Regional Transportation Planning Assistance

Regional Multimodal Transportation Operations Supplemental Data and Analysis

St. Cloud Area Planning Organization

Prepared by:

SRF

February 2018

SRF No. 10275

Table of Contents

\\vs-mpls1\ProjData\Projects\10000\10275\TS\Documentation\St Cloud APO Task 3 Final.docx

Introduction

Performance-based planning approaches are becoming widely adopted practices in transportation. These methods use data-driven processes to plan future investments. They are characterized as an objective and transparent approach, allowing planners to link decisions to performance measurements observed on the system. Finally, desired outcomes are expected to be achieved, as the actions taken are based on proven relationships between the investments and system performance.

This report summarizes an investigation of performance measures for the St. Cloud Area Planning Organization (APO) completed in advance of the update of its 2045 Long Range Transportation Plan (LRTP). Efforts are currently underway to advance performance measures – both those that are federally required as well as tailored measures for the region. This report summarized efforts to formalize this process in advance of the LRTP update and seeks to provide recommendations for performance measurement techniques that will provide the highest return on investment towards enhancing the planning and programming process.

There are several considerations that influence the current practices of the APO with respect to performance measurement since the last LRTP update. One consideration is that measures used in the previous LRTP did not become institutionalized in the APO which, in addition to staff turnover, means performance indicators have not been continuously measured. The first chapter of this report provides a summary of past performance-based planning efforts and draws conclusions regarding how these approaches ought to be changed for forthcoming efforts.

The second chapter outlines performance measures that are now required for the APO to report at the federal level. MAP-21 included requirements for Metropolitan Planning Organizations to report on several aspects of transportation system performance, and rules for this reporting have recently been finalized. This report is intended to provide a roadmap for the APO to come into compliance with these requirements.

In addition to federally required measures, there is interest in supplemental performance measures that could be implemented at the regional level. The third chapter provides an overview of various measures that may be beneficial for the APO to consider incorporating into its measurement and planning process. These measures may build upon the federal measures but expand their coverage to a larger portion of the regional roadway system. Measures extending beyond the roadway system are also explored to provide additional understanding of other modes of travel in the region.

Finally, a template providing examples of visualization techniques for communicating transportation performance measures is presented. This is intended to serve as a graphical example of how system performance can be communicated in an understandable fashion. Performance-based planning relies on making the underlying data and trends accessible to stakeholders using visual methods that go beyond the basic statistics required in the federal guidelines. Using the methods in the template, the APO should be able to update this on an annual basis as performance measurements are updated.

Existing Conditions: Transportation Systems Management (TSM) Roadway Deficiency Analysis

Previous TSM Background and Overview

As part of the *Roadways* section of the Blueprint-2040 Long Range Transportation Plan (LRTP) a Transportation Systems Management (TSM) process was undertaken. This approach utilized basic and readily available data to evaluate several aspects of operational performance on the roadways in the planning area. This facilitated identification of several high-priority problem locations that were investigated in greater detail, and concepts were developed and analyzed that could help to improve operations in these locations. The process of this approach is summarized in the following steps:

- Identify issue locations
- Screen locations for most pressing issues
- Develop lower-cost/high-benefit solutions
- Prioritize solutions with highest return on investment

The data sources included in this evaluation included **level of service**, **crash rate**, and **traffic volume**. These were aggregated in a "primary screening" process which narrowed the list to ten priority problem locations on the roadway system. Lower-cost/high-benefit solution concepts were developed for these locations with a group of local agency officials. These concepts were then evaluated to estimate their cost effectiveness in relieving observed mobility and safety concerns. A total of eight locations were found to have solutions with strong cost effectiveness estimates and were recommended in the LRTP.

In the years since adoption of the latest LRTP, none of the recommended lower-cost/high-benefit solutions have been implemented. There are likely many factors that contributed to this outcome. While it is difficult to isolate specific factors on a project-by-project basis, several overarching themes with a potential influence may include:

- Dedicated funding for these improvements was not allocated. While the TSM solutions provided cost-effective concepts, funding these investments faced competition from other capital projects.
- The metrics used in the TSM do not provide a complete picture of system performance using comprehensive data. While readily available data was used for this effort, it was unable to account for all the factors that influence the planning and programming process.
- The TSM did not combine the operational performance with physical asset conditions.

The investigation and findings presented in this report seek a new approach to data collection and performance measurement to support a successful TSM approach. Ultimately a successful TSM process will be characterized by its integration into the overall planning and programming process as well as adoption by regional stakeholders. Supplying the right performance measures, backed up with applicable data sources, is the critical first step to advancing this process.

Several questions should be considered regarding the action steps to grow from the current TSM process to a fully-fledged performance-based planning approach. For example, the output of the TSM should become an integrated input into *something* else. For instance, how will findings be used and applied to the TIP process in subsequent years? To reach these outcomes, can we evolve the current process, or does it need to be replaced with an entirely new approach?

Over the longer term, there are additional action steps that should be explored to support an enhanced TSM for performance-based planning. These may include increased ownership of the solutions which might help local agency partners to prioritize these improvements in the context of competing transportation system needs. Further, the APO could take steps to create a dedicated funding source for these types of spot improvements. Any new approaches will need to be developed and implemented cooperatively with local agency partners.

Success of a reimagined TSM approach will be measured by the adoption among agency partners responsible for managing and operating the transportation system.

Goals and Objectives: Moving to Performance Based-Planning and Programming

A key feature of MAP-21 is the establishment of a performance-based program for planning organizations to report on several aspects of transportation system performance within their jurisdiction. The objective of this performance-based program is for State DOTs and MPOs, such as the APO, to invest resources in projects that will collectively make progress toward the achievement of national transportation system performance goals.

The MAP-21 performance goals address many transportation system challenges such as improving safety, maintaining infrastructure conditions, reducing traffic congestion, improving efficiency of freight movement, and protecting the environment. Under MAP-21, FHWA and FTA have established the following nine performance measure categories for monitoring progress toward meeting the Federal highway and transit system performance goals:

1. Roadway Safety
2. NHS Pavement Condition
3. NHS Bridge Condition
4. NHS Performance
5. Interstate Freight Movement
6. Traffic Congestion
7. Mobile Source Emissions
8. Transit Asset Management
9. Transit Safety

The following sections will describe in greater detail each of the nine MAP-21 performance measure categories, identify the data and information required for each performance measure, and explain the APO's current approach to achieve compliance with the measures and identifying a method for obtaining future compliance.

MAP-21 Federal Performance Measures

Roadway Safety

Description of Measures

The purpose of this section is to establish performance measures for carrying out the Highway Safety Improvement Program (HSIP) and for the APO to use in assessing:

a. Serious injuries and fatalities per vehicle miles traveled (VMT); and
b. Number of serious injuries and fatalities.

The HSIP is a core Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. The performance measures defined in this section are applicable to all public roads covered by the HSIP within the jurisdiction of the APO.

What does it measure? What does it tell us?

The following are the five Federally-required performance measures for carrying out the HSIP:

1. Number of fatalities
2. Rate of fatalities
3. Number of serious injuries
4. Rate of serious injuries
5. Number of non-motorized fatalities and non-motorized serious injuries

Each performance measure is based on a 5-year rolling average. The performance measures are calculated as follows:

PERFORMANCE MEASURE	METHOD OF CALCULATION
Number of Fatalities	Number of fatalities for each of the most recent five consecutive years ending in the year for which the targets are established, dividing by five, and rounding to the tenth decimal place.
Rate of Fatalities	Calculation of the number of fatalities per 100 million VMT (100M VMT) for each of the most recent five consecutive years ending in the year for which the targets are established, adding the results, dividing by five, and rounding to the thousandth decimal place.
Number of Serious Injuries	Addition of the number of serious injuries for each of the most recent five consecutive years ending in the year for which the targets are established, dividing by five, and rounding to the tenth decimal place.
Rate of Serious Injuries	Calculation of the number of serious injuries per 100 million VMT (100M VMT) for each of the most recent five consecutive years ending in the year for which the targets are established, adding the results, dividing by five, and rounding to the thousandth decimal place.
Number of Non-Motorized Fatalities and Serious Injuries	Addition of the number of non-motorized fatalities to the number of non-motorized serious injuries for each of the most recent five consecutive years ending in the year for which the targets are established, dividing by five, and rounding to the tenth decimal place.

Baseline Performance Measurements

- The table below indicates the APO's baseline measurements (2015) for roadway safety performance:

Performance Measure	**Baseline Measurement (2015)**
Number of Fatalities	8.2
Rate of Fatalities (per 100M VMT)	0.639
Number of Serious Injuries	21.6
Rate of Serious Injuries (per 100M VMT)	1.470
Number of Non-Motorized Fatalities and Serious Injuries	7.0

Status in the Planning Area

Consistent with the "Toward Zero Deaths" initiative, an objective of the APO Plan is to reduce the number of fatalities and the severity of crashes throughout the APO area. Achieving this initiative requires establishing and monitoring performance measure targets and linking system improvements and investments to known problem areas. These investments will help reduce the number of fatalities and serious injuries system wide.

The APO currently monitors and reports data for the five Federally-required HSIP performance measures by utilizing the Fatality Analysis Reporting System (FARS) generated by the National Highway Traffic Safety Administration (NHTSA). The APO's Technical Advisory Committee recently approved the proposed roadway safety targets for 2018, which are:

Performance Measure	**Target Measurement (2018)**
Number of Fatalities	7.8
Rate of Fatalities (per 100M VMT)	0.598
Number of Serious Injuries	13.9
Rate of Serious Injuries (per 100M VMT)	1.070
Number of Non-Motorized Fatalities and Serious Injuries	7.0

NHS Pavement Condition

Description of Measures

The purpose of this section is to establish measures for carrying out the National Highway Performance Program (NHPP) and for the APO to use in assessing:

a. Condition of pavements on the Interstate System;

b. Condition of pavements on the National Highway System (NHS);

c. Minimum levels for pavement condition on the Interstate System;

d. Data elements that are necessary to collect and maintain standardized data to carry out a performance-based approach; and

e. Regional differences in establishing the minimum levels for pavement conditions on the Interstate System.

The NHPP, which was established under MAP-21, provides support for the condition and performance of the NHS, for the construction of new facilities on the NHS, and to ensure that investments of Federal-aid funds in highway construction are directed to support progress toward the achievement of performance targets established by local agencies. The performance measures indicated in this section are applicable to the mainline highways on the Interstate System and the non-Interstate NHS.

What does it measure? What does it tell us?

The following are the four Federally-required performance measures for carrying out the NHPP and for the APO to utilize for assessing pavement conditions:

1. Percentage of pavements of the Interstate System in Good condition
2. Percentage of pavements of the Interstate System in Poor condition
3. Percentage of pavements of the non-Interstate NHS in Good condition
4. Percentage of pavements of the non-Interstate NHS in Poor condition

State DOTs will collect and process data to calculate individual pavement condition metrics for each section of pavement that will be reported to FHWA, and will use the reported pavement condition metrics to compute an overall performance of Good, Fair, or Poor, for each section of pavement. The four condition metrics for each pavement section are IRI, Rutting, Faulting, and Cracking Percent, and are described in further detail in the following table:

METRIC	DESCRIPTION
IRI	International Roughness Index (IRI) is a statistic used to estimate the amount of roughness in a measured longitudinal profile. The IRI is computed from a single longitudinal profile using a quarter-car simulation. If an IRI value of a pavement section is less than 95, the IRI rating is Good; between 95 and 170, the IRI rating is Fair; and greater than 170, the IRI rating is Poor.
Rutting	Rutting is the longitudinal surface depressions in the pavement derived from measurements of a profile transverse to the path of travel on a highway lane. It may have associated transverse displacement. For asphalt pavement, if the rutting value of a section is less than 0.20 inches, the rutting rating is Good; if the rutting value is equal to or greater than 0.20 inches and less than or equal to 0.40 inches, the rutting rating is Fair; and if the rutting value is greater than 0.40 inches, the rutting rating for the pavement section is Poor.
Faulting	Faulting is the vertical misalignment of pavement joints in Portland Cement Concrete Pavements. For jointed concrete pavement, if the faulting value of a section is less than 0.10 inches, the faulting rating is Good; if the faulting value is equal to or greater than 0.10 inches and less than or equal to 0.15 inches, the faulting rating is Fair; and if the faulting value is greater than 0.15 inches, the faulting rating of the section is Poor.
Cracking Percent	Cracking Percent is the percentage of pavement surface exhibiting cracking as follows: For asphalt pavements, the percentage of the area of the pavement section, exhibiting visible cracking; for jointed concrete pavements, the percentage of concrete slabs exhibiting cracking; for CRCP, the percentage of pavement surface with longitudinal cracking and/or punch-outs, spalling or other visible defects.

The overall pavement section performance rating of Good, Fair, or Poor, shall be determined from the IRI, Rutting, Faulting, and Cracking Percent condition metrics as described in the following table:

RATING	CRITERIA
Good	A pavement section shall be rated an overall condition of Good only if the section is exhibiting Good ratings for **all** condition metrics (IRI, Rutting/Faulting, Cracking Percent).
Fair	A pavement section shall be rated an overall condition of Fair if it does not meet the criteria of a Good or Poor rating.
Poor	A pavement section shall be rated an overall condition of Poor if **two or more** of the condition metrics (IRI, Rutting/Faulting, Cracking Percent) are exhibiting Poor ratings.

Alternatively, State DOTs will be permitted to report the Present Serviceability Rating (PSR) for locations where posted speed limits are less than 40 miles per hour in lieu of the IRI, Rutting, Faulting, and Cracking Percent condition metrics. The PSR is an observation-based system used to rate pavements where a panel of observers ride in an automobile over the pavement in question. The PSR is scored and recorded on a 0.0 to 5.0 scale based on the following observations and attributes:

PSR RATING	OBSERVATIONS & ATTRIBUTES
4.0 – 5.0	Only new (or nearly new) superior pavements are likely to be smooth enough and distress free (sufficiently free of cracks and patches) to qualify for this category. Most pavements constructed or resurfaced during the data year would normally be rated in this category.
3.0 – 4.0	Pavements in this category, although not quite as smooth as those described above, give a first-class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
2.0 – 3.0	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching. Rigid pavements in this group may have a few joint failures, faulting and/or cracking, and some pumping.
1.0 – 2.0	Pavements in this category have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes raveling, cracking, and/or rutting and occurs on over 50 percent of the surface. Rigid pavement distress includes joint spalling, patching, cracking, scaling, and may include pumping and faulting.
0.0 – 1.0	Pavements in this category are in an extremely deteriorated condition. The facility is passable only at reduced speeds, and with considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs on over 75 percent or more of the surface.

For locations where the PSR is utilized, the pavement section performance rating of Good, Fair, or Poor, shall be determined by the following method:

- For PSR equal to or greater than 4.0, the pavement section rating is Good.
- For PSR less than 4.0 and greater than 2.0, the pavement section rating is Fair.
- For PSR less than or equal to 2.0, the pavement section rating is Poor.

Additionally, the overall condition rating for continuously reinforced concrete pavement (CRCP) sections shall be determined based on ratings of IRI and Cracking Percent, or PSR where appropriate, for each section as follows:

- A CRCP section shall be rated an overall condition of Good only if the section is exhibiting Good ratings for both IRI and Cracking Percent conditions.
- A CRCP section shall be rated an overall condition of Poor if it exhibits Poor ratings for both IRI and Cracking Percent conditions.
- A CRCP section shall be rated an overall condition of Fair if it does not meet the Good or Poor rating criteria.
- For CRCP sections that are on roadways where the State DOT reported the PSR metric, the pavement section shall be rated an overall condition equal to the PSR condition rating.

Baseline Performance Measurements

- The table below indicates the APO's baseline measurements (2015) for NHS pavement condition performance:

Performance Measure	Baseline Measurement (2015)
Percentage of pavements of the Interstate System in Good condition	81%
Percentage of pavements of the Interstate System in Poor condition	11%
Percentage of pavements of the non-Interstate NHS in Good condition	94%
Percentage of pavements of the non-Interstate NHS in Poor condition	1%

Status in the Planning Area

Select goals and objectives within the APO LRTP are directed towards pavement system preservation. To help achieve these goals and objectives, the APO will work with MnDOT in evaluating the National Highway System (NHS) and other MAP-21 NHS Principal Arterial routes from a pavement condition perspective. Over time, the APO will work with local jurisdictions to track pavement conditions on other roadways, such as minor arterials, collectors, and local roadways.

The APO currently monitors and reports data for the four Federally-required NHS pavement condition performance measures by utilizing FHWA's Highway Performance Monitoring System

(HPMS). Specific targets for each performance measure will need to be established by the APO for 2018, and the APO will seek additional guidance provided at the federal and state level. In the meantime, the APO will continue to focus investments on system preservation strategies. Segments that have been identified in poor condition, such as Highway 10, are already programmed for improvements in the 2014 – 2019 State Transportation Improvement Program (STIP). In general, the interstate and non-interstate NHS roadways within the APO are in a good condition. However, future investments will need to focus on system preservation strategies to ensure that these routes are maintained in a state of good repair.

NHS Bridge Condition

Description of Measures

The purpose of this section is to establish performance measures for carrying out the NHPP and for the APO to use in assessing the structural condition of bridges carrying the NHS, including on and off-ramps connected to the NHS. The condition of bridges, including on and off-ramps connected to the NHS, shall be classified as Good, Fair, or Poor based on the condition ratings for the deck, superstructure, substructure, and culverts provided by the National Bridge Inventory (NBI). The NBI is a FHWA database containing bridge information and inspection data for all highway bridges on public roads, on and off Federal-aid highways, including tribally owned and federally owned bridges, which are subject to the National Bridge Inspection Standards (NBIS).

What does it measure? What does it tell us?

The following are the three Federally-required performance measures for the APO to assess bridge conditions:

1. Percentage of NHS bridges classified as in Good condition.
2. Percentage of NHS bridges classified as in Fair condition.
3. Percentage of NHS bridges classified as in Poor condition.

The bridges carrying the NHS, which includes on and off-ramps connected to the NHS, are to be classified as Good, Fair, or Poor based on the following criteria:

CRITERIA	DESCRIPTION
Good	When the lowest rating of the three NBI items for a bridge (deck, superstructure, substructure) is 7, 8, or 9, the bridge will be classified as Good. When the rating of NBI item for a culvert is 7, 8, or 9, the culvert will be classified as Good.
Fair	When the lowest rating of the three NBI items for a bridge (deck, superstructure, substructure) is 5 or 6, the bridge will be classified as Fair. When the rating of NBI item for a culvert is 5 or 6, the culvert will be classified as Fair.
Poor	When the lowest rating of the three NBI items for a bridge (deck, superstructure, substructure) is 4, 3, 2, 1, or 0, the bridge will be classified as Poor. When the rating of NBI item for a culvert is 4, 3, 2, 1, or 0, the culvert will be classified as Poor.

For NHS bridges in the state of Minnesota, rating scores for each NBI item are determined from bridge inspections performed under the guidelines of the Minnesota Department of Transportation's Bridge and Structure Inspection Program Manual (BSIPM). The purpose of the BSIPM is to compile the policies and procedures in a comprehensive reference to promote consistent and uniform methods of inspection and documentation of bridge conditions throughout the state.

The manual is intended to serve as a field guide for the inspection and condition rating of bridges and culverts on roadways in Minnesota. A bridge inspection includes examining the structure, evaluating the physical condition of the structure, and reporting the observations and evaluations on the bridge inspection report. The NBI condition ratings describe the general overall condition of a bridge, culvert, or tunnel. Detailed information regarding determination of the rating scores for bridge decks, superstructures, substructures, and culverts can be found in the BSIPM Chapter B.2.

Baseline Performance Measurements

- The table below indicates the APO's baseline measurements (2015) for NHS bridge condition performance:

Performance Measure	Baseline Measurement (2015)
Percentage of NHS bridges classified as in Good condition	53%
Percentage of NHS bridges classified as in Fair condition	47%
Percentage of NHS bridges classified as in Poor condition	0%

Status in the Planning Area

Select goals and objectives within the APO Plan are directed towards bridge preservation. To help achieve these goals and objectives, the APO will begin evaluating bridges located on the NHS and other MAP-21 NHS Principal Arterial routes. The APO will work with local jurisdictions to identify other bridge investments on lower classified roadways, such as minor arterials, collectors, and local roadways.

The APO currently monitors and reports data for the three Federally-required NHS bridge condition performance measures by utilizing MnDOT's bridge inspection data and the NBI. Specific targets for each performance measure will need to be established by the APO for 2018, and the APO will seek additional guidance provided at the federal and state level. In general, bridges located on the NHS and MAP-21 NHS Principal Arterials are in good condition. However, future investments will need to focus on system preservation strategies to ensure that these bridges are maintained in a state of good repair.

The NHS within the APO area includes Interstate 94 and Highway 23. Other MAP-21 NHS Principal Arterials include Highway 10, Highway 15, and CSAH 75. Bridge conditions for these corridors, except for CSAH 75 have been documented by MnDOT's Corridor Investment Management Strategy (CIMS) in 2012. This analysis included data from 2010, which included approximately forty bridges. The CIMS analysis did not indicate any bridges in poor condition. In regards to CSAH 75, there is a bridge located over the Sauk River which was first built in 1954 and reconstructed in 1978.

The APO will continue to work with MnDOT to establish appropriate targets and a monitoring schedule. The APO will also work with its local partners to establish targets for bridges located on other functionally classified roads, such as minor arterials and collectors.

NHS Performance

Description of Measures

The purpose of this section is to establish performance measures for the APO to use in assessing travel time reliability and greenhouse gas emissions on the Interstate System and non-Interstate NHS. Travel time reliability is the consistency or dependability of travel times from day to day or across different times of the day. A greenhouse gas (GHG) is any gas that absorbs infrared radiation and traps heat in the atmosphere.

What does it measure? What does it tell us?

The following are the two Federally-required performance measures for the APO to assess travel time reliability:

1. Percent of the person-miles traveled on the Interstate that are reliable (referred to as the Interstate Travel Time Reliability measure).
2. Percent of person-miles traveled on the non-Interstate NHS that are reliable (referred to as the Non-Interstate Travel Time Reliability measure).

The following is the Federally-required performance measure for the APO to assess GHG emissions:

1. Percent change in tailpipe CO_2 emissions on the NHS compared to the calendar year 2017 level.

The two performance metrics required for the NHS Performance measures listed above are the Level of Travel Time Reliability (LOTTR) and Annual Total Tailpipe CO_2 Emissions, and are described in further detail below:

METRIC	DESCRIPTION
Level of Travel Time Reliability (LOTTR)	The Level of Travel Time Reliability (LOTTR) is a comparison, expressed as a ratio, of the 80th percentile travel time of a reporting segment to the normal (50th percentile) travel time of a reporting segment occurring throughout a full calendar year. Travel time data needed to calculate the LOTTR for each measure shall be derived from FHWA's National Performance Management Research Data Set (NPMRDS).
Annual Total Tailpipe CO_2 Emissions	The Annual Total Tailpipe CO_2 Emissions is total tailpipe CO_2 emissions on the NHS in a calendar year (to the nearest thousand tons). The FHWA will provide tailpipe CO_2 emissions factors State DOTs and MPOs to use in the calculation.

For calculating the LOTTR metric, the 50th percentile describes the median travel time, or the typical travel time a user would experience on a highway or trip. The 80th percentile describes the worst travel time out of five trips and can in other words represents the worst day of the week. By calculating the ratio of these values, this measure provides an indication of how much longer travel times are on the worst day of the week compared to typical conditions. Data are collected in 15-minute segments during all time periods other than 8 p.m.-6 a.m. local time.

For calculating the GHG metric, the APO may use the State's VMT as a proxy for the APO share of CO_2 emissions, VMT estimates along with EPA's Motor Vehicle Emission Simulator (MOVES) factors, FHWA's Energy and Emissions Reduction Policy Analysis Tool (EERPAT) model, or other methods for which the APO can demonstrate valid and useful results for CO_2 measurement.

Baseline Performance Measurements

- The table below indicates the APO's baseline measurements (2015) for NHS system performance:

Performance Measure	Baseline Measurement (2015)
Percent of person-miles traveled on the Interstate that are reliable	100%
Percent of person-miles traveled on the non-Interstate NHS that are reliable	76%

Status in the Planning Area

Select goals and objectives within the APO Plan have specifically recognized a reduction in excessive travel delays through the reduction of vehicle hours and miles traveled. To help evaluate these goals, the APO has used the APO Travel Demand Model to estimate reductions over time.

The APO will work together with federal and state agencies to calculate and report travel time reliability on the Interstate and non-Interstate NHS and annual total tailpipe CO_2 emissions. Specific targets for each performance measure will need to be established by the APO for 2018, and the APO will seek additional guidance provided at the federal and state level. In the meantime, the APO will continue to focus on promoting alternative transportation solutions, which in turn help reduce VMT. The VMT reduction are targeted for Annual Total Tailpipe CO_2 Emissions reductions. The APO will continue to work with MnDOT to establish a reporting workplan and a monitoring schedule for the NHS performance measures.

Interstate Freight Movement

Description of Measure

The purpose of this section is to establish performance measures for the APO to use in assessing national freight movement on the Interstate System.

What does it measure? What does it tell us?

The following is the Federally-required performance measure for the APO to assess freight movement on the Interstate System:

1. Truck Travel Time Reliability (TTTR) Index

The TTTR Index is the consistency or dependability of truck travel times from day to day or across various times of the day. Travel time data needed to calculate the TTTR Index shall be derived from FHWA's NPMRDS.

Unlike the LOTTR which uses a threshold to determine reliability, the TTTR Index is expressed as an average for the entire applicable area. Reporting is divided into the following five periods:

a. Morning peak (6 a.m.-10 a.m., Monday through Friday)

b. Midday (10 a.m.-4 p.m., Monday through Friday)

c. Afternoon peak (4 p.m.-8 p.m., Monday through Friday)

d. Weekends (6 a.m.-8 p.m.)

e. Overnights for all days (8 p.m.-6 a.m.)

The TTTR Index is often referred to as the planning time index and is frequently used in the freight industry for planning on-time arrivals. The measure expresses the ratio of 50th percentile to the 95th percentile travel times. As noted in the LOTTR measure, the 50th percentile travel time describes the typical travel time a user would experience. The 95th percentile reflects the worst travel time out of 20 trips, which can be roughly equated to the number of weekdays in a month. In summary, this measure provides an indication of how much longer travel times are on the worst day of the month compared to typical conditions.

The TTTR Index will be generated by multiplying each segment's largest ratio of the five periods by its length, then dividing the sum of all length-weighted segments by the total length of Interstate. The APO will have the data needed in FHWA's NPMRDS as the data set includes truck travel times for the full Interstate System. The APO may use an equivalent data set if preferred.

Baseline Performance Measurements

- The table below indicates the APO's TTTR Index baseline measurements for interstate freight movement performance:

Reporting Period	Baseline Measurement (2015) (TTTR Index – All TMCs)
Morning Peak (6 a.m.-10 a.m., M-F)	2.64
Midday (10 a.m.-4 p.m., M-F)	2.44
Afternoon peak (4 p.m.-8 p.m., M-F)	2.41
Weekends (6 a.m.-8 p.m.)	2.21
Overnights for all days (8 p.m.-6 a.m.)	2.24

Status in the Planning Area

The APO currently utilizes the NPMRDS to calculate and report the TTTR Index on its Interstate System. A specific target for the TTTR performance measure will need to be established by the APO for 2018, and the APO will seek additional guidance provided at the federal and state level. The APO will continue to work with MnDOT to establish a reporting workplan and a monitoring schedule for the interstate freight movement performance measure.

Traffic Congestion

Description of Measures

The purpose of this section is to establish performance measures for the APO to use in assessing traffic congestion for the purpose of carrying out FHWA's Congestion Mitigation and Air Quality Improvement (CMAQ) Program. The CMAQ traffic congestion performance measures are applicable to all urbanized areas that include NHS mileage and with a population over 1 million for the first performance period, and in urbanized areas with a population over 200,000 for the second and all other performance periods, that are, in all or part, designated as nonattainment or maintenance areas for ozone (O_3), carbon monoxide (CO), or particulate matter (PM_{10} and $PM_{2.5}$) by National Ambient Air Quality Standards (NAAQS).

The NAAQS pollutants referenced in this section are those with criteria used to establish the attainment status of a region. Current measurements within the APO have been observed at levels within the standards for attainment.

The performance measures described in this section reflect traffic operations performance as indicators of conditions that impact emissions of these pollutant. Therefore, methods to calculate these performance measures are based on travel time data for the peak hour excessive delay (PHED) and travel behavior for the percent of non-SOV travel.

What does it measure? What does it tell us?

The following are the two Federally-required performance measures for the APO to assess traffic congestion for carrying out the CMAQ program:

1. Annual Hours of Peak Hour Excessive Delay (PHED) Per Capita
2. Percent of Non-SOV Travel

Each performance measure is described as follows:

PERFORMANCE MEASURE	DESCRIPTION
Annual Hours of Peak Hour Excessive Delay (PHED) Per Capita	Annual hours of peak hour excessive delay is the extra amount of time spent in congested conditions defined by speed thresholds that are lower than a normal delay threshold. For the purposes of this rule, the speed threshold is 20 miles per hour or 60 percent of the posted speed limit, whichever is greater.
Percent of Non-SOV Travel	Non-SOV travel is defined as any travel mode other than driving alone in a motorized vehicle, such as single occupancy vehicle or SOV travel, including travel avoided by telecommuting.

Travel time data needed to calculate the PHED measure shall be derived from the NPMRDS. The threshold for excessive delay will be based on the travel time at 20 miles per hour or 60 percent of the posted speed limit travel time, whichever is greater, and will be measured in 15-minute intervals. Peak travel hours are defined as 6 a.m.-10 a.m. local time on weekday mornings; the weekday afternoon period is 3 p.m.-7 p.m. or 4 p.m.-8 p.m. local time. The total excessive delay metric will be weighted by vehicle volumes and occupancy.

The data to determine the Percent of Non-SOV Travel measure may be developed using any one of the following methods:

a. American Community Survey: Populations by predominant travel to commute to work may be identified from the American Community Survey using the totals by transportation mode listed within the "Commuting to Work" subject heading under the "Estimate" column of the table. The "5-Year Estimate" table using a geographic filter that represents the applicable "Urban Area" shall be used to identify these populations. The Percent of Non-SOV Travel measure shall be developed from the most recent data as of August 15th of the year in which the State Biennial Performance Report is due to FHWA.

b. Local Survey: The Percent of Non-SOV Travel may be estimated from a local survey focused on either work travel or household travel for the area and conducted as recently as two years before the beginning of the performance period. The survey method shall estimate travel mode choice for the full urbanized area using industry accepted methodologies and approaches resulting in a margin of error that is acceptable to industry standards, allow for updates on at least a biennial frequency, and distinguish non-SOV travel occurring in the area as a percent of all work or household travel.

c. System Use Measurement: The volume of travel using surface modes of transportation may be estimated from measurements of actual use of each transportation mode. Sample or continuous measurements may be used to count the number of travelers using different surface modes of transportation. The method used to count travelers shall estimate the total volume of annual travel for the full urbanized area within a margin of error that is acceptable to industry standards and allows for updates on at least a biennial frequency. The method shall include sufficient information to calculate the amount of non-SOV travel occurring in the area as a percentage of all surface transportation travel. State DOTs are encouraged to report use counts to FHWA that are not included in currently available national data sources.

Additional data and analysis is required to compute the Peak Hour Excessive Delay (PHED) measure as described in federal guidance. In addition to travel time data, peak hour traffic volumes and posted speed limits are needed to calculate this measure. The APO should investigate opportunities to supply this data in order to facilitate calculation of this measure in future reporting cycles. The following resources have been identified as potential sources of this information:

Peak Hour Traffic Volumes	Posted Speed Limits
1. Ground counts could be collected using roadside detection equipment such as pneumatic road tubes or side-fire radar. Data collection cost are potentially high due to the significant number of roadway segments within the planning area and the personnel costs associated with field data collection. An opportunity for cost savings would be to collect data at fewer sites along a stretch of roadway with similar daily travel patterns, and then scale the peak hour percent of daily traffic on upstream and downstream segments. 2. A planning-level approximation of peak hour volumes could be applied based on rules-of-thumb for peak hour percent of daily traffic. Typical rule-of-thumb peak hour values are 8 percent and 10 percent of daily traffic for AM and PM peak hours, respectively. This method could be enhanced by referencing the travel demand model to estimate directional splits for roadway segments.	1. Field observation could be performed to develop an inventory of posted speed limits on roadway segments to be included in the analysis. Virtual map tools, like Google Street View, can also facilitate this and reduce the cost of extensive staff time in the field. 2. Speed limits can be updated based on available roadway system information maintained by highway agencies (MnDOT, counties, cities). Ideally these records would be stored in GIS shapefiles to provide spatial information to link to the NPMRDS travel time data. However, if records are only available in tabular format additional manual processing would likely be required. 3. Highway speeds from the regional travel demand model could also be considered as a source for this. It is not certain, however, that the speeds in the travel demand model are consistent with posted speed limits, as travel demand models frequently use customized speeds, rather than posted speeds, to estimate travel times that more accurately reflect driver behavior.

Once data sources and collection methods are selected for the peak hour traffic volumes and posted speed limits, additional analysis will be necessary to conflate this information with segment of the NPMRDS highway network. The NPMRDS segments are provided in a shapefile available through FHWA and are the scale at which calculating PHED is recommended. The peak hour traffic volumes and posted speed limit data will, in all likelihood, be stored in a different format. Thus, a conflation process must be completed to link these attributes to the NPMRDS segments. ArcGIS software does provide some tools to facilitate spatial data conflation, however manual review and adjustments should also be performed to verify accuracy.

Status in the Planning Area

The APO is currently an urbanized area with a population under 1 million and is designated as an attainment area for ozone (O_3), carbon monoxide (CO), and particulate matter (PM_{10} and $PM_{2.5}$) by NAAQS, and therefore the CMAQ traffic congestion performance measures are not applicable. However, the APO may choose to voluntarily enact these performance measures. Additionally, other measures of congestion are also possible. We provide a more complete discussion of potential measures of congestion for the APO to consider in later sections of this document.

Mobile Source Emissions

Description of Measure

The purpose of this section is to establish a performance measure for the APO to use in assessing on-road mobile source emissions. On-road mobile source emissions are created by all projects and sources financed with funds from the CMAQ Program.

The on-road emissions performance measure is applicable to all States and MPOs with projects financed with funds from the CMAQ program apportioned to State DOTs for areas designated as nonattainment or maintenance for ozone (O_3), carbon monoxide (CO), or particulate matter (PM_{10} and $PM_{2.5}$) by NAAQS. This performance measure does not apply to States and MPOs that do not contain any portions of nonattainment or maintenance areas for the criteria pollutants identified in this section.

What does it measure? What does it tell us?

The performance measure for the purpose of carrying out the CMAQ Program and for State DOTs to use to assess on-road mobile source emissions is:

1. Total Emissions Reduction

The performance measure is described as follows:

PERFORMANCE MEASURE	DESCRIPTION
Total Emissions Reduction	The two year and four year cumulative reported emission reductions, for all projects funded by CMAQ funds, of each criteria pollutant and applicable precursors ($PM_{2.5}$, PM_{10}, CO, VOC, and NOx) under the CMAQ program for which the area is designated nonattainment or maintenance.

The data needed to calculate the Total Emission Reduction measure shall come from the CMAQ Public Access System.

Status in the Planning Area

The APO is currently designated as an attainment area for ozone (O_3), carbon monoxide (CO), and particulate matter (PM_{10} and $PM_{2.5}$) by NAAQS, and therefore the CMAQ traffic congestion performance measure is not applicable.

Transit Asset Management

Description of Measures

The National Transit Asset Management (TAM) System was established to monitor and manage public transportation capital assets to enhance safety, reduce maintenance costs, increase reliability, and improve performance. The National TAM System is a strategic and systematic process of operating, maintaining, and improving public transportation capital assets effectively, throughout their life cycles. Establishment of a local TAM system applies to all recipients and sub recipients of Federal financial assistance that own, operate, or manage capital assets used for providing public transportation.

A Tier I agency owns, operates, or manages either one hundred and one (101) or more vehicles in revenue service during peak regular service across all fixed route modes or in any one non-fixed route mode, or rail transit.

A Tier II agency owns, operates, or manages one hundred (100) or fewer vehicles in revenue service during peak regular service across all non-rail fixed route modes or in any one non-fixed route mode, or a sub-recipient under the 5311 Rural Area Formula Program, or any American Indian tribe.

The National TAM System includes the following main elements:

a. Development and implementation of a TAM plan.

b. Performance measures for capital assets and establishment of performance targets for improving the condition of capital assets.

Development of a TAM plan includes an inventory of capital assets, a condition assessment of inventoried assets, a decision support tool, and prioritization of investments. Additional requirements of a TAM plan must include:

AGENCY TYPE	TAM PLAN REQUIREMENTS
Tier I and Tier II	• Inventory of the number and type of capital assets, including all capital assets that an agency owns. • Condition assessment of those inventoried assets for which an agency has direct capital responsibility. • Description of analytical processes or decision-support tools that an agency uses to estimate capital investment needs over time and develop its investment prioritization. • Agency's project-based prioritization of investments.
Tier I Only	• Agency's TAM and state of good repair policy. • Agency's TAM plan implementation strategy. • Description of key TAM activities that an agency intends to engage in over the TAM plan period. • Summary or list of the resources, including personnel, that an agency needs to develop and carry out the TAM plan. • Outline of how an agency will monitor, update, and evaluate, as needed, its TAM plan and related business practices, to ensure the continuous improvement of its TAM practices.

A TAM plan must cover a period of at least four years. An agency may update its TAM plan at any time during the TAM plan period. An agency must update its entire TAM plan at least once every four years. A provider's TAM plan update should coincide with the planning cycle for the relevant Transportation Improvement Program or Statewide Transportation Improvement Program. An agency's initial TAM plan must be completed no later than two years after October 1, 2016.

What does it measure? What does it tell us?

The following are the four Federally-required performance measure categories for transit operators to assess capital assets within their local TAM system:

1. Equipment: Non-revenue service vehicles
2. Rolling Stock: Revenue service vehicles
3. Infrastructure: Rail fixed-guideway, track, signals, and systems
4. Facilities

Each of the four performance measure categories is described in further detail below:

CATEGORY	PERFORMANCE MEASURE
Equipment	Percentage of non-revenue vehicles that have either met or exceeded their useful life benchmark (ULB). ULB is the expected life cycle or the acceptable period of use in service for a capital asset, as determined by a transit provider, or the default benchmark provided by FTA.
Rolling Stock	Percentage of revenue vehicles within a particular asset class that have either met or exceeded their ULB.
Infrastructure	Percentage of track segments with performance restrictions.
Facilities	Percentage of facilities within an asset class rated below condition 3 on the Transit Economic Requirements Model (TERM) scale. The TERM scale is the five-category rating system used in the FTA's Transit Economic Requirements Model (TERM) to describe the condition of an asset.

The Transit Economic Requirements Model (TERM) is a tool developed by FTA for estimating the nation's transit capital expenditure needs over a 20-year period. Facility condition assessments have one overall TERM rating per facility. The APO is not required to use TERM for conducting condition assessments but must report the facility condition assessment as a TERM rating score. Descriptions of the TERM rating scores are summarized in the following table:

TERM RATING	CONDITION	DESCRIPTION
Excellent	4.8 – 5.0	No visible defects, near-new condition.
Good	4.0 – 4.7	Some slightly defective or deteriorated components.
Adequate	3.0 – 3.9	Moderately defective or deteriorated components.
Marginal	2.0 – 2.9	Defective or deteriorated components in need of replacement.
Poor	1.0 – 1.9	Seriously damaged components in need of immediate repair.

The APO must submit an annual data report to FTA's National Transit Database (NTD) that reflects the performance measure targets for the following year and condition information for the provider's public transportation system.

In addition, the APO must submit an annual narrative report to the NTD that provides a description of any change in the condition of the APO's transit system from the previous year and describes the progress made during the year to meet the performance measure targets set in the previous reporting year.

Baseline Performance Measurements

The table below indicates the APO's baseline measurements (2017) for the National TAM System performance measures:

Performance Measure	**Number of Assets**	**Percent of Assets**
Equipment		
Useful Life Remaining	2	22%
Exceeds Useful Life	7	78%
Total	9	100%
Rolling Stock		
Useful Life Remaining	65	84%
Exceeds Useful Life	12	16%
Total	77	100%
Infrastructure		
Useful Life Remaining	0	0%
Exceeds Useful Life	0	0%
Total	0	0%
Facilities	**2017 Individual Term Scale**	
Mobility Training Center	5.0	
Transit Center	4.0	
Operations	3.0	
Average	3.5	

Status in the Planning Area

Working in cooperation with Metro Bus, the APO Board has approved the following 2018 targets:

Performance Measure	Percent of Assets
Equipment	
Useful Life Remaining	35%
Exceeds Useful Life	65%
Total	100%
Rolling Stock	
Useful Life Remaining	87%
Exceeds Useful Life	13%
Total	100%
Infrastructure	
Useful Life Remaining	0%
Exceeds Useful Life	0%
Total	0%
Facilities	**Percent of Assets Rated Below 3**
Mobility Training Center	0%
Transit Center	0%
Operations	0%
Average	0%

Transit Safety

Description of Measures

The purpose of this section is to improve the safety of public transportation systems by establishing substantive and procedural rules for FTA's administration of the Public Transportation Safety Program. The Public Transportation Safety Program includes a National Public Transportation Safety Plan to improve the safety of all public transportation systems that receive Federal transit funds.

The National Public Transportation Safety Plan guides the national effort in managing the safety risks and safety hazards within our National public transportation systems. The National Safety Plan includes the following main elements:

a. Safety performance criteria for all modes of public transportation.

b. Minimum safety performance standards for public transportation vehicles used in revenue operations that are not otherwise regulated by any other Federal agency.

c. Minimum safety standards to ensure the safe operation of public transportation systems that are not related to vehicle performance standards.

d. A safety certification training program.

Transit operators that are subject to the requirements for Public Transportation Agency Safety Plans would set targets in their Safety Plans based on the measures established in this Plan.

Safety performance management is a critical tool that will support transit providers and FTA in identifying safety concerns and monitoring progress in safety improvements. Based on the vision, mission, and focus areas, FTA will establish performance measures to monitor industry progress towards improving safety performance and help build a common understanding of the state of safety performance.

To capture the broad and varied nature of public transportation, in this first National Safety Plan, FTA is relying on measures that can be applied to all modes of public transportation and are based on data that is generally currently collected in the National Transit Database (NTD). FTA's safety performance measures focus on improving transit safety performance through the reduction of safety events, fatalities, and injuries.

What does it measure? What does it tell us?

The following are the four Federally-required performance measures for transit operators to assess safety performance within their TAM system:

1. Fatalities
2. Injuries
3. Safety Events

4. System Reliability

Each of the four safety performance measures are described in further detail below:

PERFORMANCE MEASURE	DESCRIPTION
Fatalities	Fatalities is measured by the total number of reportable fatalities and rate per total vehicle revenue miles by mode. Reducing the number of fatalities is a top priority for the entire Department of Transportation. As an industry, we must try to understand the factors involved in each fatality to prevent further occurrences. Measuring the number of fatalities over vehicle revenue miles, by mode, provides a fatality rate from which to assess future performance.
Injuries	Injuries is measured by the total number of reportable injuries and rate per total vehicle revenue miles by mode. Injuries occur much more frequently compared to fatalities and are due to a wide variety of circumstances. Analyzing the factors that relate to injuries is a significant step in developing actions to prevent them. Measuring the number of injuries by mode, over vehicle revenue miles provides an injury rate from which to assess future performance.
Safety Events	Safety events is measured by the total number of reportable events and rate per total vehicle revenue miles by mode. The safety events measure captures all reported safety events that occur during transit operations and the performance of regular supervisory or maintenance activities. A reduction in safety events will support efforts to reduce fatalities and injuries, as well as damages to transit assets. Measuring the number of safety events by mode over vehicle revenue miles provides a safety event rate from which future performance can be compared.
System Reliability	System reliability is measured by the mean distance between major mechanical failures by mode. The system reliability measure expresses the relationship between safety and asset condition. The rate of vehicle failures in service, defined as mean distance between major mechanical failures, is measured as revenue miles operated divided by the number of major mechanical failures. This is a measure of how well a fleet of transit vehicles is maintained and operated. FTA recognizes the diversity of the transit industry, and that agencies have varied equipment types, with varied rates of performance, so this measure allows agencies to develop safety performance targets that are specific to their own fleet type, age, operating characteristics, and mode of operation.

The safety performance measures selected by FTA are intended to provide “state of the industry” high-level measures and help focus individual agencies on the development of specific performance indicators and measurable targets relevant to their operations. These measures should also inform agencies as they identify actions they each would take to improve their own safety outcomes. Agencies should select performance targets that are appropriate to their operations and environment.

Status in the Planning Area

The APO will work with Metro Bus to obtain safety performance measurement data, determine and select future performance targets that are appropriate to their operations and environment, and will report findings to the FTA on an annual basis.

Summary

This final MAP-21 rule establishes the process for the APO to establish and report targets and the process that FHWA and FTA will use to assess the progress towards achieving performance targets. State DOTs and MPOs that fail to meet or make significant progress toward targets in a biennial performance reporting period will be required to document the actions they will undertake to achieve their targets in their next biennial performance report.

Expanding Upon the Federal Measures

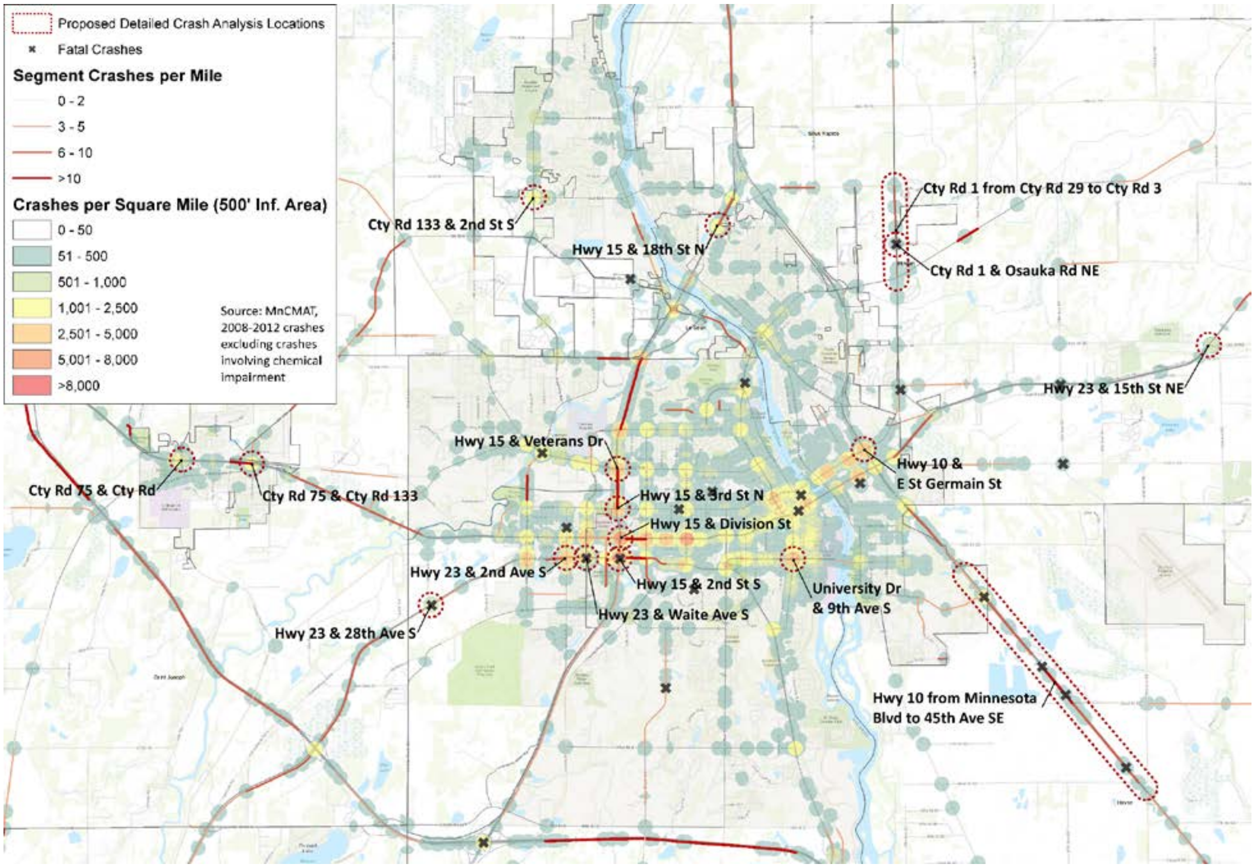
Roadway Safety

Roadway safety should be promoted as one of the key metrics in performance-based planning. Fortunately, Minnesota has a high level of data availability as an input to these measures. Coverage is also an important consideration as safety should be considered across the entire roadway network.

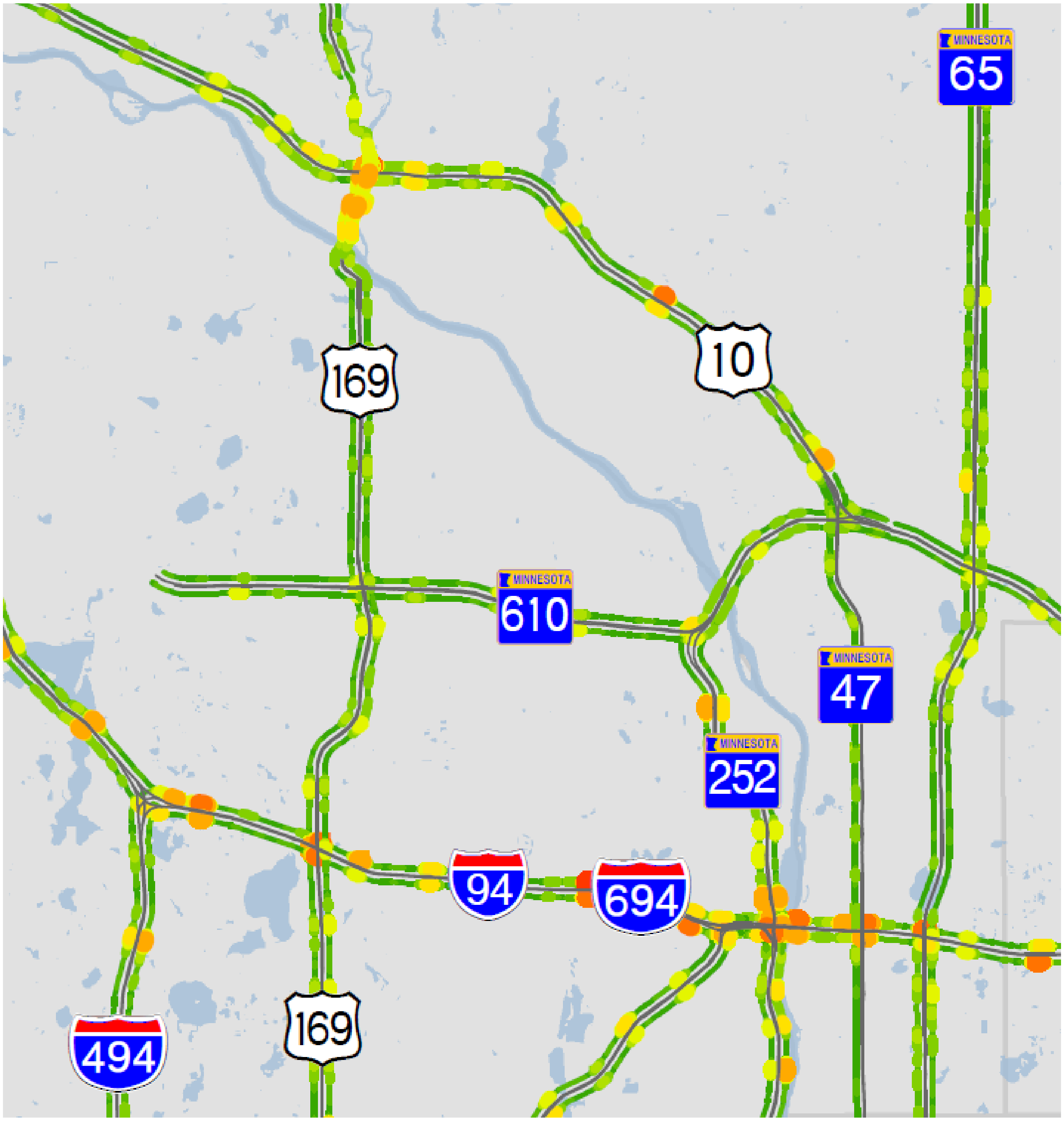
Safety issues are not limited to the NHS and therefore should be expanded to cover the entire roadway network. The APO can play an important role in measuring safety performance throughout the region to facilitate its own planning process as well as assist agency partners in theirs. The Minnesota Crash Mapping and Analysis Tool (MnCMAT) provides access to comprehensive data on all crashes reported to law enforcement. These are provided with spatial detail allowing them to be located across all roadway functional classifications.

Federal requirements include reporting on five measures in the roadway safety category. Each of these measures are valuable data elements to be considered in performance-based planning. An area where these can be expanded and improved is to provide additional specificity at the facility and segment levels. While the system-level measures are useful for reporting on overall regional performance and trends, it can be difficult to tie these outcomes back to individual investment decisions. Similarly, it does not assist in the identification of problematic locations where future investments should be prioritized.

Several measures and formulations exist for expanded coverage to be tied to additional geographic locations. The TSM performed in the previous LRTP utilized a two-dimensional spatial analysis to visually depict "hot spots" of high crash densities. This is shown in the figure below.



Alternatively, assigning crash records directly to the roadway alignments can provide additional information regarding segments with high crash histories. It can also facilitate further analysis and monetization along roadways to feed into multi-dimensional analysis of transportation performance. For example, the Congestion Management Safety Plan (CMSP) completed for MnDOT's Metro District utilized this method, as shown in the following figure.



This example shows crash densities across all severity rates. Alternative formulations could be limited to fatalities and severe injuries, or could use a weighted severity rate to exaggerate densities in locations with higher frequencies of severe crashes.

These methods can be accomplished without significant expansion of data collection techniques, since historical crash data is available through MnCMAT, as noted. Methods with increased spatial sensitivity and association to roadway segments requires additional computational techniques. These approaches should be feasible for APO staff to apply internally.

Furthermore, the APO has selected a series of additional performance measures and indicators to begin monitoring over time. These additional measures will require additional guidance and coordination with federal and state agencies; the additional safety performance measures include:

1. Percent of target investments in motorized vehicle safety projects
2. Annual number of heavy truck crashes
3. Annual number of bus crashes
4. Annual number of work zone crashes
5. Annual number of rail-crossing crashes
6. Annual number of chemically impaired crashes
7. Annual number of crashes involving trains
8. Annual number of distracted driving crashes
9. Percent of target investments in emergency management safety projects
10. Percent of population living in a flood zone
11. Number of emergency routes vulnerable to natural disasters or major incidents (e.g., river crossings or railroad crossings)

The APO will monitor and report data for the additional safety performance measures by utilizing the Minnesota Department of Transportation's Crash Mapping Analysis Tool (MnCMAT). The APO will prepare a system-wide safety analysis addressing the five required performance measures and additional safety measures on an annual basis. This analysis will help determine if other areas of concern emerge. Furthermore, the APO will document if safety investments have helped reduce the number of fatalities and serious injuries at a specific location as historical data becomes available.

Pavement Condition

The pavement condition category is also addressed through the federal performance measures. The formulations outlined in federal guidance are appropriate for use on an expanded system, however to facilitate investment decisions and reporting the effectiveness of improvements, enhanced specification to roadway facilities and segments is essential.

There is potential uncertainty around the extent to which agencies currently measure pavement condition. To the extent that it is measured, there can also be inconsistency in how these data are collected, stored, and reported. The APO can play a key role in aggregating this data and presenting it consistently to aid in performance-based planning for the region.

Collecting pavement condition data can be an expensive and time-consuming endeavor. Measurement equipment is highly specialized and is performed by a trained professional through field data collection. Additional investigation is needed regarding the cost commitments needed to conduct such an evaluation.

Expanded presentation of pavement condition data in the planning area is viewed as a critical component to the development of an effective performance-based planning process. In an era when system preservation is the key investment strategy this is a key input to agencies' decision-making process.

Furthermore, the APO has selected a series of additional pavement condition performance measures and indicators to begin monitoring over time. These additional measures will also require additional guidance and coordination with federal and state agencies; the additional performance measures include:

1. Ride Quality Index (RQI)
2. Surface Rating (SR)
3. Pavement Quality Index (PQI)
4. Remaining Service Life (RSL)

Descriptions of each additional pavement condition performance measure are summarized in the following table:

ADDITIONAL MEASURE	DESCRIPTION
Ride Quality Index (RQI)	The RQI is MnDOT's ride, or smoothness, index. It uses a zero to five rating scale, rounded to the nearest tenth. The higher the RQI, the smoother the road is. The RQI is intended to represent the rating that a typical road user would give to the pavement's smoothness as felt while driving their vehicle. The RQI is calculated from the pavement's longitudinal profile, measured by the front mounted lasers on the digital inspection vehicle.
Surface Rating (SR)	The surface rating (SR) is a 0.0 to 4.0 rating system for road pavement condition using visual inspection to evaluate pavement surface conditions. A higher SR means better condition. A road with no defects is rated at 4.0. A road in need of major rehabilitation or reconstruction will generally have an SR near or below 2.5.
Pavement Quality Index (PQI)	The pavement quality index (PQI) is a composite index, equal to the square root of the product of RQI and SR. As such, it gives an overall indication of the condition of the pavement, taking into account both the pavement smoothness and cracking. The PQI is the index used to determine if the state highway system is meeting performance thresholds established for the Government Accounting Standards Board.

Remaining Service Life (RSL)	The remaining service life (RSL) is an estimate, in years, until the RQI will reach a value of 2.5, which is generally considered the end of a pavement's design life. Most pavements will need some type of major rehabilitation when the RQI has reached this value. The RSL is determined from pavement deterioration curves. A regression curve is fit through the historical RQI data for each pavement section and the year the RQI will reach 2.5 is estimated.

The NHS within the APO area includes Interstate 94 and Highway 23. Other MAP-21 NHS Principal Arterials include Highway 10, Highway 15, and CSAH 75. Pavement conditions for these corridors, except for CSAH 75, have been documented by MnDOT's Pavement Management Condition Data in 2013. In most cases, the corridors RQI, SR, PQI, and RSL are in good to fair condition. However, there are roadway segments located on Highway 10 that contain a poor RQI and RSL. These segments are primarily located between Highway 23 and Highway 15.

In regards to CSAH 75, Stearns County's 2010 PQI data was used to identify segments in poor condition. As of 2010, CSAH 75 is in good condition with certain segments in fair condition. These segments include portions of CSAH 75 between Highway 15 and Washington Memorial Drive, and 22nd Street South, and 33rd Street South.

Bridge Condition

Like pavement condition, bridge condition must be considered in the planning process for prioritizing future infrastructure investments. Bridge condition measures outlined in the federal guidance are appropriate at the regional level; however, communicating conditions at the level of individual bridges is needed to identify and prioritize future investment needs.

Bridge inspection processes are well established and widely performed by transportation agencies. The APO can play a role in aggregating this information from its regional partners for using in the planning process.

Mobility Performance Measures

This section addresses several measures described under the federal guidance for **NHS Performance** and **Traffic Congestion** categories. The federal measures required that can collectively be characterized as mobility metrics include:

- Percent of person-miles traveled on the Interstate that are reliable
- Percent of person-miles traveled on the non-Interstate NHS that are reliable
- Annual Hours of Peak Hour Excessive Delay (PHED) Per Capita
- Percent of Non-SOV Travel

At the regional level, these are useful measures for communicating the overall performance of the system. They will also become useful over time as they can be used to track trends on the system and report performance in the aggregate.

For performance-based planning, expanded measures that provide a more in-depth understanding of facility-level performance should be considered. Like other measures, observing problematic locations on the system is important to prioritizing investments and recording outcomes of recent improvements.

Through the current work, numerous alternative mobility performance measures have been explored. These investigations utilized National Performance Measurement Research Data Set (NPMRDS) travel time records to produce illustrative maps for the NHS including:

- Free-Flow Speed
- Peak Period Speed
- Duration of Congestion
- Delay
- Travel Time Reliability

Illustrative maps showing the observed performance for these measures on NHS roadways in the St. Cloud area are provided in the Performance Measure Report template in the next chapter of this document.

Based on this investigation, peak period travel delay, expressed in units of *seconds per mile*, is recommended as a promising measure for using the LRTP update. This measure captures mobility impacts from the traveler's perspective, showing locations on the highway system where users experience recurring delays during busy times of day.

The recommended coverage area for mobility measures is the Principal and Minor arterial network. These are the roadways of the network designated as providing primarily the mobility function for the system and are therefore applicable to quantifying the delays users are subjected to in their daily journeys.

This level of coverage also coincides with facilities where speed or travel time data is likely to be available from GPS probe data sources. Data coverage beyond the NHS is not provided through the NPMRDS, but can be obtained through commercial vendors, such are TomTom, INRIX, HERE, etc.

If coverage of mobility measures is desired beyond the locations provided by commercial GPS probe data providers, additional field data collection techniques are available to capture vehicular travel times. The table below provides an overview of Bluetooth and vehicle tracing techniques, along with GPS probe speed data.

GPS Probe Speed Data

This particular data is collected via satellite communication that detect devices that are transmitting their GPS location, such as mobile phones, in-vehicle navigation equipment, and vehicle transponders. The probe speed sensors record the device's instantaneous speed to produce a time-mean speed as well as space-mean speed by computing the time required to travel between two points. In addition to speed data, each sensor collects the date and time the speed recording occurred (i.e. the speed data is time-stamped). The individual speed records of the devices in the sample are processed and aggregated by third-party vendors to produce the speed data records available to transportation professionals.

The ever-increasing prevalence of GPS-transmitting devices has seen a corresponding increase in companies gathering this data to provide more roadway travel information and aid in navigation processes. Most urban, suburban, and rural freeways, expressways, and arterials have collected speed data for several years. Expansion of this data collection network is now growing to include more rural roadways and urban / suburban local streets. This data is collected by several third-party companies such as INRIX, HERE, and TomTom; however, the Federal Highway Administration (FHWA) acquires probe speed data and provides this data to state DOTs and metropolitan planning organizations (MPOs). As noted in the "Demonstration" section, this is supported through the NPMRDS program. Data in this program was provided by HERE from July 2013 through December 2016. Starting January 2017, it is provided by INRIX.

Advantages

- As previously stated, speed data is currently, and has been, collected over a vast roadway network. Historical speed data along many roadways is available since year 2014; however, speed data may be available along particular roadways or segments back to year 2012.
- Some GPS data is accompanied by vehicle classification data. This allows for a comparison of truck speeds with passenger vehicles from this information.
- The amount of data collected and processed by this method is, by far, the largest among the three methods. This is due to GPS-transmitting devices being used more frequently by the traveling public and commercial shippers, particularly when they are traveling.
- Processed data can be obtained by a user in numerous time-slices, or epochs. Instantaneous speed data can be requested as well as time epochs that range from hourly to 15-minute or 5-minute intervals (shorter intervals are commonly used for speed analysis).

Disadvantages

- While instantaneous speed data is collected, this data cannot be provided in real-time to a user as the data needs to be collected by a data source and processed internally before distribution to a user can occur. Typically, the delay in retrieving the most-recent speed data for a particular location is a few weeks from the collection date.
- While the amount of data collected and processed by this method is, by far, the largest among the three methods, the electronic data files associated with this information can be very large – so large that specialized database software may be necessary to store and process the data.

Other Considerations

- As previously mentioned, FHWA acquires and provides speed data to state DOTs and MPOs, usually free of charge. While FHWA recently executed a new contract to continue collection of the NPMRDS, the perpetuation of this program over the longer term is unknown

Bluetooth Sensors

Bluetooth is an electronic communications platform commonly used to connect mobile devices. For roadway performance studies, this is collected via fixed-location, out-of-roadway sensors that detect transmitting devices. Bluetooth sensors collect portions of the media access control (MAC) address of Bluetooth-transmitting devices, such as mobile phones, in-vehicle navigation equipment, and vehicle transponders. Each sensor records a device's MAC address fragment and time stamps the data. Vehicular travel speeds are determined via capture-recapture of exact MAC address fragments collected by multiple Bluetooth sensors along a route. When the data is processed, matching MAC address fragments are paired and a travel time and travel speed can be developed between two count stations.

Advantages

- Bluetooth sensors gather travel time and origin-destination (O-D) data between count stations, which may be preferred by the user for their particular project. In addition, gathering travel time and travel speed information between two points considers roadway and intersection delays experienced by vehicles.
- Bluetooth sensors can be placed in locations that are agreeable to analyst's preference and the sensor network can be scaled to the user's preference: it can be simple (one roadway corridor) or more-complex (larger-scale or network area) based on the study parameters. Segmentation along a route can also be scaled from short (one-quarter mile) to long (several miles), depending on user needs.
- Bluetooth sensors can be rented from third-party companies and do not require specialized equipment for installation or operation of the devices. Sensors can also be purchased for agencies seeking a long-term data collection solution.
- Bluetooth sensors can be programmed to transmit data in real-time for post-processing, reducing the amount of time to process data from a particular time period. This may be associated with a higher-cost, depending on equipment capabilities and availability of a communications network.

Disadvantages

- Instantaneous speeds at a particular location are not collected with Bluetooth sensors. This information may be valuable in determining speeds before and after a particular location or event along a roadway.
- The sample of vehicles transmitting MAC addresses that are collected for processing are limited – typically less than ten percent of all traffic. This condition is due to the fact that Bluetooth capabilities must be enabled by a user for it to be identified by the sensors.
- The transmission area of a Bluetooth device can be up to several hundred feet in each direction. This presents some limitations when selecting sensor locations to avoid uncertainty in vehicle location. For example, locations with closely-spaced roadways, such as frontage roads, and overpasses/underpasses should be avoided due to the sensor mistakenly collecting data on a non-study roadway. In addition, high-occupancy vehicles such as buses may skew speed data as multiple data points traveling in the same vehicle may be captured by the sensors.
- While the amount of data available for processing is not as large as GPS probe speed data, the data collected (MAC address fragments) may require a user to purchase specialized software or have a third party process the data collected.

Other Considerations

- Bluetooth sensors operate on rechargeable power sources, limiting a single deployment for approximately two weeks; however some sensors can be equipped with solar-powered panels to allow for continuous use.
- It should be reiterated that MAC address *fragments* are collected. These fragments are complete enough to allow an analyst to distinguish between two devices but do not capture the entire MAC address. Concerns from the traveling public regarding privacy and security concerns of capturing MAC address fragments have been raised even though the fragments that are collected cannot be traced back to a particular device.

Vehicle Tracing

Vehicle tracing is the practice of following a particular or representative vehicle and noting travel speed and/or travel time information for that vehicle. This data is most commonly collected via the "floating car" method. This technique involves a technician following a vehicle he/she feels is representative of the traffic flow and noting their own vehicle's speed and travel time observations. These observations – typically multiple vehicle runs are performed – are processed to determine average travel speeds, travel times, and any delays incurred along the travel route.

This method can be labor and cost-intensive as it requires the data collector(s) to operate their vehicle(s) on the study roadway(s) continuously throughout the data collection period. Depending on the geographic scope of the study area and the designated sample size, this could be costly in terms of labor and vehicle operating expenses. On the other hand, this data collection technique is technologically straightforward, does not necessarily require specialized software or processing, and may benefit from the observations of the drivers collecting the data.

Advantages

- Besides a vehicle and a time-tracking device, no specialized equipment is needed to perform this data collection method.
- The technician (driver) of the following vehicle controls the travel path identified for study. This condition allows for the analysis of more circuitous travel paths.
- Because a technician is physically observing and recording data in real-time, he/she can disregard data if an incident or artificial condition occurs during data collection that would skew the results. The previous two methods described do not provide any information regarding incidents or other non-recurring conditions that may result in vehicles traveling outside of normal speed ranges.
- Intersection delay can be determined with this method as the technician can record this information during their travel runs.

Disadvantages

- This method introduces the most subjectivity to the data collection process as the technician decides which sample vehicle is representative of traffic flow. This is unlike the other two methods which records data for all vehicles that are traveling through the study area.
- Data points between travel runs can be infrequent as the technician needs to travel back to the starting point to begin their next travel run. If the technician is collecting bi-directional speeds along a travel route, this condition allows both directions to be recorded; however, the infrequency between successive travel time runs (likely several minutes apart) could omit important traffic operations characteristics from the recorded data set, such as travel speeds during peak-volume conditions.
- This method produces the smallest sample size collected due to technicians collecting speed data as they travel through the study area. Typically, multiple technicians and/or multiple days are necessary to produce a statistically significant data set for speed analysis purposes.

Over the longer term, the APO may consider other methods for collecting speed data to facilitate mobility performance measures. Roadside detection and in-pavement technologies do exist to collect these data. For speed data collection, exclusively, these are not currently cost-competitive with GPS probe data. However, many products provide a wider range of services such as facilitating adaptive signal control or other real-time traffic management applications. Should these become priorities for investment in the region, instrumented locations could be utilized to provide speed data inputs to the mobility performance measures.

Future considerations in this area include the proliferation of connected vehicles. It's anticipated that in coming years, vehicles equipped with digital short range communication (DSRC) radios will become commonplace in the vehicle fleet. These technologies allow vehicles to communicate with each other and with sensors placed on the roadside. Expanded vehicle-to-infrastructure (V2I) communications could allow for alternative methods of speed data collection through the network, and the APO is encouraged to stay apprised of these advancements to identify future opportunities.

In summary, mobility measures outlined in the federal guidance are useful for communicating a system-level snapshot of reliability and congestion performance. They can be easily summarized for use in a visual presentation, and are useful for tracking changes over time. To provide actionable information for performance-based planning, however, expanded coverage and more detailed measures are necessary to facilitate specific investment prioritization.

Freight Movement

The freight movement performance measure outline in the federal guidance includes the *Truck Travel Time Reliability* (TTTR) index on NHS routes. This is a useful measure for capturing broad trends as most regional freight movements occur on the NHS.

However, trucks must use routes beyond NHS to reach local destinations. The health of this system has a direct impact on business and consumers in the region. Expanding the coverage of these measures to include the local urban freight network should be explored to capture impacts on these facilities as well. Performance should also be computed and communicated at a facility level to identify problematic locations and consider them for future investment.

It is recommended for the APO to look for opportunities to combine freight movement measures with mobility measures (e.g. delay). The impacts of this performance affect trucks as well as passenger vehicles, and data collection and analysis technique are equivalent.

The following section will discuss potential local freight performance measures.

Potential Local Performance Measures

Performance measures are an effective tool that can be used to focus attention and decision-making on the regional freight planning goals. The APO can use a simple and streamlined performance management program that can improve communication with the public, the private sector, and elected officials. The measures will make the APO more responsive to freight sector needs.

To help accomplish each freight goal identified in Task 1, Table 1 lists potential performance measures created with the intention of incorporation into the LRTP update. This special set of performance measures should be applied to the Tiers 1, 2, and 3 designated freight networks to the extent that the required data is available. In those cases where data is not currently available, the APO should endeavor to collect or calculate the required data to help ensure that freight-movement goals are measured on all tiers of the freight network.

Table 1: Freight Goals and Performance Measures

GOALS	PERFORMANCE MEASURES
Improve congestion and reliability on the regional freight system	Level of Service (LOS) or Vehicle/Capacity Ratio
	Truck Travel Time Reliability Index
Reduce commercial vehicle crashes region wide	Commercial vehicle crashes and/or severity
Maintain the LOS and State of Good Repair on the Tier III (local) freight network and intermodal connectors	LOS on local corridors and intermodal connectors
	Pavement and bridge ratings on local corridors and intermodal connectors
Connect workers to freight clusters	Transit shed of routes connecting to freight clusters
Capitalize on existing infrastructure	Transportation Improvement Plan (TIP) investment in existing vs. new roads
	Pavement and bridge ratings
	Weight restricted bridges
Minimize negative impacts on the region's vulnerable populations	Transit shed of routes connecting Environmental Justice populations to freight clusters
	Truck volumes within a set buffer of freight network

Needs Analysis: Getting a Clear View of Transportation Systems Performance

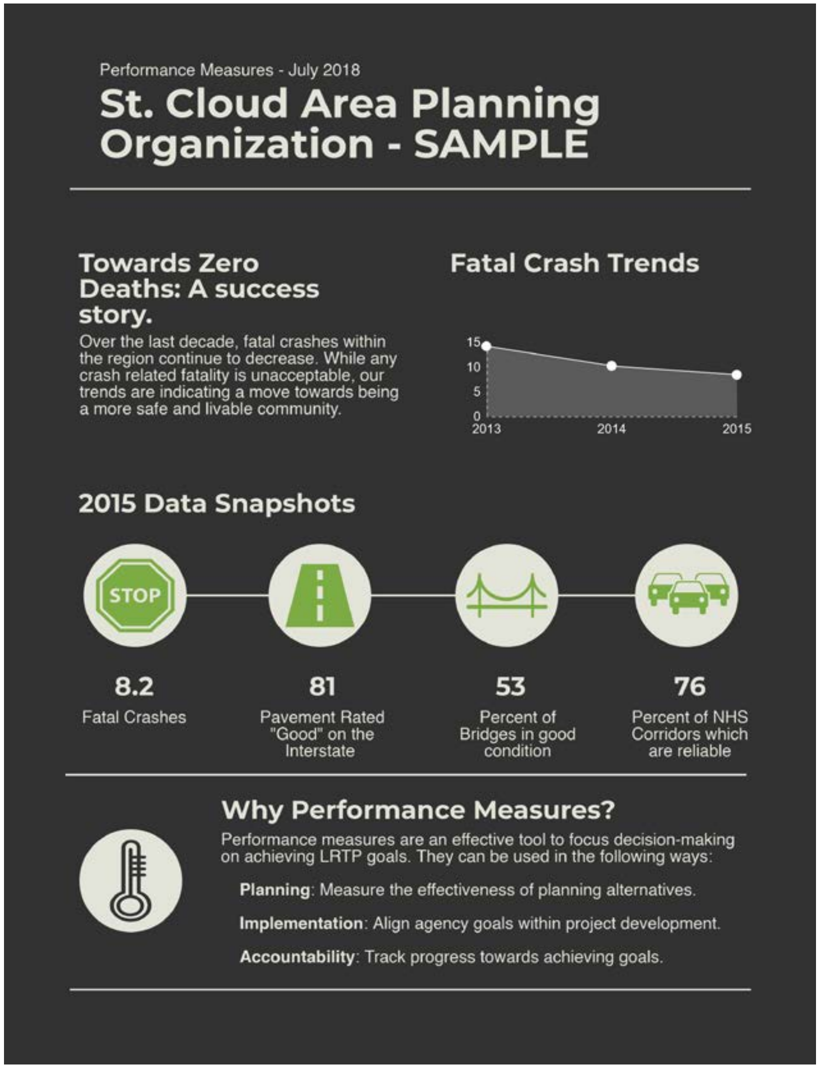
While the federal measures and corresponding datasets provide a valuable tool to monitoring progress towards achieving the APO's goals, they only provide a window into a portion of the regional multimodal transportation system. This section of the report details potential measures for inclusion in the next LRTP to monitor progress towards the following focus areas:

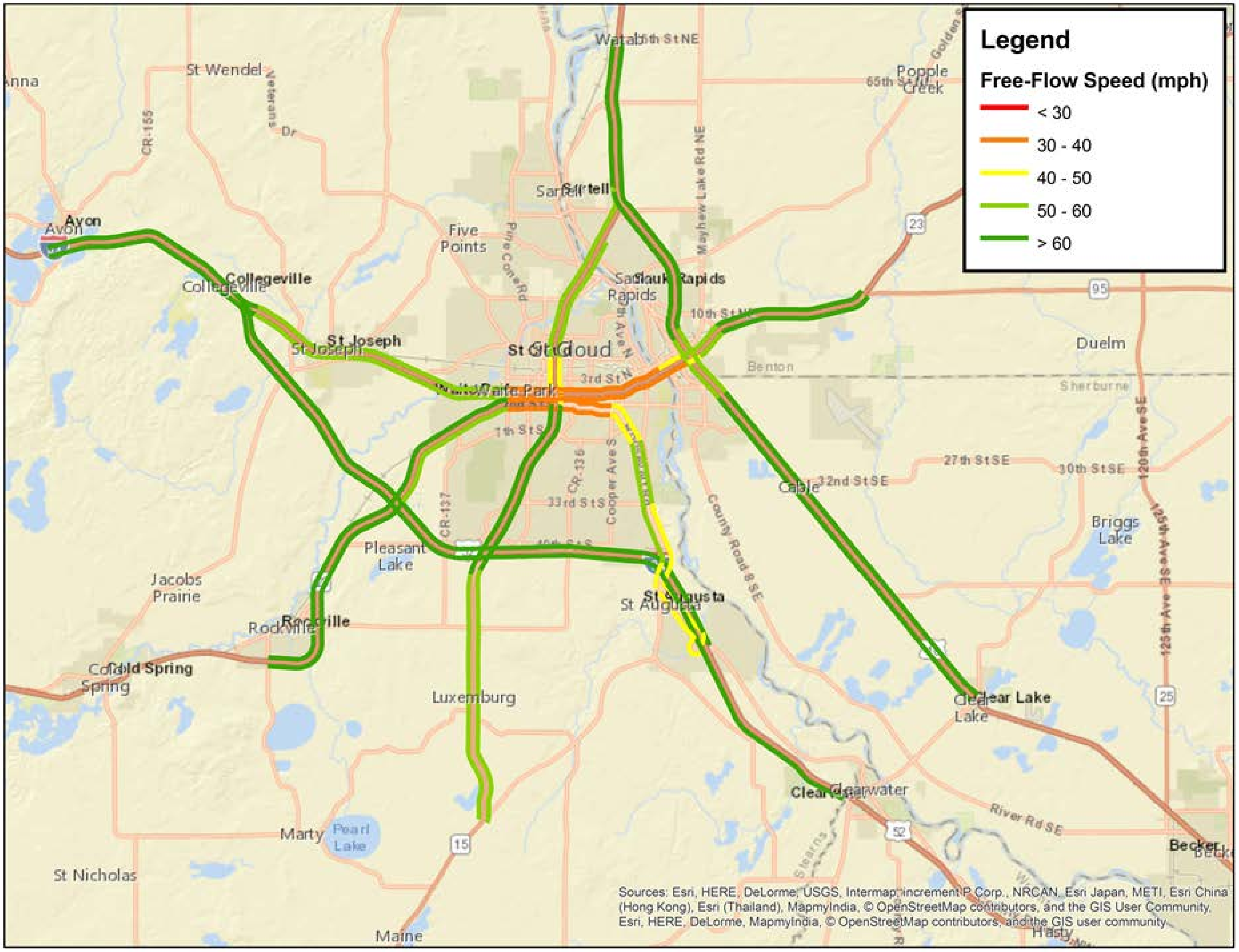
- Non-Motorized Transportation Performance
- Transit Performance (Ridership/Revenue Miles)
- Non-Interstate Freight Movement (First Mile/Last Mile)
- System Connectivity
- Economic Vitality

While performance management should be a core duty of the St. Cloud APO, it is important to understand that it is one of many responsibilities. With that in mind, this section outlines an implementation strategy to achieve the APO's "biggest bang for the buck" when it comes to performance measures.

	Method	Relative Costs		Timeframe
		Dollars	Labor	
Non-Motorized Transportation				
Access to Community Destinations, Jobs, etc.	GIS Buffer	$	$	Short
Average Trip Time/Length	Transit Data/GIS Length	$	$$	Short
Crashes	MnCMAT	$	$$	Short
Land Value	Assessment increases near investments	$	$$$	Medium
Level of Service	NCHRP 616	$$	$$$	Long
Volumes (Counts)	Manual bike/ped counts; laser counters	$	$$$$$	Long
Bike Compatibility Index	Survey of roadway cross-sections	$$$	$$$$$	Long
Walk Score	https://www.walkscore.com/MN/St._Cloud		$	Short
Transit				
Workforce Utilization	Transit Ridership/Total Workforce		$	Short
Coverage	Revenue Miles/Square Mile		$	Short
Average Headways	Transit Schedules		$	Short
Average Speed	Average Trip Time/Lengths	$	$	Short
Transit Availability	Vehicle Miles/Capita	$	$	Short
Jobs in Service Area	Census ACS Data Buffer	$	$S	Medium
First/Last Mile Freight				
Cost of Logistics	Logistics GDP/GDP (BLS Data)	$	$	Short
Freight Jobs	Jobs in selected NAICS codes (BLS Data)	$	$	Short
CMV Crashes or Severity	MnCMAT	$	$	Short
Transit shed of routes connecting to clusters	GIS buffer of transit relative to InfoUSA data	$	$	Short
Transit shed connecting EJ pop. to clusters	GIS buffer of transit relative to InfoUSA data and EJ pop	$	$$	Short
HCAADT within a set buffer of freight network	MnDOT and/or traffic counting tubes	$$	$$$	Medium
System Connectivity				
Average Number of Intersections	Intersections/Mile	$	$	Short
Average Number of Traffic Signals	Signals/Mile	$	$	Short
Average Trip/Commute Length	Travel Demand Model/US Census	$$	$$	Medium
Economic Vitality				
Basic Market Access	One-Day Truck Drive/Train Schedules	$	$$	
Cost to Market (some limitations)	USDA data used to estimate vs competitors	$	$$$	Medium
CTS Corridor Market Access Tool	http://www.cts.umn.edu/research/featured/access	$	$$$	Medium

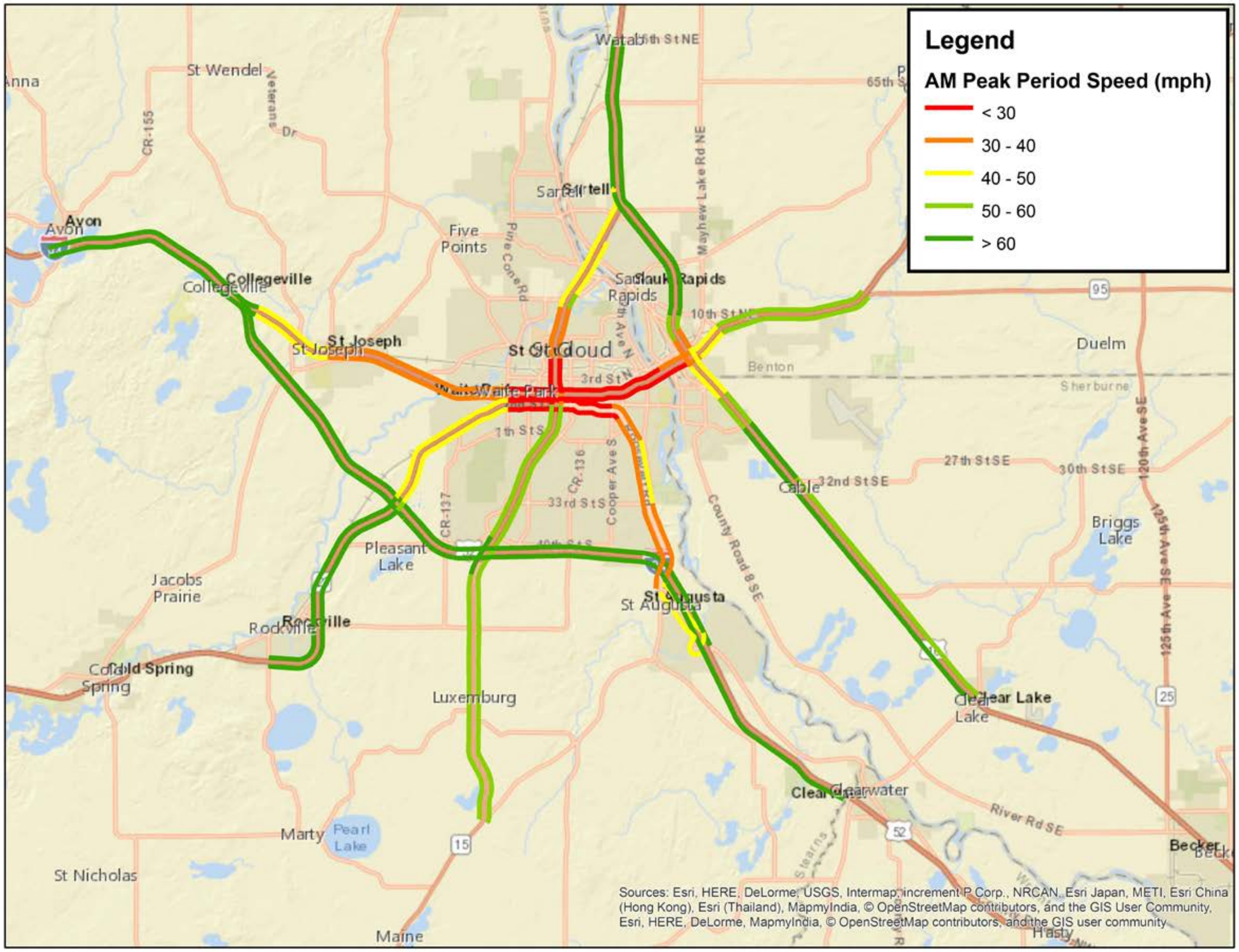
Visualization: Turning Data into Actionable Information





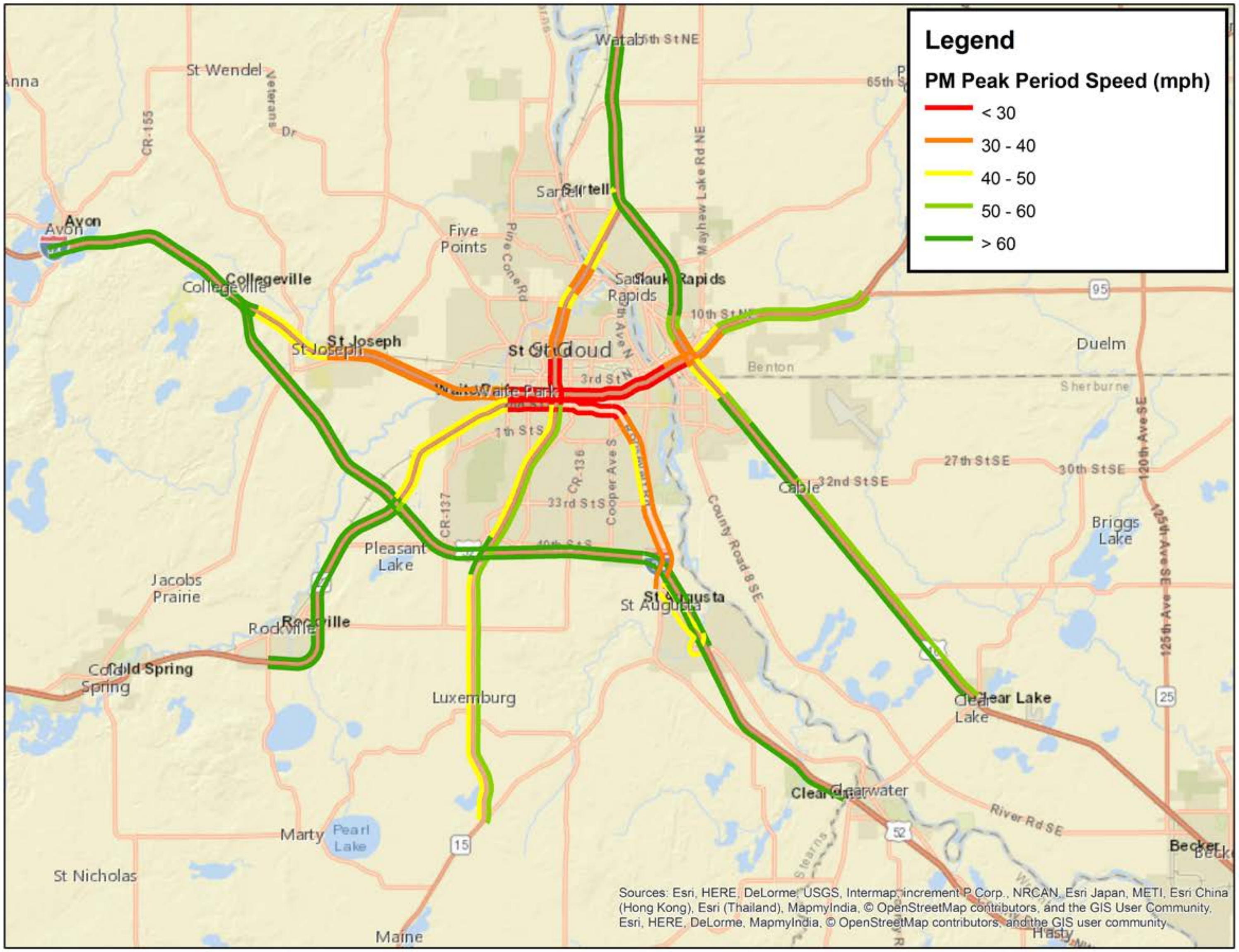
Free-Flow Speed

Free-flow speed is defined as 85th percentiles of off-peak hour* speeds



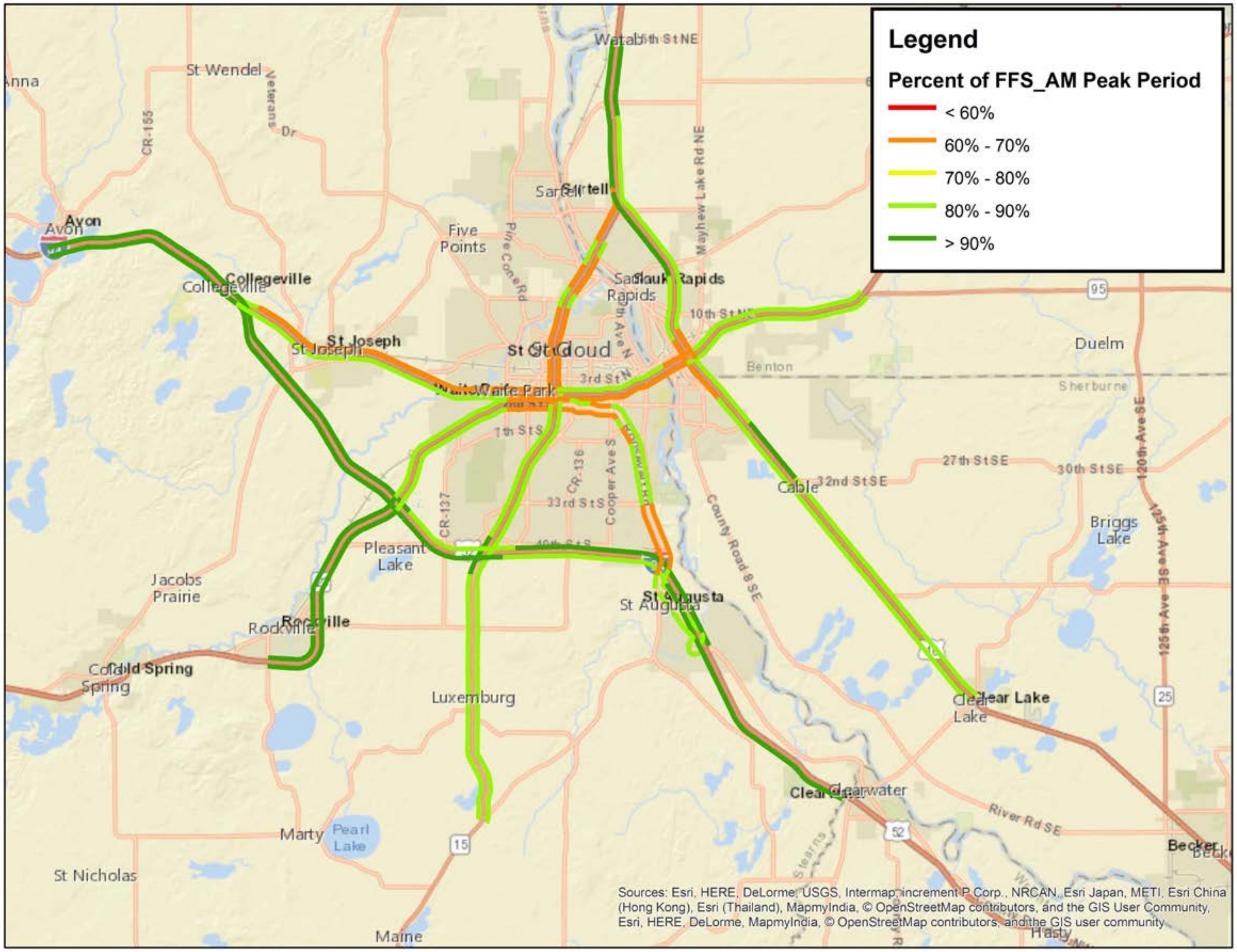
AM Peak Period Speed

Average speeds during AM peak period



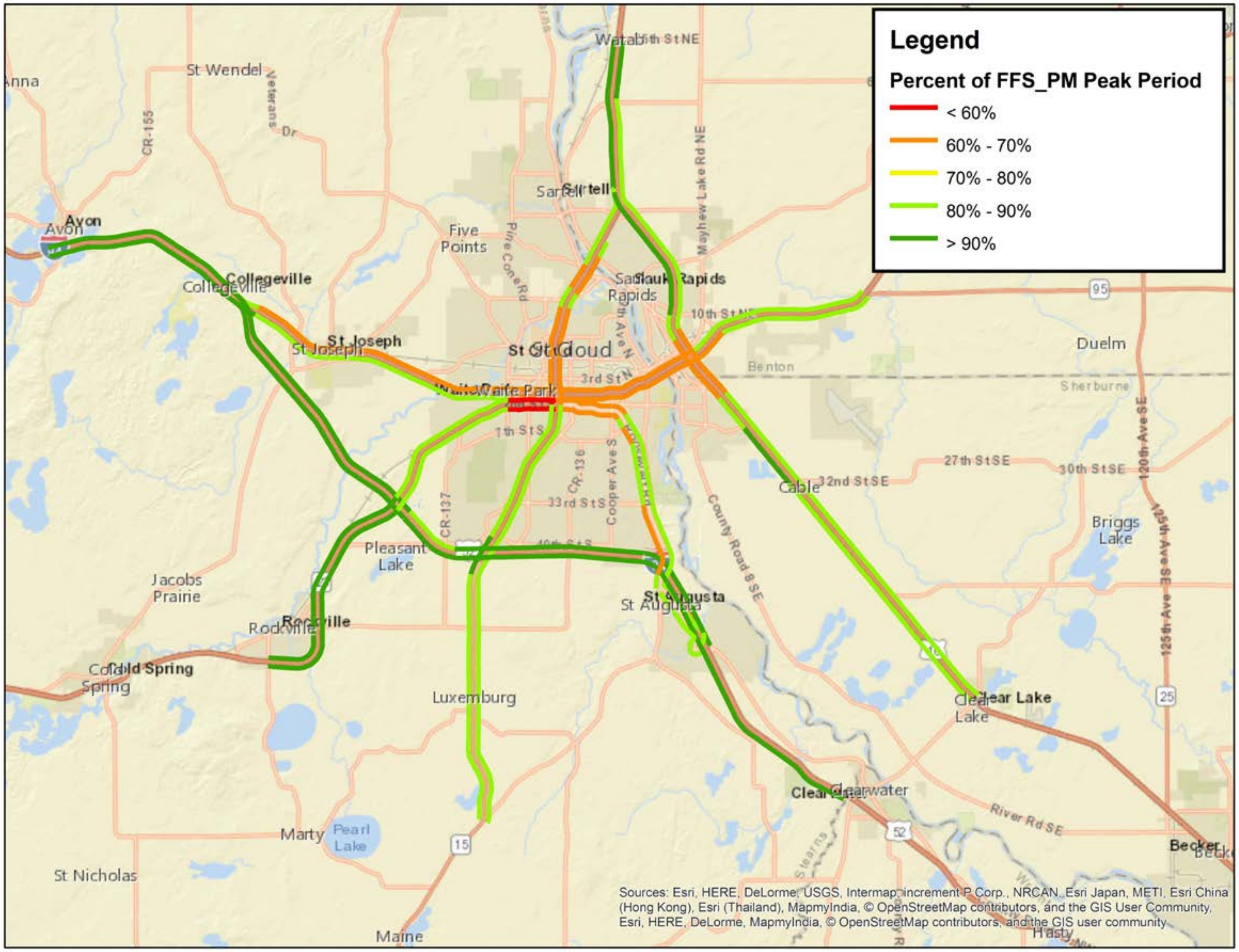
PM Peak Period Speed

Average speeds during PM peak period



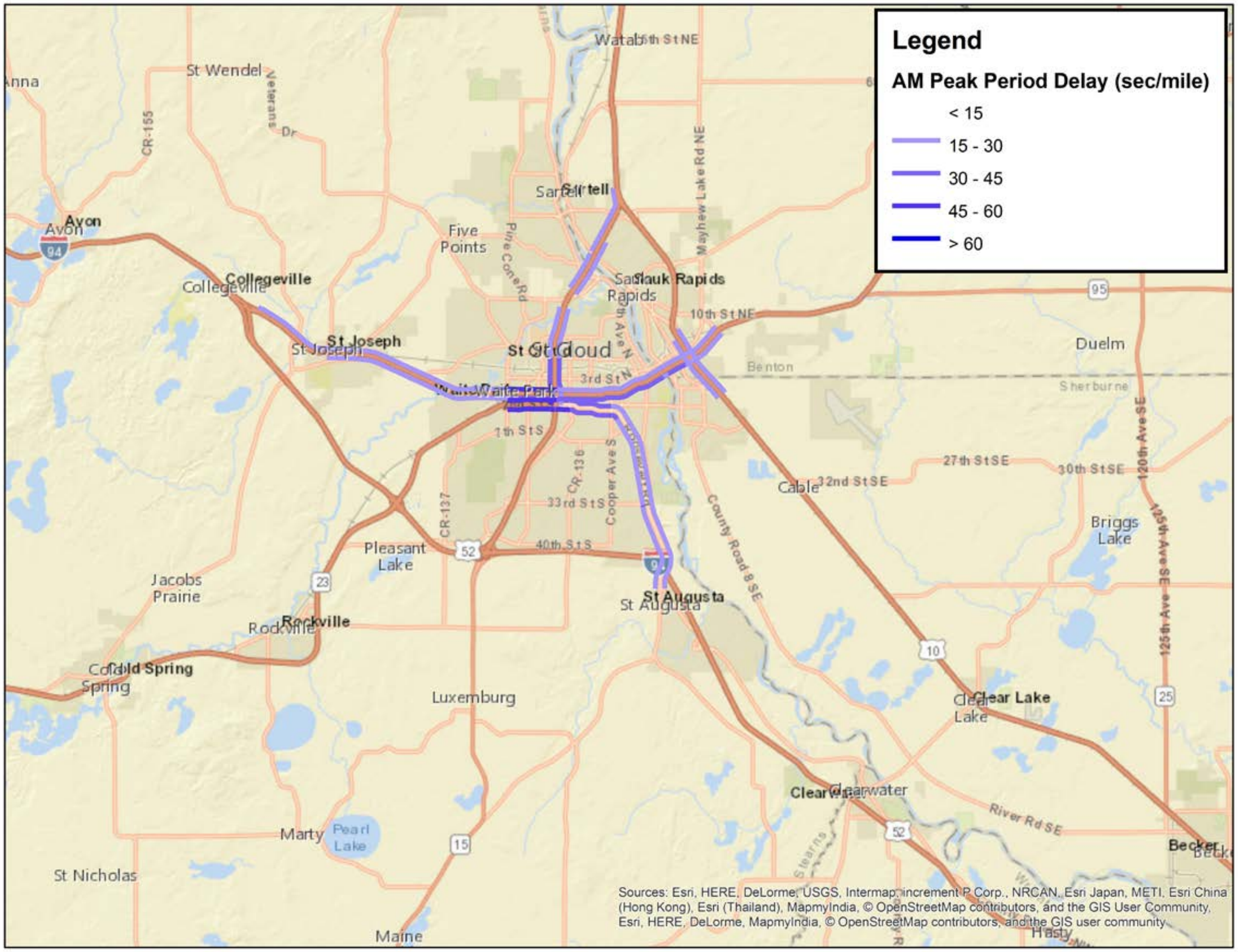
AM Peak Period Percentage of Free-Flow Speed

Ratio of AM peak period speeds to free-flow speeds



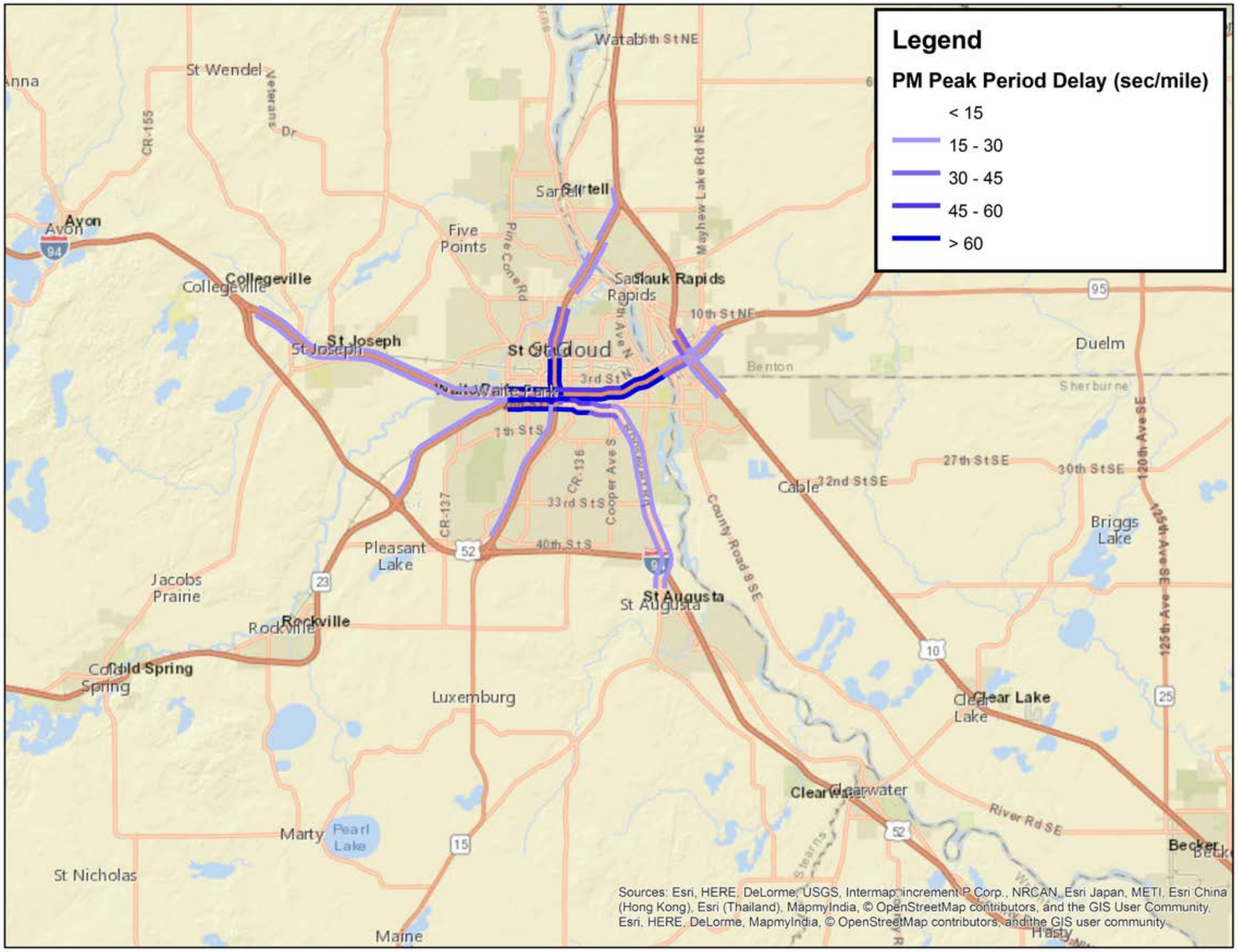
PM Peak Period Percentage of Free-Flow Speed

Ratio of PM peak period speeds to free-flow speeds



AM Peak Period Delay

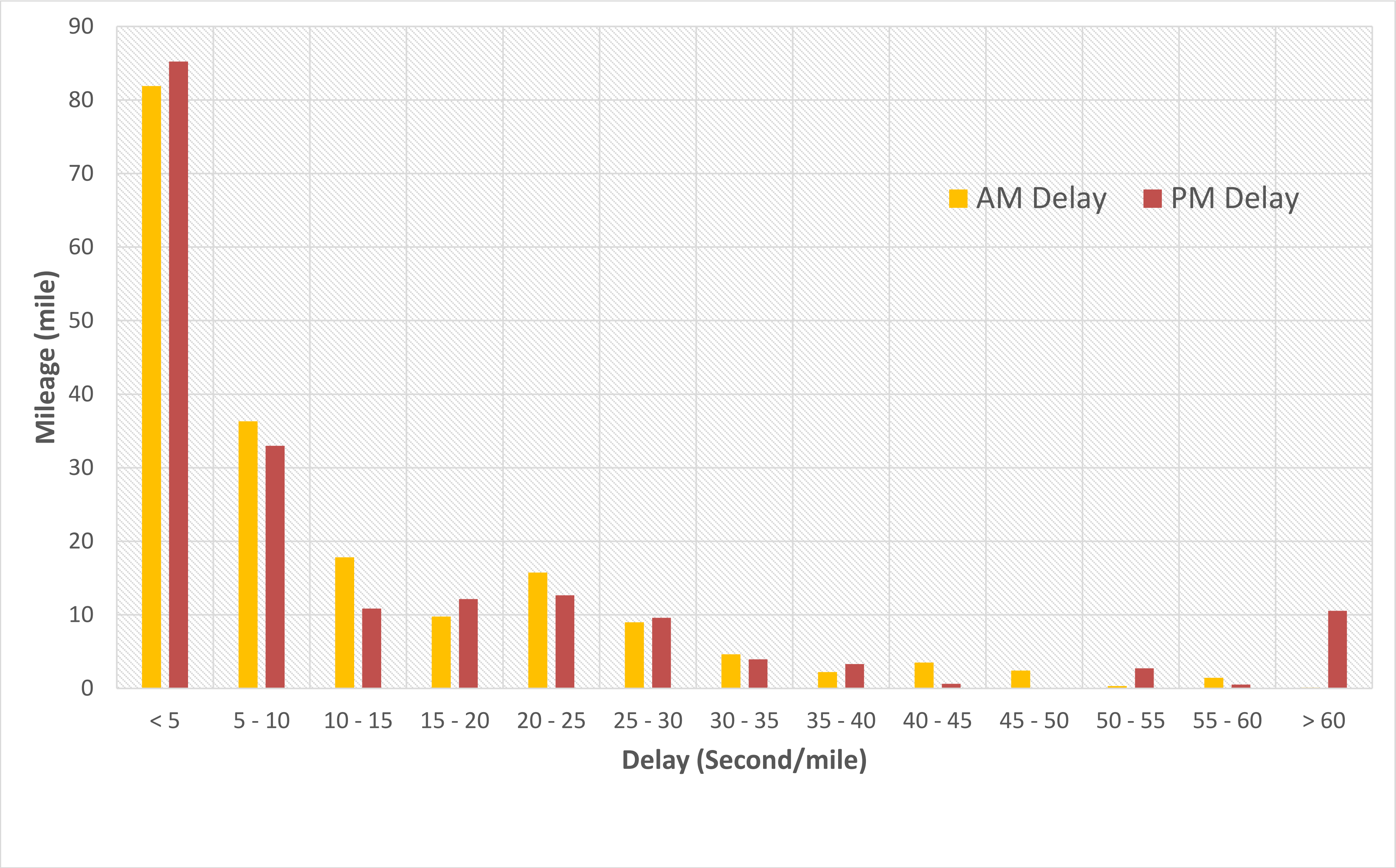
- Delay is defined as the difference between the congested travel rate and the free-flow travel rate
- Normalized by distance to allow for comparison of segments with different lengths and free-flow speeds



PM Peak Period Delay

- Delay is defined as the difference between the congested travel rate and the free-flow travel rate
- Normalized by distance to allow for comparison of segments with different lengths and free-flow speeds

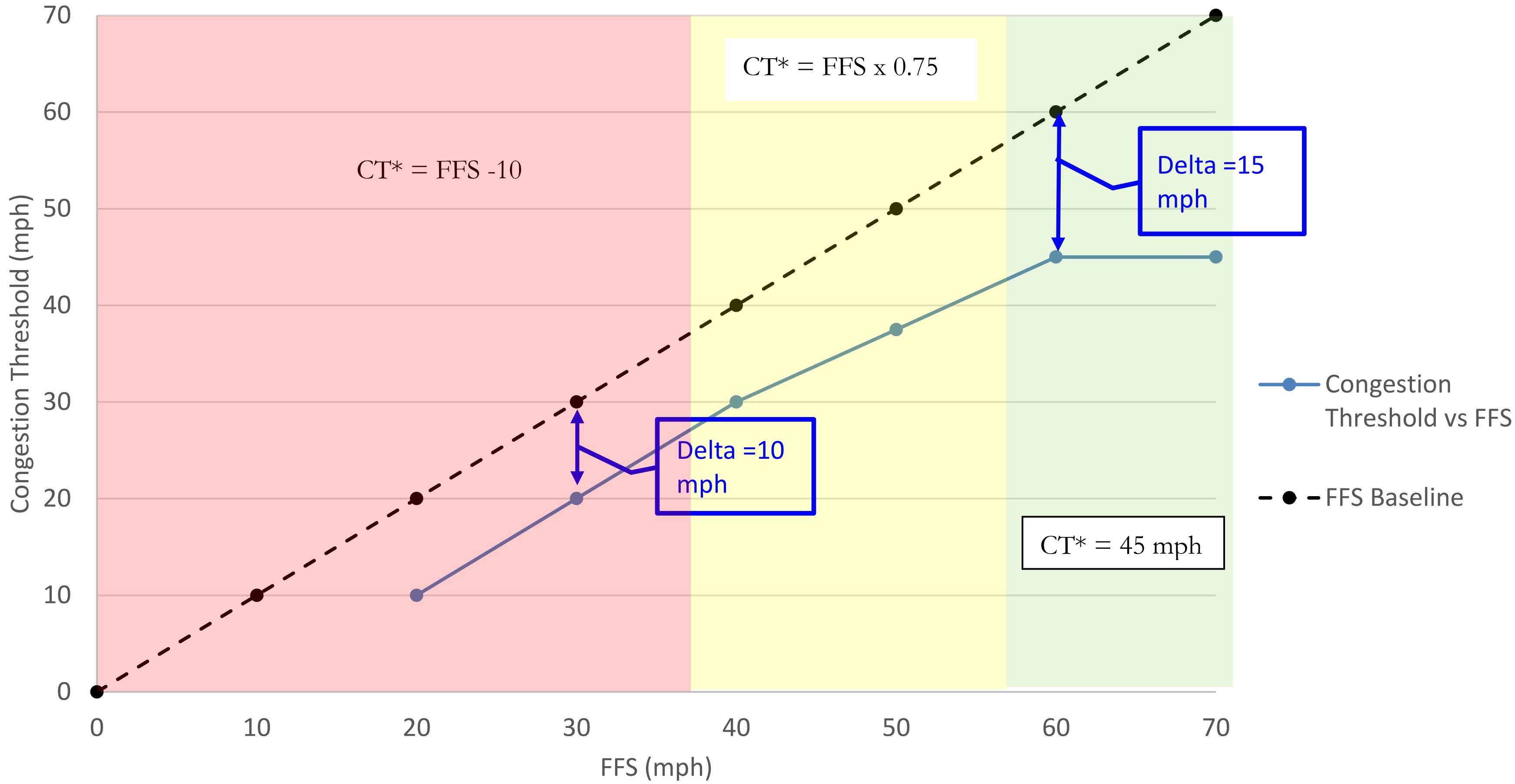
Peak Periods Delay

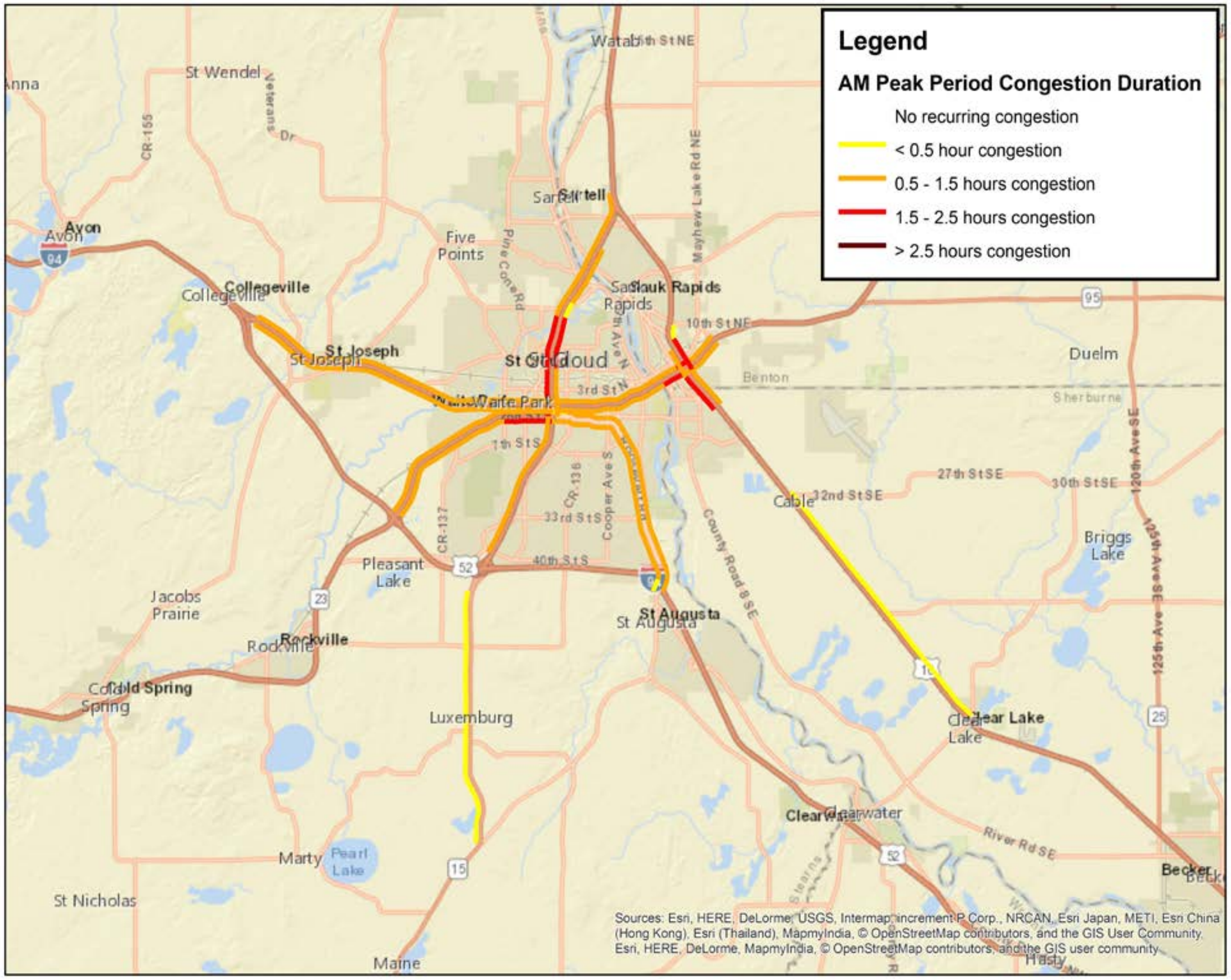


Peak Periods Congestion Duration

- Congestion duration is defined as time when congested speeds are lower than congestion thresholds
- Congestion thresholds

*CT : Congestion Threshold; FFS: Free-flow speed

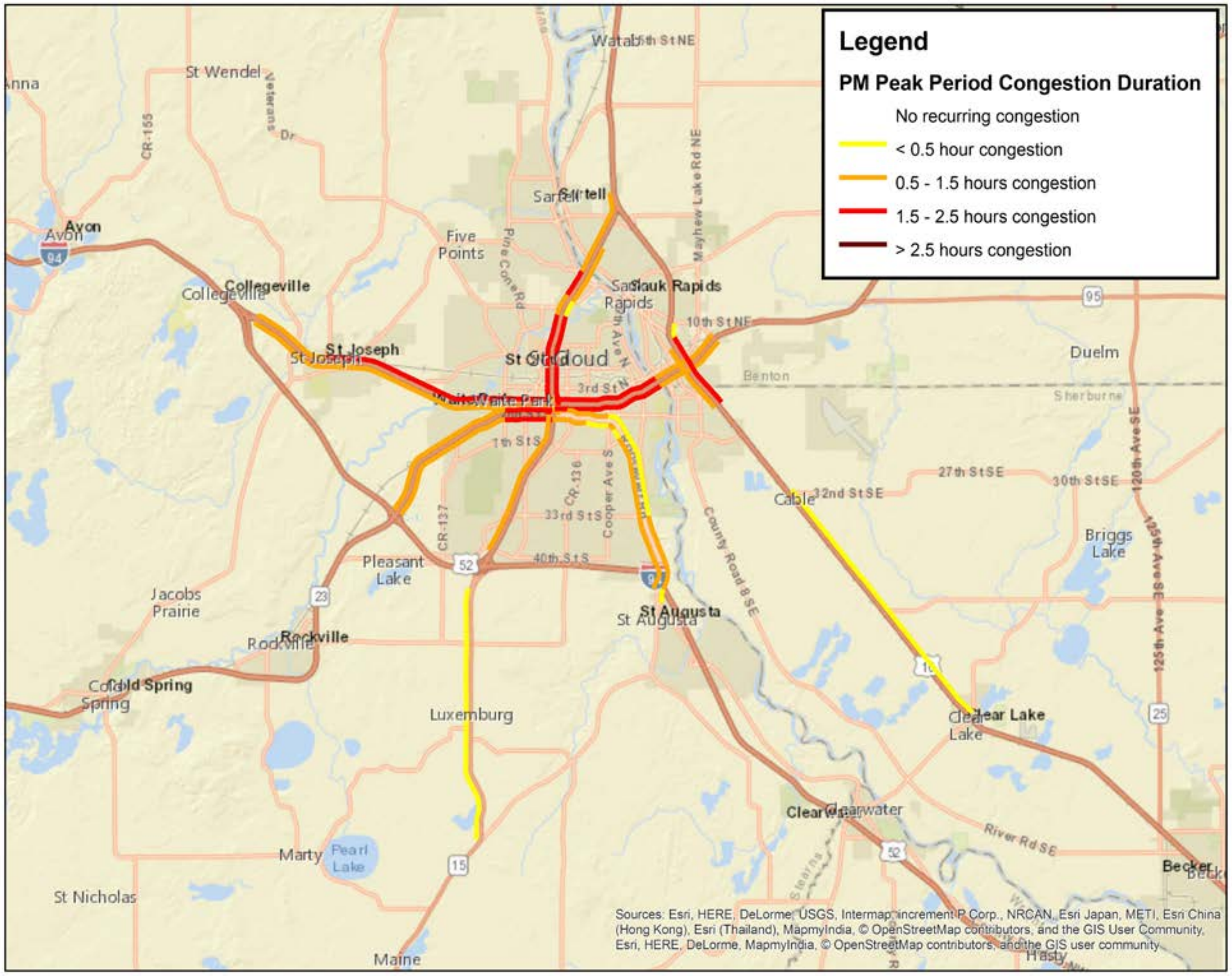




AM Congestion Duration

*Weekdays in April, 2017

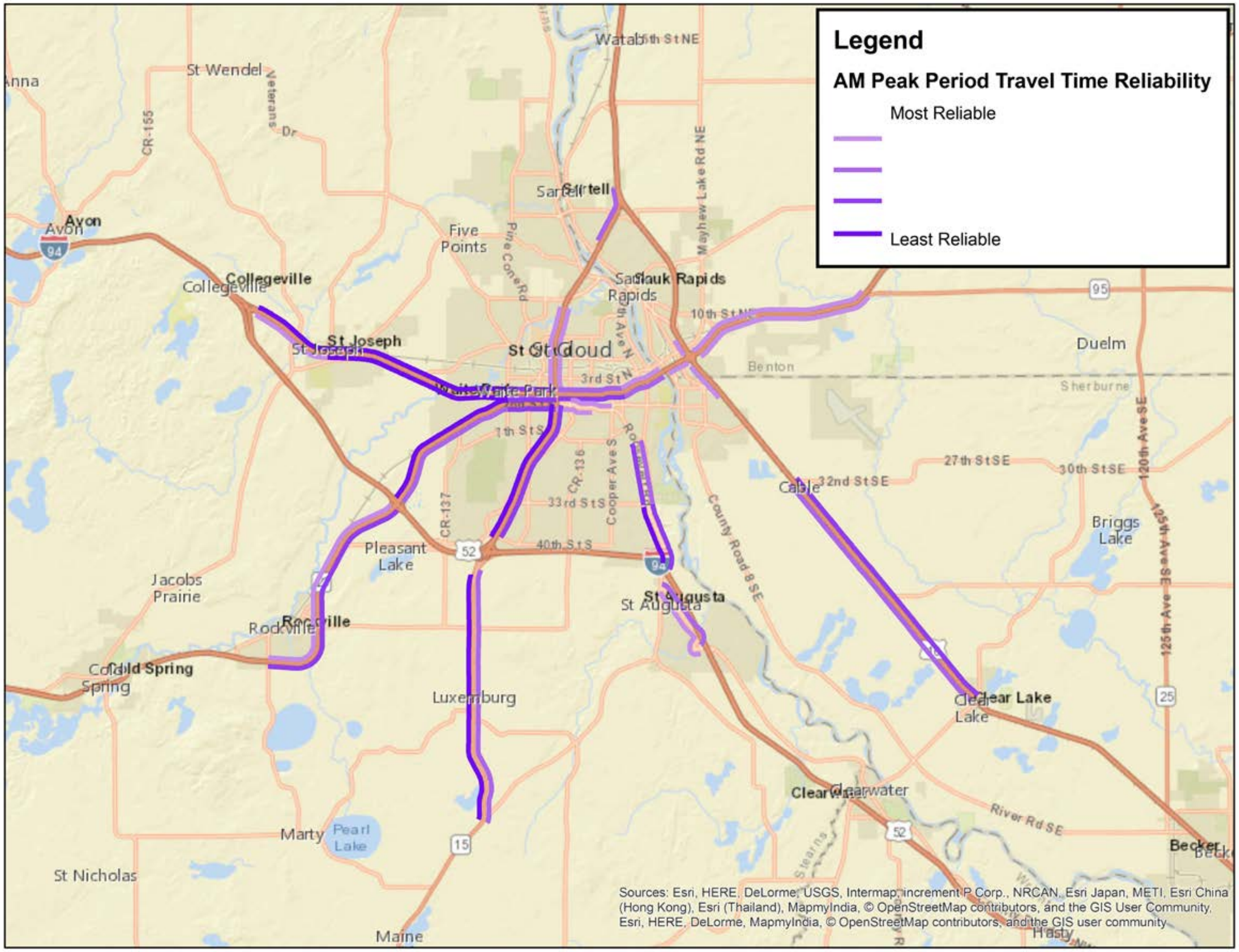
Duration (hour)	Miles	Percent
None	110	59%
<0.5 hr	14	8%
0.5-1.5	54	29%
1.5-2.5	7	4%
>2.5	0	0%



PM Congestion Duration

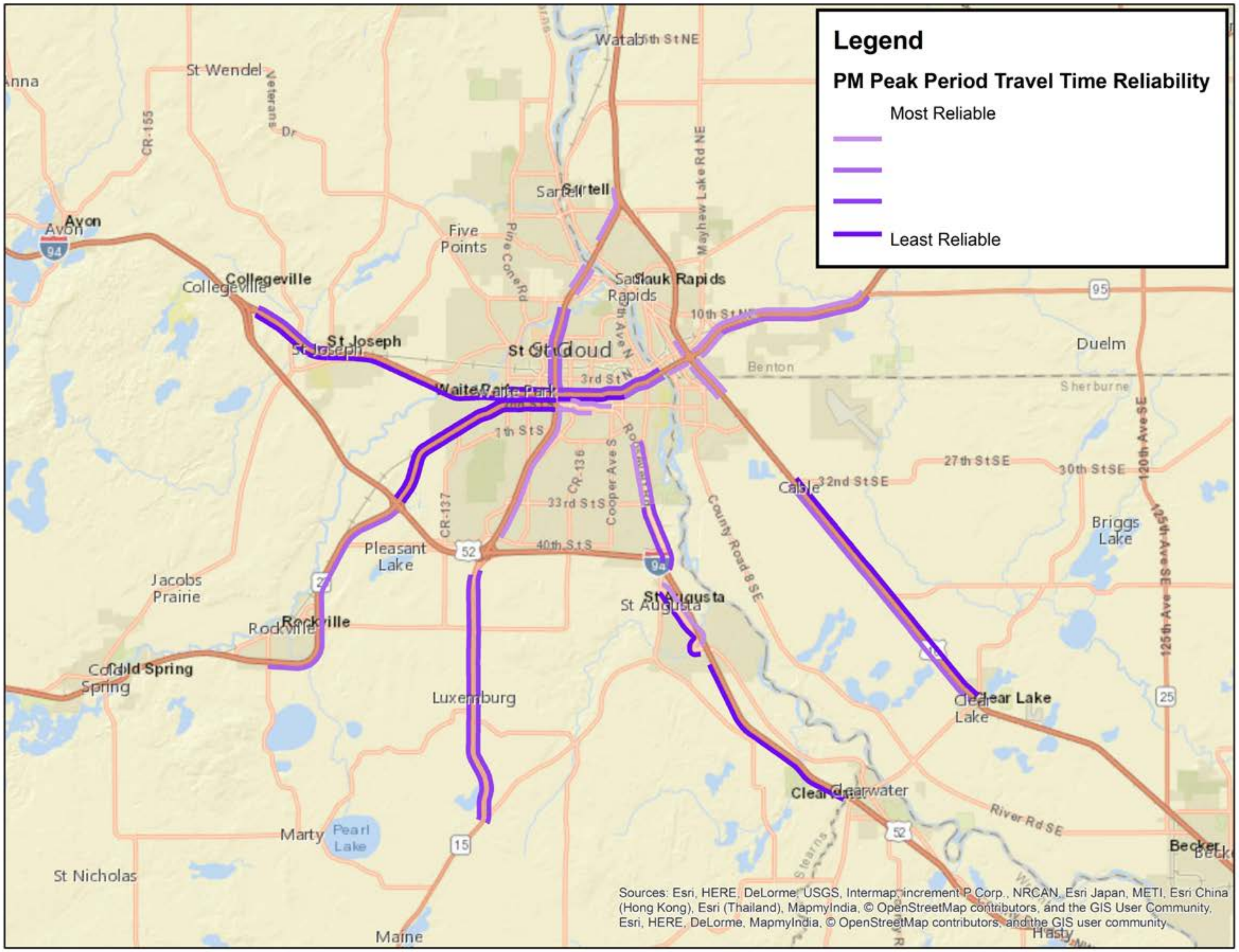
*Weekdays in April, 2017

Duration (hour)	Miles	Percent
None	110	59%
<0.5 hr	17	9%
0.5-1.5	38	21%
1.5-2.5	20	11%
>2.5	0	0%



AM Travel Time Reliability

AM travel time reliability performance is measured as the standard deviation of travel times during AM peak period



PM Travel Time Reliability

PM travel time reliability performance is measured as the standard deviation of travel times during PM peak period

Appendix – Definition of Terms

Peak Periods

AM peak period is defined as 6:00 a.m. to 9 :00 a.m. and PM peak period is defined as 4:00 p.m. to 7:00 p.m. on weekdays.

Free-Flow Speed

Free-flow speed is defined as 85th percentiles of off-peak hour speeds.

Average Peak Period Speed

Average peak period speed is defined as the average speeds during the peak periods. Speeds were computed for each TMC with AM and PM peak periods separately.

Percentage of Free-Flow Speed

Percentage of free-flow speed is defined as the ratio of peak period speeds to free-flow speeds. Percentages for AM and PM peak periods are computed separately.

Travel Rate

Travel rate is the inverse of speed with the unit of second(s) per mile.

Delay

Delay is defined as the difference between the peak period travel rate and the free-flow travel rate. It represents the time delayed per mile during peak periods with the unit of second(s) per mile. Delays for AM and PM peak periods are computed separately.

Congestion Duration

Congestion duration is defined as time when congested speeds are lower than congestion thresholds. The congestion thresholds are defined as 45 mph with free-flow speeds on highways 60 mph or higher, 75 percent of free-flow speeds on highways with free-flow speeds between 40 and 60 mph, and as 10 mph below free-flow speed on highways with free-flow speeds below 40 mph. Congestion durations for AM and PM peak periods are computed separately.

Travel Time Reliability

Travel time reliability performance is measured as the standard deviation of travel times during peak periods. Travel time reliability for AM and PM peak periods is computed separately.

Data Source

Data used for the system performance measures was obtained from the National Performance Management Research Data Set (NPMRDS). NPMRDS provides average travel times every 5 minutes, 24/7 on the National Highway System (NHS) based on samples from GPS enabled devices in vehicles. Travel time records include passenger car, truck, and an average of the two. The distance of each NPMRDS segment (TMC segment) is also provided in the dataset.

The data collection window for this task was between February 1 and June 30, 2017 with a 15-minute time interval. There are 152 segments included in the dataset which cover I-94, US-10, MN-15, MN-23, MN-95, and CR-75 within the St. Cloud APO area