulting in the presentation of nine candidate freeway corridors for review by the Technical and Advisory Committees. The nine candidate corridors are shown in the map on Figure 5.1, and the attributes of the corridors are shown in Table 5.2.

### 5.1.3 Apply Corridor Selection Criteria and Select Corridors To Be Studied

The CS team presented the candidate corridors to the Technical and Advisory Committees and facilitated the discussion and final selection of the four corridors to be studied in detail. The four corridors selected for the study provide geographic balance with the Twin Cities Metropolitan Area. The four corridors selected for the study are shown in Figure 2 and described as follows:

1. **I-494 Corridor –** This corridor serves traffic from outside the Twin Cities Metropolitan Area and commuter traffic between the residential area north of the corridor and employment destinations to the south.

2. **I-35W Corridor –** This corridor serves commuter traffic between the residential communities south of the Minnesota River (e.g., Burnsville and Lakeville) and employment destinations north of the river.

3. **I-94 Corridor –** This corridor serves traffic demand between downtown Minneapolis and downtown St. Paul.

4. **I-35E Corridor –** This corridor serves commuter traffic between the northern residential communities and various employment destinations further south.

## ■ 5.2 Field Data Collection Plan

The premise of the field data collection test plan is to measure the transportation system impacts of the ramp metering system in the Twin Cities Metropolitan Area. This task involves an extensive "with ramp metering" and "without ramp metering" traffic data collection program to address the impacts on traffic operations and safety by means of on-the-ground collection of empirical data about the metered and non-metered systems. To accomplish this, field data will be collected and evaluated with and without the ramp metering system in operation.

Traffic data will be collected at specific ramps and along selected corridors within the region over several weeks for both the "with" and "without" ramp metering evaluation scenario. Data collection will occur during a.m. and p.m. peak periods from Monday

## Table 5.1 Candidate Corridors for Ramp Meter Evaluation

| # | Type | Corridor | From | To | Length (miles) | Alternate Routes | Level of Congestion | Geographic Area |
|---|---|---|---|---|---|---|---|---|
| 1 | A | I-494 (NB) | Carlson Parkway | Weaver Lake Road | 8 | Vicksburg CR 61 | H - L | N.W. |
| | | I-494 (SB) | Weaver Lake Road | Carlson Parkway | 8 | Vicksburg CR 61 | M - L | |
| 2 | A | I-694 (WB) | I-35W | TH 252 | 4.5 | | M - L | North Central |
| | | I-694 (EB) | TH 252 | I-35W | 4.5 | | M - L | |
| 3 | B | TH 77 (NB) (a.m. only) | 140th St. | Old Shakopee Road | 6.8 | I-35W | H - L | South |
| 4 | B | I-35W (NB) (a.m. only) | Cty. Road 42 | 98th St. | 5 | TH 77 | High | South |
| 5 | C | I-94 (WB) | I-35E | I-394 | 10.9 | Univ. Ave. TH 36<br>Franklin Ave.<br>Lake St. – Marshall Ave. | H - L | Central |
| | | I-94 (EB) | I-394 | I-35E | 10.9 | Univ. Ave. TH 36<br>Franklin Ave.<br>Lake St. - Marshall Ave. | H - L | |
| 6 | D | I-394 (WB) | TAD | TH 101 | 11 | TH 55 | H - L | West Central |
| | | I-394 (EB) | TH 101 | TAD | 11 | TH 55 | H - L | |
| 7 | D | I-35E (NB) | I-694 | I-94 | 5.4 | Rice St. (TH 49)<br>Edgerton Ave. | M - L | East Central |
| | | I-35E (SB) | I-94 | I-694 | 5.4 | Rice St. (TH 49)<br>Edgerton Ave, | H - L | |
| 8 | D | I-35W (NB) | TH 36 | TH 10 | 7.4 | CR 77 | H - L | North Central |
| | | I-35W (SB) | TH 10 | TH 36 | 7.4 | CR 77 | H - L | |

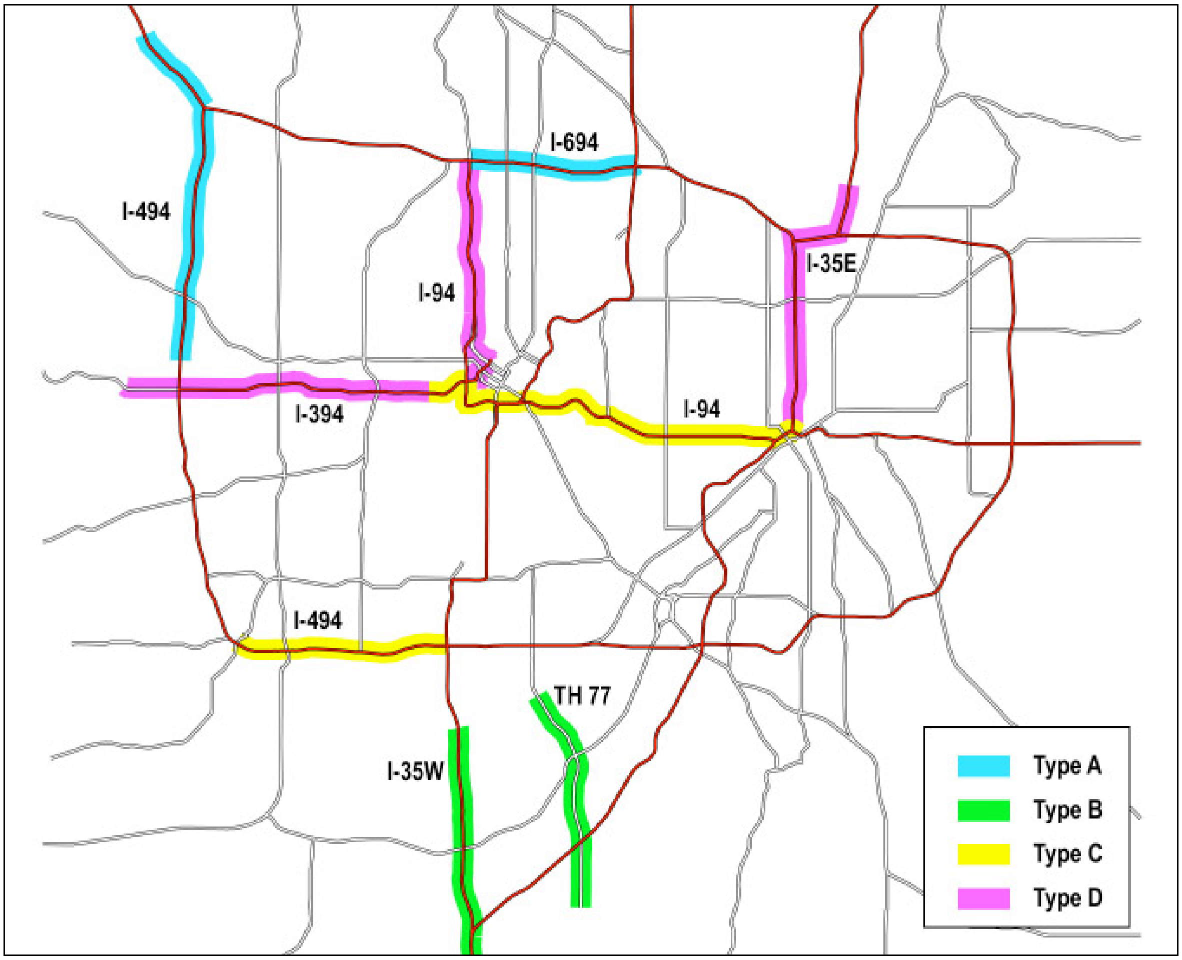
## Table 5.1 Candidate Corridors for Ramp Meter Evaluation (continued)

| # | Type | Corridor | From | To | Length (Miles) | Alternate Routes | Level of Congestion | Geographic Area |
|---|---|---|---|---|---|---|---|---|
| 9 | C | TH 100 (NB) | I-494 | I-394 (Glenwood) | 8 | France Ave.<br>TH 169 | H - L | S.W. |
| | | TH 100 (SB) | I-394 (Glenwood) | I-494 | 8 | France Ave.<br>TH 169 | H - L | |
| 10 | D | I-94 (WB) | I-394 | I-694 | 6.4 | Lyndale Central | Low | North Central |
| | | I-94 (EB) | I-694 | I-394 | 6.4 | Lyndale Central | Low | |
| 11 | C | I-494 (EB) | TH 212 | I-35W | 7 | TH 62 | High | S.W. |
| | | I-494 (WB) | I-35W | TH 212 | 7 | | High | |

**Key:**

| Freeway Type | Attributes |
|---|---|
| A | Freeway section representing the I-494/I-694 beltline, commuter, heavy commercial and recreational traffic (suburb-to-suburb). |
| B | Radial freeway outside the beltline, major geometric constraint (e.g., river bridge) presenting limited alternate routes. |
| C | Intercity connector. |
| D | Radial freeway. |

## Figure 5.1 Candidate Corridors for Ramp Meter Evaluation



## Table 5.2 Candidate Corridors for Ramp Meter Evaluation Versus Selection Criteria

| No. | Type | Corridor | From | To | Length (Miles) | Alternate Routes | Level of Congestion | Geographic Area |
|---|---|---|---|---|---|---|---|---|
| 1 | A | I-494 (NB) | Carlson Parkway | I-94/C.R. 30 | 9 | Vicksburg CR 61 | H - L | N.W. |
| | | I-494 (SB) | I-94/C.R. 30 | Carlson Parkway | 9 | Vicksburg CR 61 | M - L | |
| 2 | A | I-694 (WB) | I-35W | TH 252 | 4.5 | | M - L | North Central |
| | | I-694 (EB) | TH 252 | I-35W | 4.5 | | M - L | |
| 3 | B | TH 77 (NB) (a.m. only) | C.R. 38 – 140th St. | Old Shakopee Road | 6.8 | I-35W | H - L | South |
| 4 | B | I-35W (NB) (a.m. only) | C.R. 46 | 98th St. | 6 | TH 77 | High | South |
| 5 | C | I-94 (WB) | I-35E & Mounds | I-394/Penn. | 12 | Univ. Ave. Lake-Marshall | H - L | Central |
| | | I-94 (EB) | I-394/Penn. | I-35E & Mounds | 12 | Univ. Ave. Lake-Marshall | H - L | |
| 6 | C | I-494 (EB) | TH 212 | I-35W | 7 | TH 62 | High | S.W. |
| | | I-494 (WB) | I-35W | TH 212 | 7 | | High | |
| 7 | D | I-394 (WB) | TAD | C.R. 101 | 11 | TH 55 TH 7 | H - L | West Central |
| | | I-394 (EB) | C.R. 101 | TAD | 11 | TH 55 TH 7 | H - L | |
| 8 | D | I-94 (WB) | I-394 | I-694 | 6.4 | Lyndale Central | Low | North Central |
| | | I-94 (EB) | I-694 | I-394 | 6.4 | Lyndale Central | Low | |
| 9 | D | I-35E (NB) | C.R. 96 | I-94 | 6.5 | Rice St. (TH 49) Edgerton Ave. | M - L | East Central |
| | | I-35E (SB) | I-94 | I-694 | 6.5 | Rice St. (TH 49) Edgerton Ave, | H - L | |

## Table 5.2 Candidate Corridors for Ramp Meter Evaluation Versus Selection Criteria (continued)

| No. | Type | Corridor | ADT | Traffic Type | No. of Lanes | HOV Lanes/ Ramps | Geometric Constraints | Transit Route | No. of Metered Ramps |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | I-494 (NB) | 48,500 | Commuter Recreational HC (7%) | 2 | 2 Bypass ramps | Steep Grades Auxiliary Lanes | Minor | 5 |
| | | I-494 (SB) | 48,500 | Commuter Recreational HC (7%) | 2 | 3 Bypass ramps | Steep Grades Auxiliary Lanes | Minor | 5 |
| 2 | A | I-694 (WB) | 80,000 | Commuter Recreational HC (7%) | 3 | Bypass ramps | Auxiliary Lanes | Minor | 9 |
| | | I-694 (EB) | 80,000 | Commuter Recreational HC (7%) | 3 | Bypass ramps | Auxiliary Lanes | Minor | 10 |
| 3 | B | TH 77 (NB) (a.m. only) | 48,500 | Commuter HC (2.5%) | 3 | Bypass at every ramp | River Crossing | MVTA Major No AVL Buses | 6 |
| 4 | B | I-35W (NB) (a.m. only) | 51,500 | Commuter HC (6.7%) | 2 + HOV | HOV Lanes + 3 bypasses | River Crossing | Major No AVL Buses | 5 |
| 5 | C | I-94 (WB) | 128,500 | Commuter HC(5.7%) | 3 | Bypass ramps | Tunnel River Bridge | Major | 13 |
| | | I-94 (EB) | 128,500 | Commuter HC(5.7%) | 3 | Bypass ramps | Tunnel River Bridge | Major | 12 |
| 6 | C | I-494 (EB) | | | 2 - 3 | 3 Bypass ramps | | | 10 |
| | | I-494 (WB) | | | 2 - 3 | 2 Bypass ramps | | | 8 |
| 7 | D | I-394 (WB) | 74,000 | Commuter HC (3.2%) | 2 3 | HOV lanes + 5 Ramps | Bottleneck | Major | 16 |
| | | I-394 (EB) | 74,000 | Commuter HC (3.2%) | 2 3 | HOV Lanes + 10 ramps | Bottleneck | Major | 13 |
| 8 | D | I-94 (WB) | 63,000 | Commuter HC (3.8%) | 4 | 2 Bypass ramps | Auxiliary Lanes | Major | 3 |
| | | I-94 (EB) | 63,000 | Commuter HC (3.8%) | 4 | 2 Bypass ramps | Auxiliary Lanes | Major | 5 |

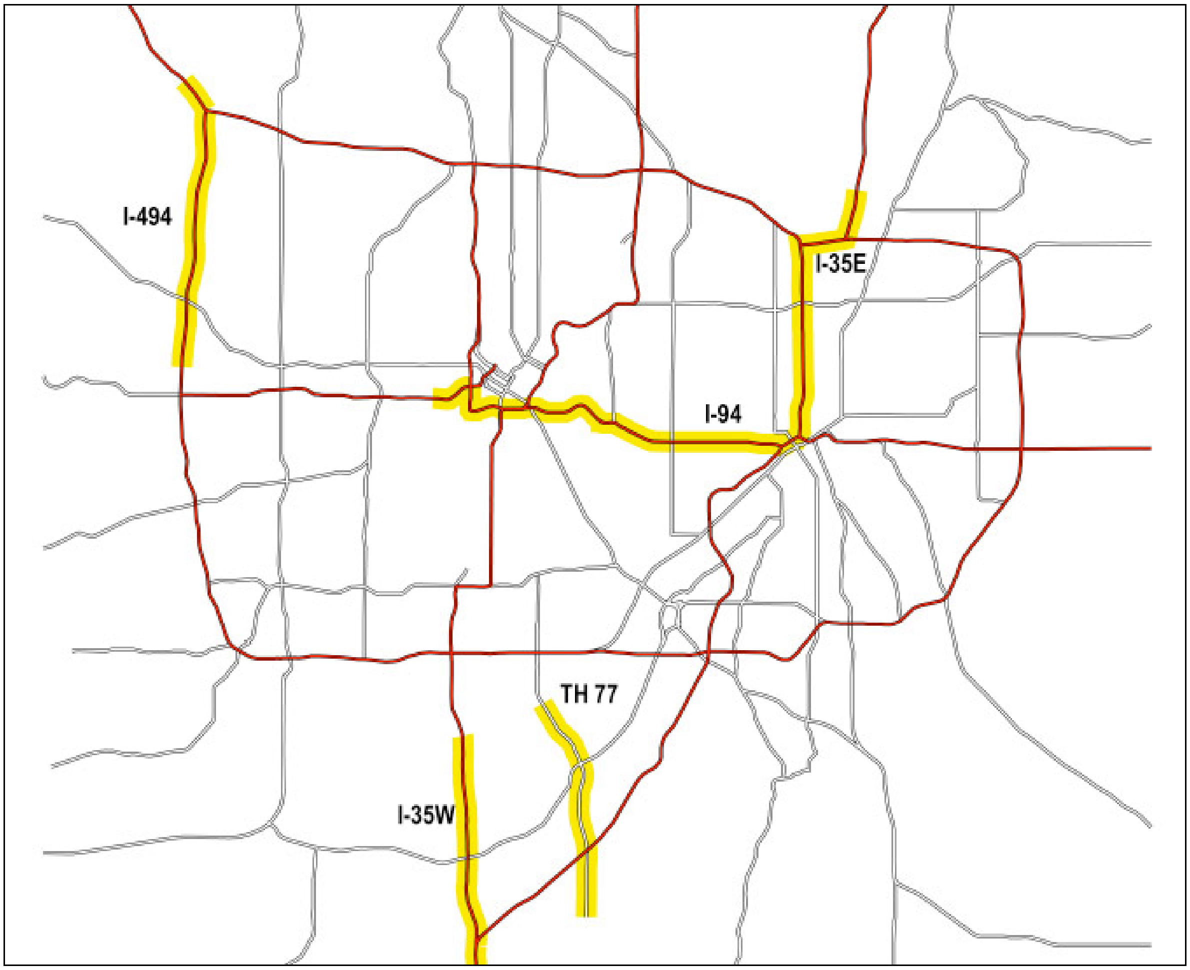
## Table 5.2 Candidate Corridors for Ramp Meter Evaluation Versus Selection Criteria (continued)

| No. | Type | Corridor | ADT | Traffic Type | No. of Lanes | HOV Lanes/ Ramps | Geometric Constraints | Transit Route | No. of Metered Ramps |
|---|---|---|---|---|---|---|---|---|---|
| 9 | D | I-35E (NB) | 62,500 | Commuter HC (4.3%) | 3 | 1 Bypass ramp & shoulder lanes | | Minor | 9 |
| | | I-35E (SB) | 62,500 | Commuter HC (4.3%) | 3 | No bypass ramps – shoulder lanes | | Minor | 6 |

**Key:**

| Freeway Type | Attributes |
|---|---|
| A | Freeway section representing the I-494/I-694 beltline, commuter, heavy commercial and recreational traffic (suburb-to-suburb). |
| B | Radial freeway outside the beltline, major geometric constraint (e.g., river bridge) presenting limited alternate routes. |
| C | Intercity connector with even directional split. |
| D | Radial freeway inside the beltline. |

## Figure 5.2 Twin Cities Corridors Selected for Detailed Evaluation



through Friday of the evaluation period. Subsets will be created for Monday and Friday data and for Tuesday through Thursday data. The Tuesday through Thursday data are the primary data collection days, and will be used to provide statistically valid data. Travel time data will be collected during the morning and afternoon peak periods for approximately 3.5 hours per peak period. Ramp operational studies will be conducted during hours the ramps are metered; this varies depending on the particular ramp.

### 5.2.1 Field Data Collection Schedule

A preliminary field data collection schedule is shown in Table 5.3. The schedule applies to those elements of the data collection which will be implemented by the consultant team during the course of the evaluation period, including ramp observations in which specific ramps will be monitored, floating car studies in which travel times across specific corridors are measured, and traffic flow data will be collected along alternate routes by means of tube counts. This schedule applies to both the "with" and "without" ramp metering conditions. Other data will be supplied by the routine automated data collection systems used by Mn/DOT to monitor traffic flow, such as freeway loop detectors. These systems are always in operation and Mn/DOT will provide the data from these systems to the consultant team for analysis.

**Table 5.3 Field Data Collection Schedule**

| | Travel Time Data Collection | | | | | Volume and Ramp Study |
|---|---|---|---|---|---|---|
| **Week of:** | **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | |
| Sept. 11 | I-494 | I-35W | I-494 | I-35W | I-494 | I-494 |
| Sept. 18 | I-35E | I-94 | I-35E | I-94 | I-35E | I-35E |
| Sept. 25 | I-35W | I-494 | I-35W | I-494 | I-35W | I-35W |
| Oct. 2 | I-94 | I-35E | I-94 | I-35E | I-94 | I-94 |
| Oct. 9 (1) | | | | | | |
| Oct. 16 (2) | I-94 | I-94 | I-94 | I-94 | I-94 | I-94 |
| Oct. 23 | I-494 | I-35W | I-494 | I-35W | I-494 | I-494 |
| Oct. 30 | I-35E | I-94 | I-35E | I-94 | I-35E | I-35E |
| Nov. 6 | I-35W | I-494 | I-35W | I-494 | I-35W | I-35W |
| Nov. 13 | I-94 | I-35E | I-94 | I-35E | I-94 | I-94 |

**Notes:**

1. On October 9 the public will be notified that the ramp meters will be shutoff beginning October 16. No data will be collected this week.
2. On October 16 the ramp meters will be shutoff. Data collection will be concentrated on I-94 during this week, and repeated along this corridor during the last week of the evaluation so that traveler behavioral change over the course of the ramp meter deactivation period can be assessed.

### 5.2.2 Evaluation Objectives

The following five objectives will be used to evaluate and quantify the transportation system impacts with and without the ramp metering system:

- Assess traffic flow impacts;
- Assess travel time impacts;
- Assess ramp impacts;
- Assess safety impacts; and
- Assess transit impacts.

Specific measures of effectiveness and their corresponding data sources are presented for each of the five evaluation objectives supporting this test plan in the sections that follow.

#### *5.2.2.1 Objective 1: Assess Traffic Flow Impacts*

This evaluation objective will examine the traffic flow impacts of the ramp metering system. Traffic volume and occupancy data from freeway mainline detector stations and volume data from alternate routes will be collected. Two different data collection methods will be used including existing freeway loop detectors and portable counting devices (road tubes). Further detail on each type of data and data source is provided below.

##### 5.2.2.1.1 Freeway Mainline Traffic Volume and Occupancy

Data from the Mn/DOT Traffic Management Center (TMC) freeway loop detector stations will be collected along each of the corridors under evaluation. The following information pertains to freeway data:

1. Sample size:
   - Thirty-second traffic volume data per lane, 24-hours per day;
   - Data aggregated to 15-minute periods during the four-hour a.m. and four-hour p.m. peak periods;
   - Four-hour peak periods selected to allow analysis of any peak-period spreading;
   - Data aggregated to daily totals;
   - Five days of data per week (Monday through Friday):
     - Monday and Friday (subset); and
     - Tuesday through Thursday (primary data subset).
   - Data will be collected from the detector stations within the corridor study limits.

2. Assumptions:
   - Mn/DOT TMC detector count data will be available;
   - Mn/DOT Maintenance will have the majority of detectors on study corridors operational at the beginning of the test, and will maintain them in operation throughout the test period;
   - Not all mainline detector counts are needed for the study;
   - Detector data can be downloaded remotely/electronically; and
   - Evaluator will run a daily automated check of the data.
3. Data collection methods and tools:
   - Mn/DOT TMC will download detector data files to SRF FTP site; and
   - Spreadsheet and/or database will be used to process data.

**5.2.2.1.2 Alternate Route Traffic Volume –** Road tubes will be used to collect traffic volume data along each of the arterial corridors under evaluation. The following information pertains to alternate route data:

1. Sample size:
   - Fifteen-minute volumes per lane during the four-hour a.m. and four-hour p.m. peak periods;
   - Daily volume totals; and
   - Five days of data per week (Monday through Friday):
     - -- Monday and Friday (subset); and
     - -- Tuesday through Thursday (subset).
2. Assumptions:
   - Collect data on arterial routes during the same period as the corresponding freeway route; and
   - Backup data collection will be done via spare portable counters and/or manual counts.
3. Data collection methods and tools:
   - Road tubes; and
   - Spreadsheet and/or database will be used to process data.

### *5.2.2.2 Objective 2: Assess Travel Time Impacts*

This evaluation objective will examine the travel time impacts of the ramp metering system. A statistically significant sample of actual running speeds over the four freeway corridors and corresponding alternate routes will be collected. Travel times and distances will be recorded from probe vehicles driven along the corridor by members of the evaluation team. The floating car method will be used, whereby the probe vehicle driver estimates the median speed of the traffic flow by passing and being passed by an equal number of vehicles.

Four Geographic Positioning System (GPS)-equipped vehicles will be used to capture the travel time profiles at discrete intervals. One GPS-equipped vehicle will be used on each freeway (and alternate route) corridor. Three additional vehicles will be equipped with traditional distance measuring instruments (Jamar) to gain enough travel time data to produce results meeting a 95 percent confidence interval. The specified error will be +/-two mph for freeways, and +/-one mph on the alternate routes. Data will be collected in both directions of travel along the corridor.

The travel time runs for two corridors, I-494 and I-35E, will have a start and end point that represents a "virtual" home to work trip. This will allow the CS team to plot the sample travel time data on a map, providing a useful tool for conveying the travel time data to the public.

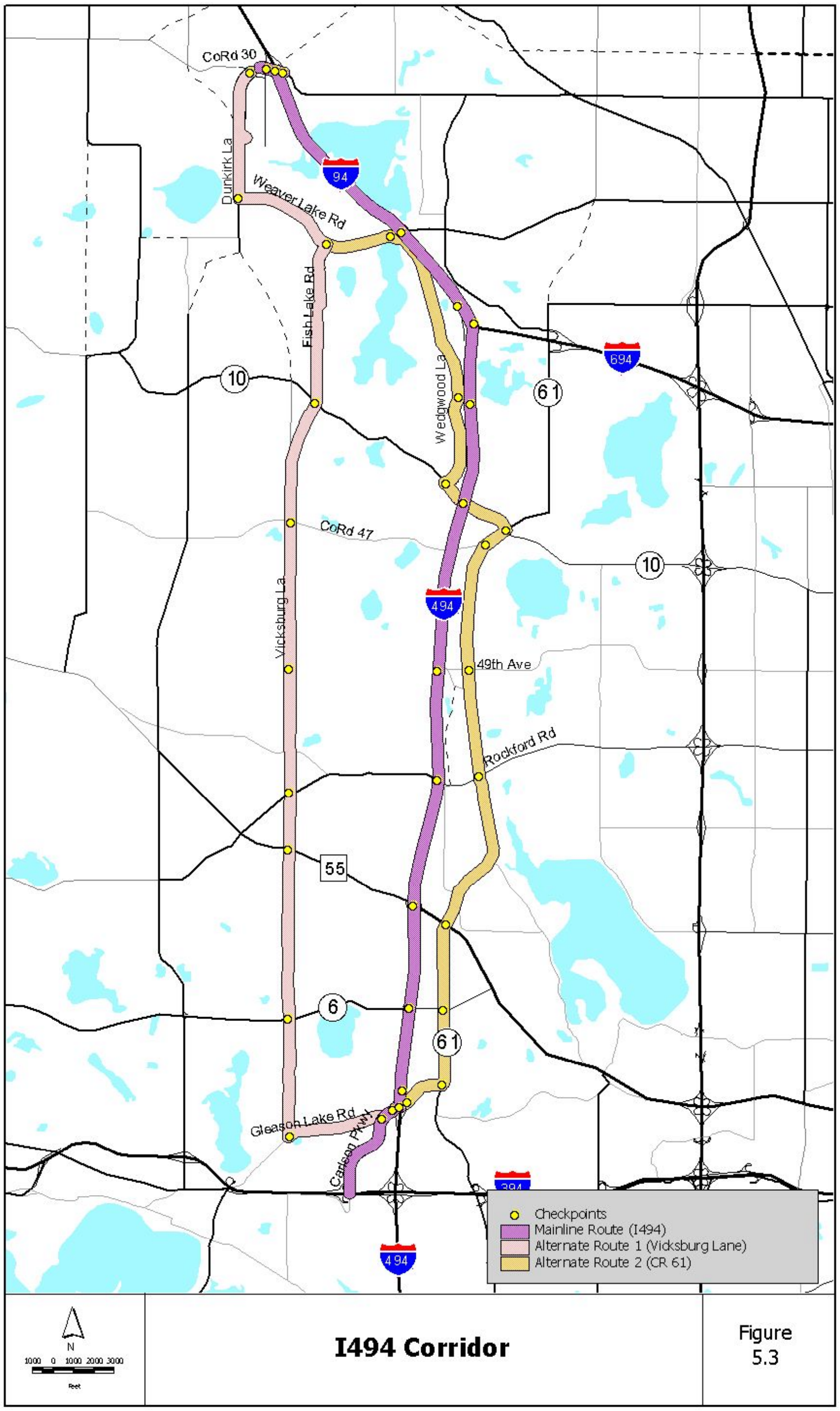
In selecting the alternate route travel time, traffic flow patterns were examined to identify routes that would be used during periods of congestion on the freeway. An overview of the travel time routes along each of the corridors is provided below:

- **I-494 Corridor –** This corridor serves traffic coming from outside the Twin Cities Metropolitan Area, as well as commuter traffic between the residential area on the north end of the corridor and employment destinations on the southern end. Travel time runs will be conducted between I-94/County Road 30 in Maple Grove and the Carlson Towers in Minnetonka. Traffic flow has a directional split with southbound congestion occurring in the a.m. peak period and northbound congestion occurring in the p.m. peak period. There are two alternate routes for this corridor. To the west of I-494 Vicksburg Lane, Weaver Lake Road and Dunkirk Lane are used between I-94/County Road 30 and Carlson Parkway. Various roadways (mainly County Road 61) are used for the route primarily to the east of I-494 between I-94/County Road 30 and Carlson Parkway. This corridor is shown in Figure 5.3.

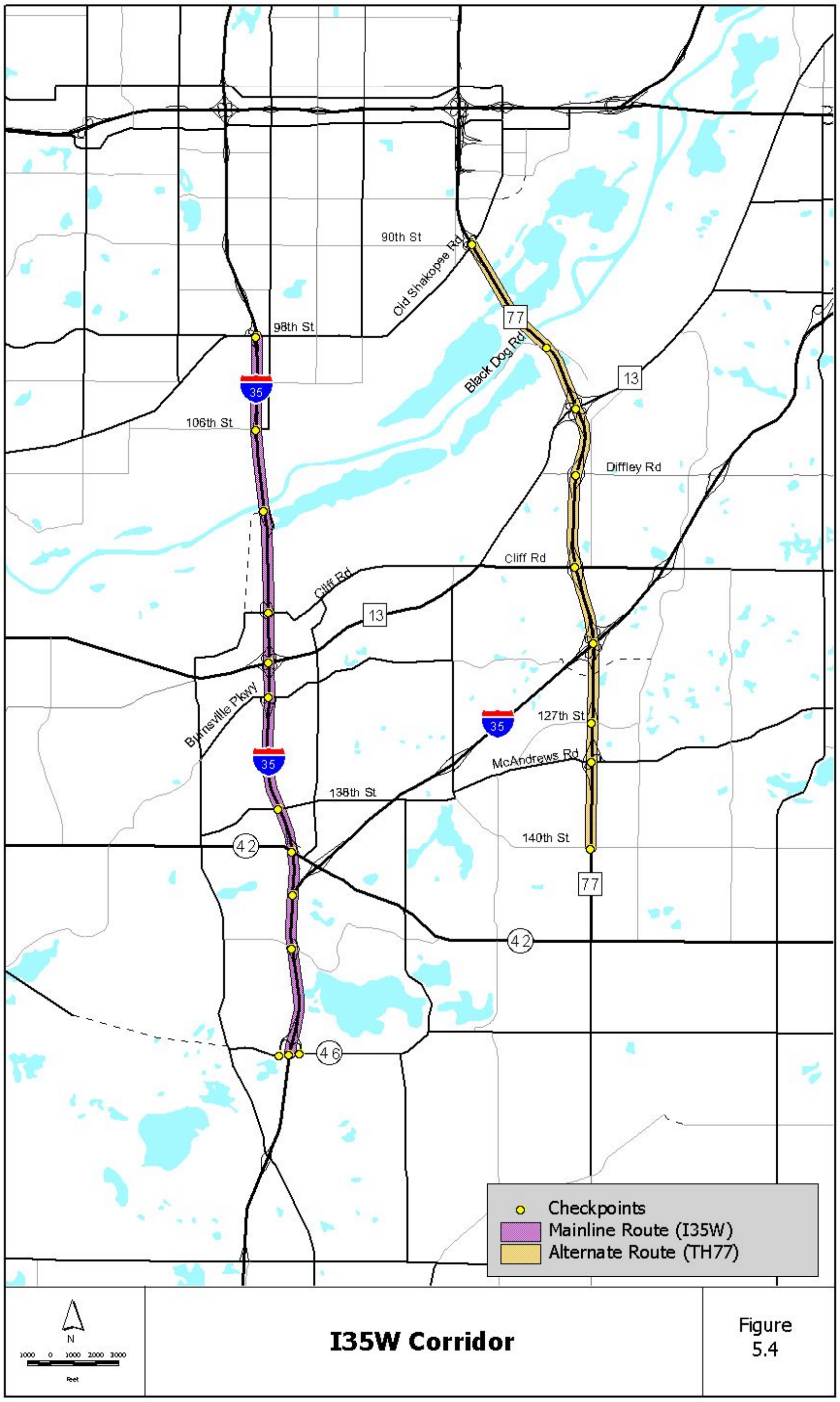
- **I-35W Corridor –** This corridor serves commuter traffic between the residential communities south of the Minnesota River (e.g., Burnsville and Lakeville) and employment destinations north of the river. Travel time runs will be conducted between Old Shakopee Road in Bloomington and County Road 46 (162nd Street West) in Lakeville. Traffic flow has a heavy directional split with northbound congestion occurring in the a.m. peak period. Data will only be collected in the northbound (a.m. period) along this route. The Minnesota River crossing creates a bottleneck in this corridor. The alternate route for this corridor is Trunk Highway (TH) 77 between Old Shakopee Road in Bloomington and County Road 38/140th Street in Apple Valley. This corridor is shown in Figure 5.4.

- **I-94 Corridor –** This corridor serves traffic demand between downtown Minneapolis and downtown St. Paul. The western end of the travel time runs will pass through the Lowry Hill Tunnel with a turn-around made via I-394 and Penn Avenue in Minneapolis. The eastern turn-around will be at Mounds Boulevard in St. Paul. Traffic flow is primarily bi-directional with congestion experienced in both directions during both the

## Figure 5.3 I-494 Corridor



## Figure 5.4 I-35W Corridor



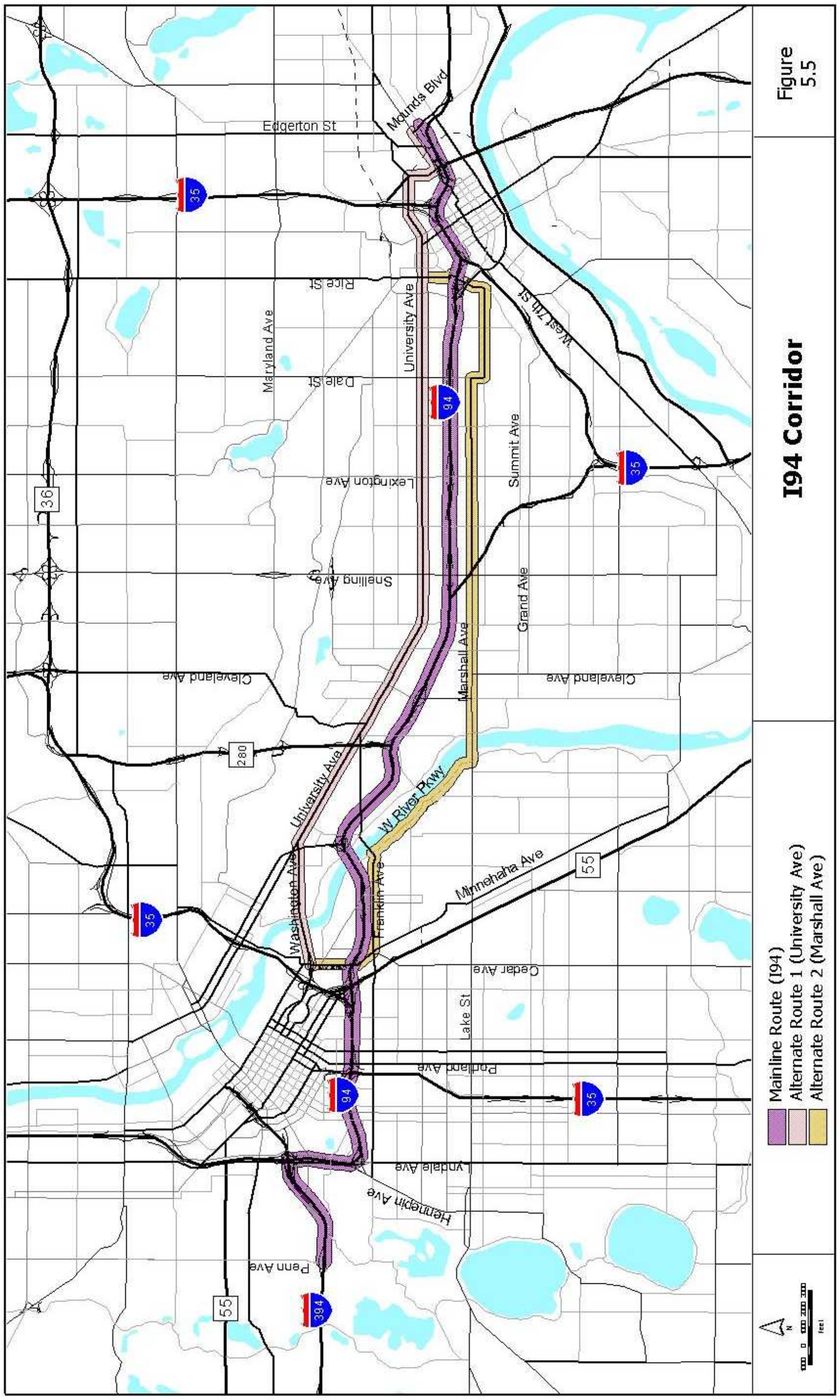
morning and afternoon peak periods. There are two alternate routes for this corridor. To the north of I-94, University and Washington Avenue are used between Cedar Avenue in Minneapolis and Mounds Boulevard in St. Paul. To the south of I-94, Franklin, West River Parkway and Marshall Avenue are used between Cedar Avenue in Minneapolis and Rice Street/University Avenue in St. Paul. This corridor is shown in Figure 5.5.

- **I-35E Corridor –** This corridor serves commuter traffic between the northern residential communities and various employment destinations further south. Travel time runs will be conducted between County Road 96 in White Bear Lake and Wacouta Street in downtown St. Paul. Traffic flow has a directional split with southbound congestion occurring in the a.m. peak period and northbound congestion occurring in the p.m. peak period. There are two alternate routes for this corridor. To the west of I-35E, Rice Street (TH 49) is used between County Road 96 and University Avenue. Primarily to the east of I-35E, Edgerton Street and Centerville Road are used between County Road 96 and 7th Street West in downtown St. Paul. This corridor is shown on Figure 5.6.

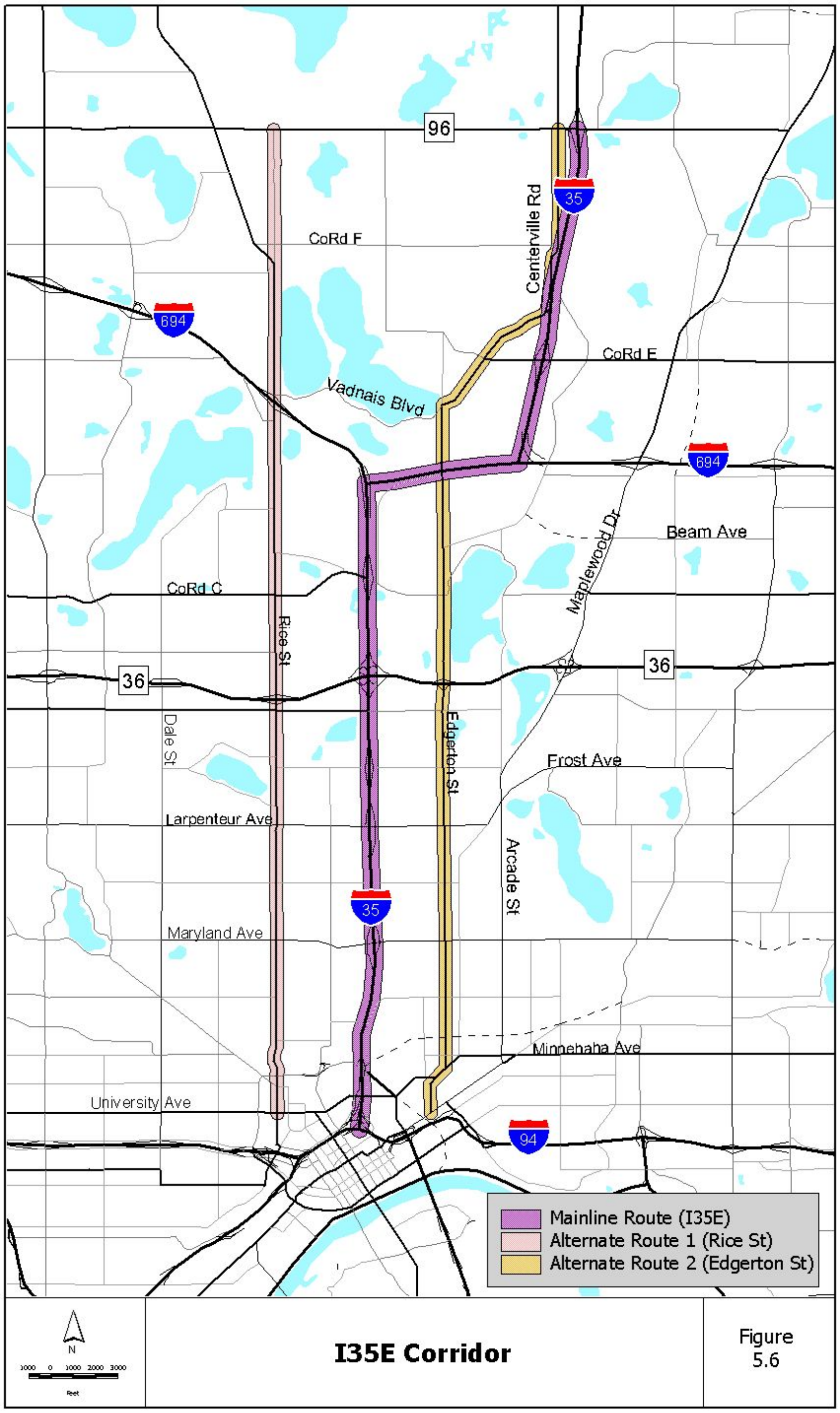
Further detail on the travel time data collection approach is provided below.

1. Sample size:
   - The first step in determining the sample size is to identify the desired level of accuracy. The bounds of statistical error vary depending on the application; examples are listed below based on the Institute of Transportation Engineers (ITE) Traffic Engineering Manual – Page 95:
     - Transportation planning applications typically allow for speed data accuracy of +/-three mph to +/-five mph;
     - Traffic operations applications typically allow for speed data accuracy of +/-two mph to +/-four mph; and
     - Before and after evaluation studies typically allow for speed data accuracy of +/-one mph to +/-three mph.
   - A Confidence Interval of 95 percent is typically used for traffic studies (source ITE Traffic Engineering Manual – Page 96); and
   - Based on the information presented above and in the list of assumptions below, a sample size of 21 travel time runs in the a.m. period and 21 runs in the p.m. will be required in order to obtain a statistically significant sample size.
2. Assumptions:
   - Corridors range from approximately six to 12 miles in length;
   - Four-hour morning period is 5:00 to 9:00 a.m.;
   - Four-hour afternoon period is 3:00 to 7:00 p.m.;
   - Data will be collected Monday through Friday:
     - Monday and Friday (subset); and
     - Tuesday through Thursday (subset).

## Figure 5.5 I-94 Corridor



## Figure 5.6 I-35E Corridor



- Four weeks with ramp metering and four weeks without;
- Average one run per hour;
- Average freeway speed will vary more than 20 mph between runs;
- Average alternate route speed will vary 10 mph between runs;
- Bound on error of +/-two mph for average freeway speed; and
- Bound on error of +/-one mph for average alternate route speed.

3. Data collection methods and tools:
   - Floating Car Method will be used to collect travel time data. With this method the probe vehicle driver estimates the median speed by passing and being passed by an equal number of vehicles.
   - GPS data collection will be used to collect travel time data in four of the probe vehicles
   - Jamar™ equipment data collection will be used to collect travel time data in three of the probe vehicles. Note that one of the vehicles will be equipped with both GPS and Jamar™ equipment in order to compare the two data collection methods. Therefore a total of six probe vehicles are available.
   - Travel time data will be collected in both the peak and non-peak direction.
   - Probe vehicle drivers will record weather, pavement conditions, light conditions, construction activity, and incidents; this will enable the isolation of anomalous data which might result from a day of severe weather, or the short-term effects of the start of standard time at the end of October which falls in the middle of the "without meters" evaluation period.

#### *5.2.2.3 Objective 3: Assess Ramp Impacts*

A variety of techniques will be used to assess the operational impact of ramp metering at freeway on-ramps. Ramp volume data (ramp merge detector data) and ramp meter turn-on times are readily available from the TMC system. Data will be collected from the ramps listed in Table 5.4.

1. Sample size:
   - Collect data for every ramp within the defined test corridors;
   - Five days of peak-period counts per site; and
   - All data will be collected in 15-minute intervals.
2. Assumptions:
   - Visual observation of ramp from persons in-field; and
   - Field observer will record ramp meter start-up/shut-off time.

## Table 5.4. Ramps Selected for Manual Field Data Collection

| Corridor | Ramp Description | A.M. Period | P.M. Period | Both Periods |
|---|---|---|---|---|
| **I-494 Corridor** | Weaver Lake Road to eastbound I-94 | X | | |
| | Bass Lake Road to northbound I-494 | | X | |
| | Bass Lake Road to southbound I-494 | X | | |
| | Rockford Road to northbound I-494 | | X | |
| | Rockford Road to southbound I-494 | X | | |
| | TH 55 to northbound I-494 | | X | |
| | TH 55 to southbound I-494 | X | | |
| | County Road 6 to northbound I-494 | | X | |
| | County Road 6 to southbound I-494 | X | | |
| | Carlson Parkway to northbound I-494 | | X | |
| **I-35W Corridor** | County Road 42 to northbound 35W | X | | |
| | Burnsville Parkway to northbound 35W | X | | |
| | Eastbound TH 13 to northbound 35W | X | | |
| | Westbound TH 13 to northbound 35W | X | | |
| | Cliff Road to northbound 35W | X | | |
| | 106th Street to northbound 35W | X | | |
| **I-94 Corridor** | Hennepin Avenue to eastbound 94 | | | X |
| | Lyndale Avenue to eastbound 94 | | | X |
| | 5th Avenue to eastbound 94 | | X | |
| | 6th Street to eastbound 94 | | X | |
| | Cedar Avenue to eastbound 94 | | X | |
| | Riverside Avenue to eastbound 94 | | X | |
| | Huron Street to eastbound 94 | | X | |
| | Cretin Avenue to eastbound 94 | | X | |
| | Snelling Avenue to eastbound 94 | | X | |
| | Lexington Parkway to eastbound 94 | | X | |
| | Dale Street to eastbound 94 | | X | |
| | Marion Street to eastbound 94 | | X | |
| | Jackson Street to eastbound 94 | | X | |
| | Broadway Street to eastbound 94 | | X | |
| | Mounds Boulevard to westbound 94 | | | X |
| | University Avenue to westbound 94 | | | X |
| | 12th Street/Wabasha to westbound 94 | | | X |
| | Marion Street to westbound 94 | | | X |
| | Dale Street to westbound 94 | | | X |
| | Lexington Parkway to westbound 94 | | | X |
| | Snelling Avenue to westbound 94 | | | X |
| | Vandalia Street to westbound 94 | | | X |
| | Highway 280 to westbound 94 | | | X |

**Table 5.4. Ramps Selected for Manual Field Data Collection (continued)**

| Corridor | Ramp Description | A.M. Period | P.M. Period | Both Periods |
|---|---|---|---|---|
| | Huron Street to westbound 94 | | | X |
| | 25th Avenue to westbound 94 | | | X |
| | Hiawatha Avenue to westbound 94 | | | X |
| | 35W to westbound 94 | | | X |
| | 4th Avenue to westbound 94 | | | X |
| **I-35E Corridor** | Broadway Street to northbound 35E | | X | |
| | Pennsylvania Avenue to northbound 35E | | X | |
| | Maryland Avenue to northbound 35E | | X | |
| | Larpenteur Avenue to northbound 35E | | X | |
| | Roselawn Avenue to northbound 35E | | X | |
| | Eastbound Highway 36 to northbound 35E | | X | |
| | Westbound Highway 36 to northbound 35E | | X | |
| | Little Canada Road to northbound 35E | | X | |
| | Little Canada Road to southbound 35E | X | | |
| | Westbound highway 36 to southbound 35E | X | | |
| | Eastbound highway 36 to southbound 35E | X | | |
| | Roselawn Avenue to southbound 35E | X | | |
| | Wheelock Parkway to southbound 35E | X | | |
| | Maryland Avenue to southbound 35E | X | | |

#### 5.2.2.3.1 Ramp Queue Length and Delay

Manual field observations will be used to collect ramp queue length and delay data. The following information pertains to this data collection effort:

Data collection methods and tools:

- Jamar equipment to record when vehicles enter and when vehicles exit the ramp queue. Two observers will be required per ramp:
  - First observer will record vehicles entering ramp queue. (This observer will also note the time that the ramp queue backs into the intersection, see Section 5.2.2.3.4.)
  - Second observer will record vehicles exiting the ramp queue. (This observer will also record the number of ramp meter violators, see Section 5.2.2.3.2.)
- Jamar software will be used to calculate queue length and vehicle delay at the ramp.

#### 5.2.2.3.2 HOV Lane Usage and Ramp Meter Violations

Manual field observations will be used to collect ramp meter violations. The same observer that is recording the number of vehicles exiting the ramp queue will count the number of violators.

TMC loop detector station data will be used to obtain the number of vehicles using the ramp's HOV bypass (it should be noted that even after the meters are shut off, there may still be some travel advantage in using the HOV bypasses at certain locations).

#### 5.2.2.3.3 Frequency of the Ramp Queue Backing into Intersection

Manual field observations will be made to measure the length of time that a ramp queue backs into the adjacent intersection. The following information pertains to this data collection effort:

Data collection methods and tools:

- The same observer that is counting the number of vehicles entering the ramp queue will note the occurrences of ramp queues backing into the intersection.

#### 5.2.2.3.4 Quality of Merge

Traffic volumes and average traffic speeds will be analyzed to determine the quality of traffic merging onto the freeway. Approximate traffic speeds will be calculated from the freeway occupancy data. As a reasonableness check, the occupancy-derived speeds will be compared to the speeds captured during the travel time runs. The volume and speed data will be used to assess the "quality of merge" at each of the on-ramps along the corridor. In addition, the freeway volumes can be analyzed on a lane-by-lane basis; an even distribution of volumes across all lanes suggests a higher quality of merge. The following information pertains to this data collection effort:

Data collection methods and tools:

- TMC entrance ramp volumes and occupancy (15-minute intervals);
- TMC mainline detector volumes and occupancy (upstream and downstream of ramp, lane-by-lane in 15-minute intervals)
- Collect data during same periods and locations as the ramp queue delay study.

### *5.2.2.4 Objective 4: Assess Safety Impacts*

This evaluation objective will examine the safety impacts of the ramp metering system. The TMC incident logs will be reviewed to collect the number and duration of incidents on those freeway corridors selected for evaluation. In addition, the automated Mn/DOT crash log system will be reviewed to collect the number of crashes within the Twin Cities Metropolitan Area. This data will be used to directly measure the number of crashes in the "with ramp metering" and "without ramp metering" condition on a systemwide basis. In addition, historical crash data will be collected and analyzed as described below.

1. Sample size:
   - Collect TMC incident log data along corridors within study area;
   - TMC documents number and duration of incidents on freeways that are monitored by the traffic management system;
   - One-month lag time before incident logs are recorded in the database;
   - Collect metro-wide crash data from Mn/DOT's automated crash log system;
   - Four to six-week lag time before crash records are in the database;
   - "With ramp metering" four-week period data available early December;
   - "Without ramp metering" four-week period data available early January;
   - Collect crash data for entire freeway system;
   - Collect historical crash data;
   - Previous two years; and
   - Do not include data from ramps if metering was implemented within the two-year period.
2. Tools:
   - TMC incident log for four study corridors; and
   - Mn/DOT crash log system for full Twin Cities Metropolitan Area.
3. Analysis:
   - Separate data by freeway and parallel arterial segment;
   - Separate data for metered vs. unmetered freeways;
   - Identify crashes by type (rear-end, side-swipe, etc.);
   - Separate data by crash severity (PDO, injury, fatality);
   - Separate data by time of day: Crash data while meters are in operation versus data in the off-peak, while meters are off-line;
   - If possible separate data by speed range and level of congestion (allows correlation between congestion and number of crashes);
   - Ramps – examine data for ramp segments before and after meter; and
   - Arterials – examine data for cities that have freeway segments with ramp metering or diversion routes.

### *5.2.2.5 Objective 5: Assess Transit Impacts*

This objective examines the impacts to transit caused by the ramp metering system. Numerous data sources will be used and performance measures will be collected. No transit data will be collected on the I-494 Corridor due to a lack of suburb-to-suburb transit service.

**5.2.2.5.1 Transit Vehicle Travel Times**

Transit vehicle travel times will be collected on a sample of transit routes running on the mainline and alternate travel routes on two to three of the four selected corridors. Travel time data collection has been confirmed for I-94 and I-35E. Discussions are underway with Metro Transit and Minnesota Valley Transit Authority as to their resource availability and willingness to provide travel times on I-35W.

Travel times on the following sample of routes will be collected over a one-week period.

| I-94 Corridor | I-35E Corridor | I-35W Corridor |
|---|---|---|
| 94BCD | 35ABC | 35MNRTV |
| 16 | 270 | 37W |
| 21 | 271 | 431 |
| 50 | 860 | 77PSV |
| | 210 | 77AST |
| | 212 | 442 |
| | 213 | |

Metro Transit will use AVL-equipped buses to collect this data on I-94. Metropolitan Council will use radio checks and field observations to collect this data on I-35E. Minnesota Valley Transit Authority will use radio checks to collect this data on I-35W.

1. Sample size:
   - A sampling of transit routes on the mainline and/or alternate travel routes within three of the four selected corridors;
   - Sample selection is dependent upon the availability of AVL-equipped transit vehicles or transit provider provided data collection personnel;
   - Selected routes are subject to change based upon data availability;
   - Transit vehicle travel times while within the corridor;
   - The a.m. and p.m. peak periods; and
   - Travel time data will be collected for one week within each of the three selected corridors.
2. Assumptions:
   - Request that Metro Transit use selected transit routes, to the extent possible, with AVL-equipped transit vehicles; and

- Request that Metro Transit and the Metropolitan Council provide personnel to conduct manual collection of travel time data on corridors lacking sufficient coverage of AVL-equipped transit vehicles.

3. Data collection methods and tools:
   - AVL-equipped transit vehicles;
   - Manual data collection; and
   - Extent of data collection to be determined by Metro Transit and other metro area transit providers.

#### 5.2.2.5.2 Transit Ridership

Transit ridership data will be collected on a sample of transit routes running on the mainline and alternate travel routes on three of the four selected corridors. Ridership data collection has been confirmed for I-94, I-35E, and I-35W.

Ridership on the following sample of routes will be collected over a four-week period during the before period and a five-week period during the during period.

| I-94 Corridor | I-35E Corridor | I-35W Corridor |
|---|---|---|
| 94BCDJL | 35ABC | 35MNRTV |
| 353 | 270 | 37W |
| 355 | 271 | 431 |
| 95MU | 860 | 77PSV |
| 16 | 210 | 77AST |
| 21 | 212 | 442 |
| 50 | 213 | |

Metro Transit, Metropolitan Council and Minnesota Valley Transit Authority will collect this data using both electronic farebox data and manual driver tally sheets.

1. Sample Size:
   - A sampling of transit routes on the mainline and/or alternate travel routes within the four selected corridors;
   - Sample selection is dependent on the availability of data;
   - Selected routes are subject to change based upon data availability;
   - The a.m. and p.m. peak periods; and
   - Entire study duration.

2. Assumptions:
   - Request that Metro Transit, the opt-out service providers and the contracted transit service providers provide ridership information on select routes with each corridor.
3. Data collection methods and tools:
   - Farebox data.

#### 5.2.2.5.3 Park-and-Ride Facility Usage

Park-and-ride utilization data will be collected at a sample of facilities serving transit routes on three of the four selected corridors. Park-and-ride utilization data collection has been confirmed for I-94, I-35E, and I-35W. Discussions are still ongoing with Minnesota Valley Transit Authority on the possible expanding the I-35W sample to include additional facilities.

Utilization at the following facilities will be collected on three days over a one-week period during both the before and during periods.

| I-94 Corridor | I-35E Corridor | I-35W Corridor |
|---|---|---|
| Woodbury Lutheran Church | Gustavus Adolphus Lutheran | Burnsville Transit Station |
| Christ Episcopal Church | Municipal Lot | Apple Valley Transit Station |
| Wooddale Recreation Center | TH61 & CRC | Palomino Hills |
| Faith United Methodist Church | Lake Owasso Beach | |
| West St. Paul Sports Complex | Rice & I-694 | |
| | Maplewood Mall | |
| | Cub Foods | |

The a.m. peak period auto travel time data collection personnel will manually collect this data through field observations directly after completion of the am peak travel runs.

1. Sample size and assumptions:
   - A sampling of facilities that serve transit routes traveling along three of the four selected corridors; and
   - Estimated number of facilities is 12.
2. Data collection methods and tools:
   - Park-and-ride lot occupancy count (after the a.m. peak period); and
   - Conducted by travel time personnel.

### *5.2.2.6 Summary of Performance Measures and Data Sources*

Table 5.5 summarizes the performance measures and data sources used in the field data collection.

### Table 5.5 Summary of Performance Measures and Data Sources

| Objective | Performance Measures | Data Source |
|---|---|---|
| 1 Assess traffic flow impacts | 1.1 Freeway Volume | TMC Station Detectors |
| | 1.2 Freeway Occupancy | TMC Station Detectors |
| | 1.3 Alternate Route | Road Tubes |
| | Volume | Traffic Signal System Detectors |
| 2 Assess travel time impacts | 2.1 Freeway travel time | GPS- and Jamar-equipped vehicles |
| | 2.2 Alternate route travel time | GPS- and Jamar-equipped vehicles |
| 3 Assess ramp impacts | 3.1 Ramp queue length | Jamar counter |
| | 3.2 Ramp queue delay | Jamar counter |
| | 3.3 HOV lane usage | Observation |
| | 3.4 HOV lane violation | Observation |
| | 3.5 Ramp meter violation | Observation |
| | 3.6 Frequency of ramp queue backing into intersection | Observation |
| 4 Assess crash impacts | 4.1 Incidents on freeway corridors within study area | TMC Incident Logs |
| | 4.2 Systemwide crashes | Mn/DOT Crash Database |
| 5 Assess transit impacts | 5.1 Mainline route travel time | AVL-equipped vehicles; field observations |
| | 5.2 Alternate route travel time | AVL-equipped vehicles; field observations |
| | 5.3 Ridership | Farebox |
| | 5.4 Facility usage | Observation |

## 5.3 Field Data Analysis Plan

During both the “with” and the “without” study periods all data collected on bad weather days (rain/snow), bad incident days, and dark vs. light conditions will be flagged. The data will then be grouped and analyzed in separate categories. If there is a statistically significant difference between groups, the data will be analyzed separately and comparisons will be made for data under similar weather/light/incident conditions. Also, the data will be analyzed across groups to identify differences in the effectiveness of ramp metering under the varying conditions. Finally, all data will be analyzed to measure the effects of peak-period spreading. The following subsets will be created with the data:

- Pavement Condition:
  - Dry,
  - Wet, and
  - Snow covered.
- Presence of Incidents along Corridor:
  - Yes, and
  - No.
- Light Condition:
  - Light (sunrise to sunset), and
  - Dark (sunset to sunrise).
- Day of Week:
  - Monday and Friday; and
  - Tuesday through Thursday.

## 5.4 Field Data Management Plan

### 5.4.1 Field Data Collection, Transfer, and Storage

The specific form of data collection, transfer, and storage will be finalized when detailed information regarding the data formats is available. An archive copy and one or more working copies of the data will be made. The original data will be stored at the SRF offices. A second archive copy will be given to Cambridge Systematics and/or Mn/DOT for storage at their offices.

The TMC detector station volume data will be electronically transmitted to SRF via the Internet File Transfer Protocol (FTP) method. Data from the previous 24-hours will be sent on a daily basis.

### 5.4.2 Field Data Security

There are no security issues related to the transfer of the field data that will be used in the evaluation process. The data will consist of traffic data, various log data entries, and public information. There will not be any data collected that will involve privacy considerations.

### 5.4.3 Configuration Control

Mn/DOT shall provide the detector station data in a binary format.

### 5.4.4 Documentation of External Influences

The main external influences on the system's performance will be weather, changes in the transportation system (lane closures, repairs, etc.), incidents causing traffic delays (crashes, stalled vehicles, etc.), and major events. Each of these will be continually monitored as a part of the project and will be used when possible to schedule the individual tests of the system.

### 5.4.5 Quality Control and Quality Assurance

A very large amount of data will be collected over the course of this evaluation. The following steps will be taken to ensure that the data is reliable and secure:

- Data collection personnel will be trained by data collection supervisors;
- Data collection supervisors will make periodic spot checks on personnel in the field;
- Data will be inspected on a daily basis to insure that the data is reasonable;
- In the event that equipment problems are encountered, backup data collection equipment will be available whenever possible;
- Make-up data collection activities will take place during week five of the before study in the event that additional data collection is required.

# 6.0 Test Plan for Focus Groups and Surveys

# 6.0 Test Plan for Focus Groups and Surveys

The primary research for this study consists of two market research tasks. As part of the qualitative market research, a set of two "with" and two "without" focus groups will be conducted to provide:

- Insights into ramp metering issues as viewed by individual travelers,
- Input to the "with" and "without" survey design process, and
- Measures of effectiveness and ways to reach non-technical audiences.

As part of the quantitative market research, a "with" and "without" set of surveys will be conducted of travelers in the Minneapolis/St. Paul metropolitan area. These surveys will include a random sample of travelers in the seven-county study area and surveys of travelers along the four area corridors for which traffic and travel time data will be collected. The survey data will be analyzed to identify:

- Changes in travel behavior and ramp usage "with" and "without" the ramp metering shutdown, and
- Changes in travelers' attitudes towards ramp meters "with" and "without" the ramp metering experiment.

## 6.1 Qualitative Research – Focus Groups

Travelers' perceptions of ramp meter shutdowns will be assessed though a series of focus group sessions among travelers in the Minneapolis/St. Paul metropolitan area. The objective of the qualitative research is to elicit travelers' overall reactions to the operation of ramp meters in the Twin City roadway system and the expected impact of shutting down the ramp meters on travelers' general travel patterns.

This will help to provide a better understanding of travelers' attitudes toward the operation of ramp meters in the region's freeway system including travelers' opinions about ramp meters in general, the types of benefits ramp meters may or may not provide, and how the existence of ramp meters affects route, mode, and departure time choices.

A screener questionnaire will be developed to select focus group participants. The criteria for recruiting participants in the focus groups include the following:

- Travelers who travel either during the morning peak period (6:00 to 9:00 a.m.) and/or during the afternoon peak periods (3:00 p.m. to 6:00 p.m.);

- Travelers who use one or more of the four study area corridors that will be analyzed in greater detail;

- Travelers are split into two groups depending on their freeway ramp usage patterns:
  - Heavy users: Six or more one-way trips per week, or
  - Light users: Less than six one-way trips per week.

Other criteria include the recruitment of respondents who are 18 years or older, travelers with and without a convenient alternate route, respondents living in urban and suburban communities, and a mix of male and female respondents across different age and income categories.

During each focus group session, the moderator will introduce topics, probe comments, and elicit reactions from all of the participants. The moderator will maintain a non-directive style of interviewing to avoid biasing any discussions. Participants will be encouraged to speak freely, interact, and offer disagreeing opinions whenever possible on each of the issues. The sessions will be conducted in a modern focus group facility with a one-way mirror to permit the observation of participants by members of the Technical and Advisory committees and Mn/DOT staff. An attempt will be made to over-recruit participants to ensure that eight to 10 individuals will actually arrive at each focus group.

The discussion topic guide that will be developed will include the following general topics for discussion during each focus group:

- Introduction by the moderator of the purpose of the discussion and the ground rules for participation in the discussion;

- General perceptions toward ramp meters;

- Evaluation of ramp meter performance and measures of effectiveness;

- Expectations for ramp meter shutdown; and

- Information needs for the ramp meter shutdown.

Tasks and deliverables in this effort include:

1. Development of a telephone screener questionnaire to select participants in the "with" focus groups.

2. Preparation of discussion topic guides to guide the discussion during the "with" and "without" focus group sessions.

3. Solicitation of input and approval from the Advisory and Technical committees and Mn/DOT for both the "with" and "without" focus groups.

4. Recruitment of a representative sample of travelers to participate in the "with" and "without" focus groups.

5. Moderation of two "with" and two "without" focus groups split among high-frequency ramp meter users (travel through ramp meters at least six times per week) and low-/ medium-frequency users.

6. A technical memorandum summarizing the results of the focus group sessions along with audio and video tapes of the group sessions will be produced following the completion of the focus groups.

## 6.2 Quantitative Research – Traveler Surveys

Travelers' perceptions of the ramp meter shutdown will be quantified though a set of "with" and "without" surveys among travelers in the Minneapolis/St. Paul metropolitan area. Travelers may perceive the effects of the ramp meter shutdown differently than the field data collected in other tasks would indicate. Therefore, an important element in the evaluation of the ramp meter shutdown experiment will be the measurement of travelers' attitudes both with operational ramp meters and with unrestricted ramp traffic.

The traveler surveys that are planned include a random sample of travelers in the seven-county study area and surveys of travelers along the four area corridors for which traffic and travel time data will be collected. The "with/without" analysis of traveler perceptions will help to interpret the findings of the traffic engineering measures and travel time data along each study corridor and for the study area population as a whole. The survey data will be analyzed to identify:

- Changes in travel behavior and ramp usage "with" and "without" the ramp metering shutdown, and

- Changes in travelers' attitudes towards ramp meters "with" and "without" the ramp metering experiment.

The total sample size planned for the "with ramp metering survey" is 750 observations. The "with" survey sample will be split by corridor and for the entire study area as follows:

- Random digit-dial sample for the seven-county metropolitan area (N = 250) and

- Random samples for each of the four corridors under study (N = 125 observations per corridor with N = 500 across the four corridors).

A sample size of 750 observations is also expected for the "without" survey. The distribution of the 750 observations across the random digit dial sample and the four corridor-specific random samples will be similar to the "with" survey.

During the month prior to the ramp meter shutdown, residents will be asked to provide information on travel behavior, freeway and ramp system usage, attitudes toward the effectiveness of the ramp meters, and demographic data. A similar wave of "without" surveys will be administered after the meters have been turned off for several weeks. The "without" survey design will be similar to the "with" survey, but will also include questions designed to evaluate the no-meter operational concept.

The random sample will be developed by means of random digit dialing and will include all travelers (potentially including transit riders) who travel during the peak periods. The corridor-specific samples will be based on license plate data collected at strategic locations along each of the test corridors. The sample will therefore be limited to automobile drivers and passengers in the designated corridors.

It is intended that a sufficient number of license plates will be collected once at the outset of the "with ramp metering" data collection effort to create a sample size sufficient to support both the "with ramp metering" and "without ramp metering" survey waves. If necessary, a second round of collection will occur during the "without ramp metering" phase. The target goal is to collect 72,000 license plates which, after discounting for duplicates, plates which cannot be converted into individual's telephone numbers (due to leased vehicles, etc.), and survey participation rates, should provide for a sufficient sample size. Mn/DOT will secure the assistance of the Department of Public Safety (DPS) to provide the support required to rapidly convert plates into contact information.

During discussions with the Technical and Advisory Committees, the issue of targeting some aspect of the primary research (either the qualitative or quantitative) to specific market subgroups such as commercial vehicle operators or transit riders was discussed. While it was recognized that such groups have unique concerns and issues, it was decided not to dilute the general random sample, or to disperse the overall level of effort, by specifically targeting such groups. The rationale for this decision was the fact that all vehicles and passengers will experience similar traffic conditions (since no vehicles operate on exclusive rights-of-way in the region with the exception of the HOV meter bypasses and highway diamond lanes), and therefore the conclusions which emerge from the general random samples can be applied to all travelers. In the case of the HOV lanes, traffic data will be collected on these facilities as part of the overall traffic data collection plan, and questions will be included in the random samples which address issues related to the operation of the HOV facilities. In addition, Metro Transit will be able to supplement the project's data collection plan with its own data regarding any operational impacts which its bus fleet may experience as a result of the meter shutdown.

The proposed structure for the "with" telephone survey includes the following groups of questions:

1. A set of screener questions will allocate peak-period users to each of the four corridors of interest. These questions include the identification of travel in corridor of interest; the direction of travel in the corridor; and the time of day that this trip is taking place. Respondents traveling in the peak direction between 6:00 and 9:00 a.m. and/or between 3:00 and 6:00 p.m. will be selected for the interview. Interviews with respondents working for Mn/DOT, planning agencies, media outlets, and city/county public works departments will be discontinued.

2. Characteristics of last peak-period trip on the freeway corridor. Information that will be collected includes:

   – Trip purpose and place of trip origin,

   – Date and time of trip,

   – Origin and destination (at town/suburb level and in detail),

   – Entry and exit points to the freeway of interest,

   – Total travel time,

   – Percentage of time traveled on freeway,

   – Rating of freeway congestion,

   – Vehicle occupancy and by-pass lane usage, and

   – Wait time at entrance meter and at other freeway-freeway meter(s).

3. Experience with "typical" freeway trip including the frequency of using the freeway, the percentage of time the respondents experience longer wait times at ramps and the corresponding longer total travel time.

4. A battery of attitudinal statements regarding the respondent's travel experiences in general and ramp meters in particular. Ramp-related questions will include travelers' attitudes toward ramp wait times, safety considerations, predictability of travel, and the usefulness of ramp by-pass lanes.

5. Demographic information to control for differences among respondents.

The analysis of the random sample survey and the four corridor-specific surveys will focus on "with/without" comparisons of travelers' attitudes toward travel in the Minneapolis/St. Paul metro area and their attitudes toward ramp meters in particular. The statistical analysis will aim to identify important differences by focusing on differences that are statistically significant at a 95 percent confidence level. To enhance the validity of these "with/without" comparisons the analysis will also take into account other factors that may have an impact on travelers' attitudes, such as:

- Frequency of travel during a typical week,
- Respondents' familiarity with different ramps in the area,
- The characteristics of the four freeway corridors under study,
- Differences in respondents' travel patterns, and
- Demographic characteristics of each respondent.

Tasks and deliverables in this effort include:

1. Design of the "with" and "without" survey instruments for a random sample traveler survey and for four surveys of respondents using each of the four study corridors.

2. Solicitation of input and approval from the Advisory and Technical committees and Mn/DOT for the "with" and "without" telephone survey design and the approach to survey sampling.

3. Collection of license plate numbers from automobiles along each of the four study corridors, translation to registration data, and development of user telephone number lists for each study corridor.

4. Revision of the survey content following each wave of focus groups.

5. Programming of the "with" and "without" random surveys and the four corridor-specific surveys into a computer aided telephone interview program.

6. Pre-testing of the "with" and "without" surveys.

7. Administration of the "with" and "without" telephone surveys for the random sample and the four random samples of corridor auto users.

8. Independent analyses of the "with" and the "without" surveys with two books of cross-tabulations (a total of 32 banner points) after the completion of the "with" and the "without" survey respectively.

9. A comparative statistical analysis of traveler perceptions and travel behavior between the "with" and "without" surveys and across various traveler market segments.

10. A technical memorandum summarizing each set of the survey findings and the comparative analysis highlighting changes in travelers' perceptions and travel behavior attributable to the ramp meter shutdown.

# 7.0 Test Plan for Benefit/Cost Analysis

# 7.0 Test Plan for Benefit/Cost Analysis

The benefit/cost analysis will extrapolate the focused findings from the analysis of the selected corridors and market research to produce estimates of regionwide impacts. A traditional spreadsheet benefit/cost model will be used to conduct the regional extrapolation of data and benefit/cost analysis.

This method involves the use of spreadsheet models to extrapolate data from the four selected corridors to the regional scale. All regional corridors will be classified similar to the selected corridors. Observed safety and traffic flow impacts from the selected corridors will then be applied to all ramp metered corridors according to their specific corridor type. Benefit values will be applied to the resulting impacts and will form the basis for the cost/benefit analysis. This method is advantageous in that the methodology is well accepted for conducting analysis of this type and can be applied in an expedient manner suitable to the schedule requirements. This method is limited in its ability to assess impacts on a location-by-location basis and would not completely capture some of the impacts on travel time reliability and other performance measures. This method is also limited in terms of presentation and data segmentation capabilities.

A second benefit-cost methodology may be used in the analysis of a broader set of ramp metering operating scenarios. After the "with/without" evaluation is completed, it is likely that there will be a need to investigate the role of ramp metering in optimizing system efficiency. Such an investigation is currently beyond the scope of the "with/without" evaluation which looks at an all-or-nothing comparison. An analysis of ramp metering operational strategies will require estimating the effect of these strategies onto multiple diversion routes for all Twin Cities corridors, queue lengths at freeways and ramps, and other details not analyzable in a spreadsheet format.

This further investigation would employ the ITS Deployment Analysis System (IDAS) software tool. IDAS was developed for the FHWA to provide planners with the ability to evaluate various traffic management strategies, including ramp metering. The IDAS software would use outputs from the Twin Cities' regional travel demand model as inputs to the software. Field data, as well as traveler survey data, will be used to calibrate the IDAS model so that it replicates traffic conditions observed in the field. The IDAS model would then be used to investigate and analyze a broader set of ramp metering operating strategies. The IDAS methodology has the advantage of analyzing the ramp meter impacts specific to each deployment location and could also be used for analyzing additional operational scenarios following the completion of this study.

The result of this task will be a technical memorandum providing an evaluation of the regional benefits of ramp metering compared with the associated costs and negative impacts. This memorandum will be supported by clear and useful graphical materials appropriate to a varying range of stakeholders and the public.

# 8.0 Test Plan for Secondary Research

# 8.0 Test Plan for Secondary Research

The purpose of this task is to review and summarize other relevant research regarding the benefits and costs of ramp metering and to identify ramp metering strategies employed in other comparable metropolitan areas.

In this task, the CS team will review, verify, and validate a currently unpublished Texas Transportation Institute (TTI) ramp meter comparison study. The CS team will identify any gaps in the TTI study, and make whatever adjustments are required to reflect the most current information regarding:

- A comparison of Minnesota's ramp metering system to other deployments in metropolitan areas across the country, including the total number of ramp meters, the type of deployment (pre-set, traffic actuated, centrally controlled), hours of operation, ramp configuration strategies (with or without HOV lanes, etc.), benefit-cost, environmental and safety studies undertaken, outreach and educational efforts, user feedback, and plans for expansions or new ramp metering deployments;
- A summary of the trends of ramp metering strategies and use; and
- A summary of the benefits, impacts, and costs of ramp metering from studies done across the country.

The CS team will also identify and search ITS and other transportation agency web sites and relevant domestic and international transportation trade press to find ramp metering information that is current and relevant. Trade press and databases anticipated to be searched include:

- Traffic Technology International;
- Roads and Bridges;
- The Journals of the Association of Metropolitan Planning Organizations; the Institute of Transportation Engineers (ITE) and American Public Works Association;
- U.S. DOT's electronic data library;
- U.S. DOT's ITS costs and benefits database; and
- State and other transportation agency DOT web sites.

The CS team will also interview and/or survey individuals from three sites to fill in any missing gaps in the TTI study.  Alternative interview sites will be recommended by the contractor and approved by the State's project manager.

A technical memorandum will be produced summarizing the results of the secondary research.

# 9.0 Schedule, Meetings, and Deliverables

# 9.0 Schedule, Meetings, and Deliverables

The objective of this task is to ensure that a broad cross-section of stakeholders with both technical and non-technical levels of expertise participates in and guides the study to ensure that the results have credibility throughout the community.

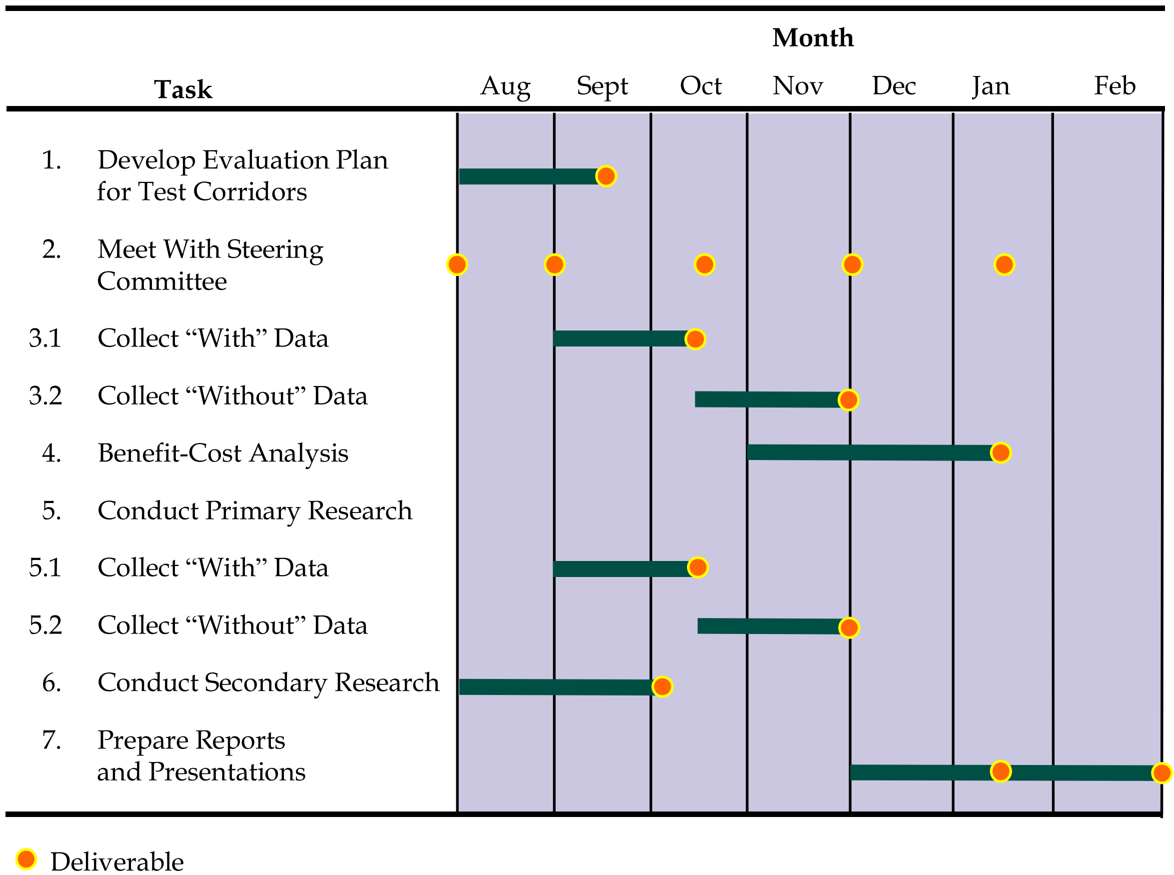
## ■ 9.1 Project Schedule

The project schedule and key task deliverables are shown in Figure 9.1. As shown in the schedule, CS is committed to meeting Mn/DOT's legislatively mandated deadline of reporting the results of the study to the legislature by February 1, 2001.

The schedule proposed in Figure 9.1 is extremely aggressive and requires that Mn/DOT be an active partner with the CS team in facilitating the review and approval of project milestone submittals.

We are developing the Evaluation Plan (Task 1) during the months of August and September. The secondary research (Task 6) also may begin immediately and will be completed by early October. We have allocated September and the first half of October for the preparation and conduct of "with ramp metering" data collection, including both traffic field data (Task 3) and survey data (Task 5). It is desirable to have these two distinct data sources temporally linked. After meter shutdown, data collection will be prepared for and conducted in the second half of October and November (Tasks 3 and 5). Preparations for the cost/benefit analysis (Task 4) will begin in November and be completed by January. The draft report and legislative presentation (Task 7) will be completed by mid-January, in time for Mn/DOT and committee review and comment such that the documents will be ready for delivery to the legislature by February 1. The final report will be completed by March 1 following receipt of comments from the legislature.

**Figure 9.1 Project Schedule**




## 9.2 Meetings

The CS team will meet with the committees at eight critical milestones in the project, including:

- Kickoff meeting;
- Evaluation strategy: Recommendation for the study period, corridor selection, corridor criteria and metering shut down;
- Completion of evaluation plan;
- Completion of "With ramp metering" data collection;
- Completion of "Without ramp metering" data collection;

- Completion of “top-down” overview of draft study report;
- Completion of cost/benefit analysis and draft report; and
- Completion of the secondary research.

Upon request of Mn/DOT’s project manager, the CS team will participate in as many as four additional meetings, including:

- One additional set of advisory and technical committee meetings; and
- Two media briefings: The CS team will serve principally as an information resource to State/Advisory/Technical committee designated spokespeople, and be expected to provide hard copy hand-outs detailing their involvement in the study, the study design/process, and/or its results.

The CS team will supply the following materials for the meetings and presentations. An electronic and hardcopy version of all materials will be provided to the project manager.

- Presentation materials;
- Hard copy hand-outs to all attendees;
- Drafts of technical memoranda in advance of the meetings; and
- Meeting minutes.

## 9.3 Reports and Presentations

The objective of this task is to produce a set of clear and concise reports and presentation materials that will successfully communicate the key findings of the study to both technical and non-technical audiences.

The CS team will prepare a draft report for review by the committees at the completion of all other task activities. The report will:

1. Be highly graphical, readable, and understandable to a wide variety of audiences;
2. Include all appropriate supporting statistical data in technical appendices, resulting in a complete accounting of the study and analysis techniques;
3. Be produced in Microsoft (MS) Office;
4. Include an Executive Summary for non-technical audiences, a detailed technical analysis, and supporting appendices; and
5. Incorporate comments received on the task-specific technical memoranda.

The CS team will present a top-down summary of the evaluation results to the committees which accurately present the conclusion and supportive finding to the ramp metering study. CS will produce a final report, based on review and input received from the committees. This report will be delivered in a format suitable for posting on the Internet. CS will also prepare a PowerPoint presentation for use by the State and/or members of both committees. The presentation, and any accompanying graphics must be suitable for on-line media. The CS team will work closely with the State to explore particularly useful presentation formats and materials suitable to the intended audiences.

Deliverables include:

1. 75 copies of the Draft Final Ramp Metering Evaluation Report including an Executive Summary and supporting appendices along with an electronic copy to the Mn/DOT project manager. Due date is January 5, 2001.

2. 75 copies of the Final Ramp Metering Evaluation Report, plus one unbound camera-ready original and an electronic file in a format that is consistent with current State standards. Due date is January 24, 2001.

3. PowerPoint presentation suitable for legislative presentation. Due date is January 24, 2001. An electronic and hardcopy version of all materials will be provided to the project manager. An electronic and hardcopy version of all materials will be provided to the project manager.