SENSITIVITY ANALYSIS OF TWIN CITIES HIGHWAY MOBILITY STUDIES

METROPOLITAN COUNCIL

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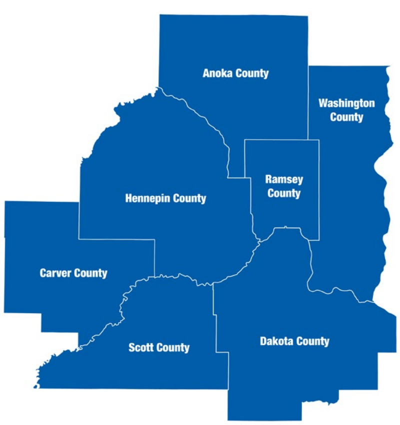

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1. Introduction and Study Goal

The Metropolitan Council, in collaboration with the Minnesota Department of Transportation (MnDOT), initiated the Sensitivity Analysis for the Twin Cities Highway Mobility Studies in May 2019. The goal of the study was to apply a new methodology, used in MnDOT's Greater Minnesota Mobility Study (2018), to identify freeway and non-freeway arterial roadway mobility and reliability issues on the National Highway System (NHS) in the Twin Cities Metropolitan Area. These results were then compared to the MnDOT Congestion Report and the Met Council congestion speed data analysis to look for differences and similarities in problem area identification. A comparison to the results of the Greater Minnesota Mobility Study or other Twin Cities Metropolitan Area studies was not made due to the differences in study purposes, evaluation methodology, study area context, and the limited value that could be derived of such comparisons.

The study was led by a Project Management Team (PMT) comprised of the following staff:

- Steve Peterson, Met Council Co-Project Manager
- Brad Utecht, MnDOT Co-Project Manager
- Paul Czech, MnDOT
- Tony Fisher, Met Council
- Dave Burns, Met Council
- Dennis Farmer, Met Council
- Angie Bersaw, Bolton & Menk
- Ross Tillman, Bolton & Menk

2. Study Area

The study analyzed the following two study areas:

- Entire Metropolitan Planning Organization (MPO) Area[1] (plus Chisago County), including both urbanized and non-urbanized areas[2].
- Entire MPO Area (plus Chisago County), including only the non-urbanized area.

As early results were reviewed, the PMT agreed to analyze the freeways separately from other facilities. That decision resulted in two sets of scoring: 1) freeways only, and 2) arterials only. Both non-urbanized and urbanized areas were analyzed within the same sets of scoring to simplify the analysis.

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[1] Seven county metro area plus urbanized portions of Wright and Sherburne counties.

[2] As defined by the U.S. Census Bureau, an urbanized area is a contiguous urbanized portion of a metropolitan area with a population of 50,000 or more.

3. Identify Highway Mobility Locations

3.1 Methodology

This section describes the overall methodology used to identify and prioritize mobility and reliability issues on the NHS in the Twin Cities MPO area and Chisago County. The information below summarizes data sources, evaluation criteria, and scoring results.

3.1.1 Data Sources

The following data sources were used as part of the study:

- National Performance Measurement Research Data Set (NPMRDS) – Travel speed data for 2015-2017 on the NHS.
- StreetLight Insight Data– Used to fill gaps in NPMRDS data and determine trip length. Travel speed data for 2015-2017.
- MnDOT – GIS base map, speed limit data, crash data (2015-2017), Annual Average Daily Traffic (AADT), Heavy Commercial Annual Average Daily Traffic (HCAADT), train volumes
- Met Council – Transit data

At the direction of the PMT, the following elements were addressed regarding the study's data sources:

- Use NPMRDS segmentation of the data. The segmentation was kept as-is for purposes of this analysis rather than utilizing StreetLight for all speed data using custom segmentation.
- Keep all the data in the analysis and do not remove winter months.
- Do not remove any data due to known construction impacts or influence.
- Continue to use posted speed in the Speed Index calculation to be consistent with the methodology applied to the Greater Minnesota Mobility Study.
- Do not screen out interchange ramps.

3.1.2 Evaluation Criteria

The PMT developed evaluation criteria to identify NHS segments that exhibit mobility and reliability issues. The PMT recommended using a travel time reliability measure consistent with the Federal Highway Administration (FHWA) and United States DOT Rule 23 CFR 490 Subpart E, which defines Level of Travel Time Reliability as the measure to assess reliability of the NHS. The Level of Travel Time Reliability was used to identify locations with high variabilities in travel time and was calculated as follows:

$$Level\ of\ Travel\ Time\ Reliability = \frac{80th\ percentile\ Travel\ Time}{50th\ percentile\ Travel\ Time}$$

Time Periods Analyzed:

- Weekday: 6am-10am, 10am-4pm, 4pm-8pm
- Weekend: 6am-8pm

Consistent with the federal performance measure, a segment was considered unreliable if Level of Travel Time Reliability was greater than 1.50 in any time period.

The PMT also developed a measure to identify highway mobility issues. This was called a Speed Index. While not a federal measure like Level of Travel Time Reliability, it was used to identify locations with consistent mobility issues. The Speed Index provides a mobility indicator based on average speed compared to posted speed as outlined below:

$$Speed\ Index = \frac{Average\ Speed}{Posted\ Speed}$$

Time Periods Analyzed:

- Weekday: 6am-10am, 10am-4pm, 4pm-8pm
- Weekend: 6am-8pm

A segment was considered to have a consistent mobility issue if Speed Index was less than 80 percent in any time period.

The 80 percent threshold, on a 55 MPH roadway, implies that average speed over a time period analyzed needed to be 44 MPH or less to be flagged. The threshold value was discussed with the PMT and was qualitatively chosen based on the number of miles the measure identified as having a mobility issue. Other thresholds were deemed to either flag too few or too many miles of roadway.

The Level of Travel Time Reliability and Speed Index statistics were summarized for each study area. Overall, the study area has less than 15 percent of the total analyzed mileage exceeding the Level of Travel Time Reliability threshold of 1.50. Similarly, less than 20 percent of mileage fell below the threshold for Speed Index. Table 1 and Figures 1, 2, and 3 display the results of this analysis[3].

Table 1. Level of Travel Time Reliability and Speed Index Statistics

Level of Travel Time Reliability Threshold	1.5
Speed Index Threshold	0.8
Mileage Exceeding Level of Travel Time Reliability Threshold	199 miles (12%)
Segments Exceeding Level of Travel Time Reliability Threshold	823 segments
Mileage Exceeding Speed Index Threshold	286 miles (17%)
Segments Exceeding Speed Index Threshold	758 segments
Mileage Exceeding Both Thresholds	56 miles (3%)
Segments Exceeding Both Thresholds	253 segments

[3] The TH 610 gap shown near I-94 is due to the completion year of that project. The segmentation was not present in the data available.

Figure 1. Segments Exceeding Level of Travel Time Reliability Threshold

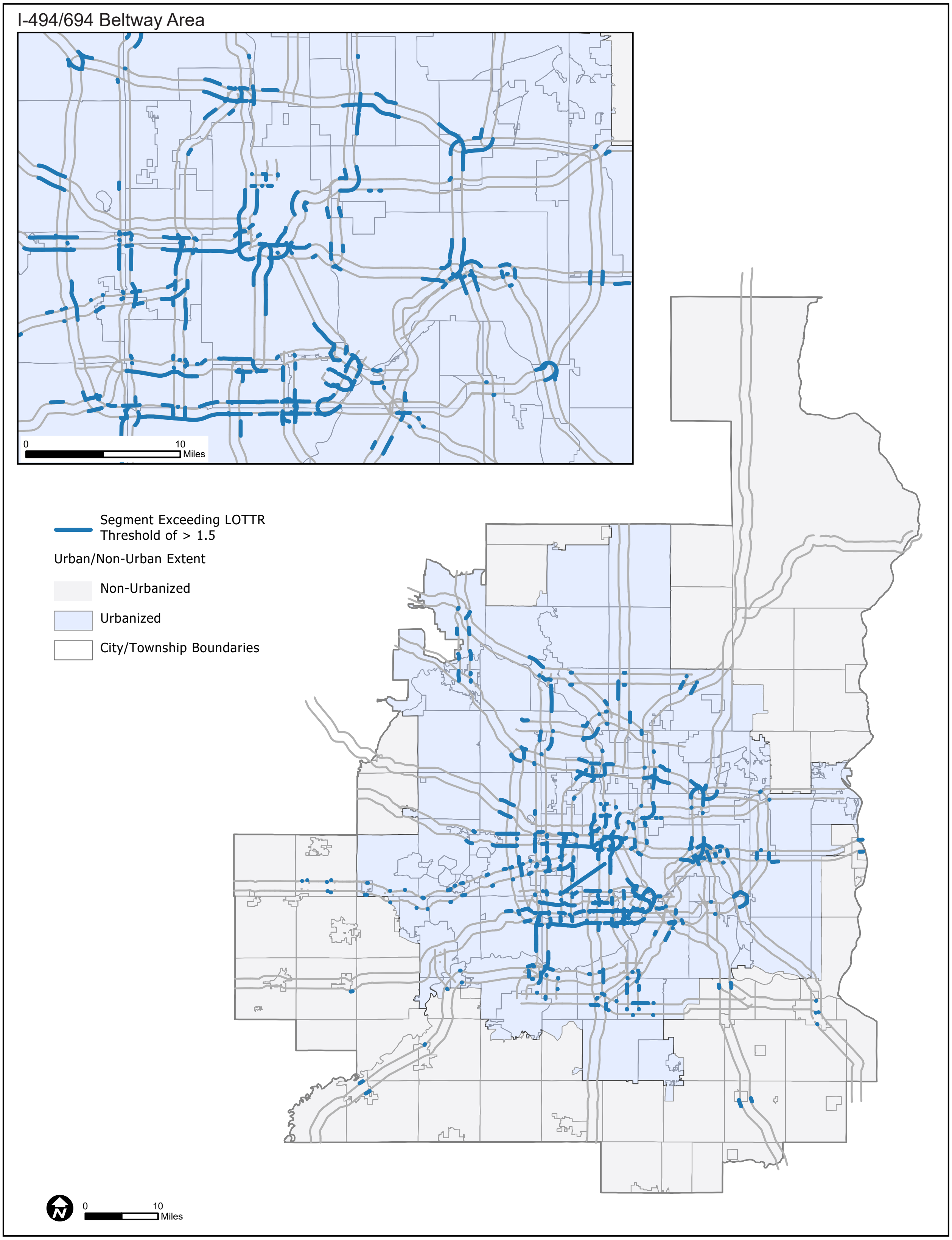


Figure 2. Segments with Speed Index Under Threshold

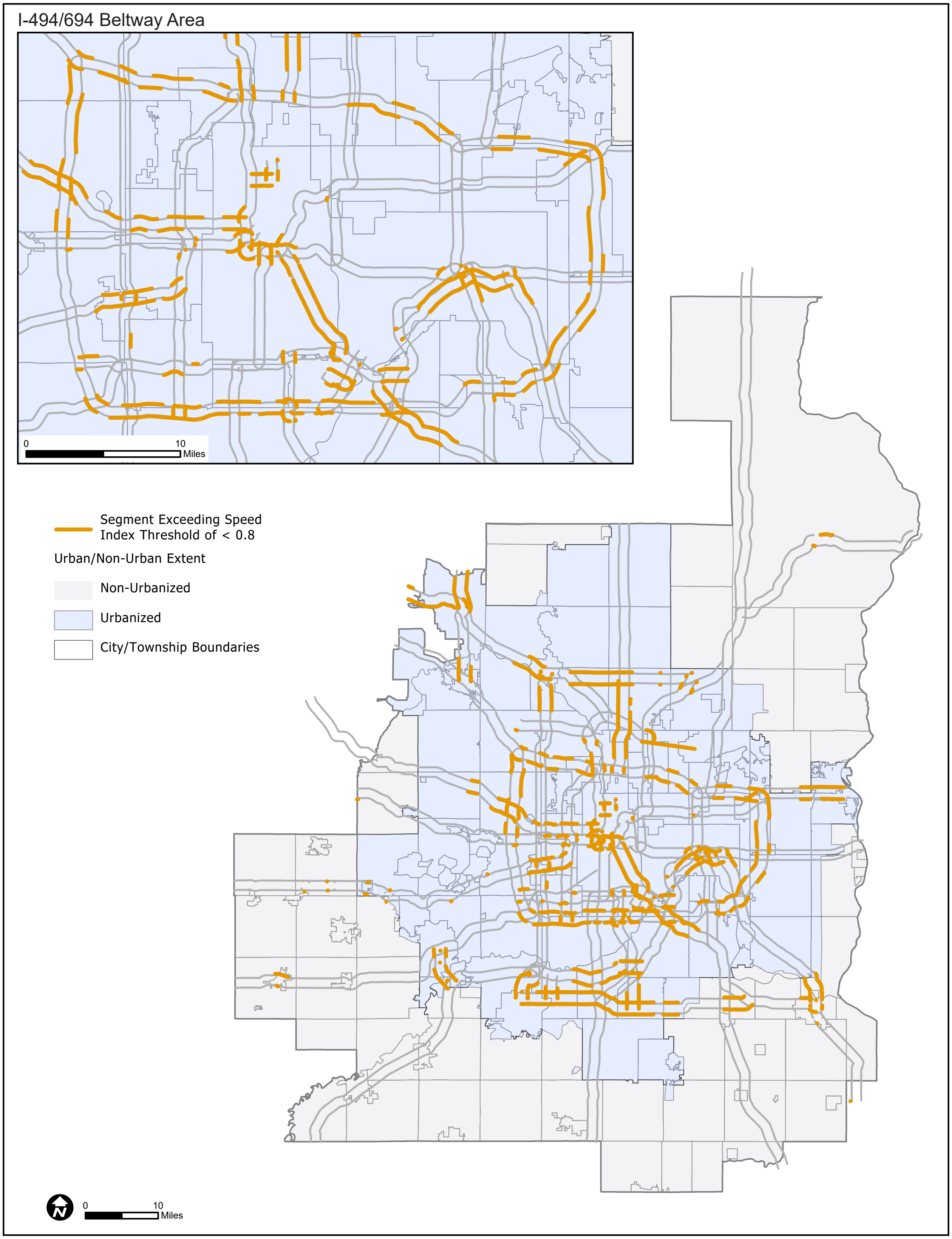
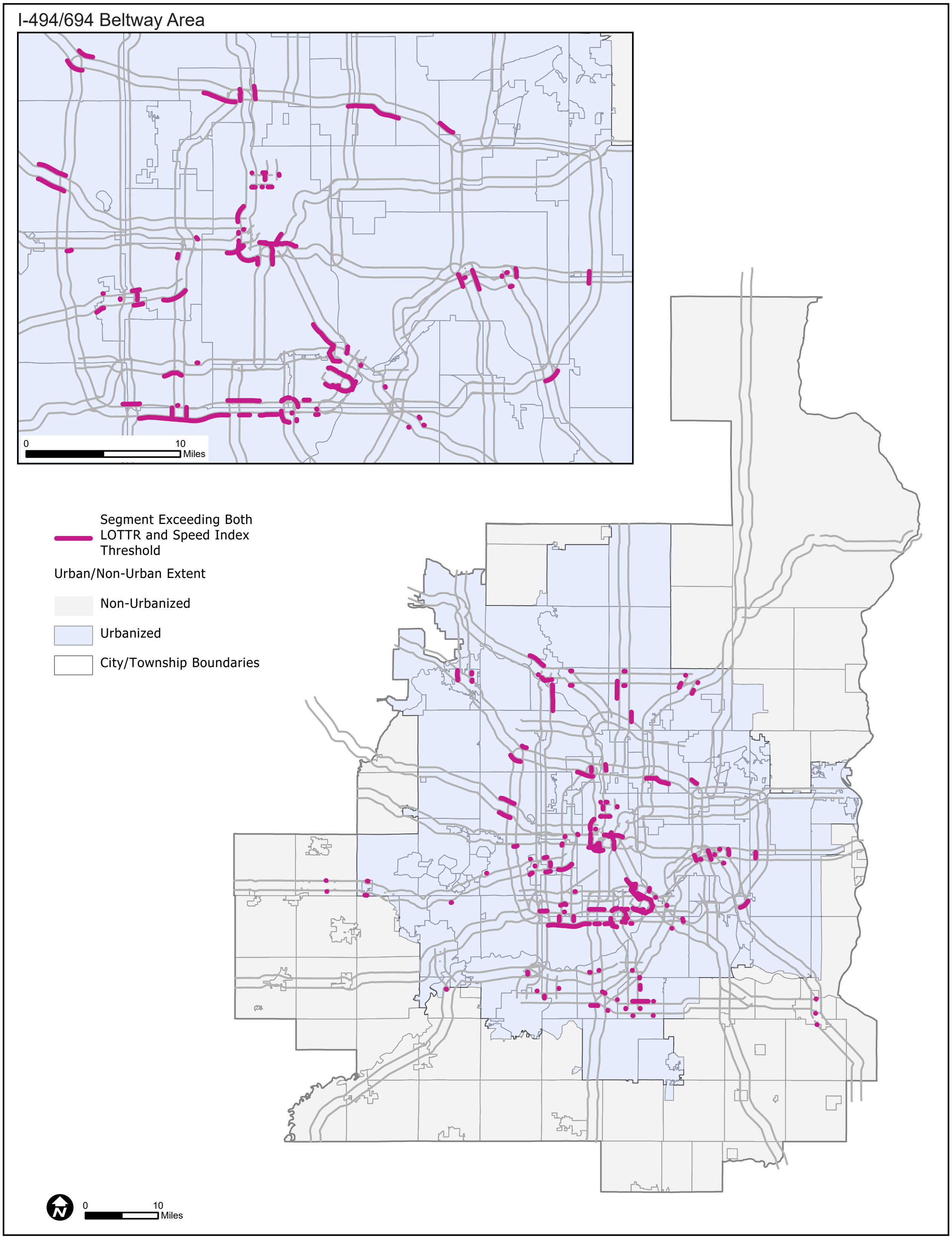


Figure 3. Segments Meeting both Level of Travel Time Reliability and Speed Index Thresholds



The PMT recognized there are other influences on highway mobility and reliability, such as safety and a segment's characteristics or role, that should be considered in the overall evaluation. Based on this discussion, the PMT developed the following evaluation criteria:

- **Mobility and Reliability** – *Prioritize locations with high variability in travel times and consistent mobility issues.*
    - Level of Travel Time Reliability – Exhibits a reliability issue based on the 80th percentile travel time/50th percentile travel time factored by the square root of AADT.[4]
    - Speed Index – Exhibits a mobility issue based on historic average speed/posted speed factored by the square root of AADT.
    - Mobility Bonus[5] – Level of Travel Time Reliability greater than 1.5 and Speed Index less than 0.80
- **Safety** – *Prioritize locations that have a high frequency of crashes (crashes correlate to potential mobility and reliability issues).*
    - Critical Crash Rate – Provides a relative score based on the number of crashes and traffic volume for a segment.
    - Fatal and Serious Crash Rate – Provides a relative score based on the number of fatal and serious injury crashes and traffic volume for a segment.
- **System Role and Route Characteristics** – *Prioritize locations that serve the greatest number of regional trips, freight traffic, and transit.*
    - HCAADT – Number of heavy commercial vehicles
    - Trip Length – Average trip length on roadway segment (from StreetLight Insight)
    - Rail – Presence of an at-grade rail crossing
    - Transit – Presence of transit service along route

Table 2 (below) outlines the weighting of evaluation criteria as established by the PMT.

Table 2. Evaluation Criteria Weighting

General Criteria	Detailed Criteria	Recommended Weighting
Mobility and Reliability	Level of Travel of Travel Time Reliability *$\sqrt{AADT}$	20%
Mobility and Reliability	Speed Index*$\sqrt{AADT}$	20%
Mobility and Reliability	Mobility Bonus (Level of Travel Time Reliability > 1.5, Speed Index < 0.80)	20%

[4] The square root was used to reduce the influence of high AADT routes compared to less traveled roadways. Without reduction, the difference between some of the higher AADT routes analyzed and the lower AADT routes could be 15 times greater, resulting in those high AADT routes (for example I-35W south of downtown Minneapolis) to dominate the mobility and reliability scoring. Both routes may have mobility concerns that could be worth investments. This is consistent with the methodology used in the Greater Minnesota Mobility Study
[5] An additional scoring bonus was provided to segments that met both Level of Travel Time Reliability and Speed Index thresholds. This is consistent with the methodology used in the Greater Minnesota Mobility Study.

General Criteria	Detailed Criteria	Recommended Weighting
Mobility and Reliability	**Subtotal**	**60%**
Safety	Crash Rate	15%
Safety	Fatal and Serious Crash Rate	15%
Safety	**Subtotal**	**30%**
System Role/Route Characteristics	HCAADT	4%
System Role/Route Characteristics	Trip Length	1%
System Role/Route Characteristics	Rail	1%
System Role/Route Characteristics	Transit	4%
System Role/Route Characteristics	**Subtotal**	**10%**
	Total	**100%**

3.1.3 Scoring

Scores were determined for each data segment based on the criteria and weighting determined by the PMT. Due to the disparity in some of the criterion between freeways and non-freeway arterials within the study area, these facilities were scored independently. Each detailed criterion was scored with a maximum score of ten and a minimum score of either zero or one. The distribution of the actual data for each criterion was used in determining the breakpoints in criteria value corresponding to the numerical score. See Tables 3 and 4 for the ranges of criteria values associated with the scoring for both freeways and non-freeway arterials. The same scoring was used for both urbanized and non-urbanized areas within both freeway and arterial categories. Weighting percentages and score values for each criterion were combined to formulate an overall weighted score for each data segment.

Table 3. Detailed Criteria Scoring (Non-Freeway Arterials)

General Criteria	Detailed Criteria	Score Range	Min Score Value	Max Score Value
Mobility and Reliability	Level of Travel Time Reliability $*\sqrt{AADT}$	0 - 10	<89	>317
Mobility and Reliability	Speed Index$*\sqrt{AADT}$	0 - 10	>439	<60
Mobility and Reliability	Mobility Bonus (Level of Travel Time Reliability > 1.5, Speed Index < 0.80)	0 or 10	No	Yes

General Criteria	Detailed Criteria	Score Range	Min Score Value	Max Score Value
Safety	Crash Rate	0 - 10	<1	>10
Safety	Fatal and Serious Crash Rate	0 or 10	<1	>1
System Role & Route Characteristics	HCAADT	1 – 10	<495	>2500
System Role & Route Characteristics	Trip Length	0 – 10	<15	>48
System Role & Route Characteristics	Rail	0 or 10	No	Yes
System Role & Route Characteristics	Transit	0 or 10	No	Yes

Table 4. Detailed Criteria Scoring (Freeways)

General Criteria	Detailed Criteria	Score Range	Min Score Value	Max Score Value
Mobility and Reliability	Level of Travel Time Reliability *$\sqrt{AADT}$	0 - 10	<170	>618
Mobility and Reliability	Speed Index*$\sqrt{AADT}$	0 - 10	>661	<150
Mobility and Reliability	Mobility Bonus (Level of Travel Time Reliability > 1.5, Speed Index < 0.80)	0 or 10	No	Yes
Safety	Crash Rate	0 - 10	<1	>8
Safety	Fatal and Serious Crash Rate	0 or 10	<1	>1
System Role & Route Characteristics	HCAADT	1 – 10	<1600	>9800
System Role & Route Characteristics	Trip Length	0 – 10	<20	>36
System Role & Route Characteristics	Rail	0 or 10	No	Yes
System Role & Route Characteristics	Transit	0 or 10	No	Yes

3.2 Results

Of the approximately 1,700 miles studied, Table 5 provides a breakdown of the scoring. Scoring was completed for all study segments, however as stated freeways and non-freeway arterials were scored separately, with results shown in Figures 4 and 5. Figure 6 shows the same scoring as Figure 5 but focuses on the non-urbanized MPO area. Low, medium, and high scoring buckets correspond to the breakdown on the mapping.

Table 5. Scoring Mileage Breakdown

	Score	Arterial Miles (miles)	Arterial Miles (percentage[6])	Freeway Miles (miles)	Freeway Miles (percentage[7])
Low	**0-1**	1	0%	22	2%
Low	**1-2**	7	1%	4	3%
Low	**2-3**	179	26%	225	26%
Low	**3-4**	153	47%	293	56%
Medium	**4-5**	259	83%	263	83%
Medium	**5-6**	91	95%	116	95%
High	**6-7**	22	98%	29	98%
High	**7-8**	8	99%	11	99%
High	**8-9**	5	99%	10	99%
High	**9-10**	1	100%	3	100%
	Average Score	3.9	--	3.8	--
	Median Score	3.7	--	3.7	--

[6] Percentages rounded to nearest whole percent.
[7] Percentages rounded to nearest whole percent.

Figure 4. Scoring Results (Freeways)

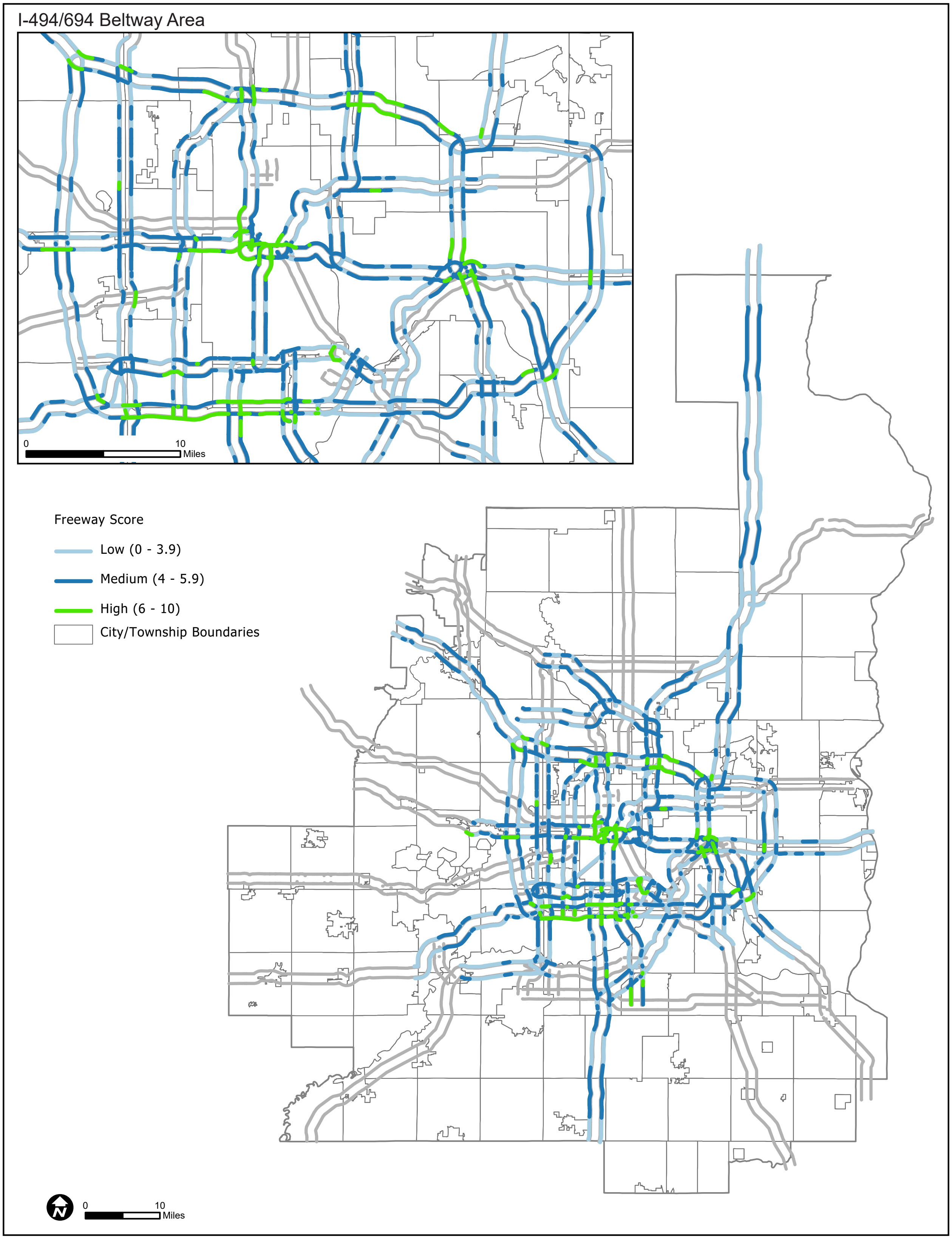


Figure 5. Scoring Results (Non-Freeway Arterials)

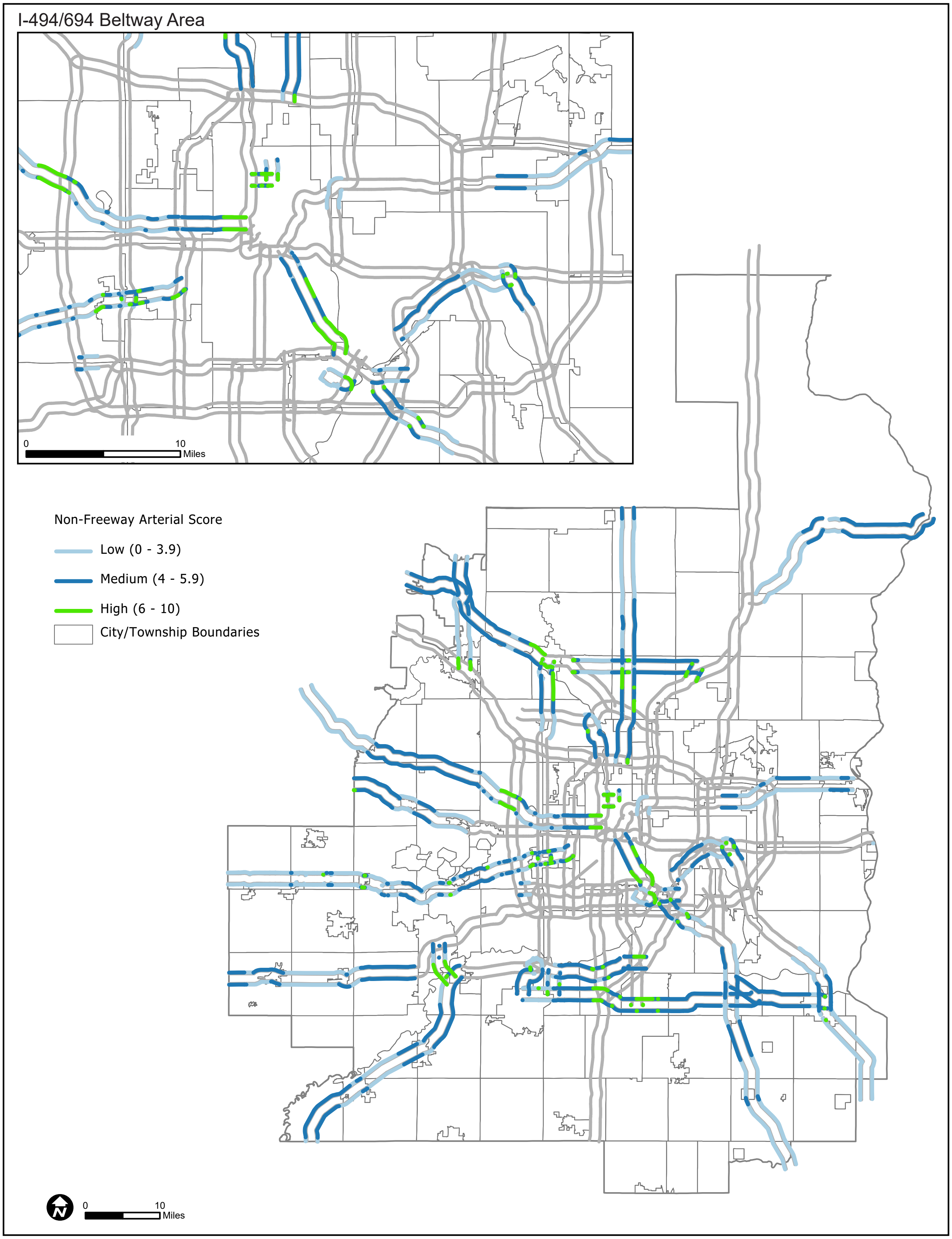
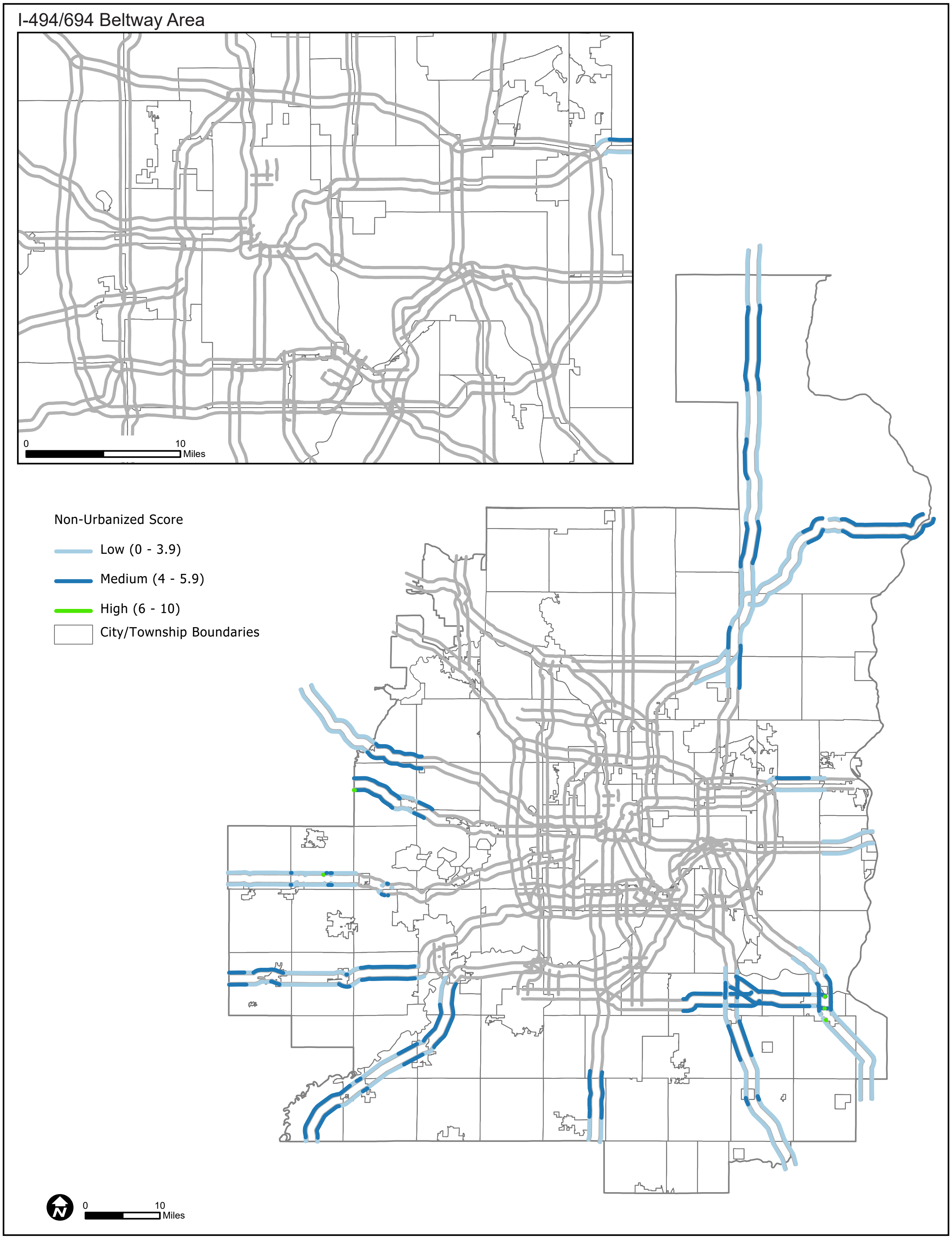


Figure 6. Scoring Results (Non-Urbanized Area Only)



4. Comparison to MnDOT Congestion Report

The PMT wanted to compare this study's results to the MnDOT Congestion Report, as they both identify highway mobility issues. The MnDOT Congestion Report is prepared annually by MnDOT's Regional Transportation Management Center to track those segments of the freeway system that experience recurring congestion.

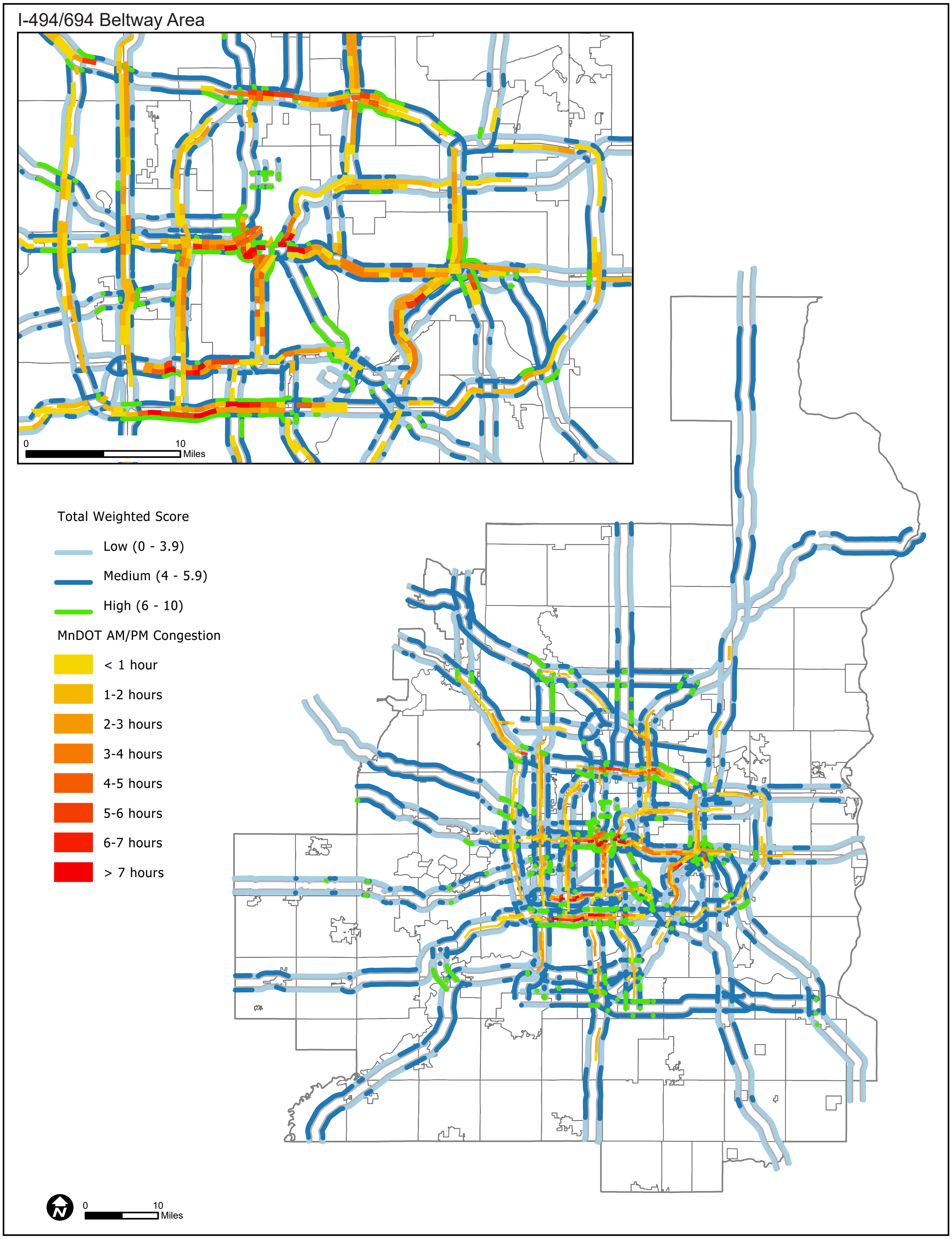
The freeway results from the Sensitivity Analysis for Twin Cities Highway Mobility Studies were compared to the 2018 MnDOT Congestion Report. For this comparison, it is important to note a few differences in data. The Sensitivity Analysis Study was based on 2015-2017 speed data. The MnDOT Congestion Report used 2018 data. In addition, the MnDOT Congestion Report utilizes data derived from the instrumented portion of the freeway network. This study used probe speed data. Lastly, the MnDOT Congestion Report is based on peak periods of data versus this study looking at 6a-8p every day.

The MnDOT Congestion Report organized results based on hours of recurring congestion, ranging from "No Recurring Congestion" to "greater than seven hours of congestion". The data is reported for the AM and PM peak periods separately but also combined. The combined results were compared with the scoring from this study and are summarized in Table 6 and shown in Figure 7.

Table 6. 2018 MnDOT Congestion Report Data Comparison

Hours of Recurring Congestion (2018 MnDOT Congestion Report)	Freeway Median Score
No recurring congestion	3.6
Less than 1 hour	3.9
1-2 hours	4
2-3 hours	4.3
3-4 hours	4.4
4-5 hours	4.8
5-6 hours	4.2
6-7 hours	5.6
More than 7 hours	7

Figure 7. Comparison to 2018 MnDOT Congestion Report



Both studies are heavily weighted by congestion-related metrics, therefore a strong correlation is expected. However, the freeway analysis does present an interesting correlation. As the amount of recurring congestion reported in the congestion report increases, the total score for the overlapping segments in this study tends to increase. This suggests the Sensitivity Analysis for Twin Cities Highway Mobility Studies provides scoring representative of the amount of congestion captured with MnDOT's data collection equipment and could provide a reasonable representation of recurring congestion on roadways that are not instrumented with data collection equipment.

5. Comparison to Met Council Congestion Speed Data Analysis

Results of from this study were also compared to the Met Council Congestion Speed Data Analysis completed using StreetLight Insight data in 2017-2018. Like the MnDOT report, the data periods used in both of these studies do not directly overlap.

The Congestion Speed Data Analysis report organized results based on peak hour speeds compared to reference speeds[8]. Lower ratios indicated the presence of lower speeds and increased congestion compared to free-flowing time periods. These results were compared with the scoring from this study and are summarized in Table 7 and shown in Figures 8 and 9. The data was sorted into bins to compare to the scoring completed for this study, however the original data was simply tied to roadway segmentation. Non-freeway arterials and freeways were compared separately.

[8] Reference speeds are taken from overnight speeds with little traffic on the roadways (12 a.m. through 6 a.m. on weekdays).

Table 7. Met Council Congestion Speed Data Comparison

Speed to Reference Speed Ratio (Met Council Congestion Speed Data)[9]	Arterial Median Score - AM	Arterial Median Score - PM	Freeway Median Score - AM	Freeway Median Score - PM
0.9 to 1.0	3.7	3.4	3.6	3.6
0.8 to 0.9	4	4	3.9	3.7
0.7 to 0.8	3.8	4.4	4.3	4.2
0.6 to 0.7	5.7	4.1	4	4.8
0.5 to 0.6	*	6.1	*	4.8
0.4 to 0.5	*	*	*	7.3
0.3 to 0.4	*	*	*	4.5
0.2 to 0.3	*	*	*	*
0.1 to 0.2	*	*	*	*
0.0 to 0.1	*	*	*	*

*No segments exhibited speed ratio results in these bin ranges

[9] Higher ratios indicate operating speeds closer to reference speeds. Lower ratios indicate operating speeds lower than reference speeds. The lower ratios correspond to varying levels of congestion.

Figure 8. Comparison to Met Council Congestion Speed Data Analysis (AM Peak Period)

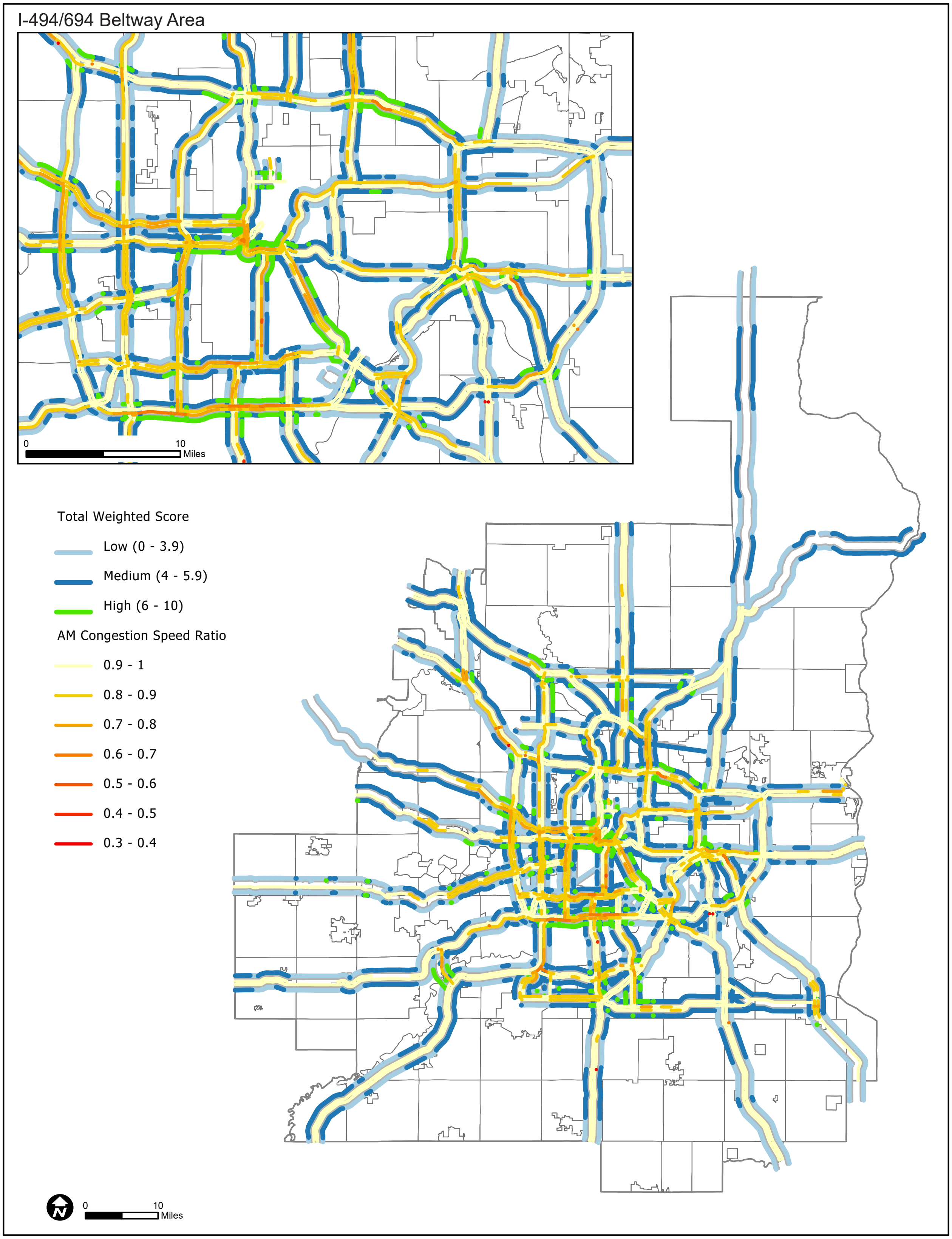
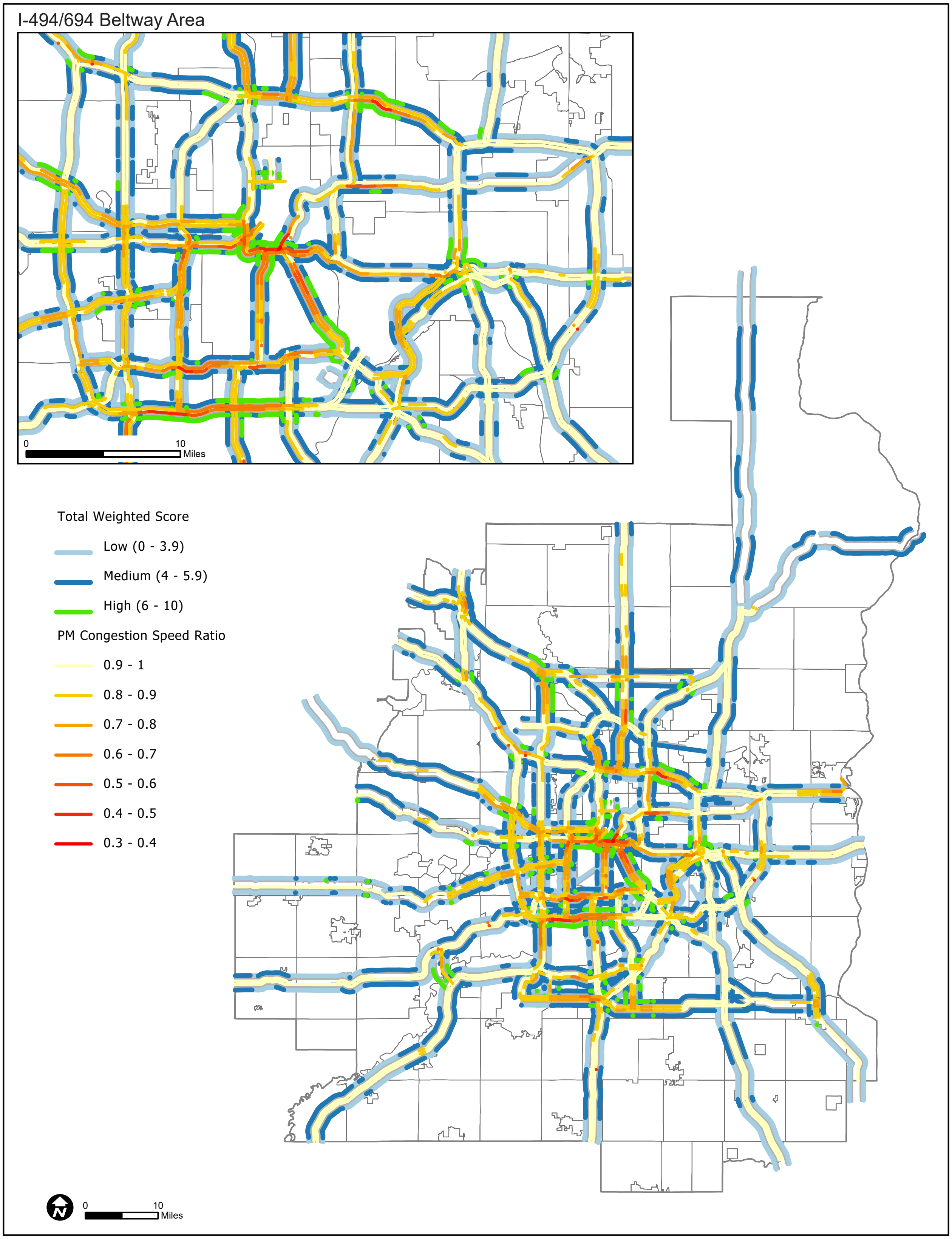


Figure 9. Comparison to Met Council Congestion Speed Data Analysis (PM Peak Period)



Both studies utilized speed data as the major data source but compared this data to different data sets. The Congestion Speed Data Study utilized a reference speed for comparison to peak hour speeds while this study utilized posted speed day between 6am and 8pm to be consistent with the methodology used in the Greater Minnesota Mobility Study. The general trends seem to indicate that the lower the speed ratio using the Congestion Speed Data, the higher the score in this study. This would imply the potential for correlation between the studies in that both are identifying the more congested areas of the Twin Cities through different scoring strategies.

In areas where data are contradictory to this correlation; however, there are other factors considered in this study compared to the Congestion Speed Data effort that could also be contributing to the differences. These include posted vs. reference speed and the inclusion of other factors such as reliability, safety statistics, and roadway characteristics. For example, this study would penalize a congested roadway segment with fewer crashes compared to a congested roadway segment that has more crashes, while the Congestion Speed Data effort did not consider safety or roadway characteristic data.

6. Study Limitations

Due to the scale of the study and data sources used there are known limitations that should be discussed.

1. **Study Scale** – Since approximately 850 centerline miles of roadway were part of the analysis area, more traditional and/or detailed analysis of the system was not possible given the study budget, schedule, or available data. For example, more detailed analysis of intersections typically requires specific site data such as turning movement counts. Data in this format for the study area was not already available and not feasible to collect.

2. **Data Sources** – The main source of highway mobility data utilized was from NPMRDS. Characteristics and issues of this data that posed limitations include:
    a. The data is originally obtained from cell phone companies, truck fleets, GPS equipment, etc. Actual quality and sources of the data for each segment is not disclosed.
    b. The roadway segmentation of the data cannot be edited. This can be an issue with both long segments potentially washing out smaller/more discrete problem areas and short segments potentially over valuing issues.
    c. In some cases, NPMRDS did not have data along certain stretches of the NHS. The team utilized Streetlight Insight data to fill these gaps (corresponded to approximately 11% of the study miles). It is unclear how data between each platform differs from the other but had to be used simultaneously as a result of data gaps.

3. **Comparison to other studies** – A comparison to the results of other Twin Cities metropolitan area studies such as the Principal Arterial Intersection Conversion Study, the Congestion Management Process Plan, MnPASS 3, Regional Truck Highway Corridor Study, and the Freeway System Interchange Study was conducted. The results of this comparison exercise are included in Appendix A. The use of this comparison to draw conclusion should be cautioned. Although each of these studies measured highway mobility and reliability to some degree, the evaluation methodology and underlying datasets are very different, making it difficult to draw truly meaningful comparisons.

A comparison to the results of the Greater Minnesota Mobility Study was not made due to the differences in issues and context and the limited value that could be derived of such a comparison. While the general methodology remained the same, the calibration of measures and scoring between the Twin Cities area and Greater Minnesota were quite different.

7. Key Study Findings

The goal of the Sensitivity Analysis for Twin Cities Highway Mobility Studies was to apply a new methodology, used in the Greater Minnesota Mobility Study (2018), to identify mobility and reliability issues on the National Highway System (NHS) in the Twin Cities Metropolitan Area and Chisago County. This new methodology, using third-party speed data as the primary data source, was then compared to the MnDOT Congestion Report and the Met Council Congestion Speed Data Analysis to look for differences and similarities in problem area identification. Below is a summary of the key findings:

- **Correlations to other Twin Cities Metro Area congestion studies –** Although using different data sets and methodology, a correlation between the Sensitivity Analysis for Twin Cities Highway Mobility Studies and the MnDOT Congestion Report and the Met Council Congestion Speed Data Analysis can be made as follows:
    - **MnDOT Congestion Report -** As the amount of recurring congestion reported in the congestion report increases, the total correlation for the overlapping segments in this study tends to increase. This suggests that this study provides scoring representative of the amount of congestion captured with MnDOT's data collection equipment and could provide a reasonable representation of recurring congestion on roadways that are not instrumented with data collection equipment. See Figure 7.
    - **Met Council Congestion Speed Data Analysis –** Both the Met Council congestion analysis and this sensitivity analysis are identifying the more congested areas of the Twin Cities through different scoring strategies. See Figures 8 and 9.

- **Similar mobility/reliability problem area identification –** The Sensitivity Analysis for Twin Cities Highway Mobility Studies, the MnDOT Congestion Report, and the Met Council Congestion Speed Data Analysis all generally are highlighting mobility concerns within the urbanized area. Within the urbanized area, many of the areas with mobility concerns fall on the I-494/I-694 ring or within it. The differences between Figures 4, 5 and 6 illustrate this.
    - Approximately 60% of the high scoring mileage falls on or within the I-494/I-694 ring.
    - Because the criteria used in the Sensitivity Analysis for Twin Cities Highway Mobility Studies included safety as 30% of the overall score, this methodology appears to place more emphasis on targeted intersections where most conflicts occur as compared to the other studies. All studies generally indicate the same areas for mobility issues, but the highest scoring segments in the Sensitivity Analysis are often more confined.
    - Areas such as I-494 in Bloomington and I-94/I-35W commons area in Minneapolis are examples of where all three studies highlight major issues.

    - One area not highlighted in the Sensitivity Analysis for Twin Cities Highway Mobility Studies but generally identified as higher congestion levels in the MnDOT Congestion Report and the Met Council Congestion Speed Data Analysis is TH 62 through Edina. In this area, it appears the reliability metric used in this study was not exceeded, implying that the congestion occurring in this area is somewhat reliable (reliability slow). In addition, this stretch did not have the crash data history to support obtaining a high safety score.

- **Reliability congested corridors may not achieve high scores** – Corridors that have consistent congestion issues during the same periods of each day may still be considered reliable. Therefore, these roadway segments would not achieve high mobility/reliability scores within this study and may not be flagged as high scoring locations. An example of this is TH 62 through Edina, as described above.

- **Programmed investments are targeting key mobility/reliability issues –**The results of this study confirm investment decisions in programmed projects are targeting areas with the highest mobility and reliability issues. Although not all encompassing, a comparison to Figure 5 in the 2020-2023 Transportation Improvement Program (TIP) for the Twin Cities Metropolitan Area confirms some of the problem areas identified in this analysis as medium and high scoring are being addressed through major projects under construction or programmed in the 4-year TIP. These areas include I-494 in Bloomington, US 169/TH 41 in Scott County, and I-35W/I-94. In addition, the current revenue scenario as presented in the Transportation Policy Plan (TPP) contains projects along many of the most congested areas on the freeways. Non-freeway arterials are better represented in the TPP increased revenue scenario and are also targets for locally led projects partially funded through the Regional Solicitation.

  There are areas receiving funding through major projects that did not score as highly as others in this study, which could be a result of the specific metrics utilized and the weighting applied. For example, reliably slow corridors with limited crash history may not score highly with this scoring system.

- **High scoring segments are not all equal** – When considering the scoring presented in this study, it is important to understand the context in which the roadways operate. For example, there are unique constraints or operating conditions (including adjacent land use, transit operations, available right-of-way, and natural features) along TH 55 (Hiawatha) in Minneapolis, CSAH 42 in Burnsville, and TH 169 through Anoka that may prohibit achieving improved mobility, reliability, etc. Poor mobility conditions/high scores may be expected and could be acceptable given the context of certain corridors.

Appendix A: Comparison to Other Studies

The Sensitivity Analysis for Twin Cities Highway Mobility Studies began with goal to compare the results of this study with other metropolitan area studies related to congestion to understand how the results may align or not and determine what that means. The study team did complete this analysis as shown in Table 1 and the sections that follow. However, this analysis is being included as information only since the study team was unable to draw meaningful conclusions due to the differences in study purposes, evaluation methodology, and study area contexts.

Table 1. Comparison Study Evaluation Metrics

Study	Mobility Measures	Safety Measures	Freight Measures	Transit Measures	Other Measures
Sensitivity Analysis of Twin Cities Highway Mobility Studies (this study)	• Level of Travel Time Reliability • Speed Index	• Frequency and Severity of Crashes	• HCAADT • Presence of Grade Rail Crossing	• Presence of Transit Service	• Average Trip Length
Congestion Management Safety Plan IV	• Duration of Congestion • Travel Time Reliability	• Frequency and Severity of Crashes	<None>	<None>	<None>
MnPASS 3	• Severity of Current Congestion • Person Throughput • Person Hour Savings • Travel Time Savings • Change in VMT, VHT, Speed • V/C Ratio	<None>	<None>	• Express Commuter Bus Demand	• Proximity to Employment Centers • Connection to Other MnPASS Corridors and Major Destinations • Construction Cost
Principal Arterial Intersection Conversion Study	• Traffic Volume • V/C Ratio • Reliability	• Frequency and Severity of Crashes	• HCAADT	• Presence of Express Transit Service	• Functional Classification of Intersecting Roadways • Intersection Density • Proximity to Existing Grade Separations • Existing Land Use • Prior Interchange Planning • Presence of RBTN
Regional Truck Highway Corridor Study	• Truck Delay[10]	<None>	• Tier 1 Truck Corridor Network	<None>	<None>
Congestion Management Process	• V/C Ratio	<None>	<None>	<None>	<None>

[10] The Top 30 delay hotpots were identified based on a truck delay metric using speeds versus target speeds. *https://metrocouncil.org/Transportation/Publications-And-Resources/FREIGHT/Regional-Truck-Freight-Corridors-Study.aspx*

Each of the comparison studies, as they relate to this effort, are described in more detail below. All of these study results are overlaid against this study's scoring results in Figure 15.

Congestion Management Safety Plan IV (CMSP IV)

As shown in Table 1, CMSP IV used similar mobility and safety criteria to this study; however, the criteria used in this sensitivity analysis included other metrics related to freight, transit, and trip length. Only the MnDOT system is represented in CMSP IV.

CMSP IV generated recommendations for improvements in different categories, including problems related to entering traffic, exit capacity, intersection, lane drop, and ramp to ramp weaving. Both exit capacity and ramp to ramp weaving areas overlapped with higher scores, which makes sense as the issues caused in those types of problems are most noticeably exhibited on the mainline (likely included in this study) rather than on the side street (likely not included in this study).

Twenty-two of the recommendations from CMSP IV were not on the National Highway System and therefore did not overlap with this study effort for comparison. See Figure 10 for additional information.

MnPASS 3

MnPASS 3 went into detail regarding mobility benefits anticipated by adding MnPASS to study corridors, generating project specific metrics. In addition, MnPASS 3 looked at other factors including those related to transit and impacts to employment areas. A major difference between MnPASS 3 and this sensitivity analysis is the lack of safety and freight factors. Only the MnDOT system is represented in MnPASS 3.

MnPASS 3 provided recommendations for Tier 1, Tier 2, and Tier 3 corridors, which overlapped median scores in this study of 4.4, 5.1, and 4.1 respectively. The difference in average scoring is not drastic between the tiers, however the Tier 2 segments scored highest in this study. The differences in methodology with MnPASS considering location/project specific benefits with future volumes is significant enough that the results may not be directly comparable.

All the MnPASS recommended corridors overlap with this study effort. See Figure 11.

Principal Arterial Intersection Conversion Study (PAICS)

The Principal Arterial Intersection Conversion Study focused on locations that might be good candidates for intersection grade separation improvements. The PAICS study included similar metrics to this study; however, PAICS included many more contextual metrics. The major difference was the mobility statistics were not based on real, observed travel data while this study was.

PAICS recommended both intersection grade separation and at-grade projects in three priority categories: high, medium, and low. These categories overlapped with median scores from this study of 5.1, 4.32, and 4.5 respectively. Like CMSP, side street delay and factors that played a factor in PAICS were not considered as part of this study due to the data sources used, which may factor into the average scoring compared to PAICS categories.

All PAICS recommended intersections overlap with this study effort. Many intersections were screened out in the PAICS study prior to categorizing priority, therefore only those that passed the initial screening and were categorized were analyzed. See Figure 12.

Regional Truck Highway Corridor Study

The Regional Truck Highway Corridor Study focused specifically on freight travel throughout the Twin Cities region. This focus carried over into the evaluation criteria, which only included freight related factors.

The study identified the top 30 freight bottlenecks along Tier 1 truck corridors within the region, which overlapped with a median score in this study of 4.5. The overlap between studies could be largely coincidental rather than due to the freight factors analyzed in both efforts. For example, some areas with freight bottlenecks are also likely bottlenecks for car/light truck travel which would likely be the main reason an area scored highly in this study compared to freight related factors.

Many areas (143) identified in the Regional Truck Highway Corridor Study did not overlap with the study area used in this effort. See Figure 13.

Congestion Management Process Plan (CMP)

The CMP study is focused solely on volume to capacity (V/C) analysis, therefore, the only metric utilized to date has been the V/C ratio. Compared to this study, the CMP study and V/C ratio are taking a more theoretical view of comparing actual volumes to a set capacity value based on roadway characteristics. This study is using collected travel speed data to determine mobility issues, along with adding in numerous other criteria as different factors. The CMP study is currently being updated to include speed-based congestion analysis from the StreetLight InSight platform.

The CMP study sorted segments into various groupings based on the V/C ratio. These were <0.9, 0.9-1.0, 1.0-1.15, and >1.15. Compared to this study, those same groupings overlapped with median scores of 3.8, 4.1, 4.4, and 4 respectively. While the method of determining mobility issues is quite different, there may be a minor correlation between segments approaching or above capacity with higher scores in this study as compared to segments under capacity with lower scores in this study.

Many segments (135) analyzed in the CMP study were not within the study area for this effort and therefore are not accounted for in the above statistics. See Figure 14.

Figure 10. Congestion Management Safety Plan IV

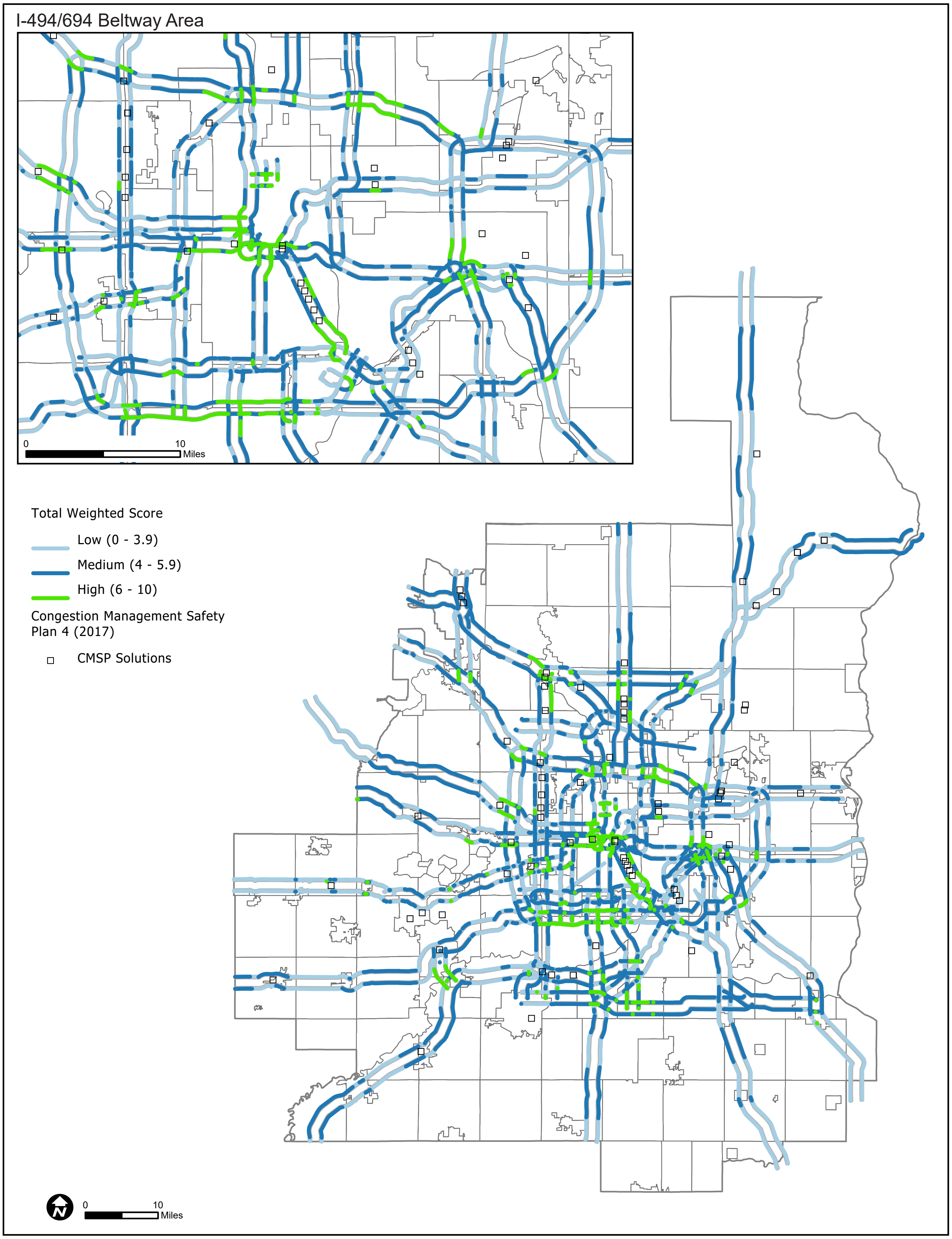


Figure 11. MnPASS System Study 3

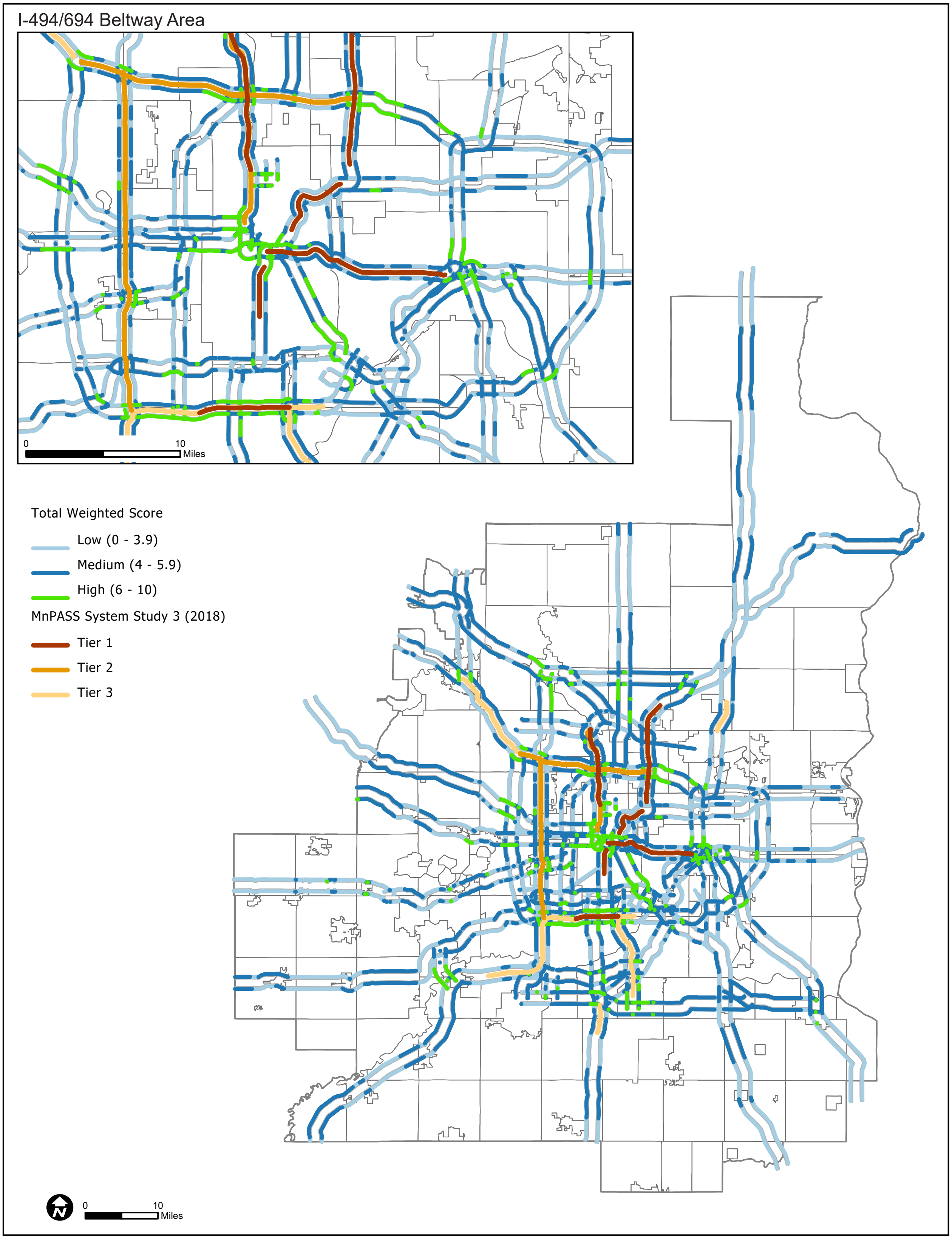


Figure 12. Principal Arterial Intersection Conversion Study

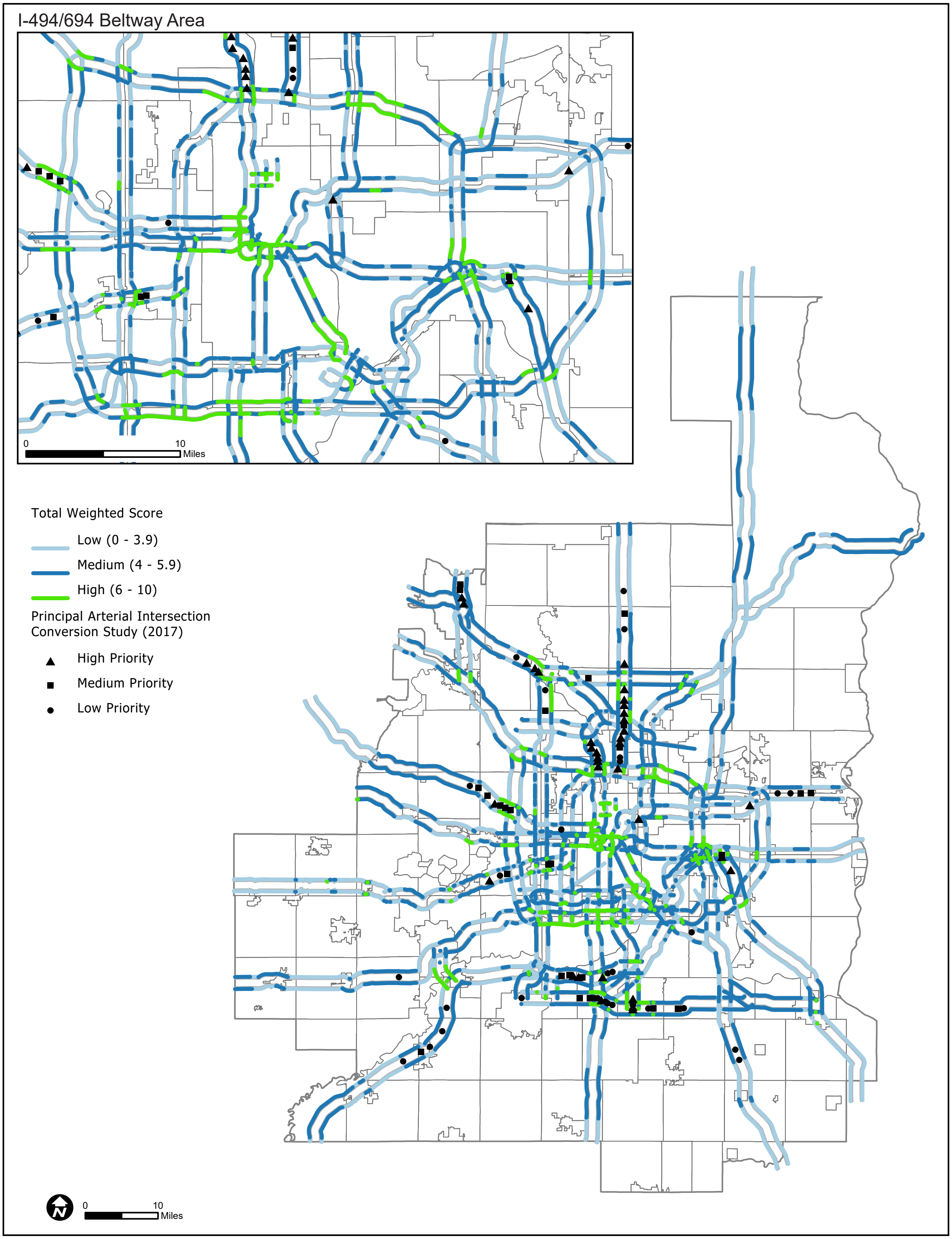


Figure 13. Regional Truck Highway Corridor Study

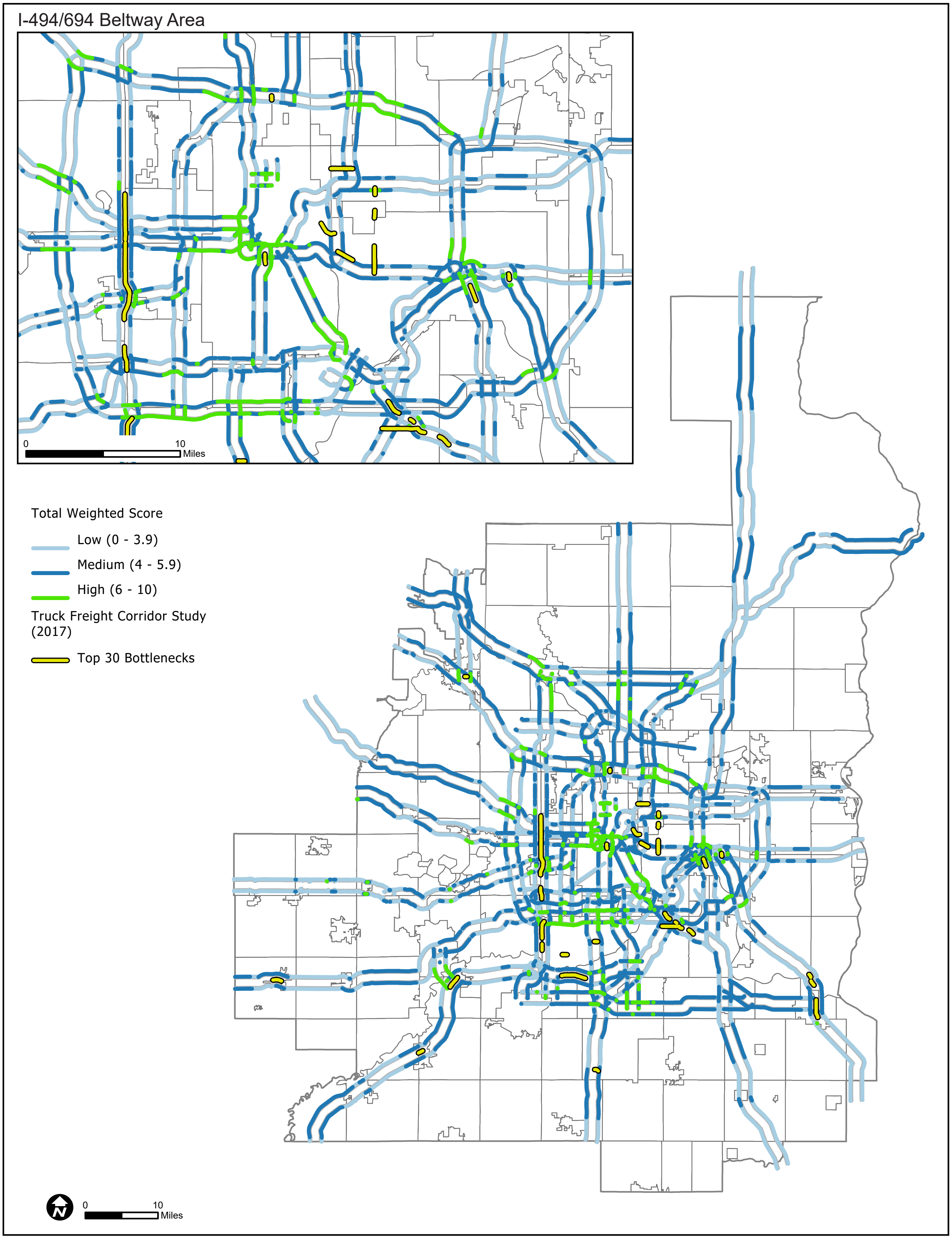


Figure 14. Congestion Management Process Plan

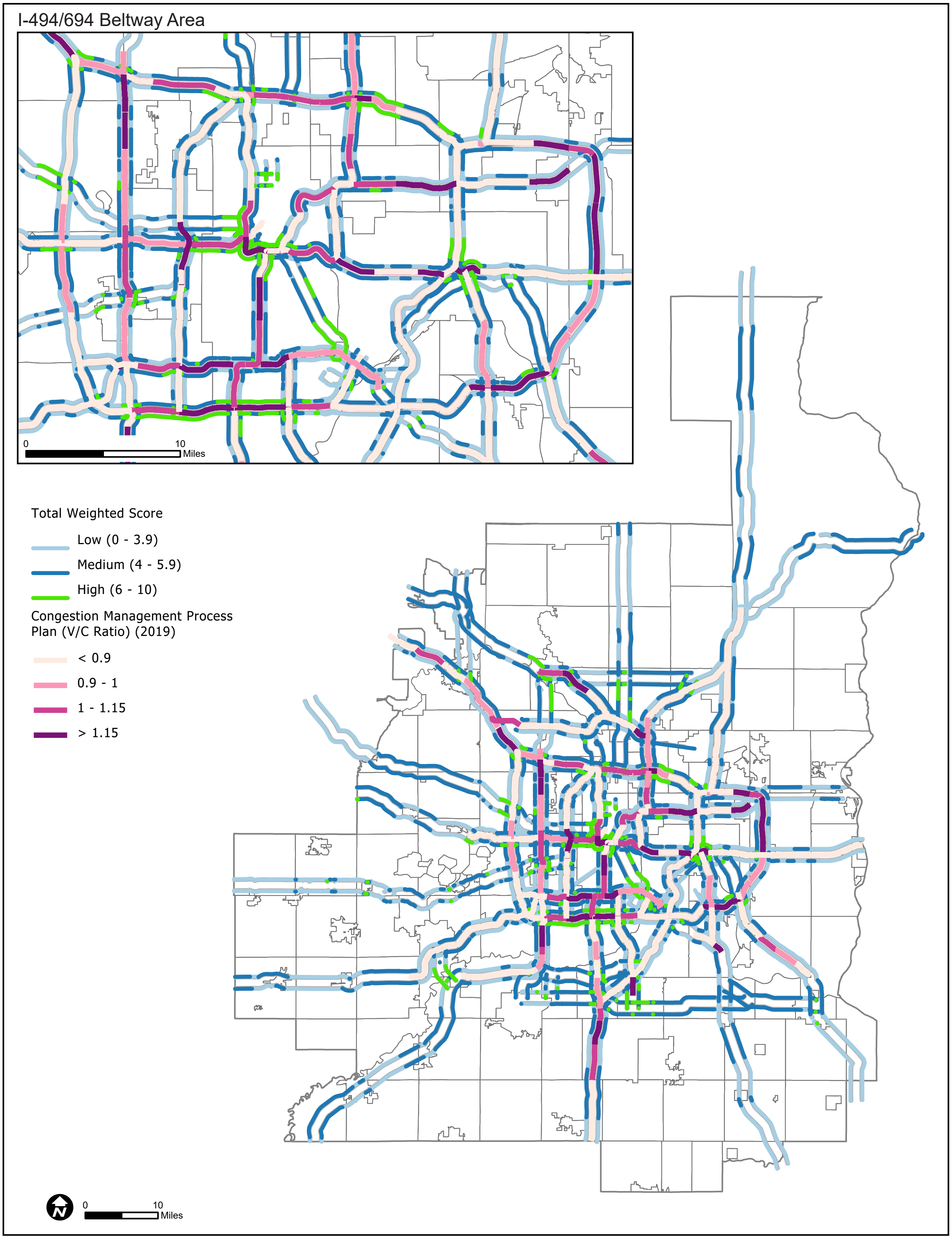
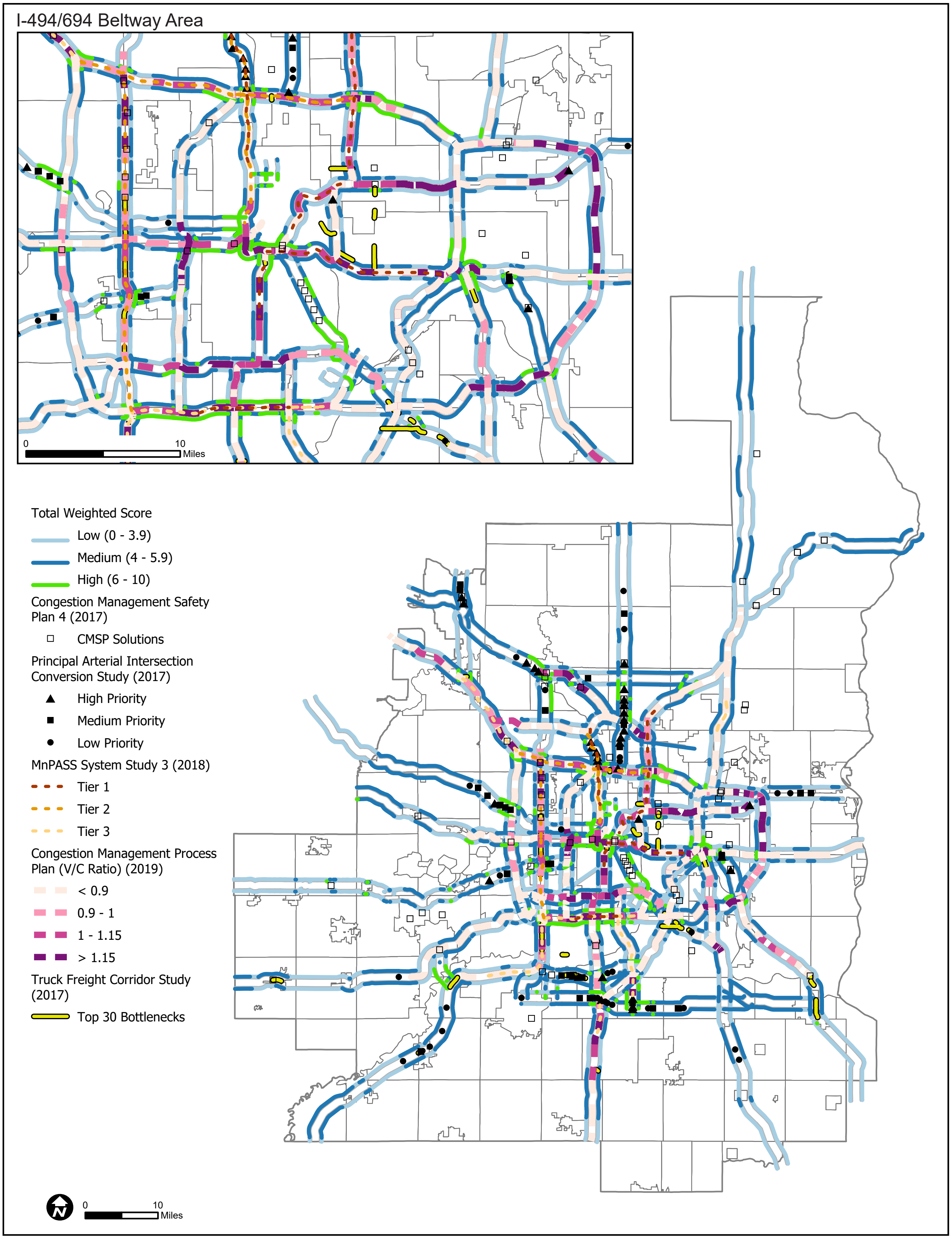


Figure 15. All Comparison Studies



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