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Developing Twin Cities Arterial Mobility Performance Measures Using GPS Speed Data

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May 2013

Research Project
Final Report 2013-14

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The overall goal of this study was to use commercially-available travel speed data to develop arterial street mobility performance measures in the eight-county Twin Cities Metropolitan Area. The research team licensed 2011 historical traffic speed data from INRIX for 1,604 directional-miles of arterial streets, and conflated this speed data with MnDOT traffic volume data on the same street network. Based on prevailing practice, TTI recommended travel speed-based mobility performance measures that compare peak traffic speeds to speeds during light daytime traffic. However, it was recognized that light daytime traffic speeds are not necessarily the goal or target for the performance measures, but simply a convenient and easily-measured reference point. Instead, performance measure target values should be context-sensitive and based upon surrounding land use. Multiple measures should be used to quantify and monitor mobility on arterial streets, including delay per mile, travel time index, and the planning time index (a measure of reliability). The exact mobility performance measures and target values are likely to evolve and be refined as MnDOT and partner agencies gain experience in performance monitoring on arterial streets. At this time, TTI recommends calculating, tracking, and gaining experience with multiple measures, while also determining where these measures can be used to improve agency decisions.

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Executive Summary

Introduction

The overall goal of this study was to use commercially available travel time data to develop arterial street (non-freeway roads) performance measures, and to document the supporting analytical processes for future Minnesota Department of Transportation (MnDOT) analysis and performance reporting.

Overview of Methods

The approach used in this study was as follows:

1. Obtain travel speed data from commercial data provider.
2. Review mobility performance measures in MnDOT policy documents.
3. Develop arterial street mobility performance measures and supporting analytical process.
    a. Define segmentation levels for performance measure reporting.
    b. Combine/conflate the travel time data with MnDOT volume data using GIS.
    c. Define mobility performance measures and corresponding target values.
    d. Calculate, report, and illustrate performance measure results.
4. Document the study methods and findings in a final project report.

Each of these major steps is summarized in the following sections.

Obtain Travel Speed Data

The Texas A&M Transportation Institute (TTI) issued a request for proposals (see Appendix A) for travel speed data, and three commercial data providers responded. INRIX was selected by MnDOT as the winning data provider and soon thereafter delivered 2011 data for the pre-defined roadway links:

- Roadway location reference (common street name and cross streets, latitude longitude of link endpoints, and spatial relationship with upstream and downstream links);
- Time/date range (hour-of-the-day and day-of-week averages);
- Average speed, reference speed, and distribution percentiles of speed.

Review of Policy and Practice Regarding Performance Measures

The MnDOT policy documents (i.e., *Minnesota Statewide Transportation Policy Plan: 2009-2028*, *MnDOT Metro District 20-year Highway Investment Plan 2011-2030*) reviewed in this study focus on speed and travel time-based mobility performance measures. They include:

- Travel time index
- Duration and extent of congestion (as defined by speed)
- Travel time reliability
- Travel delay
- Arterial speed index

In other states and regions, the focus was similar in nature, and focused on travel time and speed-based mobility performance measures. The 2010 Highway Capacity Manual (HCM) also uses a speed-based performance measure for arterial streets. In fact, the HCM level of service is determined by the travel speed as a percentage of the base free-flow speed. In principle, this is the same concept on which the travel time index is based.

Develop Arterial Street Mobility Performance Measures and Supporting Analytical Process

Most of the project analysis was conducted in this step. There were several sub-steps:

1. Define roadway network and reporting segmentation
2. Conflate travel speed network with traffic volume network
3. Define appropriate performance measures
4. Define target values for performance measures
5. Calculate performance measures

All of the technical details for this step are provided in the main part of this project report.

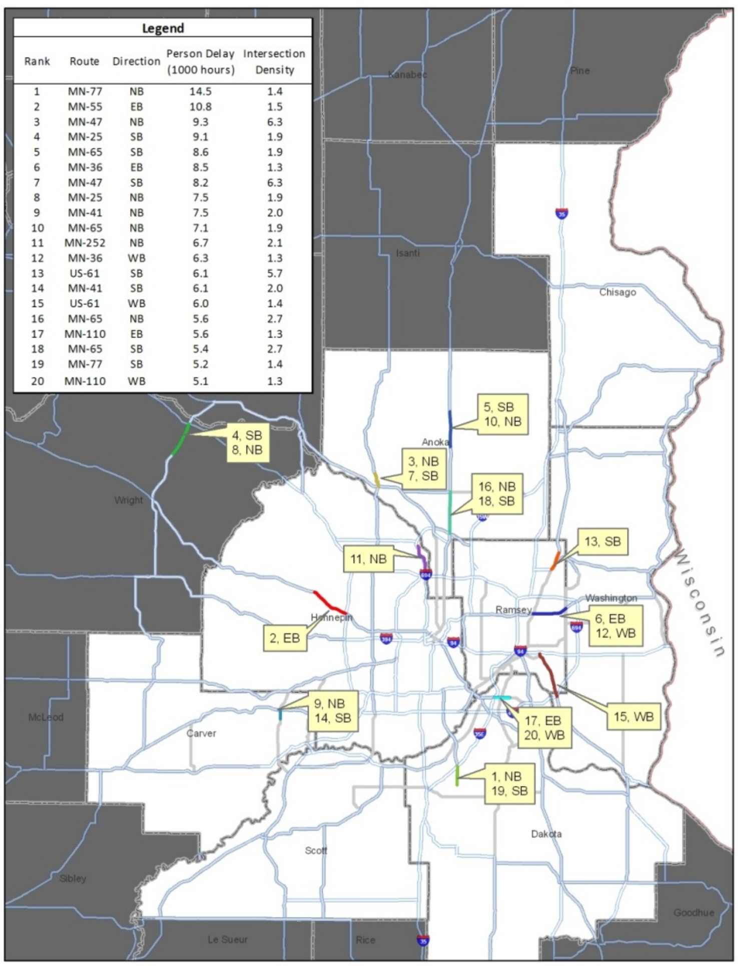
Findings and Conclusions

TTI researchers developed the following conclusions based on the research and analysis:

1. **Private sector data providers are a viable source of travel speed data for mobility performance monitoring on arterial streets.** In this project, TTI licensed historical average hourly speed data for 2011 for all arterial streets in the eight-county Twin Cities metropolitan area from INRIX at a total cost of $22,600. TTI researchers visually reviewed samples of the INRIX speed data for selected arterial segments and found speed patterns and trends that were as expected.
2. **Mobility performance measures for arterial streets should be travel speed-based measures that compare peak traffic speeds to speeds during light traffic, recognizing that the light traffic speed is not a target value but simply a reference point for performance measures.** TTI researchers did identify other non-mobility multimodal performance measures that are appropriate for urban streets (such as pedestrian and bicyclist safety). However, it was beyond the scope of this project to define and calculate these other non-mobility measures.
3. **Performance measure target values should be context-sensitive and based on surrounding land use**. After researching data availability and analyzing several possible attributes to quantify context, TTI researchers chose intersection density. Conceptually, the target values are set lower on streets that have higher intersection density. That is, MnDOT may be “willing to accept” higher congestion levels on urban streets in

downtown or dense, mixed-use districts (than on access-controlled arterials with low intersection density).

4. **Multiple performance measures should be used to quantify and monitor mobility on arterial streets.** The delay per mile measure (example shown in Figure ES-1, based on target values) includes multiple dimensions of congestion and normalizes the delay values per unit length, allowing comparison among different roadway lengths. The travel time index is another common, easily understood measure, but only captures the intensity dimension of congestion. The recommended reliability measure is the planning time index, which represents the total travel time that should be planned for a specified on-time arrival.
5. **The exact mobility performance measures and target values are likely to evolve and be refined** as MnDOT and partner agencies gain experience in performance monitoring on arterial streets. At this time, we think it is best to calculate, track, and gain experience with multiple measures, while also determining where these measures can be used to improve agency decisions.



Rank	Route	Direction	Person Delay (1000 hours)	Intersection Density
1	MN-77	NB	14.5	1.4
2	MN-55	EB	10.8	1.5
3	MN-47	NB	9.3	6.3
4	MN-25	SB	9.1	1.9
5	MN-65	SB	8.6	1.9
6	MN-36	EB	8.5	1.3
7	MN-47	SB	8.2	6.3
8	MN-25	NB	7.5	1.9
9	MN-41	NB	7.5	2.0
10	MN-65	NB	7.1	1.9
11	MN-252	NB	6.7	2.1
12	MN-36	WB	6.3	1.3
13	US-61	SB	6.1	5.7
14	MN-41	SB	6.1	2.0
15	US-61	WB	6.0	1.4
16	MN-65	NB	5.6	2.7
17	MN-110	EB	5.6	1.3
18	MN-65	SB	5.4	2.7
19	MN-77	SB	5.2	1.4
20	MN-110	WB	5.1	1.3

Figure ES-1. Top 20 Congested Directional Arterial Segments, Ranked by Annual Target Delay per Mile

Chapter 1. Introduction

This report summarizes research conducted by the Texas A&M Transportation Institute (TTI) to develop and report mobility performance measures on arterial streets and highways in the Minneapolis-St. Paul metropolitan area (or Twin Cities metropolitan area, TCMA). The mobility performance measures were developed and analyzed using travel time/speed data licensed from a commercial data provider. In addition to defining the mobility performance measures, the analysis also included the development of suggested performance measure target values. The remaining sections of this chapter provide an overview of the research study, in terms of objectives and scope.

Study Overview

The overall goal of this study was to use commercially-available travel time data to develop arterial street (non-freeway roads) performance measures, and to document the supporting analytical processes for future Minnesota Department of Transportation (MnDOT) analysis and performance reporting.

The tasks were as follows:

1. Obtain travel time data from commercial data provider.
2. Review mobility performance measures in MnDOT policy documents.
3. Develop arterial street mobility performance measures and supporting analytical process.
    a. Define segmentation levels for performance measure reporting.
    b. Combine/conflate the travel time data with MnDOT volume data using GIS.
    c. Define mobility performance measures and corresponding target values.
    d. Calculate, report, and illustrate performance measure results.
4. Document the study methods and findings in a final project report.

Study Scope

The study scope was defined in the proposal and was limited as follows:

- **Mobility performance measures –** There are multiple types of performance measures associated with transportation goals, such as safety, environmental impact, economic impact, etc. The focus of this study was mobility performance measures.
- **Arterial streets and highways –** This study was focused solely on those roads that have a MnDOT arterial classification (i.e., non-freeway). There are several types of arterials in MnDOT's classification, including urban and rural categories, as well as major and minor classes. Therefore, the study included roads with a wide range of design and operating characteristics, from low-speed urban streets with frequent access, to high-speed rural highways with moderate access control.
- **Twin Cities metropolitan area (TCMA) –** This study was focused on the metropolitan area as defined by the following eight counties:
    1. Anoka
    2. Carver

3. Chisago
4. Dakota
5. Hennepin
6. Ramsey
7. Scott, and
8. Washington.

All arterial roads that were included in this study are shown in Figure 1-1. At the request of MnDOT, TTI did include a few additional arterial roads in Sherburne and Wright County.

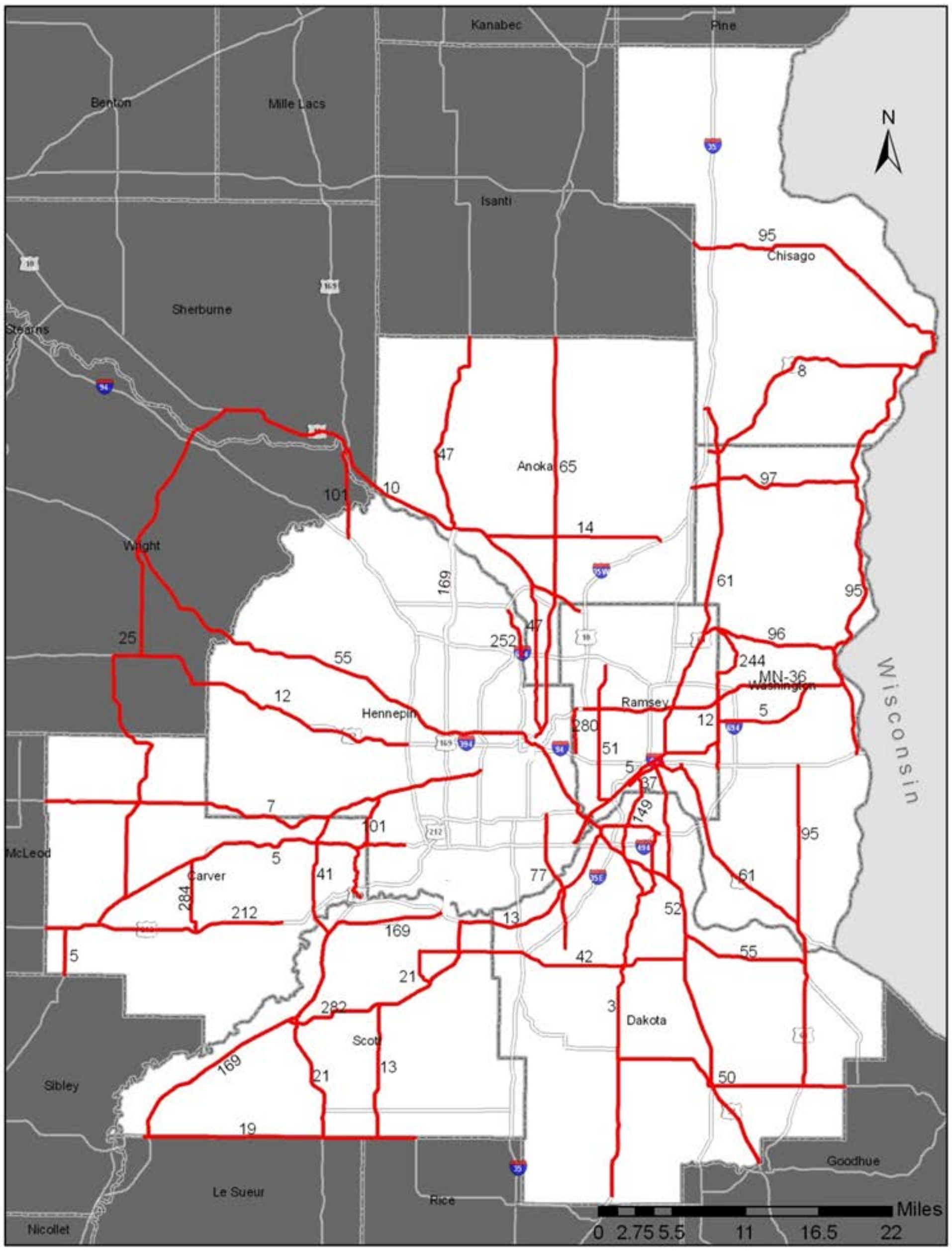


Figure 1.1: Map of Study Area and Arterial Street Network

Chapter 2. Background

This chapter provides background information on arterial performance measures from two different contexts: 1) MnDOT policy and planning documents; and 2) Practices in other states.

MnDOT Policy and Planning Documents

MnDOT's *Minnesota Statewide Transportation Policy Plan: 2009-2028* [1] provides the strategic direction for the transportation system in the next 20-year period. Policy 6 of the plan, Twin Cities Mobility, provides mobility and addresses congestion in the Twin Cities. Table 2-1 outlines the performance measures and indicators selected for monitoring the performance of travel within the Twin Cities Metropolitan Area (TCMA).

Table 2.1: Performance Measures for Policy 6: Travel within the Twin Cities Metro Area

Performance Measure	Definition/ Description
Travel Time Index (TTI) and Ranking	MnDOT will use the travel time index values and national ranking as reported by the Texas Transportation Institute.
Duration and Extent of Congestion on Freeways	The measure to be used is "the percent of freeway miles congested in weekday peak periods". Freeway congestion is defined as speeds below 45 miles per hour (for at least 5 minutes) during the morning and evening peak periods.
Transit Ridership	This measure tracks the number of people carried annually on transit throughout the TCMA.
Bus-only Shoulders	The number of miles of bus-only shoulders within the TCMA.
Incident Clearance	The average incident clearance time (in minutes) for urban freeway incidents (includes stalled cars, crashes, and other things that disrupt normal traffic flow).
Metro Signal Retiming on Arterial Routes	The signal retiming frequency (i.e., how often are traffic signals retimed).
FIRST Route Coverage	The number of miles covered by the Freeway Incident Response Safety Team (FIRST).
Instrumented Principal Arterial Routes	The number of principal arterial street miles in the TCMA instrumented with cameras and pavement sensors.
Regional Park-and-Ride Spaces	The number of park-and-ride spaces in the Twin Cities regional park-and-ride system, which is tracked in annual park-and-ride survey.
Developmental Measures MnDOT is exploring the feasibility of these additional performance measures: • Person Throughput • Duration and Extent of Congestion on Arterials • Arterial and Freeway Travel Time Reliability • Vehicle Throughput • Metro Area Delay Estimates for Freight	

(Source: *Minnesota Statewide Transportation Policy Plan: 2009-2028*)

Of the mobility measures listed in the *Statewide Transportation Policy Plan*, the relevant performance measures for arterials are:

- Travel Time Index
- Duration and Extent of Congestion
- Travel Time Reliability

MnDOT's *Metro District 20-year Highway Investment Plan 2011-2030* [2] lists a more specific set of performance measures used to track mobility performance. These measures are very similar to the measures used in the policy plan and are shown below in Table 2-2. The specific measure listed in the *Investment Plan* for the arterials is the arterial speed index, which is the same as the Travel Time Index for arterials in the *Statewide Transportation Policy Plan*.

Table 2.2: Performance Measures and Indicators

Performance Measure	Definition/ Description
Freeway Delay	Minnesota Department of Transportation considers a facility congested when speeds are at 45 miles per hour or less for at least 5 minutes.
Travel Time Index (TTI)	The ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds.
Other Performance Indicators Being Considered	
Person throughput	Throughput refers to the number of persons traversing the corridor on both transit and in private vehicles.
Reliability	Percent or miles of new managed lanes such as High Occupancy Vehicles (HOV), Bus Rapid Transit (BRT) and High Occupancy Toll (HOT)
Arterial (non-freeway) speed index	Actual speed vs. posted speed or free flow conditions

(Source: *MnDOT Metro District 20-year Highway Investment Plan 2011-2030*)

The University of Minnesota has developed a system called SMART-SIGNAL that is able to collect and archive event-based traffic signal data simultaneously at multiple intersections. Using the event-based traffic data, SMART-SIGNAL can generate time-dependent performance measures for both individual intersections and arterials including intersection queue length and arterial travel time. The most current information [3,4] indicates that "…the SMART-Signal system has been field-tested on three major arterial corridors in Minnesota including six intersections on Trunk Highway 55 in Golden Valley, eleven intersections on France Avenue in Bloomington, and three intersections on Prairie Center Drive in Eden Prairie. A demonstration project is also being carried out on Orange Grove Boulevard in Pasadena, California. A large-scale implementation project currently under discussion with MnDOT will monitor 100 intersections in the Twin Cities area using the SMART-Signal system."

In general, MnDOT is at the beginning of making policies for mobility performance on arterials. The congestion measures for arterials follows the same measures as used for the freeways.

State-of-the-Practice Outside of Minnesota

Maricopa Association of Governments, Phoenix, Arizona

The Maricopa Association of Governments (MAG) has developed a Performance Measurement Framework to illustrate the most important characteristics associated with the status of surface transportation in the region. Performance measures are used in the planning and programming processes of MAG. The two examples are 1) the development of the MAG *Regional Transportation Plan (RTP)* [5] which included a performance-based planning and programming process and 2) the *Congestion Management Process* [6].

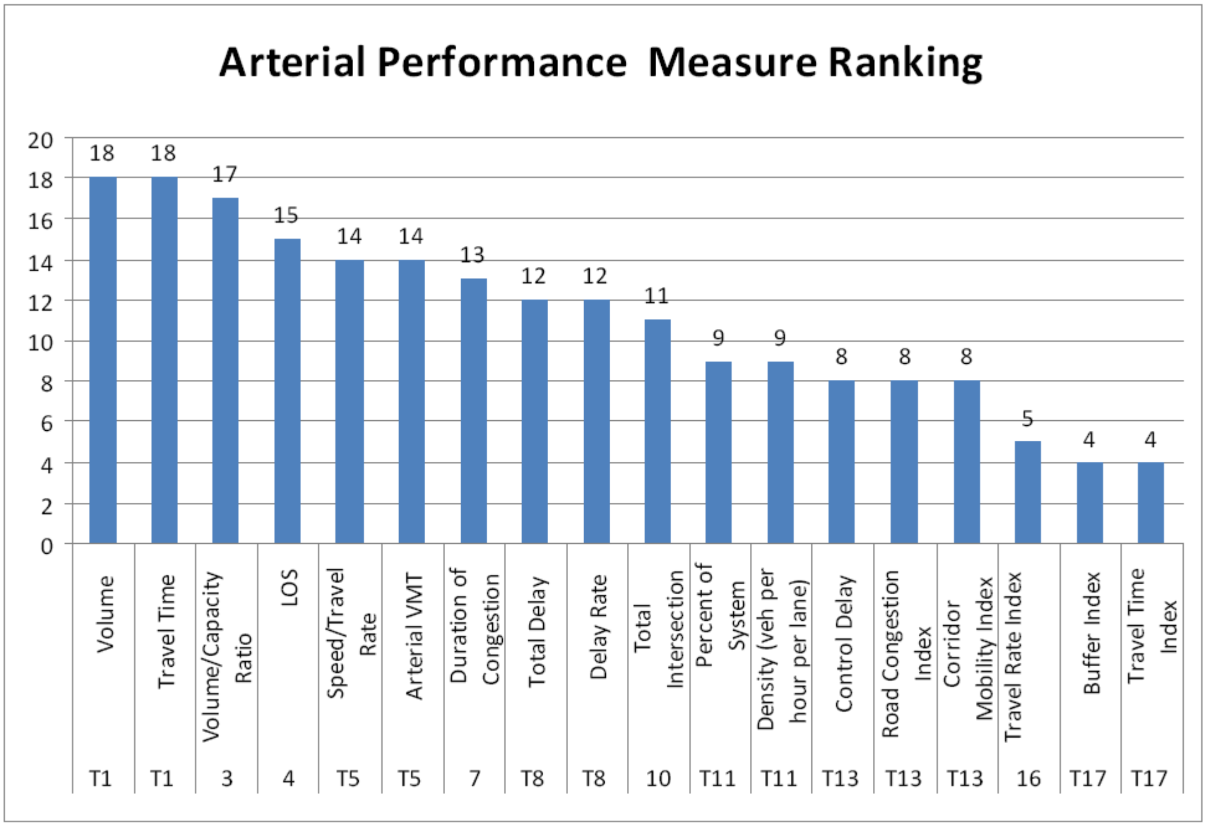
The performance measures developed by MAG focus on the availability of transportation facilities and services, as well as the range of service options provided. Table 3 lists the performance measures developed for various facility types. For the arterials, the following mobility/throughput measures are recommended:

- Mean and 80^{th}-95^{th} percentile and point-to-point travel times
- Congestion: spatial and temporal
- Travel time variability
- Incident clearance time
- Person and vehicle throughout
- Intersection level of service (based on volume-to-capacity ratio)
- Signal cycle failures/intersection queue size
- Per capita vehicle-miles traveled

Texas

A University of Texas study [7] gathered information current practices for arterial street performance measures. The research team surveyed 25 Metropolitan Planning Organizations (MPOs), 25 Department of Transportation (DOT) Districts, and 8 Regional Mobility Authorities (RMAs) in Texas for their use of arterial performance measures. The survey results were then ranked by a weighting system, with currently used measures worth twice the weight of planned measures. The weighted results are shown in Figure 2-1.

The study found that these performance measures— volume, travel time, and volume-to-capacity ratio—are the top three measures used for arterial performance in the Texas.



Note: T—tied

Figure 2.1: Arterial Performance Measures from University of Texas Study

The 2010 Highway Capacity Manual

The 2010 Highway Capacity Manual (HCM) uses the level of service (LOS) criteria for the automobile mode on arterial segments. The criteria for the automobile mode, which are different from the criteria used for the non-automobile modes, are based on performance measures that are field-measureable and perceived by the travelers.

"Two performance measures are used to characterize vehicular LOS for a given direction of travel along an urban street segment. One measure is travel speed for through vehicles. This speed reflects the factors that influence running time along the link and the delay incurred by through vehicles at the boundary intersection. The second measure is the volume-to-capacity ratio for the through movement at the downstream boundary intersection. These performance measures indicate the degree of mobility provided by the segment."

Table 2-3 lists the LOS threshold established for automobile mode on urban streets.

Table 2.3: Level of Service Designation in 2010 Highway Capacity Manual

Travel Speed as a Percentage of Base Free-Flow Speed (%)	LOS by Volume-to-Capacity Ratio*	
	<= 1.0	> 1.0
>85	A	F
>67-85	B	F
>50-67	C	F
>40-50	D	F
>30-40	E	F
<=30	F	F

Note: *Volume-to-capacity ratio of through movement at downstream boundary intersection

For the performance measures on the boundary intersection, four input data elements were listed on the HCM:

- Through control delay
- Through stopped vehicles
- 2nd- and 3rd-term back-of-queue size
- Capacity

For the performance measures on each segment, two input data elements were listed:

- Mid-segment delay
- Mid-segment stops

In the HCM, three performance measures are estimated for each segment travel direction:

- Travel speed,
- Stop rate, and
- Automobile traveler perception score.

The perception score is derived from traveler perception research and is an indication of travelers' relative satisfaction with service provided along the segment.

University Research

Several universities and/or research groups have researched the feasibility of gathering and archiving traffic signal system data for congestion analysis (similar to the SMART-SIGNAL work by the University of Minnesota). Berkeley Transportations Systems, the developer of the PeMS performance monitoring system software, has developed an arterial component of their PeMS that relies on sensor information as well as signal timing information [6,7]. Portland State University research focused on gathering speed and detector occupancy data from the traffic signal system detectors [8]. Purdue University researchers proposed collecting and logging phase indications and detector actuations on a cycle-by-cycle basis [11]. The performance measures they recommended include the volume-to-capacity ratio and arrival type defined by the *Highway Capacity Manual*.

Chapter 2 Summary

The MnDOT policy documents (i.e., *Minnesota Statewide Transportation Policy Plan: 2009-2028*, *MnDOT Metro District 20-year Highway Investment Plan 2011-2030*) reviewed in this study focus on speed and travel time-based mobility performance measures. They include:

- Travel time index
- Duration and extent of congestion (as defined by speed)
- Travel time reliability
- Travel delay
- Arterial speed index

The MnDOT policy documents also indicated that vehicle and person throughput was a mobility performance measure to be considered.

In other states and regions, the focus was similar in nature, and focused on travel time and speed-based mobility performance measures.

The *2010 Highway Capacity Manual (HCM)* also uses a speed-based performance measure for arterial streets. In fact, the HCM level of service is determined by the travel speed as a percentage of the base free-flow speed. In principle, this is the same concept on which the travel time index is based.

Chapter 3. Overview of Methods

This chapter provides an overview of the methods and procedures used to develop and refine arterial performance measures. Each step of the process will serve as a section within this chapter.

1. Obtain (or develop) historical travel speed dataset;
2. Define roadway network and reporting segmentation;
3. Conflate travel speed network with traffic volume network;
4. Define appropriate performance measures;
5. Define target values for performance measures;
6. Calculate performance measures

Obtain (or Develop) Historical Travel Speed Dataset

The focus of this research project was to use commercially-available travel speed datasets to develop arterial street performance measures. Therefore, TTI prepared and posted a request for proposals (see Appendix A) that identified the required data attributes. Three providers responded: INRIX, Nokia/NAVTEQ, and TomTom. TTI developed criteria for evaluating the responses. The project panel members separately evaluated each proposal, and TTI consolidated the evaluations for consideration by the MnDOT Project Manager. After discussions and deliberation, INRIX was selected by the MnDOT Project Manager as the winning data provider and was notified on September 5. INRIX provided the required data to TTI in mid-September, and the INRIX data currently resides on a TTI computer server.

The INRIX data consists of the following for pre-defined roadway links:

- Roadway location reference (common street name and cross streets, latitude longitude of link endpoints, and spatial relationship with upstream and downstream links);
- Time/date range (hour-of-the-day and day-of-week averages);
- Average speed, reference speed, and distribution percentiles of speed.

The original speed data set provided by INRIX for the Twin Cities Metro Area was quite large (more than 3 gigabytes), and manipulating the raw data required powerful database software. Relational databases like Oracle or SQL Server are commonly used for these large datasets.

In the initial data processing steps, TTI aggregated and summarized the raw speed data into a smaller, derivative dataset (less than 20,000 records, able to fit within a Microsoft Excel spreadsheet). TTI transmitted this derivative summary dataset to MnDOT as a project deliverable, as the INRIX licensing terms permits this aggregate derivative dataset to be freely and publicly distributed.

There are other possible ways to develop travel speed datasets on arterial streets. Historical practice has been for public agencies to conduct floating car travel time studies; however, the cost of floating car data collection is high and provides very limited samples throughout the year.

Other MnDOT-sponsored research underway at the University of Minnesota is estimating real-time travel times using signal controller data [3,4].

Define Roadway Network and Reporting Segmentation

The study scope was focused solely on those roads that have a MnDOT arterial classification (i.e., non-freeway). There are several types of arterials in MnDOT's classification, including urban and rural categories, as well as major and minor classes. Therefore, the study included roads with a wide range of design and operating characteristics, from low-speed urban streets with frequent access, to high-speed rural highways with moderate access control.

The study scope was also defined to be within the Twin Cities metropolitan area (TCMA), which includes the following eight counties: 1) Anoka; 2) Carver; 3) Chisago; 4) Dakota; 5) Hennepin; 6) Ramsey; 7) Scott; and, 8) Washington. At MnDOT's request, TTI did include a few additional arterial roads in Sherburne and Wright County. All arterial roads that were included in this study are shown in Figure 1-1.

MnDOT staff provided an electronic geo-referenced (i.e., GIS) file of the defined arterial roadway network for this study. The MnDOT GIS network contained basic roadway inventory attributes, and was segmented at a relatively disaggregate level. For the purposes of performance monitoring and reporting, more aggregate segmentation was desired. Therefore, TTI defined performance reporting *segments* that combined multiple MnDOT GIS links with the following characteristics:

- One travel direction only;
- Similar cross-section design (e.g., number of lanes, type of land use, etc.);
- Similar operational characteristics (e.g., traffic volumes, speeds, and queuing);
- Approximately 2 to 5 miles in urban areas, as long as 8 to 10 miles in suburban or developing areas;
- Terminates at major cross streets, interchanges, or other traffic generators.

These reporting *segments* were defined as the minimum reporting level for performance measures. As an example, Table 3-1 shows the performance reporting segments for MN 51 (Snelling Avenue) as it bisects the TCMA. In addition to *segments*, TTI also defined *corridors* for performance measures. Corridors were defined as a collection of all segments along a named route, in both directions. As an example using Table 3-1, MN 51 is a corridor for which performance measures will be calculated. The corridor performance measures are aggregated from segment-based performance measures using vehicle-miles of travel (VMT) weighting.

Table 3.1: Example of Segments for MN 51 Northbound (Snelling Avenue)

Corridor Name	Corridor ID	Segment ID	From	To	Length (mi)
MN 51	0510	0300000051001	MN 5	MN 51	0.88
		0300000051002	MN 51	I-94	2.73
		0300000051003	I-94	MN 36	4.02
		0300000051004	MN 36	I-694	3.86
				Corridor Length	11.48

In total, TTI defined 360 directional reporting segments and 38 corridors, with a total mileage of 1,604 directional-miles. The defined segments are shown in Figure 3-1, and the defined corridors are shown in Figure 3-2.

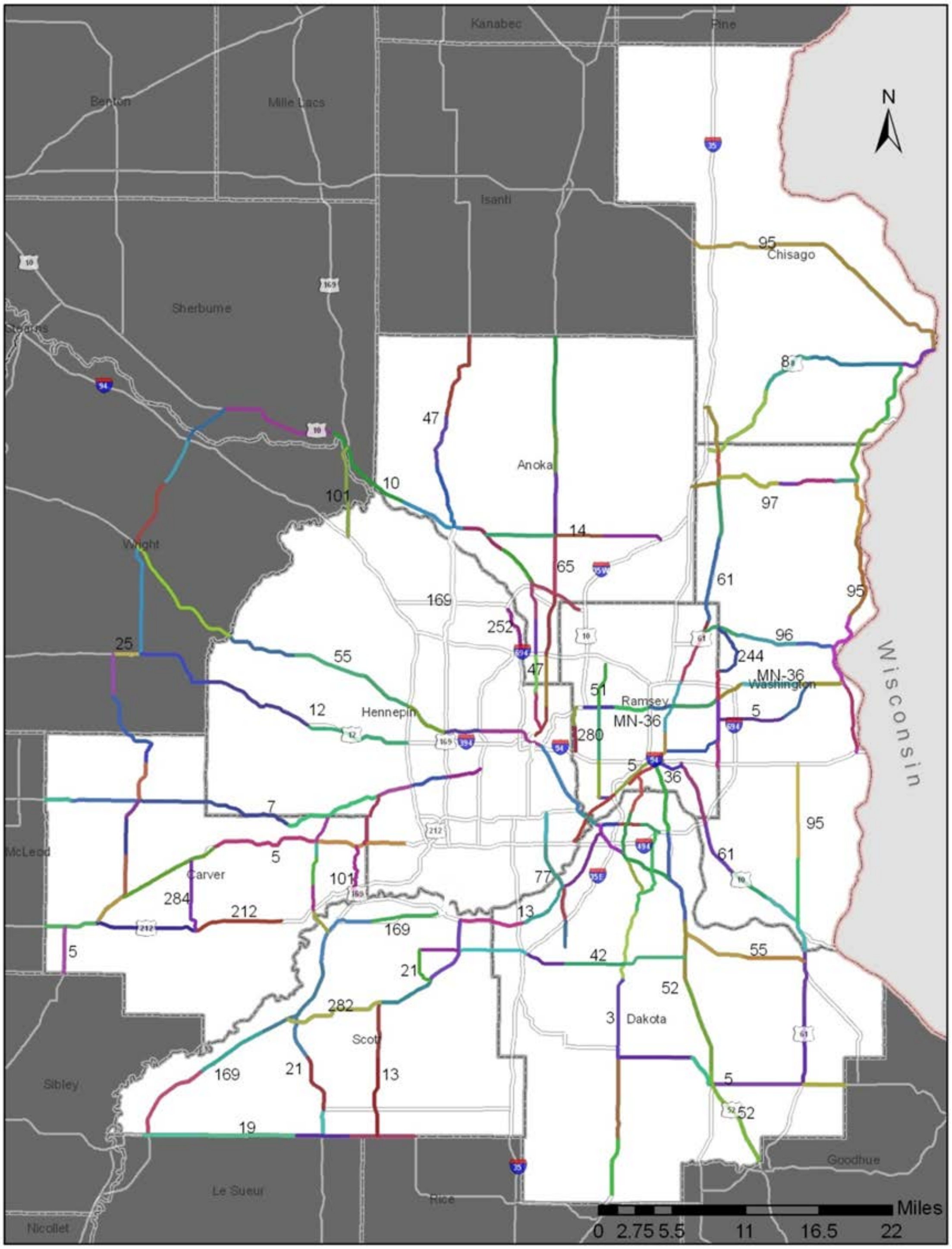


Figure 3.1: Defined Arterial Segments in the Twin Cities Metropolitan Area

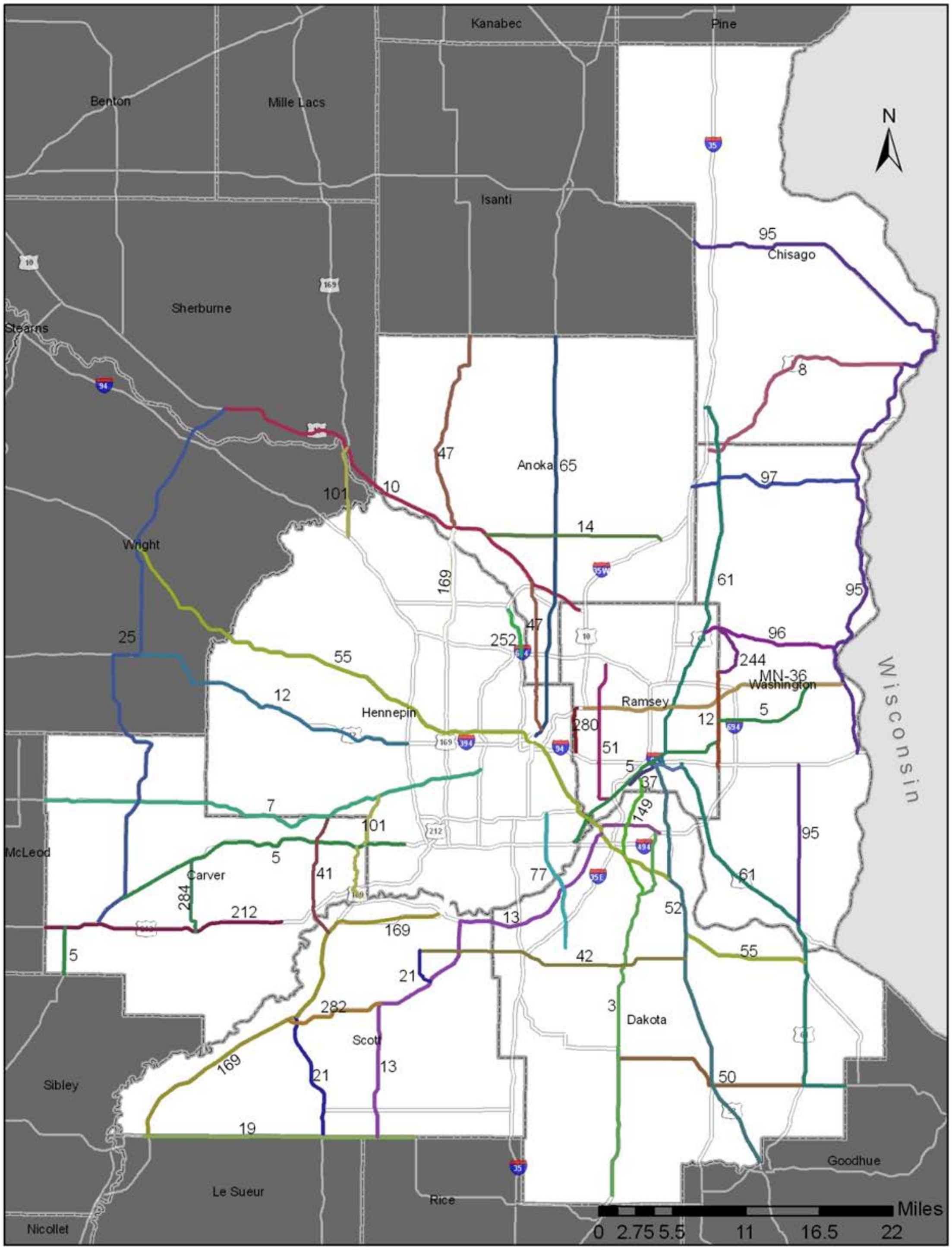


Figure 3.2: Defined Arterial Corridors in the Twin Cities Metropolitan Area

Conflate Travel Speed Network with Traffic Volume Network

Since the INRIX travel speed data was referenced to different segmentation than the MnDOT network, TTI had to conflate (or combine) the INRIX road network (2,235 unique directional road links) to the MnDOT GIS network (1,009 unique directional road links). Also, to include traffic volumes in any of the mobility performance measures, the INRIX speed network had to be integrated with the MnDOT traffic volume network.

TTI obtained MnDOT's traffic volume network as part of the defined GIS network provided in the previous step. The GIS file contained multiple years of traffic data, and TTI used traffic volumes for the most recent year available, which was 2009.

TTI performed the conflation process within the ESRI ArcView GIS software, using a mostly automated process that has been described elsewhere [12]. The automated network conflation results were reviewed and some adjustments were made by a GIS analyst. Overall, the match rate between the two GIS networks was 98 percent, which was considered excellent.

Define Appropriate Performance Measures

After obtaining private sector travel speed data and conflating this data onto MnDOT's traffic volume network, the next step was to define the performance measures to be calculated. From the state-of-the-practice review in Chapter 2, most mobility performance measures were based on travel time/speed. TTI also considered the need to be consistent with traditional traffic analysis methods (*Highway Capacity Manual*), state-of-the-art methods used by "leading" agencies, and the USDOT rulemaking on mobility performance measures that is currently in process.

One finding that did emerge from this step is the recognition that arterial streets, particularly urban streets in downtown or mixed-use settings, serve a variety of multimodal functions other than mobility, and that multimodal, non-mobility performance measures are necessary in these urban settings. Other performance measures include those that support complete streets:

- Crashes and injuries for motorists, pedestrians, and cyclists
- Volume of vehicles, bus passengers, bicycle riders, and users of public space
- Provision of adequate/safe facilities for all potential street users

However, this project was scoped to focus on mobility performance measures, and designation and calculation of other performance measures was beyond the scope of this project. In the future, MnDOT and other regional agencies should consider these mutimodal performance measures. This is consistent with future additions being considered for the Highway Capacity Manual, which includes a multimodal level of service [13].

After reviewing these considerations, TTI determined that best practice for mobility performance measures was to compare actual operating speeds to prevailing traffic speeds during light traffic, recognizing that this uncongested speed is not a target value, but simply a reference point for performance measures. This is consistent with the Highway Capacity Manual, which defines urban street level of service criteria as the ratio of operating speeds to free-flow speed (i.e., percent of base free-flow speed). This measure -- the percent of base free-flow speed -- is another common mobility performance measure and is the inverse of the travel time index.

With this basic definition in place, there are multiple speed-based measures that can be calculated. Many of these speed-based measures are likely to be highly correlated, and what is most important for performance monitoring is the **change** in these measure values. Additionally, the exact mobility performance measures are likely to evolve and be refined as MnDOT and partner agencies gain experience in performance monitoring on arterial streets. Therefore, at this time, TTI recommends an approach to calculate, track, and gain experience with **multiple** measures, while also determining where these measures can be used to improve agency decisions. Past experience with performance measures has indicated that debates about "THE best measure and THE target value" are counterproductive until several years of actual monitoring experience have been gained.

Therefore, these mobility performance measures are recommended for arterial streets:

1. Person-based congestion delay per mile, peak period and daily total
2. % of free-flow speed (or its inverse, travel time index)
3. Reliability, expressed as 80^{th} percentile travel time index or % of trips exceeding travel time index of 2.50

Congestion Reference Point versus Target Values

All of these mobility performance measures are defined and calculated relative to a congestion threshold, or a point at which travel is considered to be congested. There has been much debate in the transportation profession about a common or standardized definition for congestion, simply because traveler's perceptions and opinions of traffic congestion vary by trip purpose, mode of travel, normal conditions, etc.

For the sake of consistency in measurement, TTI researchers recommend a congestion definition that separates quantitative measurement from travelers' perceptions. This can be accomplished by defining congestion and unacceptable congestion, a concept first introduced by TTI researchers in 1997 [14,15]. NCHRP Report 398 defined the following terms:

> ***Congestion*** – travel time or delay in excess of that normally incurred under light or free-flow travel conditions.
>
> ***Unacceptable Congestion*** **–** travel time or delay in excess of an agreed-upon norm [or target value]. The agreed-upon norm may vary by type of transportation facility, geographic location, and time of day.

By using these definitions, traffic ***congestion*** can be consistently and systematically measured on any transportation facility anywhere in the world, regardless of mode or context. Because the perceptions of congestion may vary significantly, ***unacceptable congestion*** is used to represent the perceptions and expectations of travelers. In the context of this MnDOT project, unacceptable congestion is calculated by defining target values that reflect the prevailing transportation policies and goals.

Because of this distinction, each performance measure will have 2 variations:

1. **Light traffic –** measure is calculated based on prevailing travel speed/time during light traffic conditions; and,
2. **Target –** measure is calculated based on target values as defined by transportation policy.

The next section discusses these performance measure target values for arterial streets in more detail.

Define Target Values for Performance Measures

The key determinant for performance measure targets is a state or region's transportation policy and plan, which defines the goals for the transportation system. Because performance monitoring on arterial streets is an emerging practice for both MnDOT as well as the Metropolitan Council, current policy and planning documents do not explicitly address performance measure target values. However, the following paragraphs describe the process that TTI researchers used to develop initial estimates for target values based on existing MnDOT policy as well as other traffic engineering documents.

Both MnDOT and Metropolitan Council plans emphasize these key points that are useful when considering performance measure targets:

- Recognition that congestion will not be eliminated or significantly reduced.
- Instead, congestion should be mitigated by:
    - Strategic highway investment;
    - Providing multimodal travel alternatives;
    - Changing travel demand patterns; and,
    - Planning and implementing appropriate land uses.

Based on this and other language in policy and planning documents, TTI researchers concluded that performance measure target values should be set based on one or more of these attributes:

- **Context** – the surrounding land use that is being served or will be served in the future.
- **Functional class –** to a lesser extent, this determines street character and traveler expectations.

For quantifying the context attribute, TTI considered the Metropolitan Council's *Planning Areas* as defined in their *Regional Development Framework* (see Figure 3-3). However, these *Planning Area* definitions were not fine-grained enough to adequately capture the variations in land use context. For example, there were only two urban planning areas defined: *Developing Area* and *Developed Area*. TTI researchers also considered the land use types as defined in Metropolitan Council's travel demand forecasting model, but these were also considered to be inadequate for arterial street performance measure targets.

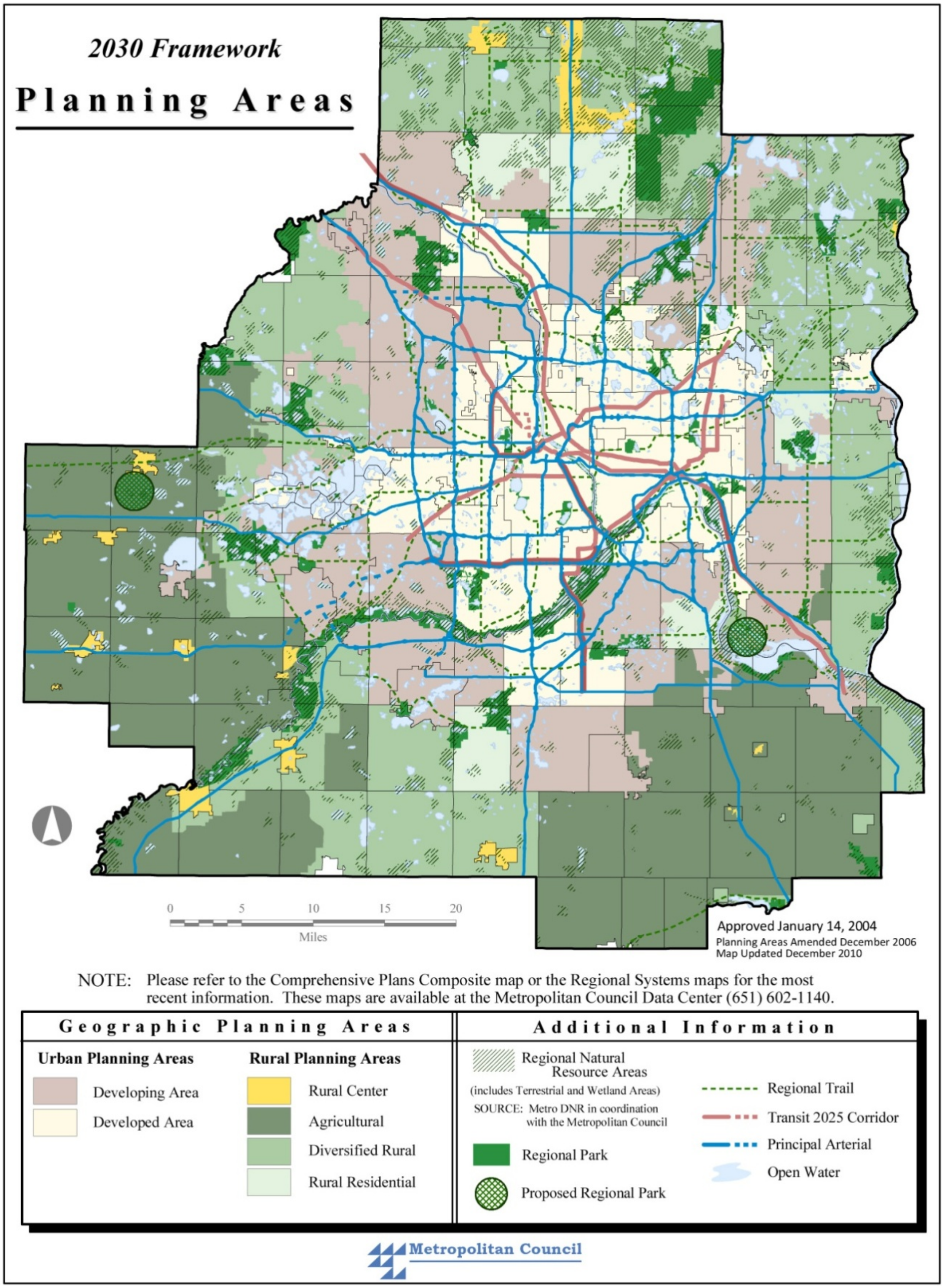


Figure 3.3: Metropolitan Council 2030 Regional Development Framework

(Source: http://gis.metc.state.mn.us/mapgallery/pdfs/Framework/framework2030_pa_8x11.pdf)

Intersection density is sometimes used to characterize development type and/or characteristics. Block sizes tends to be shorter in dense, mixed-use, downtown areas. Conversely, block sizes are typically longer in suburban and developing areas. Intersection density for this project was calculated using the GIS network provided by MnDOT, which included local streets but did not include alleys or commercial driveways.

TTI also considered several attributes to characterize functional classification, as there is a need to differentiate between “high-type” suburban highways that primarily provide through mobility, versus urban streets that serve multiple functions aside from mobility.

One possibility is the *Arterial Class* that was defined in the 2000 *Highway Capacity Manual*. These *Arterial Classes* were defined based on intended street function, character, and approximate free-flow speed as follows:

- Class I: 50 mph typical free-flow, ranges from 45-55 mph
- Class II: 40 mph typical free-flow, ranges from 35-45 mph
- Class III: 35 mph typical free-flow, ranges from 30-35 mph
- Class IV: 30 mph typical free-flow, ranges from 25-35 mph

However, these *Arterial Classes* were not included in the 2010 *Highway Capacity Manual*. Further, MnDOT’s Metro District does not use this HCM *Arterial Class* attribute and instead follows the Met Council’s definition of *Major Arterials* and *Minor Arterials* (which are subdivided into *A Minor* and *B Minor* arterials).

After considering and experimenting with multiple attributes to reflect both land use context and street functional classification, TTI researchers selected a single attribute of *Intersection Density* that reflects both land use context and street functional class in a single variable. The *Intersection Density* was calculated based upon the MnDOT GIS network file. This GIS network included all functional classes, so signalized as well as unsignalized intersections were counted. However, alleys and driveways were not included in the GIS network and therefore were not included in the calculation of intersection density.

Other classification variables for setting arterial streets performance measure targets are possible; however, based on data currently available, we recommend *Intersection Density*. Sub-categories of intersection density were based on MnDOT’s Access Management policy, which recommends access frequency based on functional class and area/facility type. Therefore, the following intersection density ranges were selected (see Figure 3-4):

- Less than 2 intersections per mile
- 2 to 4 intersections per mile
- 4 to 8 intersections per mile
- Greater than 8 intersections per mile

The exact category endpoints and number categories were selected for consistency with MnDOT Access Management policy and ease of use/reference. For example, 2 intersections per miles translates to an average intersection spacing of ½-mile, 4 intersections per miles translates to an average intersection spacing of ¼-mile, etc.

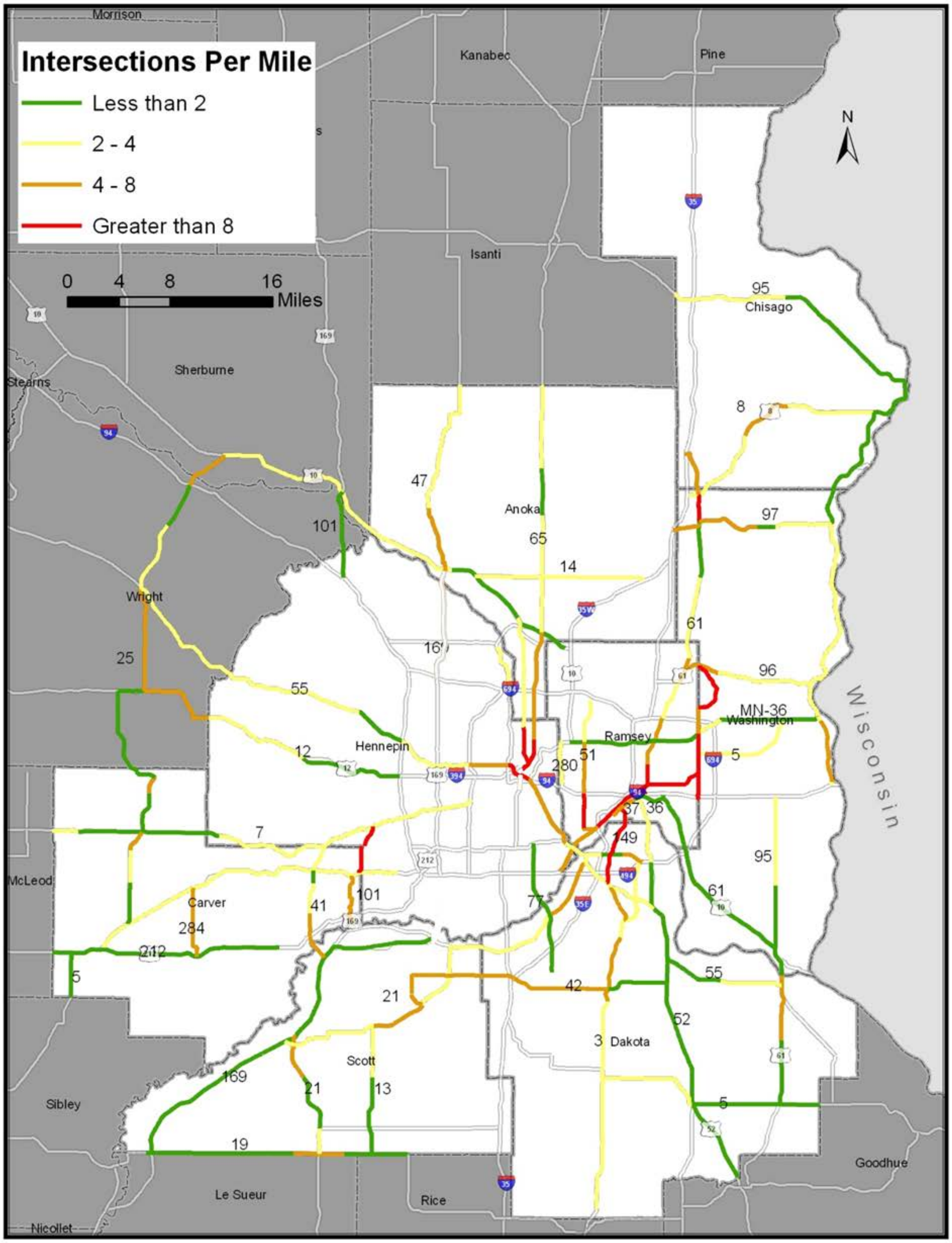


Figure 3.4: Proposed Intersection Density Categories for Performance Measure Targets

Next, TTI considered target speed values for each of these four intersection density categories. We initially considered the "percent of free-flow speed" values as defined in the Highway Capacity Manual for different levels of service (Table 2-3). However, these "percent of base free-flow speed" values were adjusted because the base free-flow speed as defined in the 2010 Highway Capacity Manual is the prevailing light traffic speed with **NO** traffic control signal delay included, whereas the congestion threshold as determined from the measured speed data does include traffic control signal delay. Therefore, the Highway Capacity Manual percentage values from Table 2-3 were adjusted to account for this difference in definitions of free-flow speed.

Table 3-2, then, presents the recommended performance measure target values for different intersection density categories. It should be recognized that these are preliminary targets that are likely to evolve as more experience is gained with performance monitoring on arterial streets. Ultimately, the target values will be set according to state and regional policies and plans (i.e., regarding what is a realistic target to achieve).

Table 3.2: Performance Measure Target Values Based on Intersection Density

Intersection Density (intersections per mile)	**Target Value = Percent of Prevailing Light Traffic Speed**
Less than 2	100
2 to 4	90
4 to 8	85
More than 8	75

Note: To determine actual target speed, the percentage value is multiplied by the prevailing speed in light traffic, which is calculated from measured traffic speed data during daytime hours.

Calculate Performance Measures

Three mobility performance measures were calculated for the MnDOT arterial network at different spatial and temporal levels. The three spatial levels are: 1) the segment by direction (as shown in Figure 3-1), 2) the corridor (as shown in Figure 3-2), and 3) the entire arterial system. The temporal levels used to calculate performance measures are the entire year and typical workday peak periods which are defined by setting 6am-9am as the morning peak period and 4pm-7pm as the evening peak period.

The formulation and use of the measures are described as follows.

1. **Delay**
   The total delay is used to measure congestion magnitude. The total segment delay is formulated in Equation 1 using a reference travel time. It can be reformulated with a congestion threshold speed in Equation 2. It can be seen from Equation 3 that the total delay divided by segment length is a function of congestion threshold speed. Two traffic

conditions corresponding to two congestion threshold speeds were used to estimate delay, namely, the daytime light traffic speed and the target speed. The daytime light traffic speed is calculated by averaging the fastest two hourly speeds during 6 am to 8 pm. The target speed is obtained by multiplying the daytime light traffic speed by the target values introduced in Table 3-2.

$$\underset{(vehicle\text{-}minutes)}{Total\ Segment\ Delay} = \left[\underset{(minutes)}{Actual\ Travel\ Time} - \underset{(minutes)}{Reference\ Travel\ Time}\right] \times \underset{(vehicles)}{Vehicle\ Volume}$$

Equation 1

$$\underset{(vehicle\text{-}hours)}{Total\ Segment\ Delay} = \left[\frac{1}{\underset{(mph)}{Average\ Speed}} - \frac{1}{\underset{(mph)}{Congestion\ Threshold\ Speed}}\right] \times \underset{(vehicle\ miles)}{Vehicle\ Miles\ Traveled\ (VMT)}$$

Equation 2

$$\underset{(vehicle\text{-}hours/mile)}{\frac{Total\ Segment\ Delay}{Segment\ Length}} = \left[\frac{1}{\underset{(mph)}{Average\ Speed}} - \frac{1}{\underset{(mph)}{Congestion\ Threshold\ Speed}}\right] \times \underset{(vehicles)}{Vehicle\ Volume}$$

Equation 3

Here is an example to illustrate the calculation. A segment of MN-51 with a length of 2.73 mile, the average speed from 7am to 8 am is 25.6 mph and the 80th percentile speed is 18 mph, the vehicle miles traveled (VMT) for the hour is 8,617 vehicle miles. If 29 mph is the congestion threshold speed (which is calculated by averaging the highest two speeds during the 14 daytime hours 6am-8pm), the hourly segment delay would be 39 vehicle hours using Equation 2 ((1/25.6-1/29) x 8,617).

2. **Travel Time Index (TTI)**
TTI is used to measure congestion intensity. It is the ratio of time spent in traffic during peak traffic times as compared to light or free flow traffic times. For example, a TTI value of 1.2 indicates that for a 15-minute trip in light traffic, the average travel time for the trip is 18 minutes (15 minutes × 1.20 = 18 minutes), which is 20 percent longer than light traffic travel time. The formulation of TTI is presented in Equation 4. If speed is used in calculation, TTI can also be reformulated with congestion threshold speed in Equation 5. The daytime light traffic speed was used as the congestion threshold speed for the project.

$$TTI = \frac{Average\ Travel\ Time\ (minutes)}{ReferenceTravel\ Time\ (minutes)}$$

Equation 4

$$TTI = \frac{Congestion\ Threshold\ Speed\ (mph)}{Average\ Travel\ Speed\ (mph)}$$ Equation 5

Using the example for the delay measure, the travel time index for the hour would be 1.13 (29mph / 25.6mph) using Equation 5.

3. **Planning Time Index (PTI)**
PTI is used to measure congestion reliability. The planning time index represents the total travel time that should be planned when an adequate buffer time is included. The planning time index compares near-worst case travel time to a travel time in light or free-flow traffic. For example, a planning time index of 1.60 means that for a 15-minute trip in light traffic, the total time that should be planned for the trip is 24 minutes (15 minutes × 1.60 = 24 minutes). The planning time index is computed as the 80th percentile travel time divided by the reference travel time (Equation 6) which is under the daytime light traffic condition for this project. The PTI can also be reformulated with congestion threshold speed in Equation 7.

$$PTI = \frac{80^{th}\ Percentile\ Travel\ Time\ (minutes)}{Reference\ Travel\ Time\ (minutes)}$$ Equation 6

$$PTI = \frac{Congestion\ Threshold\ Speed\ (mph)}{80^{th}\ Percentile\ Travel\ Speed\ (mph)}$$ Equation 7

Using the example for the delay measure, the planning time index for the hour would be 1.61 (29mph / 18mph) using Equation 7.

Tables 3-3 through 3-6 illustrate the calculation of these performance measures for the entire day of the segment of MN-51.

Table 3.3: Example Segment Information

Segment ID	Street Name	Direction	From	To	Length	Day of Week
0300000051002	MN-51	SB	I-94	Snelling Ave	2.73	Week Day

Table 3.4: Target Value Lookup Table

Intersection Density (Numbers per mile)	Target Value
0	100%
1	100%
2	90%
3	90%
4	85%
5	85%
6	85%
7	85%
8	85%
9	75%
>9	75%

Table 3.5: Annual Delay and Annual Target Delay Calculation

Hour	Length (a) (Table 1)	Intersection Density (numbers per mile) (Table 2)	Target Value[1] (b) (Table 2)	Average Speed (mph) (c)	Light Traffic Daytime Speed[2] (mph) (d)	Target Speed[3] (mph) (e) =(b) * (d)	Travel Time Difference[4] (f) $=Max\left(\frac{1}{(c)}-\frac{1}{(d)},0\right)$	Hourly VMT (Vehicle Miles) (g)	Hourly Delay (h) =(f) * (g)	Target Travel Time Difference[5] (i) $=Max\left(\frac{1}{(c)}-\frac{1}{(e)},0\right)$	Hourly Target Delay (j) =(i)*(g)	Annual Person Delay Per Mile (k) $=\frac{(h)*1.25*52}{(a)}$	Annual Target Delay Per Mile (l) $=\frac{(j)*1.25*52}{(a)}$
0	2.73	17	0.75	30	29	29*0.75=21	Max(1/30-1/29, 0) = 0	1,464	0 * 1464 = 0	Max(1/30-1/21, 0) = 0	0 * 1464 = 0	0 * 1.25 *52/2.73 = 0	0 * 1.25 * 52/2.73 = 0
1	2.73	17	0.75	30	29	21	0	896	0	0	0	0	0
2	2.73	17	0.75	30	29	21	0	617	0	0	0	0	0
3	2.73	17	0.75	30	29	21	0	579	0	0	0	0	0
4	2.73	17	0.75	30	29	21	0	952	0	0	0	0	0
5	2.73	17	0.75	28	29	21	0.000769299	2,425	2	0	0	44	0
6	2.73	17	0.75	27	29	21	0.00237461	5,788	14	0	0	328	0
7	2.73	17	0.75	25	29	21	0.004502127	8,617	39	0	0	925	0
8	2.73	17	0.75	26	29	21	0.004132297	8,679	36	0	0	855	0
9	2.73	17	0.75	24	29	21	0.005880295	8,956	53	0	0	1256	0
10	2.73	17	0.75	24	29	21	0.006901694	10,221	71	0	0	1682	0
11	2.73	17	0.75	24	29	21	0.007493086	11,775	88	0	0	2104	0
12	2.73	17	0.75	24	29	21	0.006719416	12,403	83	0	0	1987	0
13	2.73	17	0.75	25	29	21	0.005750436	12,422	71	0	0	1703	0
14	2.73	17	0.75	24	29	21	0.006839649	13,829	95	0	0	2255	0
15	2.73	17	0.75	23	29	21	0.008039923	16,369	132	0	0	3138	0
16	2.73	17	0.75	23	29	21	0.008064418	17,989	145	0	0	3459	0
17	2.73	17	0.75	24	29	21	0.006322855	15,670	99	0	0	2362	0
18	2.73	17	0.75	28	29	21	0.000629813	10,887	7	0	0	163	0
19	2.73	17	0.75	29	29	21	0	8,390	0	0	0	0	0
20	2.73	17	0.75	30	29	21	0	7,010	0	0	0	0	0
21	2.73	17	0.75	30	29	21	0	5,738	0	0	0	0	0
22	2.73	17	0.75	30	29	21	0	4,247	0	0	0	0	0
23	2.73	17	0.75	30	29	21	0	2,767	0	0	0	0	0

Note: 1. Target value represents the discount for reference speed, based on different intersection density (see table 3-4).
2. Light Traffic Daytime Speed is the average of the highest 2 speeds during 14 daytime hours (6am-8pm). In the above case, hour 18 (6pm-7pm) and 19 (7pm-8pm) with speed 28mph and 29mph are the highest 2 speeds during the 14 hours.
3. Target speed is the light traffic daytime speed multiplied by target value.
4. Travel time difference is the travel time difference between average speed and light traffic daytime speed. Use 0 when the calculated value is less than 0, meaning that the average speed is faster than the light traffic daytime speed and there is no delay.
5. Same as 4, but use target speed instead of light traffic daytime speed.

Table 3.6: Travel Time Index and Planning Time Index Calculation

Hour	Hourly Vehicle Miles Traveled (a)	Average Speed (b)	80th percentile Speed (c)	Light Traffic Daytime Speed (d)	Travel Time Index (e) $= max(\frac{60}{(b)}/\frac{60}{(d)}, 1)$	Planning Time Index (80th percentile) (f) $= max(\frac{60}{(c)}/\frac{60}{(d)}, 1)$
0	1,464	30	---	29	Max((60/30)/(60/29),1) =1	---
1	896	30	---	29	1.00	---
2	617	30	---	29	1.00	---
3	579	30	---	29	1.00	---
4	952	30	26	29	1.00	1.09
5	2,425	28	23	29	1.02	1.23
6	5,788	27	21	29	1.07	1.36
7	8,617	25	18	29	1.13	1.61
8	8,679	26	19	29	1.12	1.51
9	8,956	24	17	29	1.17	1.65
10	10,221	24	16	29	1.20	1.76
11	11,775	24	15	29	1.21	1.86
12	12,403	24	16	29	1.19	1.80
13	12,422	25	17	29	1.16	1.67
14	13,829	24	16	29	1.20	1.75
15	16,369	23	16	29	1.23	1.78
16	17,989	23	15	29	1.23	1.90
17	15,670	24	16	29	1.18	1.82
18	10,887	28	20	29	1.02	1.43
19	8,390	29	20	29	1.00	1.43
20	7,010	30	23	29	1.00	1.23
21	5,738	30	16	29	1.00	1.82
22	4,247	29	---	29	1.00	---
23	2,767	29	---	29	1.00	---
Weighted Average[1]					1.14	1.68
Weighted Average (AM Peak): hour 6,7,8					1.11	1.51
Weighted Average (PM Peak): hour 16,17,18					1.16	1.76

Note: 1. Weighted Average Travel Time Index use Hourly Vehicle Miles Traveled (a) as weights.

Chapter 4. Results

Based on the analysis methods described in the previous chapters, the following performance measure results were obtained for the entire MnDOT arterial street network:

Length of Arterial System:	1,764 miles
Total Annual Delay:	7.6 million person-hours
Peak Period Delay:	3.8 million person-hours
Total Annual Target Delay:	4.1 million person-hours
Average Delay per Mile:	4,301 person-hours per mile
Average Target Delay per Mile:	2,308 person-hours per mile
AM Peak Travel Time Index:	1.07
PM Peak Travel Time Index:	1.08
AM Peak Planning Time Index:	1.36
PM Peak Planning Time Index:	1.41

Figure 4-1 shows the top 20 most congested arterial segments in the Metro District by the measure of delay per mile. The measure was calculated based on the light daytime traffic condition. Because of the variations in travel patterns, surrounding land uses, and signal timing plans among corridors, it is suggested not to specify a fixed time frame for such light traffic condition for all segments. Instead, choosing the fastest two hourly speeds within the 14-hour daytime period (defined as 6 am to 8 pm) gives the highest speed the segment can achieve under those daytime conditions. The legend in the Figure 4-1 shows that most of these 20 segments have a high intersection density.

Figure 4-2 shows the top 20 most congested arterial segments in the Metro District by the measure of target delay per mile. Target delay used the target speed as the congestion threshold speed to calculate the delay. The arterial segments with higher intersection density were applied with lower target values due to certain acceptance of delay in these subareas. Therefore, when target speed was used as congestion threshold, the segments with lower intersection density are shown as the most congested (as seen in Figure 4-2) comparing to the segments in Figure 4-1. In other words, the congestion evaluation standard was not lowered for the low intersection density segments.

Figure 4-3 and Figure 4-4 respectively show the annual delay per mile and annual target delay per mile for the entire Metro area arterial network.

Figure 4-5 shows the top 20 most congested arterial segments in the morning peak period (6am-9am) of an average weekday by the measure of Travel Time Index. Since the Travel Time Index measures the intensity of the congestion, the directions of these congested segments would indicate the primary directions of the corridors during the morning peak. As can be seen from Figure 4-3, the directions of the segments identified pointed toward the city center.

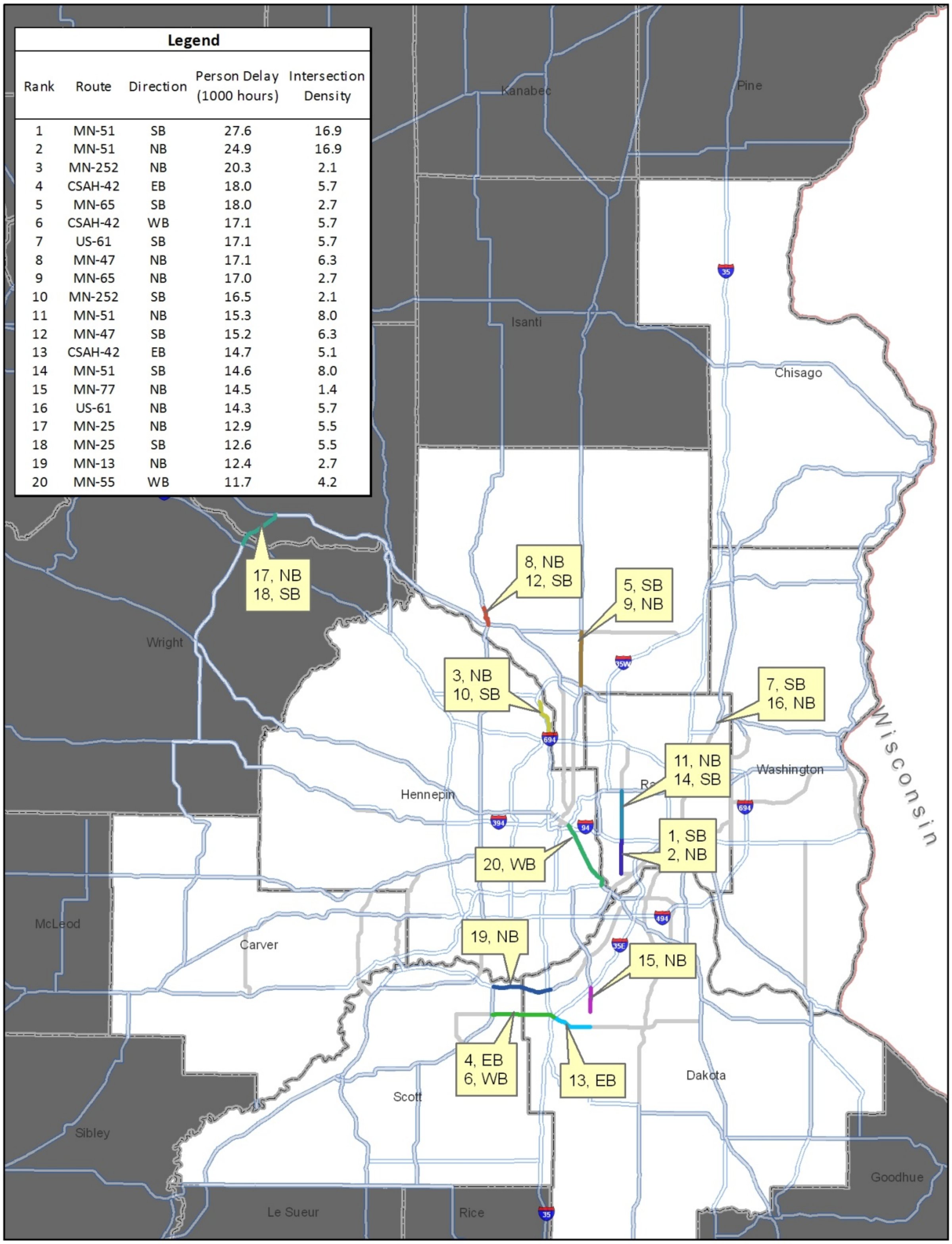
Figure 4-6 shows the top 20 most congested arterial segments in the evening peak period (4pm-7pm) of an average weekday by the measure of Travel Time Index. The directions of these congested segments identified indicated the primary directions of the corridors for the evening peak which tend to point away from the city center.

Figure 4-7 and Figure 4-8 respectively show the morning and evening peak period Travel Time Index for the entire Metro area arterial network.

Figure 4-9 shows the top 20 most congested arterial segments in the morning peak period (6am-9am) of an average weekday by the measure of Planning Time Index. The segments identified by the Planning Time Index have a high overlap with the segments identified by the Travel Time Index. However, since the planning time index measures the reliability, the segments identified by the measure have high variation in travel time. The high inconsistency could be due to factors such as road construction, incidents, weather, and geographic locations.

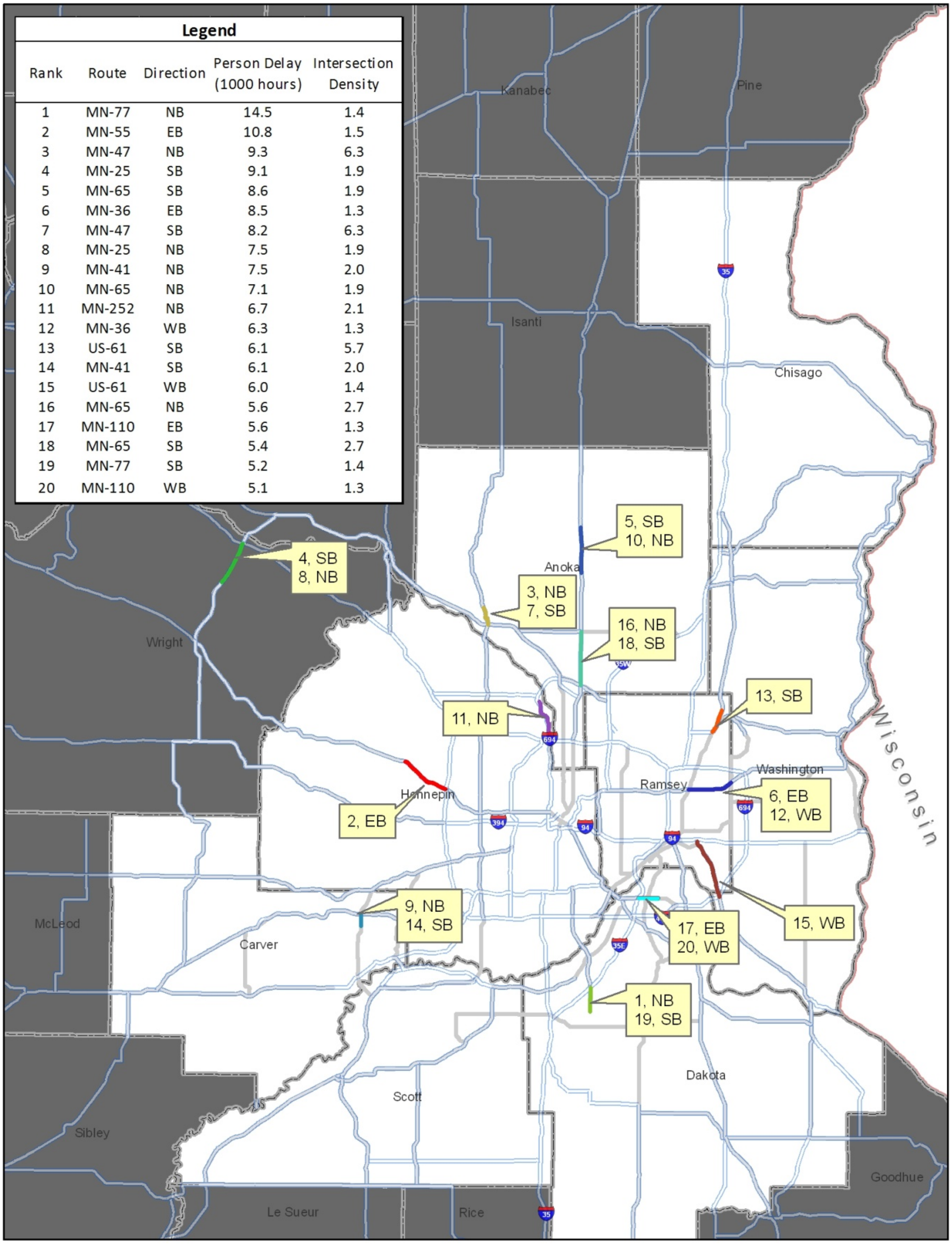
Figure 4-10 shows the top 20 most congested arterial segments in the evening peak period (4pm-7pm) of an average weekday by the measure of Planning Time Index.

Figure 4-11 and Figure 4-12 respectively show the morning and evening peak period Planning Time Index for the entire Metro area arterial network.



Rank	Route	Direction	Person Delay (1000 hours)	Intersection Density
1	MN-51	SB	27.6	16.9
2	MN-51	NB	24.9	16.9
3	MN-252	NB	20.3	2.1
4	CSAH-42	EB	18.0	5.7
5	MN-65	SB	18.0	2.7
6	CSAH-42	WB	17.1	5.7
7	US-61	SB	17.1	5.7
8	MN-47	NB	17.1	6.3
9	MN-65	NB	17.0	2.7
10	MN-252	SB	16.5	2.1
11	MN-51	NB	15.3	8.0
12	MN-47	SB	15.2	6.3
13	CSAH-42	EB	14.7	5.1
14	MN-51	SB	14.6	8.0
15	MN-77	NB	14.5	1.4
16	US-61	NB	14.3	5.7
17	MN-25	NB	12.9	5.5
18	MN-25	SB	12.6	5.5
19	MN-13	NB	12.4	2.7
20	MN-55	WB	11.7	4.2

Figure 4.1: Top 20 Congested Arterial Segments by Annual Delay Per Mile (Daytime Light Traffic)



Rank	Route	Direction	Person Delay (1000 hours)	Intersection Density
1	MN-77	NB	14.5	1.4
2	MN-55	EB	10.8	1.5
3	MN-47	NB	9.3	6.3
4	MN-25	SB	9.1	1.9
5	MN-65	SB	8.6	1.9
6	MN-36	EB	8.5	1.3
7	MN-47	SB	8.2	6.3
8	MN-25	NB	7.5	1.9
9	MN-41	NB	7.5	2.0
10	MN-65	NB	7.1	1.9
11	MN-252	NB	6.7	2.1
12	MN-36	WB	6.3	1.3
13	US-61	SB	6.1	5.7
14	MN-41	SB	6.1	2.0
15	US-61	WB	6.0	1.4
16	MN-65	NB	5.6	2.7
17	MN-110	EB	5.6	1.3
18	MN-65	SB	5.4	2.7
19	MN-77	SB	5.2	1.4
20	MN-110	WB	5.1	1.3

Figure 4.2: Top 20 Congested Directional Arterial Segments by Annual Target Delay per Mile (Target Values based upon Intersection Density)

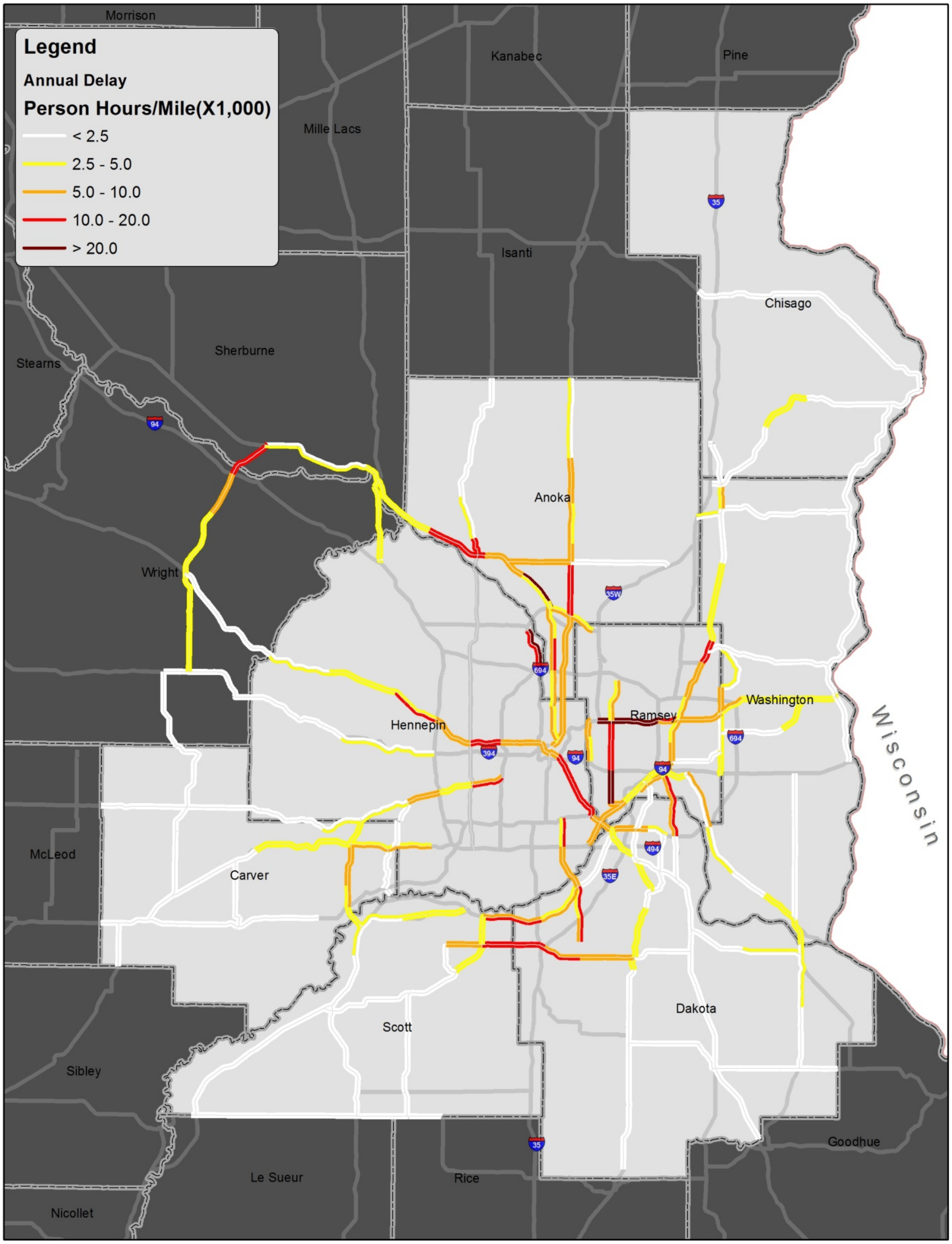


Figure 4.3: All Directional Arterial Segments by Annual Delay Per Mile (Daytime Light Traffic)

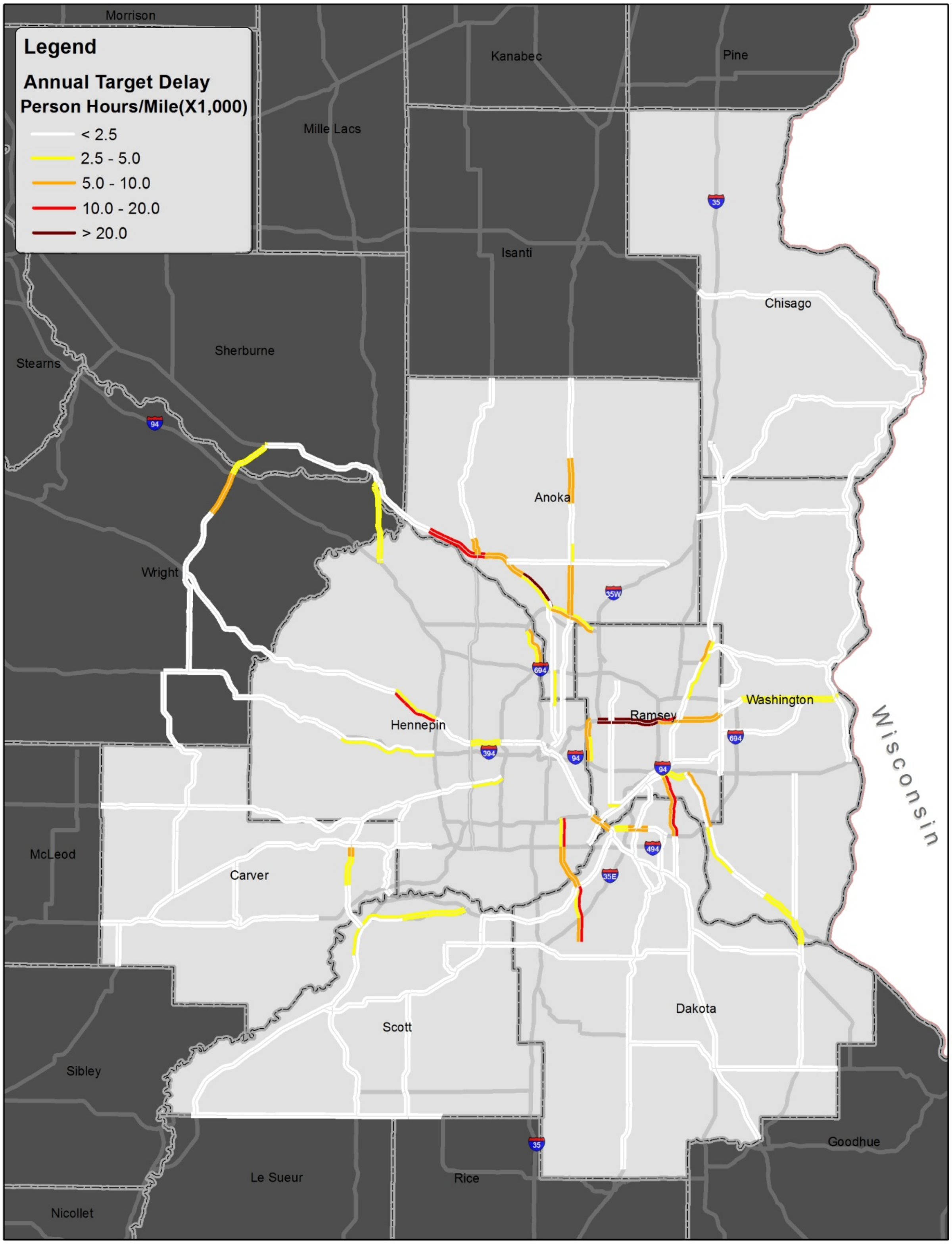
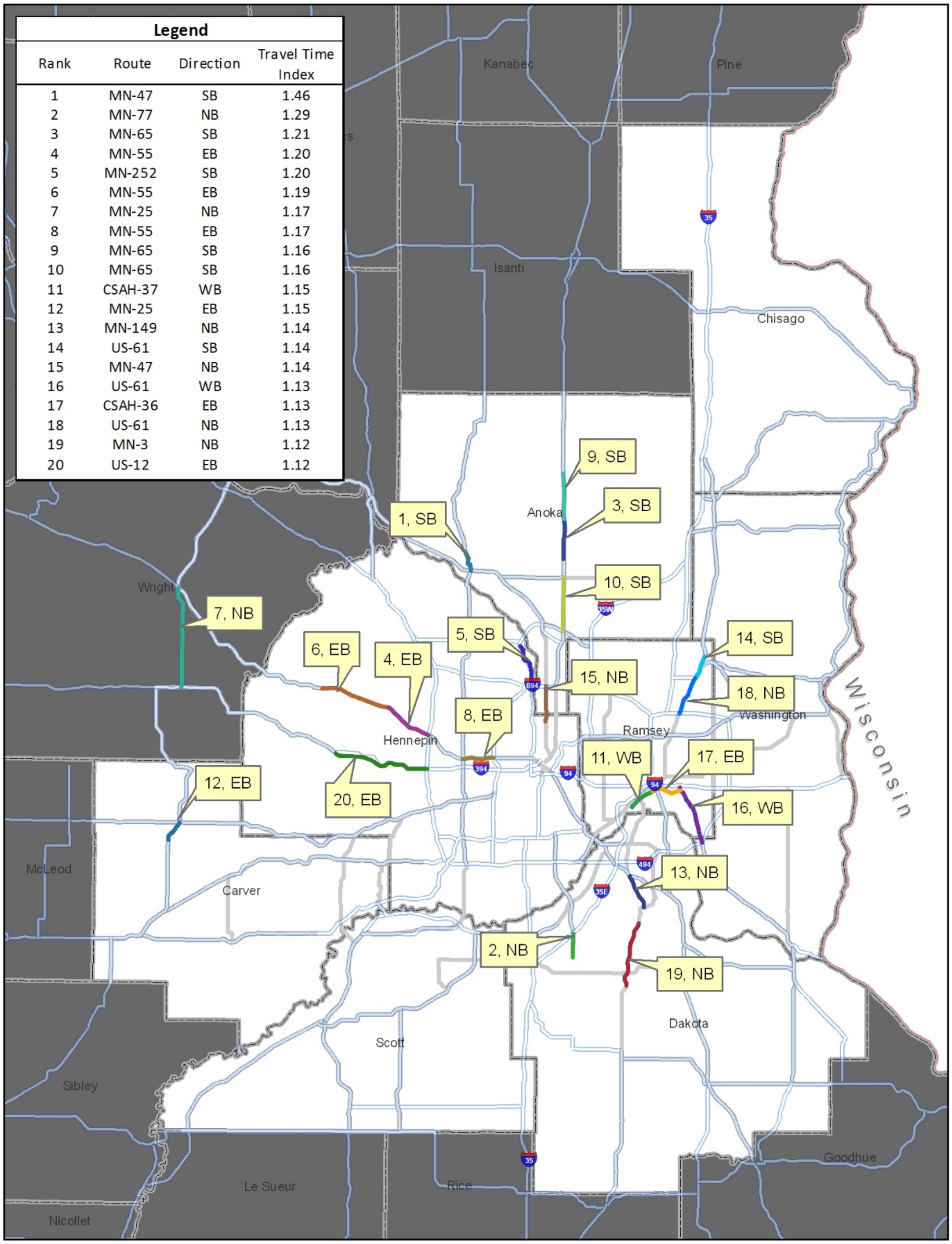


Figure 4.4: All Directional Arterial Segments by Annual Target Delay Per Mile (Target Values based upon Intersection Density)



Rank	Route	Direction	Travel Time Index
1	MN-47	SB	1.46
2	MN-77	NB	1.29
3	MN-65	SB	1.21
4	MN-55	EB	1.20
5	MN-252	SB	1.20
6	MN-55	EB	1.19
7	MN-25	NB	1.17
8	MN-55	EB	1.17
9	MN-65	SB	1.16
10	MN-65	SB	1.16
11	CSAH-37	WB	1.15
12	MN-25	EB	1.15
13	MN-149	NB	1.14
14	US-61	SB	1.14
15	MN-47	NB	1.14
16	US-61	WB	1.13
17	CSAH-36	EB	1.13
18	US-61	NB	1.13
19	MN-3	NB	1.12
20	US-12	EB	1.12

Figure 4.5: Top 20 Congested Directional Arterial Segments in the Morning Peak (6-9am) by Travel Time Index (Daytime Light Traffic)

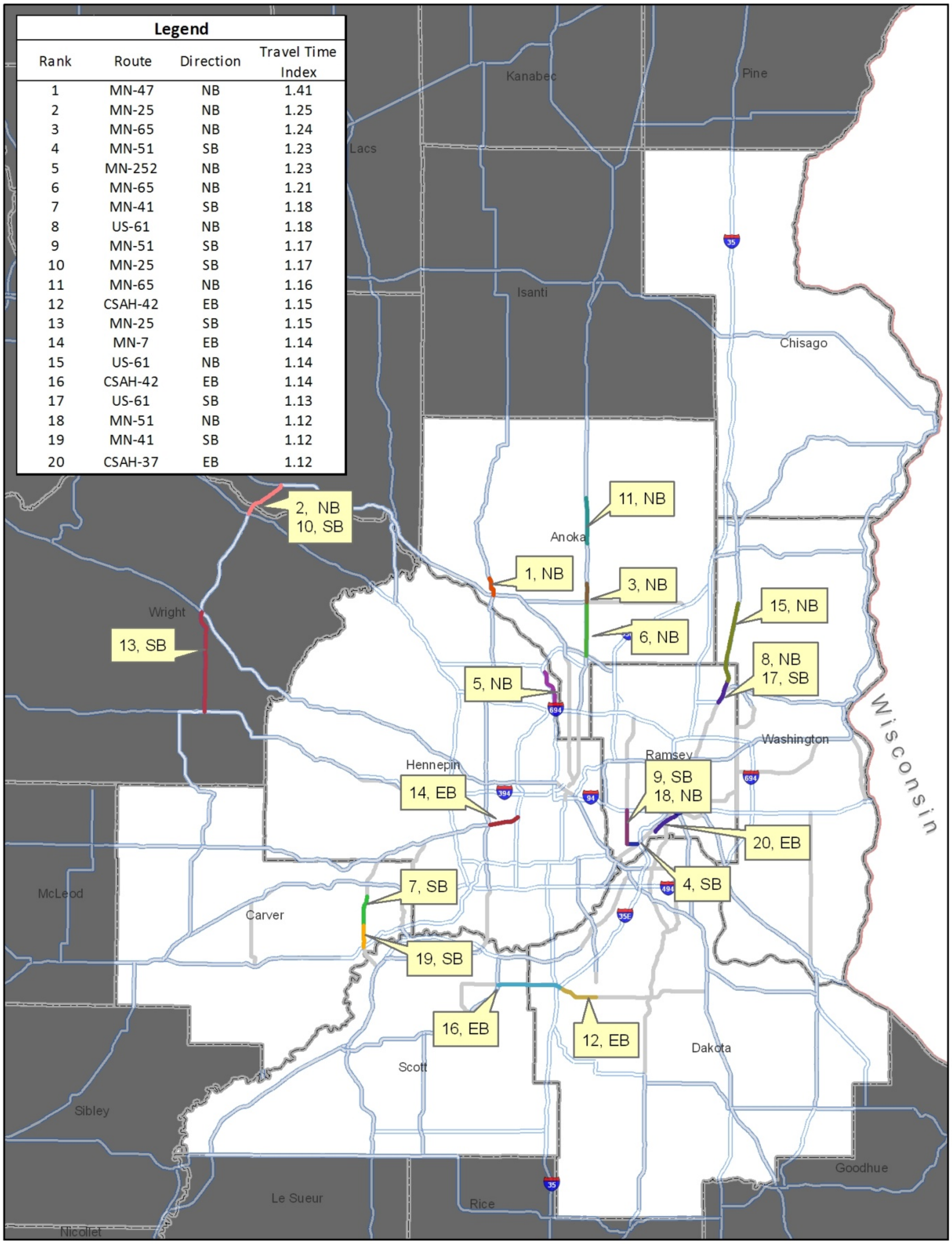


Figure 4.6: Top 20 Congested Directional Arterial Segments in the Evening Peak (4-7pm) by Travel Time Index (Daytime Light Traffic)

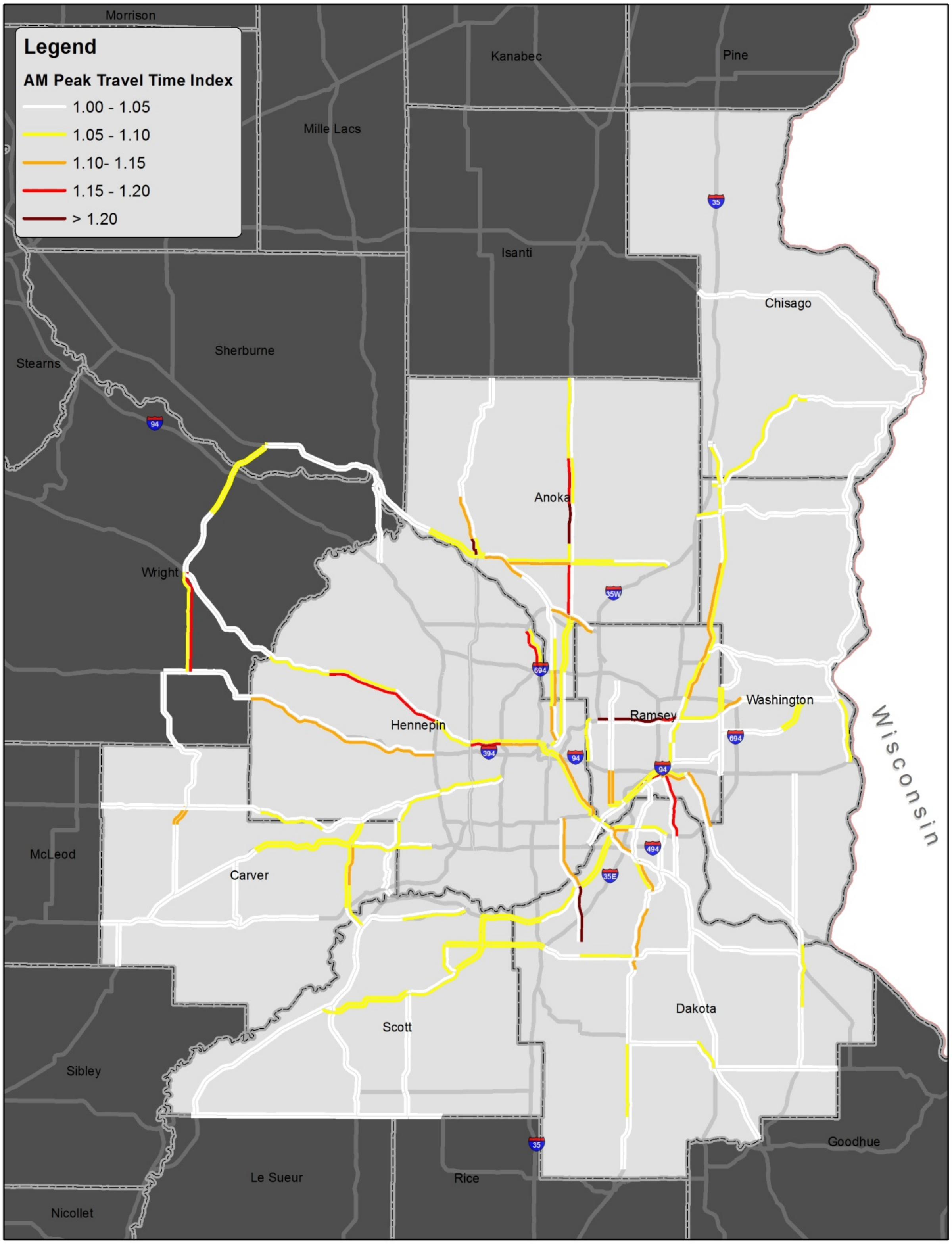


Figure 4.7: All Directional Arterial Segments in the Morning Peak (6-9am) by Travel Time Index (Daytime Light Traffic)

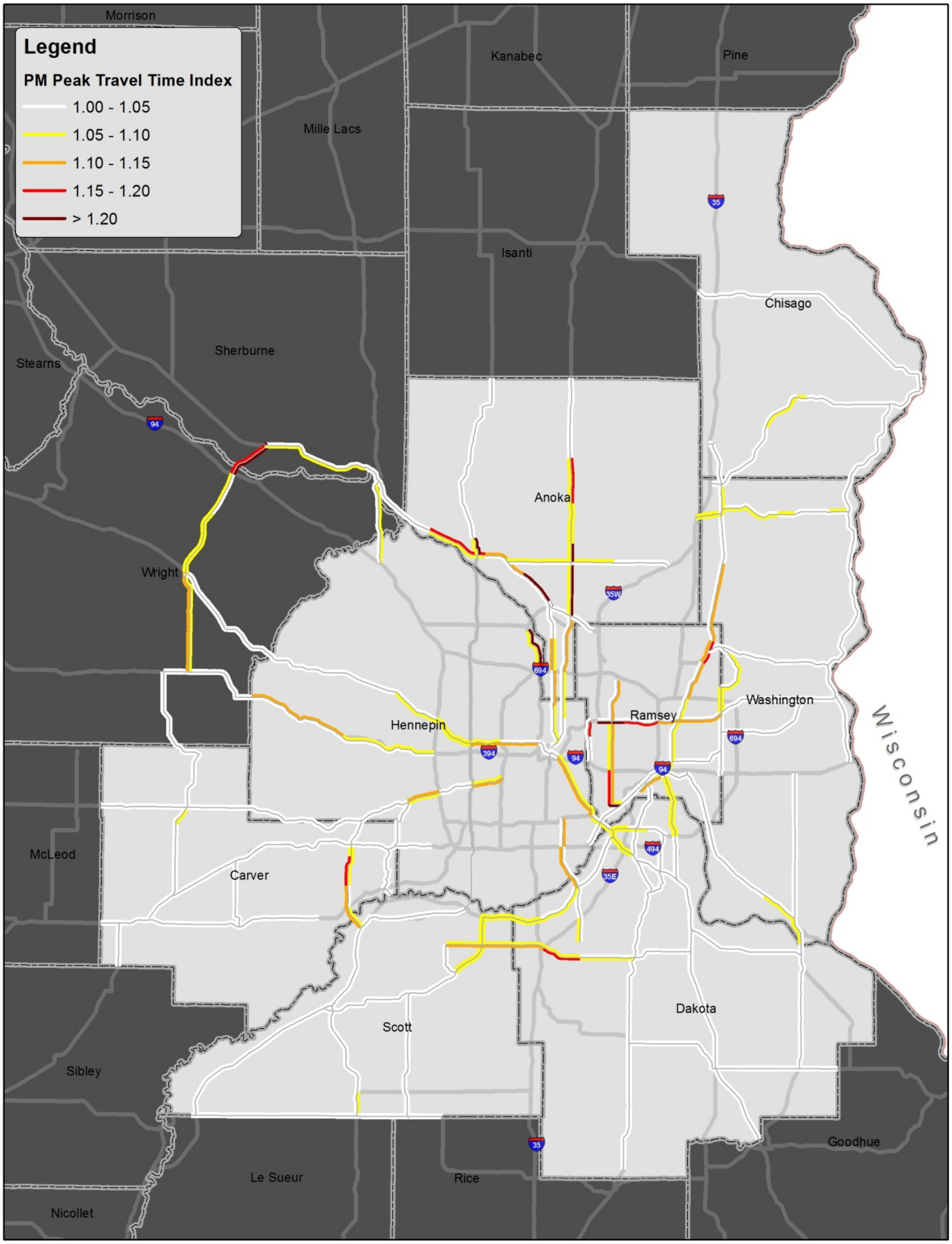
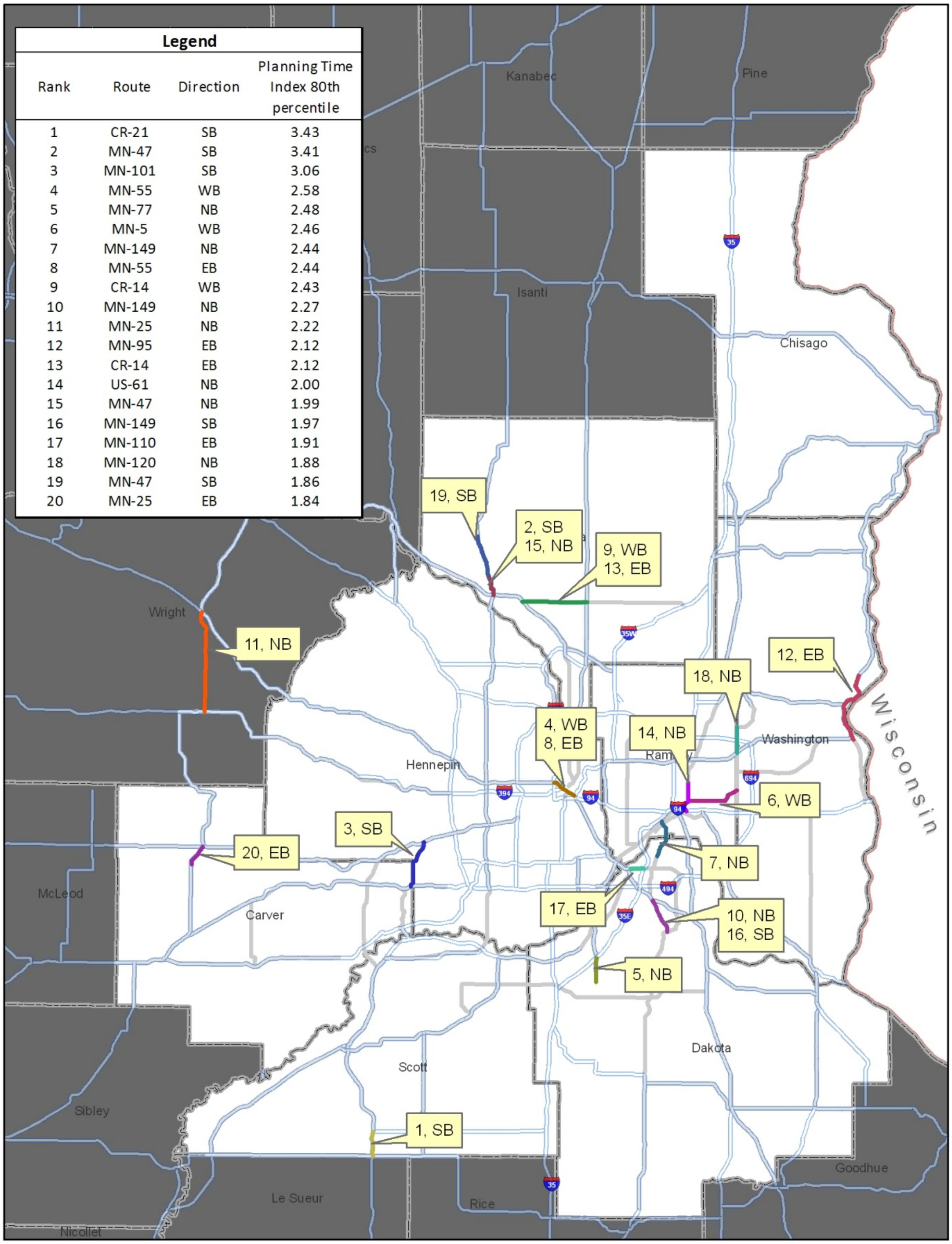


Figure 4.8: All Directional Arterial Segments in the Evening Peak (4-7am) by Travel Time Index (Daytime Light Traffic)



Rank	Route	Direction	Planning Time Index 80th percentile
1	CR-21	SB	3.43
2	MN-47	SB	3.41
3	MN-101	SB	3.06
4	MN-55	WB	2.58
5	MN-77	NB	2.48
6	MN-5	WB	2.46
7	MN-149	NB	2.44
8	MN-55	EB	2.44
9	CR-14	WB	2.43
10	MN-149	NB	2.27
11	MN-25	NB	2.22
12	MN-95	EB	2.12
13	CR-14	EB	2.12
14	US-61	NB	2.00
15	MN-47	NB	1.99
16	MN-149	SB	1.97
17	MN-110	EB	1.91
18	MN-120	NB	1.88
19	MN-47	SB	1.86
20	MN-25	EB	1.84

Figure 4.9: Top 20 Unreliable Directional Arterial Segments in the Morning Peak (6-9am) by Planning Time Index (Daytime Light Traffic)

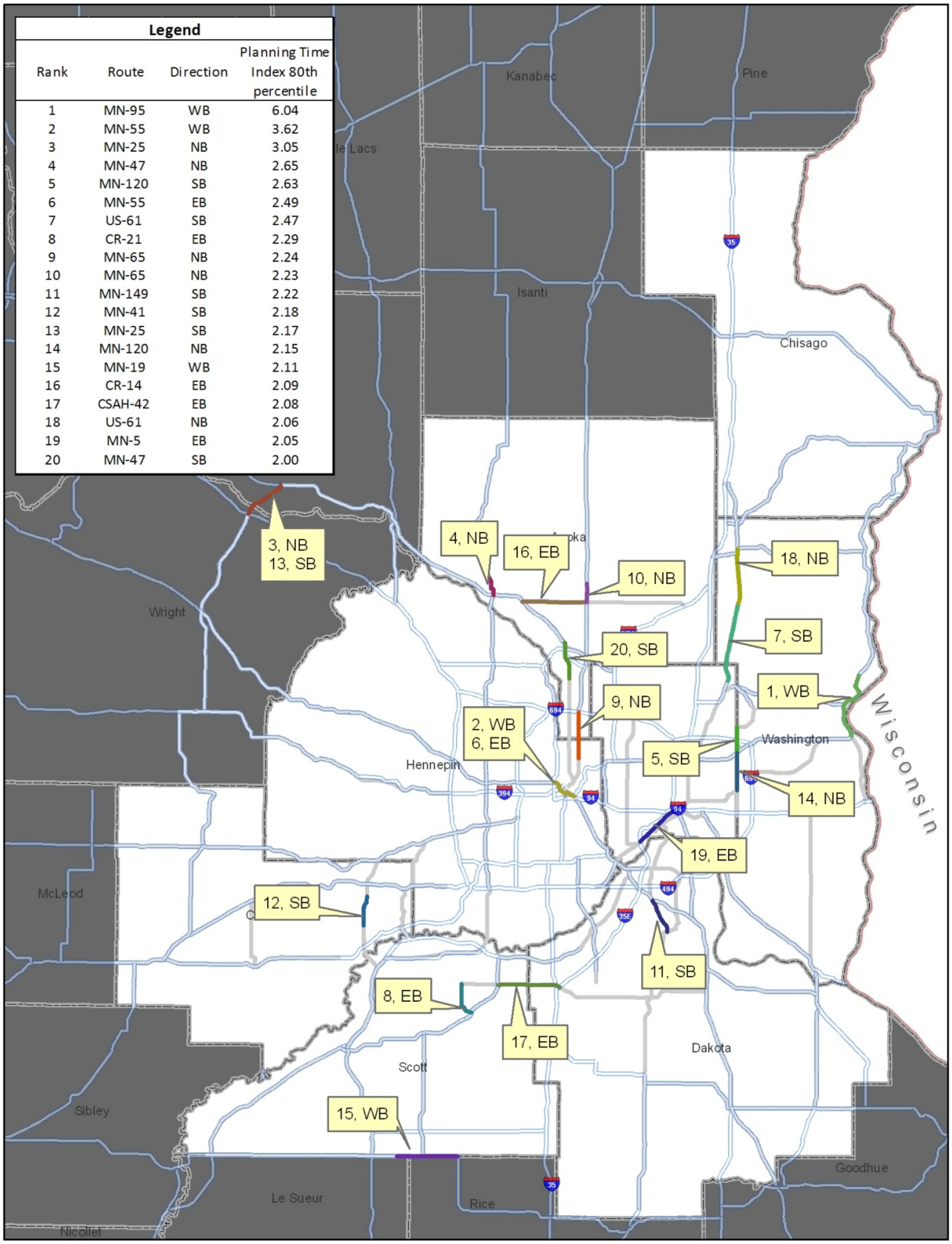


Figure 4.10: Top 20 Unreliable Directional Arterial Segments in the Evening Peak (4-7pm) by Planning Time Index (Daytime Light Traffic)

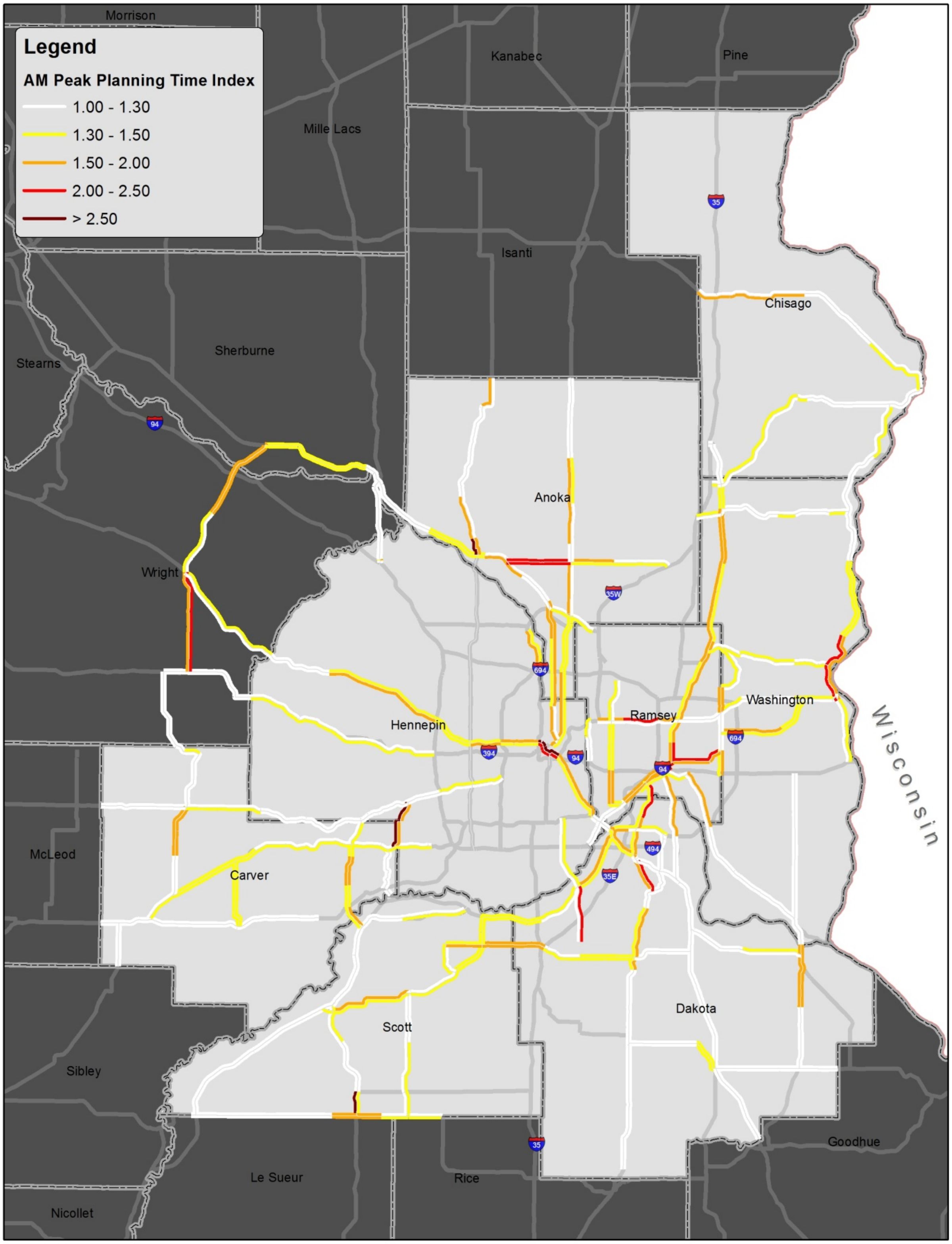


Figure 4.11: Directional Arterial Segments in the Morning Peak (6-9am) by Planning Time Index (Daytime Light Traffic)

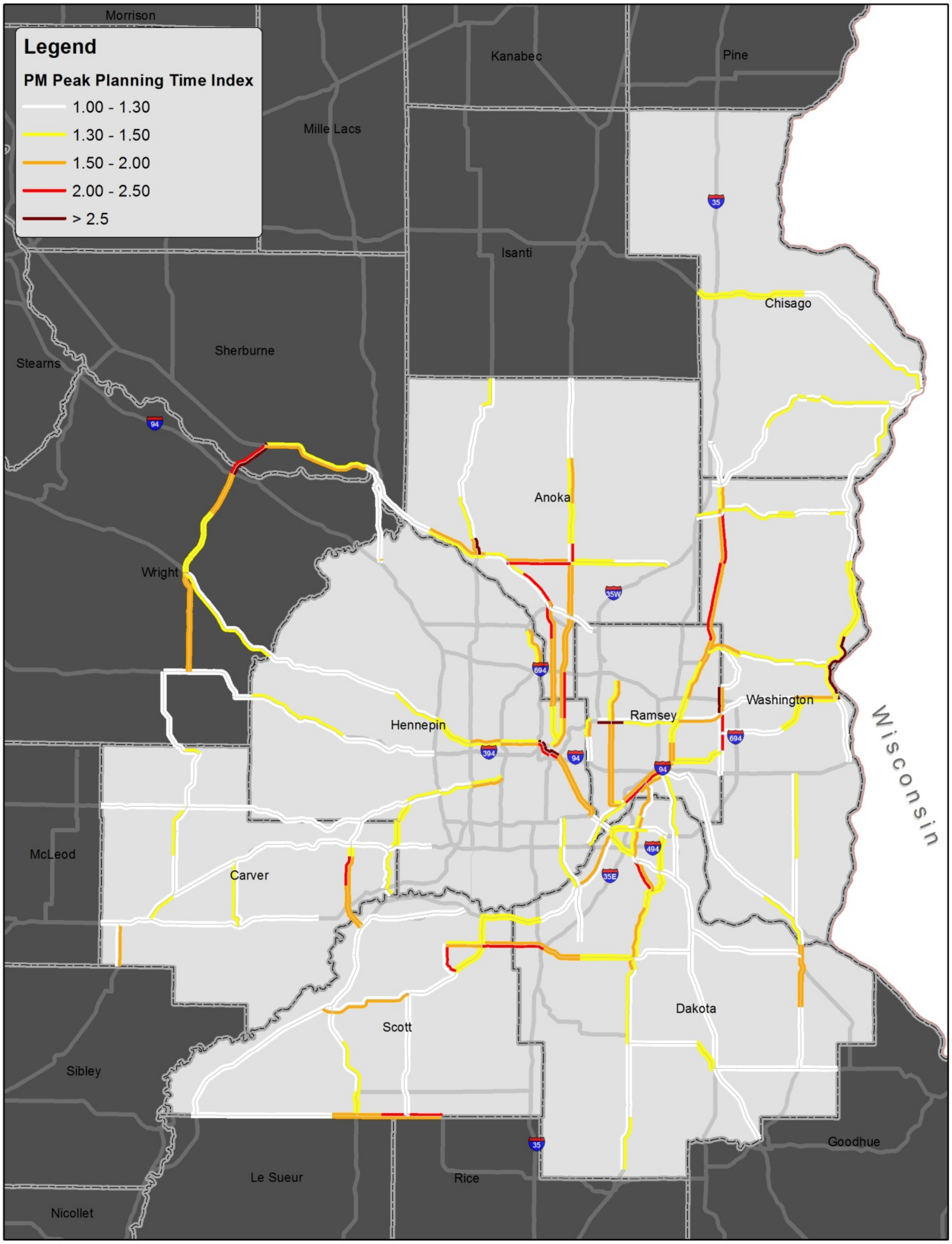


Figure 4.12: All Directional Arterial Segments in the Evening Peak (4-7pm) by Planning Time Index (Daytime Light Traffic)

Chapter 5. Conclusions and Recommendations

The overall goal of this study was to use commercially available travel time data to develop arterial street (non-freeway roads) performance measures. The previous chapters describe the research and analysis we performed to meet this overall goal. This final chapter summarizes our main conclusions and recommendations, with an emphasis on implementing these research results within MnDOT.

We developed the following conclusions and recommendations based on our research and analysis:

1. **Private sector data providers are a viable source of travel speed data for mobility performance monitoring on arterial streets.** In this project, we used a competitive request for proposals (RFP) to license historical average hourly speed data for 2011 for all arterial streets in the eight-county Twin Cities metropolitan area. INRIX was selected from three RFP respondents, with a bid of $22,600 for the licensing terms of this project (see Appendix A). We visually reviewed samples of the INRIX speed data for selected arterial segments and found speed patterns and trends that were as expected. This private sector speed data has an advantage over other possible arterial street data sources (such as the SMART-SIGNAL data): it is immediately available at relatively low cost for the entire arterial street network.

2. **Mobility performance measures for arterial streets should be travel speed-based measures that compare peak traffic speeds to speeds during light traffic, recognizing that the light traffic speed is not a target value but simply a reference point for performance measures.** This recommendation is consistent with current MnDOT policy documents, as well as current practice with other agencies and current discussions about USDOT rulemaking on congestion performance measures. Arterial street performance measures have seen limited use by other agencies, primarily because of data availability issues. We did identify other non-mobility multimodal performance measures that are appropriate for urban streets (such as pedestrian and bicyclist safety). However, it was beyond the scope of this project to define and calculate these other non-mobility measures.

3. **Performance measure target values should be context-sensitive and based on surrounding land use**. After researching data availability and analyzing several possible attributes to quantify context, we chose intersection density. For example, if an arterial street has high intersection density (e.g., urban street in downtown or dense, mixed-use district), then it is more likely to serve higher levels of access and lower levels of mobility. Conversely, an arterial street with low intersection density (e.g., access-controlled suburban highway) is designed to serve higher levels of mobility and lower levels of access. Conceptually, then, the target values are set lower on streets that have higher intersection density. That is, MnDOT may be “willing to accept” higher congestion levels on urban streets in downtown or dense, mixed-use districts (than on access-controlled arterials with low intersection density).

4. **Multiple performance measures should be used to quantify and monitor mobility on arterial streets.** The delay per mile measure (calculated based on target values) includes multiple dimensions of congestion (i.e., duration, extent, and intensity) and normalizes the delay values per unit length, allowing comparison among different roadway lengths. The travel time index is another common, easily understood measure, but only captures the intensity dimension (i.e., how bad is it?) of congestion. The recommended reliability measure is the planning time index, which represents the total travel time that should be planned for a specified on-time arrival (i.e., 80% and 95% on-time arrival).

5. **The exact mobility performance measures and target values are likely to evolve and be refined** as MnDOT and partner agencies gain experience in performance monitoring on arterial streets. At this time, we think it is best to calculate, track, and gain experience with multiple measures, while also determining where these measures can be used to improve agency decisions. We think that debates about "THE best measure" and "THE target value" are counterproductive until several years of monitoring experience on arterial streets have been gained.

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Appendix A: Request for Proposals Used to License Data

Request for Proposals (RFP)

Historical Traffic Speed Data on Minneapolis-St. Paul Roadway Network

July 16, 2012

Under contract to the Minnesota Department of Transportation (MnDOT), the Texas Transportation Institute (TTI) is developing mobility performance measures for the roadway network in the Minneapolis-St. Paul region that requires historical traffic speed data. In lieu of manually conducting travel time and speed runs, TTI and MnDOT would like to license region-wide historical traffic speed data from a private company that is already engaged in collecting traffic speed data for real-time traveler information purposes. The intent of this RFP is to procure and license, in a single transaction, historical speed data for the major road network in the Minneapolis-St. Paul region for one or more years. Additional details and specifications are contained below.

Required Specifications

On behalf of MnDOT, TTI has identified the following specifications as requirements. Proposals that do not meet these specifications will be considered non-responsive.

1. Average traffic speeds shall be provided in 60-minute intervals for each day of the week (e.g., Sunday, Monday, etc. through Saturday), for each segment and direction of all Traffic Message Channel (TMC) designated roads in the Minneapolis-St. Paul region. For the purposes of this RFP:
    a. The Minneapolis-St. Paul region is defined as the following 8 counties: Anoka, Carver, Chisago, Dakota, Hennepin, Ramsey, Scott, and Washington.
    b. The approximate anticipated mileage for the 8-county region for each FRC category is:
        i. FRC 1: ~550 directional miles
        ii. FRC 2: ~1,060 directional miles
        iii. FRC 3: ~3,385 directional miles
        iv. FRC 4: ~1,590 directional miles
        v. FRC 5: ~1,030 directional miles
2. In addition to average traffic speeds, the following statistical measures shall be provided for the traffic speed data:
    a. Sample size
    b. Minimum speed
    c. Maximum speed
    d. Standard deviation
    e. Speed percentiles as follows: 5^{th}, 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th}, 85^{th}, 90^{th}, 95^{th}

3. Average traffic speeds shall be referenced to the current version (at the time of proposal submittal) of the Traffic Message Channel (TMC)-encoded network, and location information (start and end latitude/longitude, or GIS polyline) shall be provided for each unique TMC path.

4. Average traffic speeds for all hours of the day should be provided. If average traffic speeds are not available during low-volume overnight hours, then a free-flow (reference) speed shall be provided for each TMC path to indicate average traffic speeds during light traffic.
5. Average traffic speeds shall be provided for the 2011 calendar year.
6. Licensing rights shall be provided to the current version (as of the date of proposal submittal) of the TMC-encoded network in the Minneapolis-St. Paul region, both in ESRI shapefile format and in a TMC location code table in CSV format. The TMC location code table shall include, at a minimum, the following TMC path attributes:
    a. Roadway name
    b. Cross street
    c. Cardinal direction of travel (i.e., northbound, southbound, eastbound, westbound)
    d. Length of TMC path (in miles)
    e. FRC code
    f. FIPS county name or county code
7. Licensing rights shall be provided that permits TTI to verbally disclose a few selected average speed data values on TMC paths to MnDOT and their public sector partners in the state of Minnesota. The purpose of this limited verbal disclosure is to assure MnDOT and their public sector partners of the quality and integrity of the average speed data values, without publicly releasing all of the TMC path average speed values.
8. <u>Perpetual</u> licensing rights shall be provided that permits TTI to analyze the speed data and create derivative congestion statistics for the purposes of developing roadway performance measures for the Minneapolis-St. Paul region. Bidders with "seat-based" licensing can assume that there will be five or fewer concurrent users of the traffic speed data sets.
9. Licensing rights shall be provided that permits TTI to publicly release and redistribute these derivative congestion statistics at the segment-level (e.g., 2- to 5-mile long directional sections of road). Examples of these derivative congestion statistics include, but are not limited to, measures such as start time of congestion, end time of congestion, average congestion duration, average multi-hour speed, travel time index, travel delay, etc.).
10. The winning bidder shall provide the required traffic speed data sets (and optional data sets if so indicated) to TTI within 60 days of award notice.

Proposal Options

In addition to the required specifications detailed in the previous section (i.e., 2011 average speeds and other statistical measures), there are three optional elements that may be bid as separate cost line items. Proposers are not required to submit a bid on these optional elements; however, the provision of these options and their respective bid costs will be considered in the evaluation of proposals.

- **Option 1:** The proposer may offer an option for "unlimited use" licensing for the 2011 data, which permits TTI and/or MnDOT (and/or other public sector partners in Minnesota) to perform an unlimited number of analyses of the 2011 data. If the unlimited use license option is offered, it shall also permit the derivative works to be publicly distributed by these other public agencies. Bidders with “seat-based” licensing can assume that there will be between 6 and 50 concurrent users of the traffic speed data sets for this “unlimited use” option.

- **Option 2:** The proposer may offer an option to provide average traffic speeds and other statistical measures for calendar year 2010. If this option is proposed, the 2010 data shall meet the exact same required specifications as stated for 2011.
- **Option 3:** If Option 2 is bid, the proposer may also offer an option for “unlimited use” licensing for the 2010 data. If this option is offered, licensing rights shall be provided which permits TTI and/or MnDOT (and/or other public sector partners in Minnesota) to perform an unlimited number of analyses of the 2010 data. If the unlimited use license option is offered for 2010 data, it shall also permit the derivative works to be publicly distributed by these other public agencies. Bidders with “seat-based” licensing can assume that there will be between 6 and 50 concurrent users of the traffic speed data sets for this “unlimited use” option.

If a bid is provided for any of these options, proposers should indicate for how long that option price is valid (e.g., if MnDOT or a partner agency decided to license the 2010 data or purchase an “unlimited use” license after the base 2011 licensing).

Proposal Submittals

Interested proposers shall submit the following:

- A technical proposal (not to exceed 10 pages) that briefly summarizes the sources of the average traffic speed data, analytical processes, quality assurance practices. The technical proposal should also summarize past experience with developing and delivering historical speed data to public sector agencies.
- A cost bid for 2011 average traffic speed data and associated statistical measures that meets the *Required Specifications*.

Interested proposers may also submit one or more of the following:

- A cost bid for Option 1, Unlimited Use Licensing for 2011 Traffic Speed Data
- A cost bid for Option 2, Single Use Licensing for 2010 Traffic Speed Data
- A cost bid for Option 3, Unlimited Use Licensing for 2010 Traffic Speed Data

Evaluation Criteria

Proposals will be evaluated based on the following criteria:

1. Demonstration (via the technical proposal) that vendor can deliver data that meets all required specifications. Maximum of 20 points.

2. Cost for data that meets the *Required Specifications.* Maximum of 30 points.

3. Provision of bids for optional data products/services and their respective costs. Maximum of 20 points.

4. Past experience (as documented in the technical proposal) with developing historical average speed datasets. Maximum of 30 points.

Appendix B: System, Corridor, and Segment Performance Measure Results for the MnDOT Arterial Street Network

Table B-1. Summary Performance Measures for the Arterial System within the Twin Cities Metro Area

Length of Arterial System	Total Annual Delay	Peak Period Delay	Total Annual Target Delay	AM Peak Travel Time Index	PM Peak Travel Time Index	AM Peak Planning Time Index	PM Peak Planning Time Index	Average Delay per Mile	Average Target Delay per Mile
1,764 miles	7,589,215 person-hours	3,858,619 person-hours	4,073,068 person-hours	1.07	1.08	1.36	1.41	4,301 person-hours per mile	2,308 person-hours per mile

Note: AM/PM Travel Time Index and AM/PM Planning Time Index only account for weekdays, but Annual Delay, Annual Target Delay account for both weekdays and weekends

Table B-2. Summary Performance Measures for the 22 Arterial Corridors

CorridorName	Length	Annual Delay	Annual Target Delay	AM Peak Travel Time Index	AM Peak Planning Time Index	PM Peak Travel Time Index	PM Peak Planning Time Index	Delay per Mile	Target Delay per Mile
MN-3	59.17	68418	2271	1.05	1.31	1.02	1.31	1156	38
MN-5	100.74	332767	26273	1.05	1.41	1.04	1.31	3303	261
MN-7	68.79	191399	38273	1.04	1.24	1.05	1.28	2782	556
US-8	36.88	58046	2996	1.04	1.25	1.04	1.23	1574	81
US-10	79.37	612185	514640	1.06	1.25	1.12	1.42	7713	6484
US-12	47.28	98898	54465	1.07	1.24	1.04	1.20	2092	1152
MN-13	68.57	232797	21596	1.07	1.39	1.06	1.34	3395	315
CR-14	27.18	88470	23522	1.08	1.90	1.05	1.74	3255	865
MN-19	48.61	31179	9296	1.03	1.35	1.02	1.64	641	191
CR-21	25.48	22717	4111	1.04	1.42	1.03	1.47	891	161
MN-25	100.97	260864	124388	1.05	1.48	1.08	1.61	2584	1232
MN-36	41.62	477147	456141	1.14	1.47	1.12	1.39	11465	10960
CSAH-36	4.83	13989	13989	1.12	1.34	1.03	1.27	2896	2896
CSAH-37	4.32	32087	5851	1.11	1.56	1.11	1.50	7422	1354
MN-41	18.72	101679	36687	1.08	1.47	1.09	1.64	5432	1960
CSAH-42	40.84	363041	40507	1.06	1.45	1.09	1.64	8889	992
MN-47	54.91	218511	49654	1.07	1.62	1.06	1.54	3979	904
MN-50	32.11	17664	10151	1.03	1.19	1.02	1.16	550	316
MN-51	22.57	316491	12940	1.05	1.36	1.10	1.64	14022	573
MN-52	65.08	190772	190772	1.04	1.19	1.02	1.13	2931	2931
MN-55	128.99	629983	173862	1.08	1.40	1.06	1.41	4884	1348
US-61	121.21	442034	190589	1.05	1.35	1.04	1.38	3647	1572
MN-65	62.74	518930	145638	1.09	1.46	1.11	1.58	8271	2321
MN-77	22.28	205432	205432	1.12	1.47	1.05	1.23	9222	9222
MN-95	146.57	84628	34891	1.02	1.29	1.02	1.52	577	238
MN-96	20.35	4117	277	1.01	1.23	1.01	1.38	202	14
MN-97	26.34	37274	7098	1.04	1.26	1.04	1.29	1415	269
MN-101	32.65	77469	51993	1.03	1.34	1.03	1.23	2372	1592
MN-110	8.93	43902	25354	1.07	1.37	1.06	1.33	4917	2839
MN-120	14.76	62374	9420	1.05	1.53	1.04	1.70	4226	638
MN-149	18.83	34267	1904	1.06	1.89	1.02	1.69	1819	101
US-169	124.56	1484258	1484258	1.11	1.36	1.18	1.55	11916	11916
US-212	36.57	15312	15312	1.01	1.08	1.01	1.08	419	419
MN-244	9.40	24717	972	1.03	1.32	1.04	1.18	2629	103
MN-252	7.73	142841	44991	1.14	1.49	1.16	1.61	18490	5824
MN-280	7.97	40605	40605	1.04	1.20	1.06	1.30	5093	5093
MN-282	15.24	9550	1453	1.07	1.55	1.01	1.34	627	95
MN-284	11.29	2401	493	1.01	1.37	1.01	1.22	213	44

Note: 1. AM/PM Travel Time Index and AM/PM Planning Time Index only account for weekdays, but Annual Delay, Annual Target Delay account for both weekdays and weekends

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-51	I-94	Snelling Ave (MN-51)	2.73	SB	4	75,277	27,611	665	1
MN-51	Snelling Ave (MN-51)	I-94	2.73	NB	4	67,747	24,852	173	2
MN-252	I-694	MN-610	3.95	NB	3	80,378	20,349	6,667	3
CSAH-42	I-35E	Langfod Ave (MN-13)	5.09	EB	3	91,781	18,038	1,928	4
MN-65	125th Ave	US-10	4.37	SB	3	78,767	18,005	5,411	5
CSAH-42	Langfod Ave (MN-13)	I-35E	5.11	WB	3	87,275	17,078	1,552	6
US-61	CR-96	Buffalo St	1.93	SB	4	32,887	17,067	6,146	7
MN-47	US-10	Bunker Lake Blvd	1.53	NB	4	26,152	17,057	9,296	8
MN-65	US-10	125th Ave	4.37	NB	3	74,508	17,032	5,644	9
MN-252	MN-610	I-694	3.78	SB	3	62,463	16,546	4,942	10
MN-51	I-94	MN-36	4.02	NB	4	61,535	15,313	443	11
MN-47	Bunker Lake Blvd	US-10	1.58	SB	4	23,966	15,185	8,233	12
CSAH-42	MN-77 (Cedar Ave)	I-35E	3.16	EB	3	46,302	14,651	1,830	13
MN-51	MN-36	I-94	4.02	SB	4	58,875	14,650	161	14
MN-77	140th St	I-35E	2.35	NB	3	34,122	14,526	14,526	15
US-61	Buffalo St	CR-96	1.94	NB	4	27,635	14,269	4,067	16
MN-25	I-94	US-10	3.65	NB	3	47,057	12,890	4,010	17
MN-25	US-10	I-94	3.65	SB	3	46,149	12,629	3,265	18
MN-13	Langfod Ave (MN-13)	I-35W	4.72	NB	3	58,627	12,412	1,206	19
MN-65	I-94	10th St	0.98	NB	4	11,781	11,991	6,368	20
MN-55	MN-62 (Crosstown HWY)	I-35W	6.31	WB	3	74,095	11,747	156	21
MN-55	US-169	MN-100	2.53	EB	3	29,654	11,700	3,509	22
MN-55	I-35W	MN-62 (Crosstown HWY)	6.22	EB	3	70,789	11,383	471	23
MN-55	MN-100	US-169	2.51	WB	3	28,255	11,270	2,701	24
MN-47	I-694	Osborne Rd	2.59	NB	4	28,540	11,021	1,819	25
MN-55	CR-101	I-494	5.24	EB	3	56,777	10,833	10,833	26
MN-7	US-169	MN-100	2.51	EB	3	26,338	10,481	2,710	27
US-61	CR-96	I-694	3.20	NB	4	31,814	9,957	3,135	28
MN-13	I-35W	Langfod Ave (MN-13)	4.80	SB	3	45,573	9,497	1,048	29
MN-65	Constance Blvd	Bunker Lake Blvd	3.28	SB	3	30,827	9,400	2,435	30
MN-55	I-494	US-169	3.58	EB	3	33,392	9,338	1,692	31
MN-7	I-494	CR-101	2.70	WB	3	24,952	9,228	1,804	32
MN-120	Dellwood Ave, Mathomedi Ave, Wildwood Rd (MN-244)	MN-36	2.25	SB	4	20,564	9,140	2,487	33

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-51	Snelling Ave (MN-51)	Fort Rd, 7th St (MN-5)	0.88	SB	4	8,013	9,137	2,914	34
MN-25	I-94	CR-37 (70th St)	3.63	SB	3	32,976	9,095	9,095	35
MN-47	Osborne Rd	I-694	2.59	SB	4	23,000	8,891	1,362	36
CSAH-42	I-35E	MN-77 (Cedar Ave)	3.16	WB	3	27,947	8,853	270	37
CSAH-37	Sibley St	Randolph Ave	2.17	WB	3	19,090	8,803	1,908	38
MN-55	MN-100	I-94	3.07	EB	3	27,004	8,784	896	39
MN-7	MN-100	US-169	2.78	WB	3	24,367	8,766	1,439	40
MN-47	St Anthony Pky	I-694	2.91	NB	4	25,255	8,675	2,852	41
MN-65	Viking Blvd	Constance Blvd	3.69	SB	3	31,770	8,602	8,602	42
MN-65	125th Ave	Bunker Lake Blvd	1.49	NB	3	12,823	8,597	3,805	43
MN-65	Lowry Ave	I-694	3.75	NB	4	32,123	8,556	852	44
MN-7	CR-101	I-494	2.70	EB	3	23,100	8,549	1,058	45
MN-36	E County Line Rd (MN-120)	US-61	3.85	EB	3	32,662	8,473	8,473	46
MN-65	I-694	US-10	4.70	NB	3	39,415	8,388	122	47
MN-41	Lyman Blvd	US-212	2.41	SB	4	20,001	8,311	3,249	48
CSAH-42	MN-77 (Cedar Ave)	MN-3 (Chippendale Ave)	4.43	WB	3	34,631	7,816	64	49
MN-65	Lowry Ave	Washington Ave	2.61	SB	4	20,244	7,771	0	50
US-61	I-694	CR-96	3.19	SB	4	24,669	7,728	1,766	51
MN-5	I-35E	I-494	4.79	WB	2, 4	36,696	7,660	5	52
MN-65	US-10	I-694	4.70	SB	3	35,868	7,632	146	53
MN-110	Langfod Ave (MN-13)	I-35E	1.12	EB	3	8,568	7,619	3,085	54
MN-65	I-694	Lowry Ave	3.75	SB	4	28,568	7,610	508	55
MN-5	I-494	I-35E	5.42	EB	2, 4	40,923	7,545	8	56
MN-41	US-212	Lyman Blvd	2.41	NB	4	18,158	7,536	2,696	57
MN-25	CR-37 (70th St)	I-94	3.63	NB	3	27,258	7,518	7,518	58
MN-110	I-35E	Langfod Ave (MN-13)	1.19	WB	3	8,918	7,502	3,762	59
MN-41	Lyman Blvd	Fort Rd, 7th St (MN-5)	1.00	NB	4	7,495	7,491	7,491	60
MN-5	MN-41	US-212	6.63	EB	4	49,401	7,452	751	61
MN-55	I-94	MN-100	3.08	WB	3	22,723	7,390	746	62
MN-51	Fort Rd, 7th St (MN-5)	Snelling Ave (MN-51)	0.88	NB	4	6,427	7,322	2,062	63
MN-65	Washington Ave	Lowry Ave	2.61	NB	4	18,710	7,171	38	64
MN-36	E County Line Rd (MN-120)	Hilton Trl	2.03	WB	3	14,483	7,123	1,003	65
MN-65	Constance Blvd	Viking Blvd	3.69	NB	3	26,306	7,120	7,120	66
MN-120	MN-36	Dellwood Ave, Mathomedi Ave, Wildwood Rd (MN-244)	2.25	NB	4	15,834	7,040	1,500	67

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
CSAH-42	Langfod Ave (MN-13)	Eagle Creek Ave	2.93	EB	3, 4	19,871	6,772	1,462	68
MN-55	US-169	I-494	3.64	WB	3	24,190	6,642	658	69
CSAH-42	MN-3 (Chippendale Ave)	MN-77 (Cedar Ave)	4.43	EB	3	29,111	6,576	62	70
MN-55	I-35W	I-94	2.04	WB	4	13,100	6,425	8	71
MN-36	US-61	E County Line Rd (MN-120)	3.84	WB	3	24,096	6,269	6,269	72
MN-47	St Anthony Pky	MN-65 (Central Ave NE)	2.93	SB	4	18,076	6,162	15	73
MN-41	Fort Rd, 7th St (MN-5)	Lyman Blvd	1.01	SB	4	6,159	6,125	6,125	74
CSAH-37	Randolph Ave	Sibley St	2.15	EB	3	12,996	6,032	795	75
CR-14	MN-65 (Central Ave NE)	US-10	5.55	EB	3	33,434	6,028	1,771	76
US-61	I-94	I-494	4.93	WB	3	29,599	5,998	5,998	77
MN-51	MN-36	I-694	3.86	NB	4	23,058	5,979	933	78
MN-55	I-94	I-35W	2.24	EB	4	13,318	5,947	22	79
CR-14	US-10	MN-65 (Central Ave NE)	5.57	WB	3	32,713	5,869	1,753	80
US-61	I-694	Wheelock Pky	3.92	NB	4	22,959	5,850	224	81
CSAH-42	Eagle Creek Ave	Langfod Ave (MN-13)	2.93	WB	3, 4	16,702	5,692	634	82
MN-65	Bunker Lake Blvd	125th Ave	1.49	SB	3	8,459	5,680	415	83
US-61	I-94	Wheelock Pky	3.26	SB	4	18,421	5,642	34	84
MN-110	I-35E	Delaware Ave (CR-63)	1.60	EB	4	8,975	5,623	5,623	85
US-61	US-8	MN-97 (Scandia Trail)	2.32	NB	4	13,028	5,619	65	86
MN-77	I-35E	140th St	2.78	SB	3	14,523	5,221	5,221	87
MN-41	Chaska Blvd	US-212	1.79	NB	4	9,318	5,202	340	88
US-61	Wheelock Pky	I-94	3.30	NB	4	17,158	5,198	4	89
MN-110	Delaware Ave (CR-63)	I-35E	1.60	WB	4	8,187	5,129	5,129	90
MN-13	I-35W	MN-77 (Cedar Ave)	4.34	NB	3, 4	22,213	5,115	279	91
MN-47	CR-11	Osborne Rd	3.18	SB	4	16,041	5,045	398	92
MN-97	I-35	US-61	2.33	WB	4	11,630	4,990	694	93
US-61	Mississippi River	Innovation Rd	5.36	EB	3	26,429	4,931	4,931	94
MN-5	I-35E	I-94	4.55	EB	4	22,235	4,890	0	95
MN-41	US-212	Chaska Blvd	1.79	SB	4	8,684	4,840	335	96
MN-13	MN-77 (Cedar Ave)	I-35W	4.28	SB	3, 4	20,672	4,828	329	97
MN-47	MN-65 (Central Ave NE)	St Anthony Pky	2.93	NB	4	14,068	4,803	53	98
MN-55	CR-19	CR-101	5.68	EB	3	27,019	4,758	1,265	99
MN-41	Chaska Blvd	US-169	2.03	SB	4	9,494	4,687	1,236	100
MN-13	Eagle Creek Ave	CR-101	5.52	NB	4	25,872	4,685	712	101
MN-5	I-94	I-35E	4.50	WB	4	21,048	4,682	0	102

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-55	Dodd Rd (MN-149)	Langfod Ave (MN-13)	3.09	WB	3	14,391	4,656	894	103
MN-65	Bunker Lake Blvd	Constance Blvd	3.28	NB	3	15,253	4,654	295	104
MN-149	MN-3 (Chippendale Ave)	MN-55 (Oleson HWY)	2.86	NB	4	13,224	4,627	504	105
US-61	MN-97 (Scandia Trail)	US-8	2.31	SB	4	10,685	4,620	45	106
MN-55	I-494	CR-101	5.08	WB	3	23,158	4,560	4,560	107
US-61	170th St	Buffalo St	6.47	NB	4	29,475	4,553	1,501	108
MN-5	US-212	MN-41	6.76	WB	4	30,696	4,540	128	109
US-61	Wheelock Pky	I-694	3.92	SB	4	17,717	4,516	200	110
MN-51	I-694	MN-36	3.47	SB	4	15,561	4,484	75	111
MN-7	US-169	I-494	2.70	WB	3	12,084	4,471	573	112
MN-25	CR-37 (70th St)	MN-55 (Oleson HWY)	5.48	SB	2, 3	24,223	4,423	1,069	113
MN-36	Manning Ave	Manning Ave (MN-95)	3.66	WB	3	15,928	4,353	4,353	114
MN-36	Hilton Trl	E County Line Rd (MN-120)	2.03	EB	3	8,829	4,346	131	115
MN-5	Lake Elmo Ave	MN-36	3.57	EB	4	15,431	4,317	1,218	116
MN-5	MN-36	Lake Elmo Ave	3.58	WB	4	15,081	4,216	1,132	117
MN-55	CR-101	CR-19	5.67	WB	3	23,686	4,177	451	118
US-169	Marschall Rd	CR-101	4.86	NB	3	19,613	4,034	4,034	119
MN-13	CR-101	Eagle Creek Ave	5.56	SB	4	22,363	4,024	364	120
MN-41	US-169	Chaska Blvd	2.03	NB	4	8,070	3,983	320	121
MN-101	I-94	US-10	7.17	NB	3	28,477	3,972	3,972	122
MN-47	I-694	St Anthony Pky	2.91	SB	4	11,540	3,964	609	123
MN-5	Laketown Pky	MN-41	8.75	EB	4	34,479	3,942	574	124
MN-36	Manning Ave	Hilton Trl	4.27	EB	3	16,421	3,841	3,841	125
US-169	Marschall Rd	150th St	6.03	SB	3	22,988	3,813	3,813	126
US-10	Proctor Ave	MN-25	8.92	EB	3	33,636	3,770	211	127
MN-47	Osborne Rd	CR-11	3.15	NB	4	11,847	3,758	71	128
MN-65	245th Ave	Viking Blvd	6.51	SB	3	24,285	3,730	110	129
MN-55	Langfod Ave (MN-13)	Dodd Rd (MN-149)	3.07	EB	3	11,424	3,725	284	130
MN-110	I-494	Delaware Ave (CR-63)	1.70	WB	4	6,244	3,664	146	131
MN-36	Hilton Trl	Manning Ave	4.28	WB	3	15,616	3,647	3,647	132
US-12	I-494	6th Ave	8.39	EB	3	30,175	3,598	3,598	133
MN-3	160th St	Cliff Rd	6.08	NB	4	21,828	3,587	160	134
MN-25	MN-55 (Oleson HWY)	CR-37 (70th St)	5.48	NB	2, 3	19,337	3,531	453	135
MN-7	I-494	US-169	2.92	EB	3	10,235	3,502	258	136

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
US-61	Innovation Rd	Mississippi River	5.37	WB	3	18,104	3,374	3,374	137
MN-41	MN-7 (Yellowstone Trail)	Fort Rd, 7th St (MN-5)	2.15	SB	4	7,246	3,364	1,008	138
MN-41	Fort Rd, 7th St (MN-5)	MN-7 (Yellowstone Trail)	2.10	NB	4	7,054	3,352	1,039	139
US-61	Buffalo St	170th St	6.47	SB	4	21,205	3,277	876	140
MN-149	MN-55 (Oleson HWY)	MN-3 (Chippendale Ave)	2.86	SB	4	9,342	3,262	162	141
US-10	Proctor Ave	Armstrong Blvd	7.64	WB	2, 3	24,925	3,261	110	142
MN-36	Manning Ave (MN-95)	Manning Ave	3.72	EB	3	11,989	3,226	3,226	143
US-169	CR-101	Marschall Rd	5.17	SB	3	16,404	3,174	3,174	144
MN-25	US-12	MN-55 (Oleson HWY)	8.25	NB	4	25,931	3,144	1,248	145
US-8	Olinda Trl	MN-98	4.52	EB	3	14,194	3,139	130	146
MN-101	US-10	I-94	7.26	SB	3	22,740	3,131	3,131	147
CSAH-36	Sibley St	US-10	2.41	EB	3	7,406	3,069	3,069	148
MN-120	Fort Rd, 7th St (MN-5)	MN-36	3.06	NB	4	9,176	3,002	77	149
US-61	Mississippi River	190th St	5.13	NB	3, 4	15,382	2,996	196	150
US-8	MN-98	Olinda Trl	4.54	WB	3	13,255	2,921	2	151
MN-120	I-94	Fort Rd, 7th St (MN-5)	2.07	NB	4	5,985	2,898	87	152
US-10	Armstrong Blvd	Proctor Ave	7.63	EB	2, 3	21,845	2,864	66	153
MN-244	MN-96 (Dellwood Rd)	County Line Rd	4.70	SB	4	13,416	2,854	113	154
MN-5	MN-41	Laketown Pky	8.30	WB	4	23,296	2,808	134	155
MN-25	MN-55 (Oleson HWY)	US-12	8.25	SB	4	22,816	2,764	863	156
MN-7	Smithtown Rd	CR-101	7.62	EB	3	20,998	2,757	121	157
CSAH-36	US-10	Sibley St	2.42	WB	3	6,583	2,724	2,724	158
MN-55	US-61	CR-85 (Goodwill Ave)	4.79	WB	3	12,484	2,606	247	159
MN-120	Fort Rd, 7th St (MN-5)	I-94	2.07	SB	4	5,369	2,594	14	160
MN-3	Cliff Rd	160th St	6.08	SB	4	15,478	2,544	26	161
US-61	80th St	I-494	4.30	EB	3	10,915	2,540	2,540	162
MN-55	Woodland Trl	CR-19	5.26	EB	3	13,289	2,528	129	163
MN-47	167th Ave	Bunker Lake Blvd	3.56	SB	4	8,970	2,519	475	164
CR-21	Langfod Ave (MN-13)	Egan Dr, 142 St. (CR-42)	2.83	EB	4	6,930	2,451	267	165
MN-101	Fort Rd, 7th St (MN-5)	MN-7 (Yellowstone Trail)	5.56	NB	4, 7	13,462	2,423	103	166
MN-244	County Line Rd	MN-96 (Dellwood Rd)	4.70	NB	4	11,301	2,404	94	167
US-10	MN-25	Proctor Ave	8.92	WB	3	21,382	2,397	114	168
US-169	Delaware Ave	150th St	7.40	NB	3	17,666	2,386	2,386	169
US-61	I-494	I-94	4.93	EB	3	11,745	2,382	2,382	170
CR-14	Lexington Ave	MN-65 (Central Ave NE)	3.55	EB	3	8,247	2,320	455	171

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
CR-21	Egan Dr, 142 St. (CR-42)	Langfod Ave (MN-13)	2.81	WB	4	6,478	2,308	239	172
US-12	6th Ave	I-494	8.30	WB	3	18,824	2,267	2,267	173
MN-52	I-494	117th St	7.03	NB	2, 3	15,434	2,196	2,196	174
US-61	MN-97 (Scandia Trail)	170th St	4.44	NB	4	9,628	2,168	2,168	175
MN-55	MN-25	Woodland Trl	10.24	EB	3	22,131	2,162	260	176
CR-14	MN-65 (Central Ave NE)	Lexington Ave	3.56	WB	3	7,679	2,154	482	177
US-61	190th St	Mississippi River	5.13	SB	3, 4	11,007	2,144	0	178
MN-55	CR-85 (Goodwill Ave)	US-61	4.87	EB	3	10,382	2,130	194	179
MN-13	MN-77 (Cedar Ave)	MN-55 (Oleson HWY)	5.21	NB	4	10,917	2,096	1	180
US-169	150th St	Marschall Rd	6.32	NB	3	12,833	2,029	2,029	181
MN-19	141st Ave	181st Ave	5.98	SB	4	11,999	2,006	64	182
US-12	Hennepin	6th Ave	8.96	WB	3	17,884	1,996	360	183
MN-13	MN-55 (Oleson HWY)	MN-77 (Cedar Ave)	5.21	SB	4	10,389	1,993	37	184
MN-7	CR-92	Smithtown Rd	5.52	EB	3	10,971	1,987	75	185
US-61	I-494	80th St	4.30	WB	3	8,388	1,952	1,952	186
US-12	6th Ave	Hennepin	8.90	EB	3	17,384	1,952	239	187
MN-7	CR-101	Smithtown Rd	7.61	WB	3	14,459	1,901	26	188
US-61	US-8	I-35	3.88	SB	4	7,278	1,877	391	189
MN-97	Manning Trl	US-61	4.93	EB	4	9,038	1,833	139	190
MN-55	Dodd Rd (MN-149)	US-52	4.33	EB	3	7,867	1,816	40	191
MN-19	181st Ave	141st Ave	5.86	EB	4	10,544	1,799	47	192
MN-95	I-94	MN-36	5.65	NB	4	10,058	1,780	55	193
MN-120	MN-36	Fort Rd, 7th St (MN-5)	3.07	SB	4	5,445	1,775	3	194
MN-13	Langford Ave	Eagle Creek Ave	4.31	NB	4	7,606	1,764	132	195
MN-110	Delaware Ave (CR-63)	I-494	1.72	EB	4	3,010	1,751	1	196
MN-55	Woodland Trl	MN-25	10.25	WB	3	17,745	1,731	191	197
MN-55	CR-85 (Goodwill Ave)	US-52	6.60	WB	3	11,419	1,730	1,730	198
US-61	I-35	US-8	3.88	NB	4	6,594	1,700	296	199
MN-95	US-8	US-8	6.56	EB	3	10,882	1,659	1,659	200
US-8	I-35	MN-98	7.04	WB	3	11,413	1,621	128	201
US-169	150th St	Delaware Ave	7.40	SB	3	11,763	1,590	1,590	202
MN-55	CR-19	Woodland Trl	5.26	WB	3	8,325	1,583	33	203
US-61	170th St	MN-97 (Scandia Trail)	4.63	SB	4	7,286	1,574	1,574	204
MN-65	Viking Blvd	245th Ave	6.51	NB	3	9,939	1,527	0	205

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-149	MN-55 (Oleson HWY)	Wentworth Ave	3.32	NB	4	5,007	1,507	0	206
MN-52	117th St	I-494	7.04	SB	2, 3	10,067	1,429	1,429	207
MN-95	MN-36	I-94	5.13	SB	4	7,266	1,417	49	208
MN-3	220th St	160th St	6.10	NB	4	8,059	1,322	44	209
MN-97	US-61	Manning Trl	4.93	WB	4	6,508	1,320	135	210
MN-5	Laketown Pky	MN-25	8.10	WB	4	10,549	1,303	198	211
US-8	MN-98	I-35	7.05	EB	3	9,169	1,301	123	212
MN-13	Eagle Creek Ave	Langford Ave	4.31	SB	4	5,589	1,297	64	213
MN-55	US-52	CR-85 (Goodwill Ave)	6.61	EB	3	8,537	1,291	1,291	214
MN-47	Bunker Lake Blvd	167th Ave	3.56	NB	4	4,591	1,289	13	215
MN-3	160th St	220th St	6.14	SB	4	7,437	1,211	31	216
US-12	MN-25	Hennipin	6.32	WB	3	7,649	1,210	17	217
MN-55	US-52	Dodd Rd (MN-149)	4.34	WB	3	5,156	1,189	0	218
MN-7	Smithtown Rd	CR-92	5.52	WB	3	6,466	1,172	4	219
MN-97	US-61	I-35	2.53	EB	4	2,926	1,155	86	220
CSAH-42	MN-3 (Chippendale Ave)	US-52	4.80	WB	3	5,502	1,147	1,147	221
MN-95	I-94	70th St	6.97	SB	4	7,978	1,145	79	222
MN-5	MN-25	Laketown Pky	8.67	EB	4	9,921	1,144	198	223
MN-5	Arcade St	Century Ave	4.99	EB	4	5,668	1,135	0	224
US-61	80th St	Innovation Rd	3.18	WB	3	3,594	1,130	1,130	225
MN-97	Manning Trl	Lofton Ave	1.38	WB	4	1,553	1,128	1,128	226
MN-5	Century Ave	Lake Elmo Ave	5.06	EB	4	5,656	1,118	64	227
MN-101	MN-7 (Yellowstone Trail)	Fort Rd, 7th St (MN-5)	3.96	SB	4, 7	4,396	1,110	0	228
MN-52	Brandel Dr	117th St	4.68	SB	3	5,145	1,098	1,098	229
MN-52	117th St	Brandel Dr	4.68	NB	3	5,135	1,097	1,097	230
US-12	Hennipin	MN-25	6.40	EB	3	6,982	1,090	1	231
MN-7	MN-25	CR-92	6.09	EB	3	6,531	1,073	1,073	232
CR-21	New Prague Blvd, E 280th St (MN-19)	260th St	2.02	NB	4	2,101	1,037	327	233
MN-25	MN-25	MN-25	4.13	WB	3	4,281	1,037	1,037	234
MN-25	MN-25	MN-25	4.13	EB	3	4,284	1,037	1,037	235
MN-5	Lake Elmo Ave	Century Ave	5.06	WB	4	5,172	1,023	108	236
MN-95	US-8	US-8	6.56	WB	3	6,645	1,013	1,013	237
MN-101	Minnesota River	Fort Rd, 7th St (MN-5)	4.36	NB	4, 7	4,376	1,005	36	238

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-149	Wentworth Ave	MN-55 (Oleson HWY)	3.32	SB	4	3,325	1,003	0	239
MN-95	70th St	I-94	6.97	NB	4	6,903	990	51	240
MN-5	Century Ave	Arcade St	4.99	WB	4	4,880	979	0	241
MN-52	CR-47	Brandel Dr	6.82	SB	3	6,561	963	963	242
MN-52	CR-47	Cannon River	8.39	NB	3	7,959	949	949	243
MN-95	MN-36	Stonebridge Trl	5.97	WB	3, 4	5,549	929	9	244
MN-101	Fort Rd, 7th St (MN-5)	Minnesota River	4.35	SB	4, 7	4,018	924	11	245
CR-21	260th St	New Prague Blvd, E 280th St (MN-19)	2.02	SB	4	1,820	899	149	246
MN-25	CR-30 (181 St)	MN-7 (Yellowstone Trail)	1.75	EB	4	1,453	830	414	247
CSAH-42	US-52	MN-3 (Chippendale Ave)	4.80	EB	3	3,919	816	816	248
MN-97	Olinda Trl	Manning Ave (MN-95)	1.59	WB	4	1,286	811	381	249
MN-97	Lofton Ave	Manning Trl	1.38	EB	4	1,073	779	779	250
US-8	Olinda Trl	Manning Ave (MN-95)	6.87	WB	3	5,324	775	0	251
CR-14	Lexington Ave	I-35W	4.47	WB	3	3,397	760	56	252
MN-95	Stonebridge Trl	MN-36	6.48	EB	3, 4	4,831	745	24	253
US-61	Innovation Rd	80th St	3.19	EB	3	2,356	739	739	254
MN-282	US-169	Langfod Ave (MN-13)	7.63	EB	4	5,604	734	134	255
MN-52	Brandel Dr	CR-47	6.82	NB	3	4,866	713	713	256
US-61	US-61	Orlando Ave	3.11	NB	4	2,167	697	697	257
MN-7	CR-92	MN-25	6.09	WB	3	4,224	693	693	258
US-8	Manning Ave (MN-95)	Olinda Trl	6.87	EB	3	4,691	683	92	259
CR-21	US-169	220th St	3.54	SB	4	2,410	680	3	260
MN-47	Norris Lake Rd	245th Ave	2.93	NB	4	1,987	678	86	261
CR-14	I-35W	Lexington Ave	4.47	EB	3	2,999	671	77	262
MN-95	I-35	Sunrise Rd	8.97	EB	4	5,974	666	86	263
MN-50	Darsow Ave	US-52	2.68	EB	4	1,728	645	160	264
US-61	Orlando Ave	US-61	3.22	SB	4	2,010	624	624	265
MN-52	Cannon River	CR-47	8.46	SB	3	5,215	617	617	266
MN-96	US-61	Quail Rd	2.82	WB	4	1,721	609	21	267
US-212	MN-25	Zebra Ave	3.78	WB	3	2,271	601	601	268
MN-97	Manning Ave (MN-95)	Olinda Trl	1.59	EB	4	952	600	282	269

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
US-169	Meridian St	Delaware Ave	6.47	NB	3	3,859	597	597	270
MN-50	US-61	US-52	7.86	WB	4	4,671	595	595	271
US-169	Delaware Ave	Meridian St	6.20	SB	3	3,653	589	589	272
MN-95	MN-243	MN-97 (Scandia Trail)	5.65	EB	4	3,262	577	577	273
MN-149	Wentworth Ave	Fort Rd, 7th St (MN-5)	3.24	NB	4	1,850	572	0	274
MN-7	Salem Ave (CR-33)	MN-25	4.97	EB	3	2,825	568	568	275
MN-3	MN-110	Cliff Rd	7.02	SB	4	3,954	564	2	276
MN-50	US-52	Darsow Ave	2.68	WB	4	1,473	549	73	277
US-169	Meridian St	280th St	6.89	SB	3	3,740	543	543	278
MN-25	MN-7 (Yellowstone Trail)	CR-30 (181 St)	1.75	SB	4	950	542	170	279
MN-50	Darsow Ave	Chippendale Ave	5.52	WB	4	2,876	521	90	280
MN-50	US-52	US-61	7.85	EB	4	4,084	520	520	281
MN-282	Langfod Ave (MN-13)	US-169	7.60	WB	4	3,946	519	56	282
MN-50	Chippendale Ave	Darsow Ave	5.52	EB	4	2,832	513	50	283
MN-19	141st Ave	New Prague Blvd, E 280th St (MN-19)	7.01	EB	4	3,580	511	511	284
MN-95	MN-97 (Scandia Trail)	MN-243	5.65	WB	4	2,845	503	503	285
MN-19	New Prague Blvd, E 280th St (MN-19)	141st Ave	6.87	WB	4	3,441	501	501	286
US-212	Zebra Ave	MN-25	3.78	EB	3	1,875	496	496	287
MN-3	220th St	280th St	5.98	SB	4	2,961	495	54	288
MN-96	Quail Rd	US-61	2.82	EB	4	1,390	492	19	289
US-212	MN-25	CR-53	7.67	EB	3	3,633	474	474	290
MN-149	Fort Rd, 7th St (MN-5)	Wentworth Ave	3.24	SB	4	1,519	469	0	291
MN-7	Salem Ave (CR-33)	Zebra Ave	2.04	WB	3	950	466	25	292
MN-3	Cliff Rd	MN-110	7.02	NB	4	3,211	458	1	293
MN-7	MN-25	Salem Ave (CR-33)	4.98	WB	3	2,240	450	450	294
MN-97	Olinda Trl	Lofton Ave	2.84	EB	4	1,180	415	33	295
US-212	CR-53	MN-25	7.70	WB	3	3,176	413	413	296
CR-21	220th St	US-169	3.12	NB	4	1,272	408	0	297
MN-3	280th St	220th St	6.02	NB	4	2,416	401	46	298
MN-97	Lofton Ave	Olinda Trl	2.84	WB	4	1,128	397	49	299
MN-3	Northfield Blvd	280th St	4.37	NB	4	1,727	396	6	300
MN-95	70th St	US-61	4.85	SB	4	1,863	384	384	301
MN-95	Sunrise Rd	I-35	8.97	WB	4	3,423	382	20	302

Table B-3. Ranking Based on Annual Target Delay per Mile: For all Segments

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-47	245th Ave	Norris Lake Rd	2.91	SB	4	1,109	381	63	303
US-212	CR-53	Jonathan Carver Pkwy	7.01	EB	3	2,436	347	347	304
US-169	280th St	Meridian St	6.89	NB	3	2,380	346	346	305
MN-95	US-61	70th St	4.81	NB	4	1,628	339	339	306
MN-7	Zebra Ave	Salem Ave (CR-33)	2.04	EB	3	660	324	0	307
MN-47	167th Ave	Viking Blvd	3.99	NB	4	1,254	314	20	308
MN-3	280th St	Northfield Blvd	4.37	SB	4	1,346	308	6	309
MN-25	Fort Rd, 7th St (MN-5)	Salem Ave (CR-33)	2.67	WB	4	805	302	32	310
US-212	Jonathan Carver Pkwy	CR-53	6.63	WB	3	1,920	290	290	311
MN-47	Viking Blvd	Norris Lake Rd	3.84	NB	4	1,007	262	14	312
MN-13	220th St	MN-282 (County Trail)	4.07	NB	4	1,053	259	9	313
MN-25	State St	CR-122 (30th St)	1.71	SB	4	438	255	56	314
MN-5	212	MN-25	3.52	SB	4	876	249	249	315
MN-284	Fort Rd, 7th St (MN-5)	US-212	5.65	SB	4	1,316	233	29	316
MN-5	MN-25	212	3.51	NB	4	760	216	216	317
CR-21	220th St	260th St	4.57	SB	4	975	213	213	318
US-61	240th St	190th St	5.01	SB	4	988	197	197	319
MN-13	MN-282 (County Trail)	220th St	4.07	SB	4	794	195	21	320
MN-25	CR-122 (30th St)	State St	1.71	NB	4	334	195	34	321
MN-96	Manning Ave	Manning Ave (MN-95)	2.82	WB	4	549	195	48	322
MN-284	US-212	Fort Rd, 7th St (MN-5)	5.65	NB	4	1,085	192	58	323
MN-95	Sunrise Rd	350th St	7.03	EB	4	1,290	183	183	324
US-61	190th St	240th St	4.98	NB	4	912	183	183	325
MN-47	Viking Blvd	167th Ave	3.99	SB	4	710	178	8	326
MN-95	350th St	US-8	6.06	EB	4	994	164	164	327
MN-95	350th St	Sunrise Rd	7.03	WB	4	1,147	163	163	328
MN-25	MN-25	Creek Rd (CR-10)	2.54	SB	4	411	162	162	329
MN-25	Creek Rd (CR-10)	MN-25	2.54	NB	4	411	162	162	330
CR-21	260th St	220th St	4.57	NB	4	733	160	160	331

Corridor Name	From	To	Length	Direction	Functional Class	Annual Delay	Annual Delay per Mile	Annual Target Delay per Mile	Rank Annual Delay per Mile
MN-95	US-8	350th St	6.06	WB	4	882	146	146	332
MN-95	US-8	MN-243 (Osecola Road)	4.75	EB	4	605	127	127	333
MN-47	Norris Lake Rd	Viking Blvd	3.84	SB	4	398	104	17	334
MN-13	280th St	220th St	6.09	NB	4	613	101	101	335
MN-19	181st Ave	251st Ave	7.05	WB	4	676	96	96	336
MN-96	Manning Ave (MN-95)	Manning Ave	2.82	EB	4	252	89	10	337
MN-13	220th St	280th St	6.08	SB	4	516	85	85	338
MN-19	251st Ave	181st Ave	7.05	EB	4	567	80	80	339
MN-25	CR-30 (181 St)	US-12	2.99	NB	4	231	77	77	340
MN-25	US-12	CR-30 (181 St)	2.99	SB	4	230	77	77	341
MN-25	221 St. (CR-32)	CR-30 (181 St)	3.06	NB	4	226	74	0	342
MN-25	Salem Ave (CR-33)	Fort Rd, 7th St (MN-5)	2.67	EB	4	178	67	7	343
MN-25	CR-122 (30th St)	MN-7 (Yellowstone Trail)	3.19	SB	4	204	64	64	344
MN-25	CR-30 (181 St)	221 St. (CR-32)	3.06	SB	4	177	58	0	345
MN-25	CR-30 (181 St)	CR-20 (Watertown Rd)	4.18	SB	4	212	51	51	346
MN-19	Lehnert Ln	251st Ave	4.40	EB	4	207	47	47	347
MN-25	MN-7 (Yellowstone Trail)	CR-122 (30th St)	3.18	NB	4	148	47	47	348
MN-95	MN-243 (Osecola Road)	US-8	4.75	WB	4	209	44	44	349
MN-19	251st Ave	Lehnert Ln	4.40	WB	4	165	37	37	350
MN-95	Maple St	Stonebridge Trl	6.63	EB	4	200	30	0	351
MN-95	MN-97 (Scandia Trail)	Maple St	4.22	EB	4	115	27	0	352
MN-96	Manning Ave	Quail Rd	4.53	EB	4	111	25	1	353
MN-25	CR-20 (Watertown Rd)	CR-30 (181 St)	4.18	NB	4	98	23	23	354
MN-96	Quail Rd	Manning Ave	4.53	WB	4	94	21	0	355
MN-95	Maple St	MN-97 (Scandia Trail)	4.22	WB	4	36	9	0	356
MN-25	Fort Rd, 7th St (MN-5)	221 St. (CR-32)	3.26	NB	4	27	8	8	357
MN-95	Stonebridge Trl	Maple St	6.63	WB	4	42	6	0	358
MN-25	221 St. (CR-32)	Fort Rd, 7th St (MN-5)	3.26	SB	4	20	6	6	359