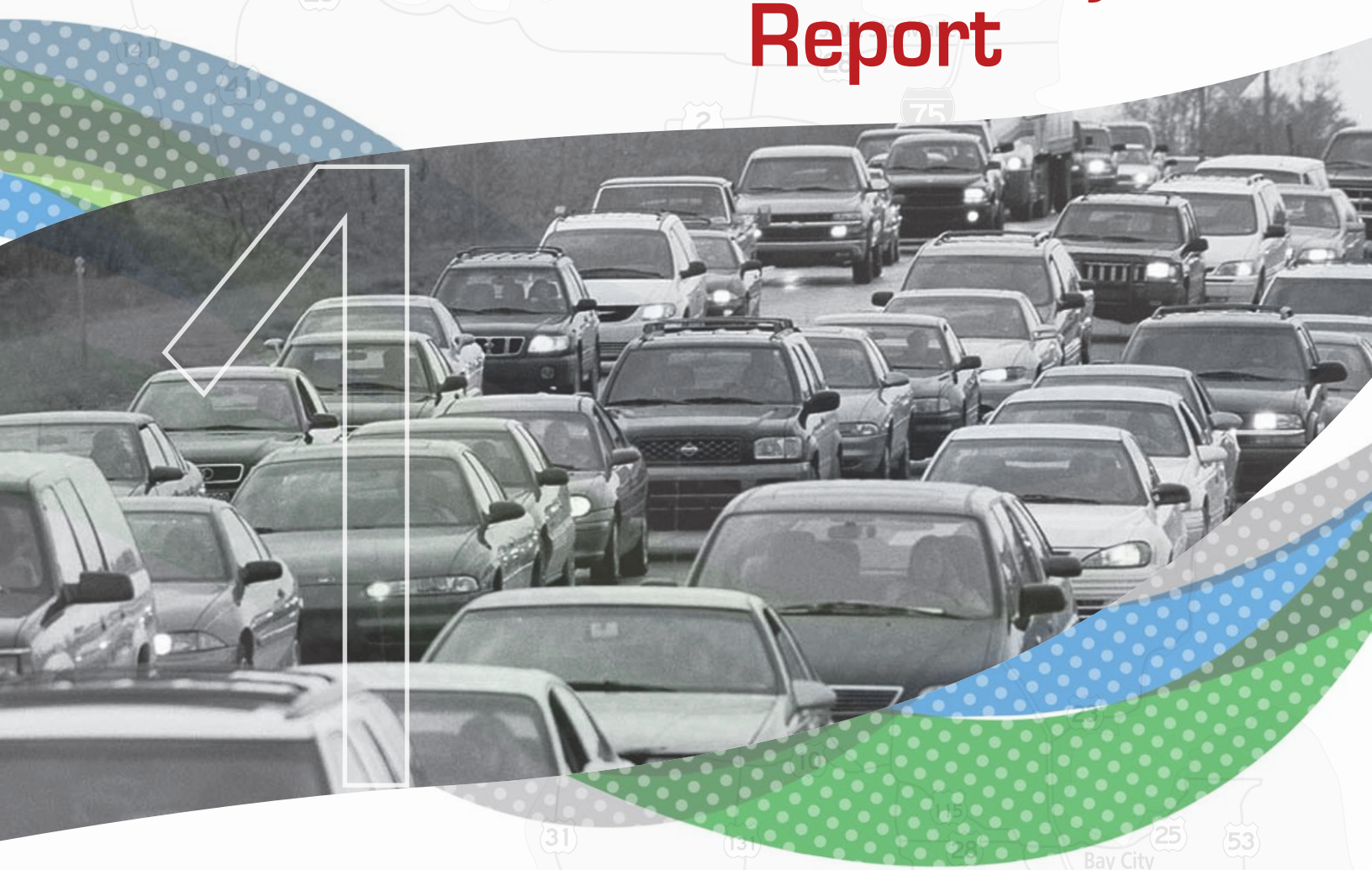
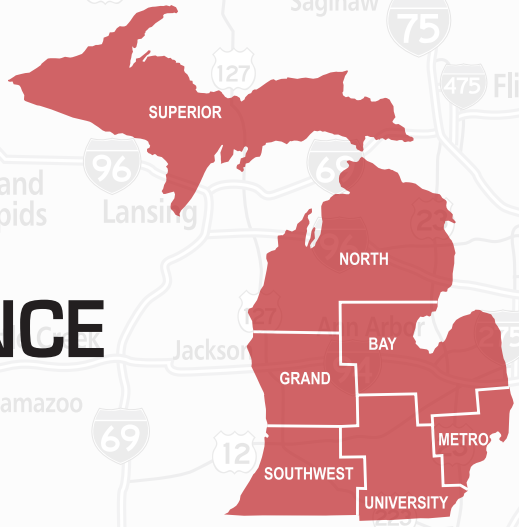
MDOT
Michigan Department of Transportation

2014 Congestion & Mobility Report



Chapter 1
FREEWAY PERFORMANCE MEASURES



Acknowledgements

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Chapter 1

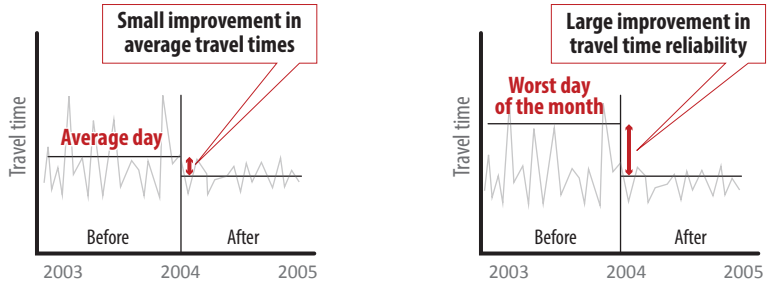
Introduction

Performance measures are growing in the transportation arena to better monitor traffic conditions, improve traveler information, and identify congested areas with the aim of improving operations on roadways. MDOT initially used probe data to show travel time information to the public. Due to the enormous amount of data collected, it made it difficult to use for any other type of analysis. The University of Maryland Center for Advanced Transportation Technology Lab developed a visual analytics and information visualization tool called the Regional Integrated Transportation Information System (RITIS). With this tool, MDOT is able to monitor speed, incidents, weather, events, and many other types of data.

This report expands the performance measures to all freeway routes in Michigan and offers additional measures (except some small segments due to data quality issues). This document is for internal use to help MDOT regions, Transportation Service Centers (TSCs), and planners expand their knowledge on how Michigan freeways are operating over time and how they compare to each other. This information helps identify congested areas, when congestion occurs and how often, corridor rankings, cause of delay, and more. This report is only a starting point, with the potential for a more in depth analysis. If your area has plans to share this information externally, please contact the Congestion and Mobility Unit to ensure the correct measures are being used.

A new performance measure was added for 2014. We now show travel time reliability for most urban area freeways. Two routes could have relatively the same amount of delay but could be experienced by the public very differently. Knowing a route always experience 10 minutes of delay consistently can be planned for. Another route that goes from no delay to 20 minutes of delay frequently can be frustrating.

Figure 1. Travel time average and reliability improvements



Each performance measure provides a view of how freeways may be operating. Looking at it from many perspectives can give a more complete picture and better understanding of what is going on.

Project management services for RITIS deployment and operation were provided by Atkins North America. Atkins also produced the final report package, based upon content generated by MDOT staff.

Probe Data

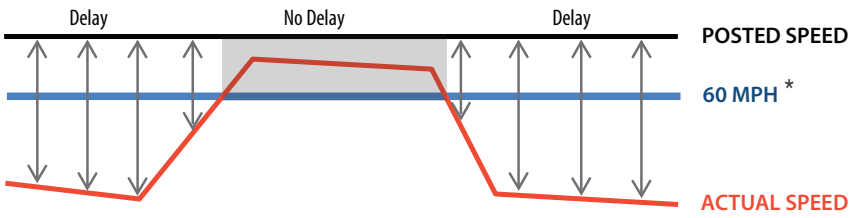
MDOT utilizes probe vehicle data from HERE (a Nokia company) to calculate freeway performance measures across the state of Michigan. In contrast to detector-based data, which relies on roadside sensors to collect vehicle speed information, probe data uses location information generated by GPS-equipped fleet vehicles, cell phones, and connected navigation devices. Companies such as HERE process location data from their connected vehicle partners to compute real-time speed and travel time information, which is then provided to agencies on a subscription basis.

Probe data provides a consistent view of how MDOT freeways operate across the state, but the data does have some limitations. Some freeway segments, particularly those in rural areas, can have a minimal number of probe data collections during low volume periods or overnight hours. During these periods, the speeds reported by the system are more heavily weighted toward the historical average speed, which may occasionally miss speed reductions caused by minor incidents on those segments of freeway. These data limitations should be reduced over time as the number of probes on the roadway increases. Michigan is one of only a few states that have different speed limits for commercial and passenger vehicles on the freeways. The posted speed limit for commercial vehicles is 60 mph; for passenger vehicles it's 70 mph. This results in lower average speeds during free-flow conditions.

Total Delay

Delay is calculated by taking the difference between actual speeds when they fall below 60 mph and the speed limit for freeways posted at 70 mph. This is to take out the delay caused by the lower average speeds from commercial vehicles. Figure 2 is an illustration of when delay is calculated.

Figure 2. Calculated delay



* On segments with a speed limit of 55 mph, delay is calculated when speeds fall below 55 mph.

The following tables rank the top ten locations for delay statewide. Delay in the Metro Region is excluded from Tables 3 and 4, as traffic patterns in this region differ from the rest of the state. Tables 1 and 3 highlight the total hours of delay per year, while tables 2 and 4 show the delay hours per mile. Each freeway segment consists of the county limits of each route.

Table 1. Total delay statewide

	2012-2013 Average	
Rank	Total UDC	Location (Route, County)
1	$41,923,576	I-75 Oakland Co.
2	$30,154,710	I-696 Oakland Co.
3	$27,605,196	I-96 plus Local Detroit TSC
4	$23,065,579	I-75 Detroit TSC
5	$22,840,168	I-94 Detroit TSC
6	$20,590,315	US-131 Kent Co.
7	$17,652,627	I-94 Macomb Co.
8	$17,372,282	I-96 Oakland Co.
9	$15,727,301	M-39 Detroit TSC
10	$15,233,275	I-94 Taylor TSC

	2014	
Rank	Total UDC	Location (Route, County)
1	$55,888,275	I-75 Oakland Co.
2	$50,803,834	I-696 Oakland Co.
3	$37,164,561	I-75 Detroit TSC
4	$35,745,456	I-94 Detroit TSC
5	$35,512,385	I-96 plus Local Detroit TSC
6	$24,928,383	I-96 Oakland Co.
7	$24,070,535	I-94 Taylor TSC
8	$21,537,930	M-39 Detroit TSC
9	$20,524,820	US-131 Kent Co.
10	$18,498,940	I-96 Taylor TSC

Table 2. Delay per mile statewide

	2012-2013 Average	
Rank	UDC Per Mile	Location (Route, County)
1	$1,507,735	I-696 Oakland Co.
2	$1,281,421	I-75 Detroit TSC
3	$718,832	M-10 Oakland Co.
4	$713,755	I-94 Detroit TSC
5	$707,826	I-96 plus Local Detroit TSC
6	$584,227	M-10 Detroit TSC
7	$561,689	M-39 Detroit TSC
8	$508,705	I-96 Oakland Co.
9	$503,836	I-96 Taylor TSC
10	$477,985	M-59 Oakland Co.

	2014	
Rank	UDC Per Mile	Location (Route, County)
1	$2,540,192	I-696 Oakland Co.
2	$2,064,698	I-75 Detroit TSC
3	$1,117,046	I-94 Detroit TSC
4	$987,893	M-10 Oakland Co.
5	$910,574	I-96 plus Local Detroit TSC
6	$801,167	I-96 Taylor TSC
7	$773,604	M-10 Detroit TSC
8	$769,212	M-39 Detroit TSC
9	$729,967	I-96 Oakland Co.
10	$618,192	M-59 Oakland Co.

Table 3. Total delay statewide, excluding Metro Region

	2012-2013 Average		2014		
Rank	Total UDC	Location (Route, County)	Rank	Total UDC	Location (Route, County)
1	$20,590,315	US-131 Kent Co.	1	$20,524,820	US-131 Kent Co.
2	$14,740,860	US-23 Washtenaw Co.	2	$17,499,755	US-23 Washtenaw Co.
3	$11,734,955	I-94 Washtenaw Co.	3	$16,077,558	I-94 Washtenaw Co.
4	$10,526,665	I-196 Kent Co.	4	$10,724,743	I-196 Kent Co.
5	$8,656,471	I-94 Berrien Co.	5	$10,263,717	I-94 Berrien Co.
6	$6,074,538	I-75 Monroe Co.	6	$9,340,718	I-96 Kent Co.
7	$5,604,065	US-23 Livingston Co.	7	$8,535,749	I-75 Monroe Co.
8	$5,213,302	I-96 Kent Co.	8	$6,561,614	US-23 Livingston Co.
9	$5,207,715	US-31 Muskegon/Ottawa Co. (70 mph Section)	9	$6,277,533	I-94 Kalamazoo Co.
10	$5,084,165	I-94 Jackson Co.	10	$5,420,382	I-94 Calhoun Co.

Table 4. Delay per mile statewide, excluding Metro Region

	2012-2013 Average		2014		
Rank	UDC Per Mile	Location (Route, County)	Rank	UDC Per Mile	Location (Route, County)
1	$328,958	I-196 Kent Co.	1	$335,148	I-196 Kent Co.
2	$300,746	Mackinac Bridge (45mph)	2	$318,614	Mackinac Bridge (45mph)
3	$268,016	US-23 Washtenaw Co.	3	$318,177	US-23 Washtenaw Co.
4	$260,637	US-131 Kent Co.	4	$259,808	US-131 Kent Co.
5	$180,538	I-94 Washtenaw Co.	5	$247,347	I-94 Washtenaw Co.
6	$156,676	I-496 Eaton/Ingham Co. (Excludes US-127)	6	$158,069	I-75 Monroe Co.
7	$146,816	M-14 Washtenaw Co. (Excludes US-23 portion)	7	$150,657	I-96 Kent Co.
8	$112,491	I-75 Monroe Co.	8	$131,232	US-23 Livingston Co.
9	$112,081	US-23 Livingston Co.	9	$129,100	I-496 Eaton/Ingham Co. (Excludes US-127)
10	$103,387	I-675 Saginaw Co.	10	$122,398	US-131 Kalamazoo Co.

User Delay Cost

Cost is calculated by multiplying delay x hourly volume x hourly user cost. Delay is calculated by taking the difference between actual speeds when they fall below 60 mph and the posted speed limit. Hourly volumes are derived from Average Daily Traffic (ADT) and Commercial Average Daily Traffic (CADT). Hourly user costs are based on Federal Highway Administration (FHWA) publication number FHWA-SA-98-079, "Life-Cycle Cost Analysis in Pavement Design." Currently, MDOT updates these costs yearly using the Consumer Price Index (CPI), which follows the same methodology as detailed in the FHWA publication. This can be located at: http://www.michigan.gov/mdot/0,1607,7-151-9625_54944-227053--,00.html

Table 5. Total delay statewide. The following rates were used for 2012, 2013, and 2014.

Hourly User Costs			
	2012	2013	2014
Passenger	$17.09	$17.44	$17.70
Commercial	$30.14	$30.77	$31.22

Probe data does not include volumes as it is cost prohibitive to have traffic counters on every mile of freeway. This necessitates the use of ADT and CADT and an hourly profile created for each day of week. Although the calculations are not actual volumes, most trends and comparisons are useful and valid. UDC calculations do not start until speeds are below 60 mph. This is to eliminate counting the delay caused by slower commercial vehicles having a speed limit of 60 mph.

The following maps show 2014 UDC for each route by TSC broken down per mile to compare the various lengths of each route.

Figure 3. 2014 statewide user delay cost per mile

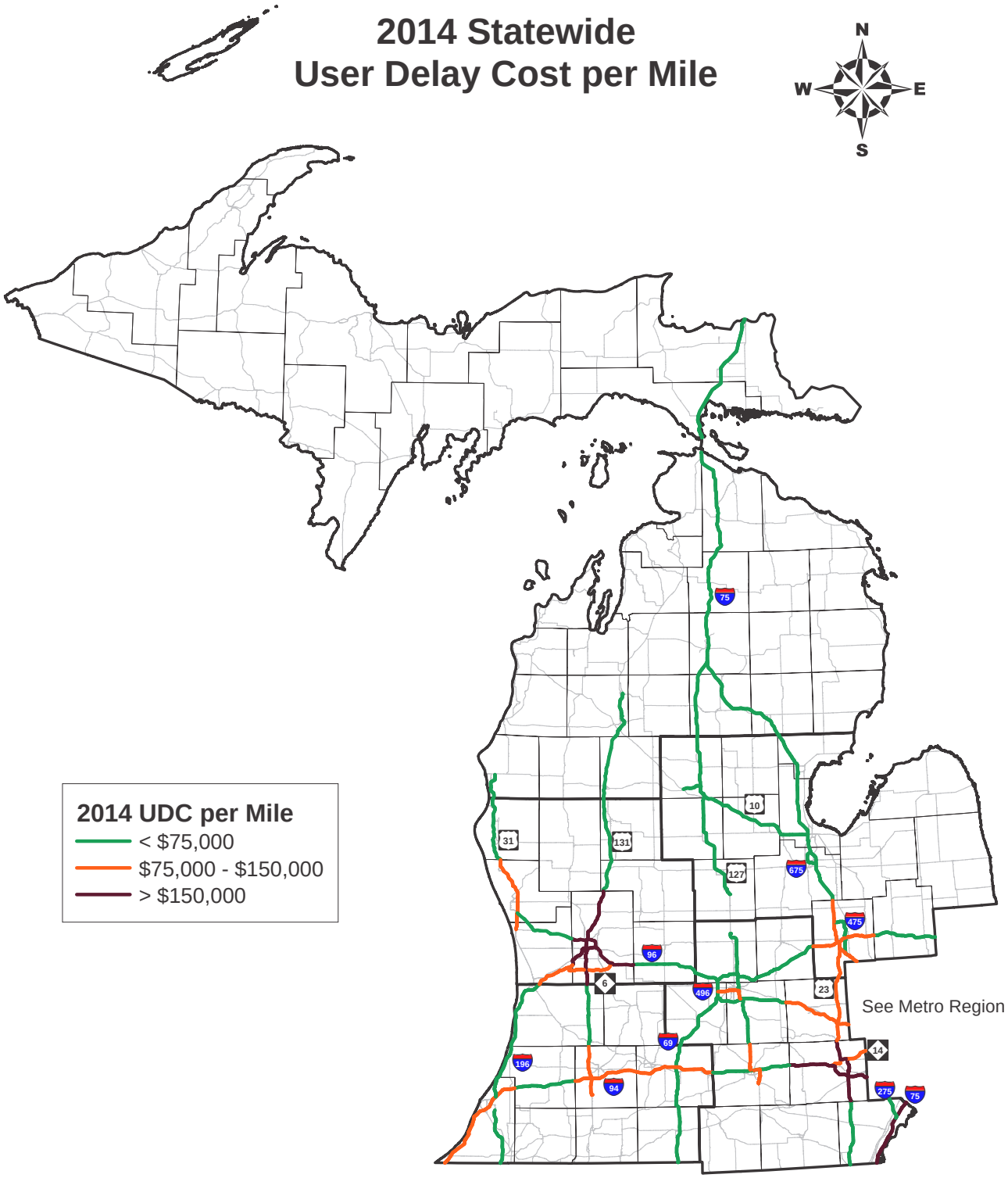
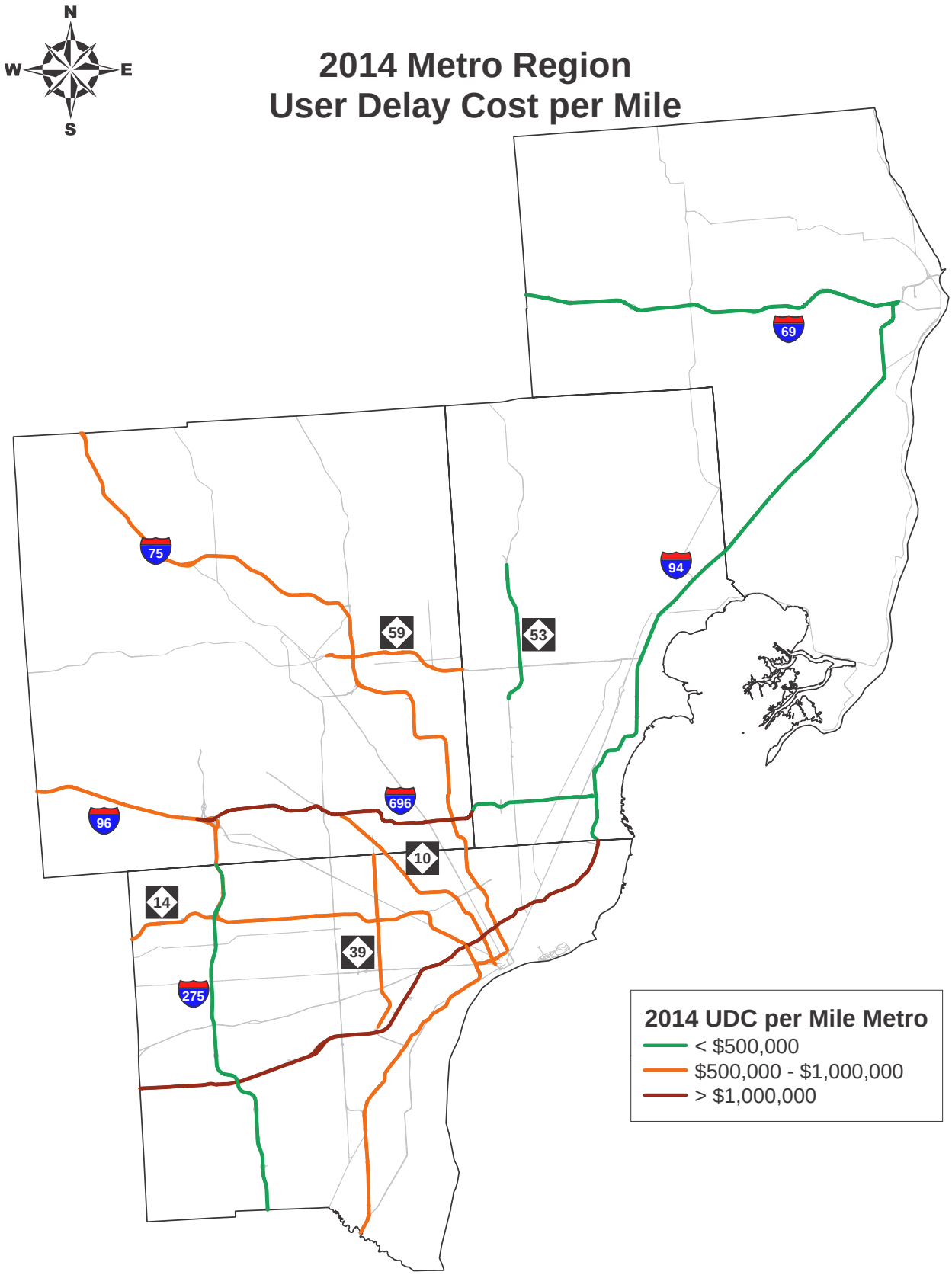


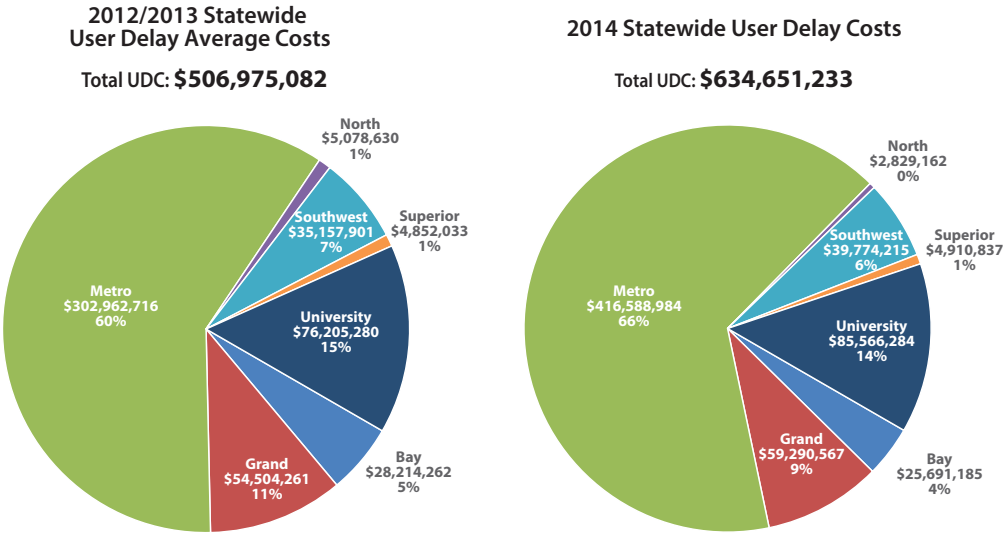
Figure 4. 2014 Metro Region user delay cost per mile



User Delay Cost (continues)

A breakdown per region is shown below. 2012/2013 average and 2014 UDCs are shown side-by-side to give an idea of trends from year-to-year.

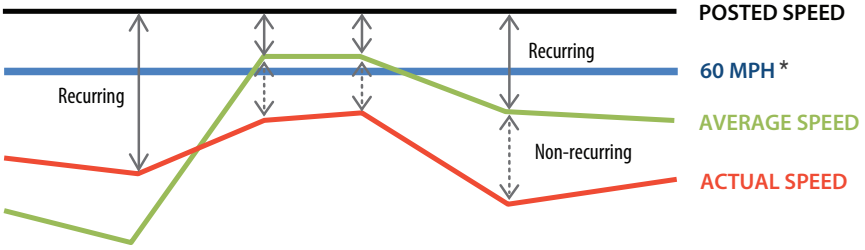
Figure 5. 2012/2013 average and 2014 UDCs



2014 saw a significant increase in user delay costs compared to the previous two years, with the Metro Region seeing the majority of the increase. Some of these increases were due to some winter events early in 2014. Other causes could be related to construction and the continued increase in traffic volumes on roads that are already near or at capacity. A more in-depth analysis would be required to verify the cause of the increase.

Non-recurring UDC is calculated in a similar manner; however, non-recurring delay is calculated by taking the difference between the actual speed (any time the speed falls below 60 mph) and the average speed. The average speed used was an average of speed readings from August 2009 to July 2012. The average speed calculation is an average of the speeds for that day of week and time of day for each individual location. In future years, this value may change to a rolling consecutive two or three-year average. Recurring UDC is the difference of total UDC and non-recurring UDC.

Figure 6. Recurring and non-recurring UDCs

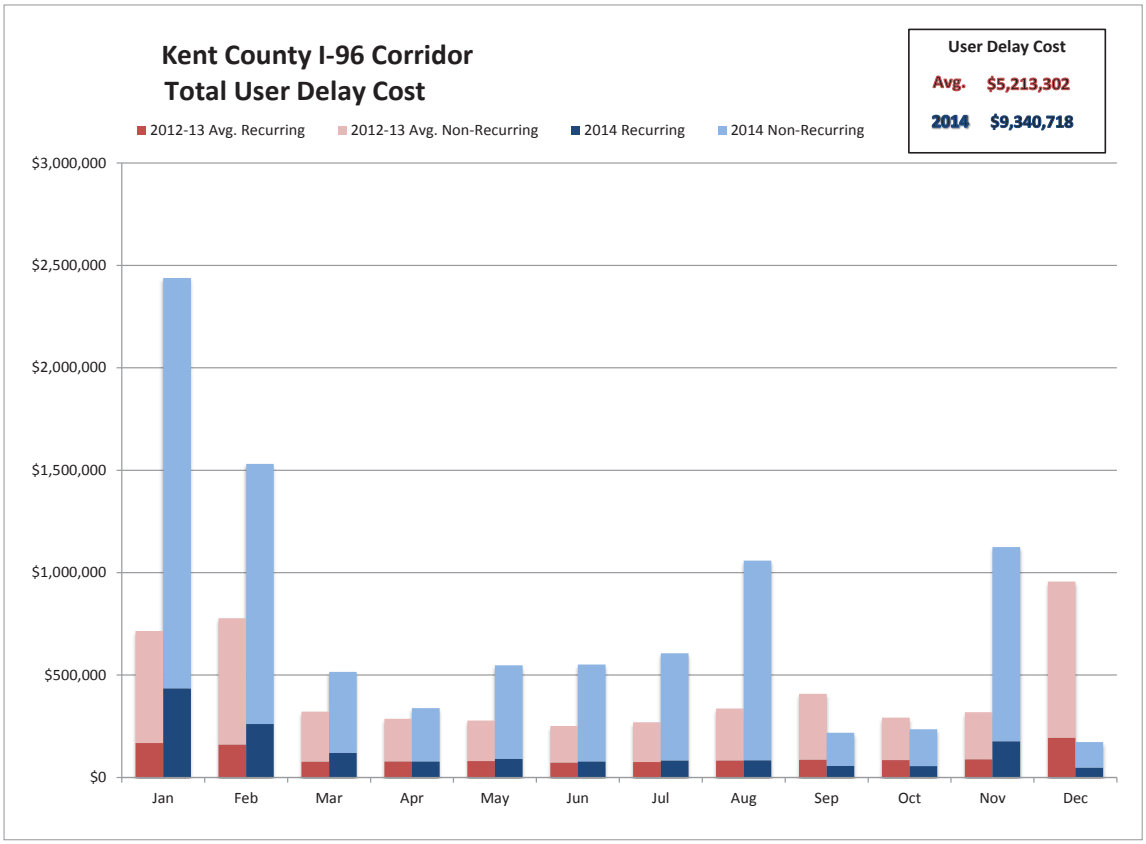


*** On segments with a speed limit of 55 mph, delay is calculated when speeds fall below 55 mph.**

User Delay Cost (continues)

Figure 7 shows what months are incurring the most UDC, and compares how the UDC patterns changed from the 2012/2013 average with 2014. This also shows the amount of recurring/non-recurring delay per month. This highlights the impacts that winter weather and construction can have on the amount on non-recurring delay.

Figure 7. Recurring and non-recurring delay per month



Major winter storms had a significant impact on UDC in January 2014 for the Grand Rapids TSC area (as shown in the above figure) and other TSC areas statewide.

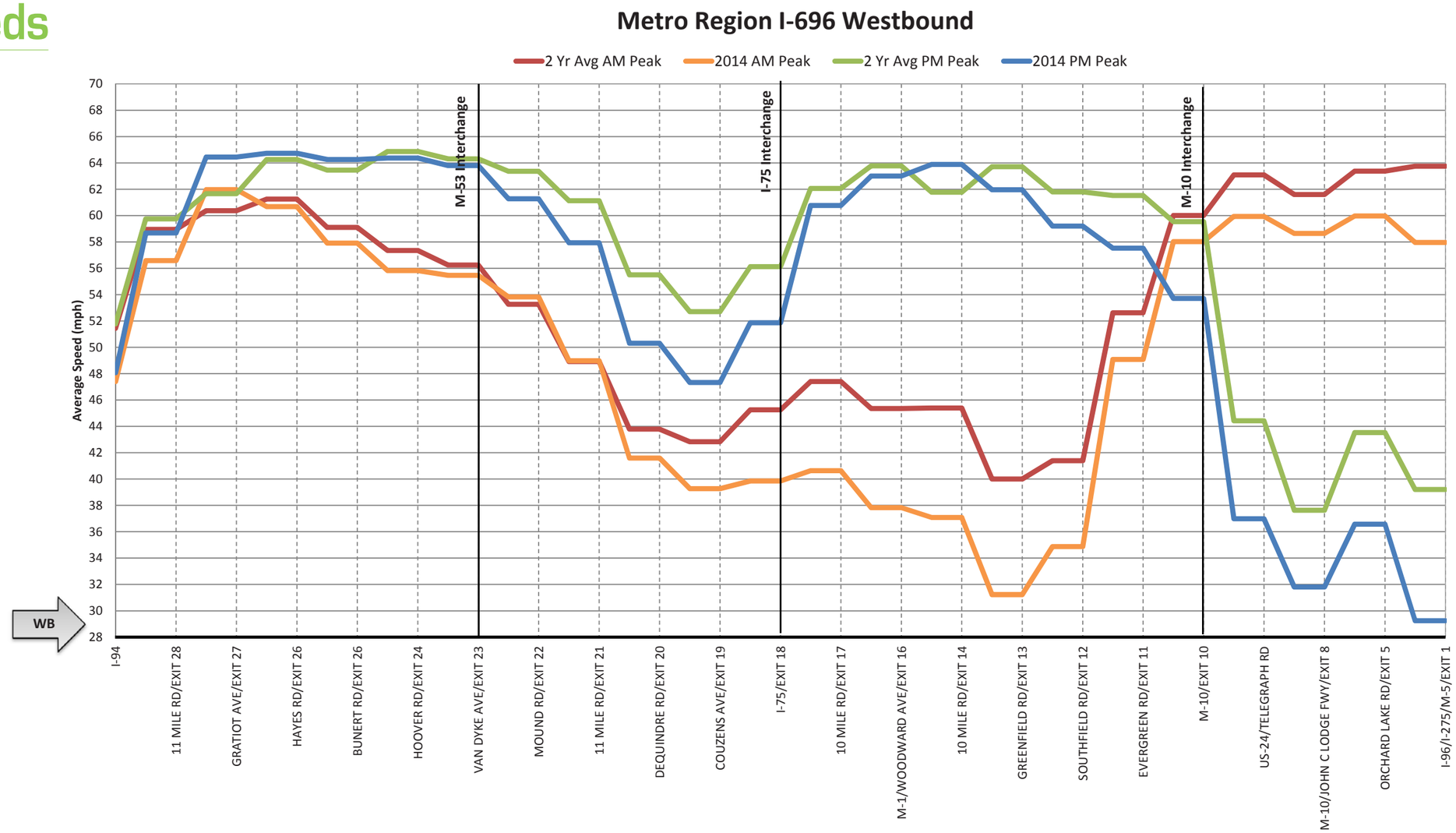
Figure 8. 2014 Metro Region I-696 westbound

Average Speeds

Average speed charts were created to compare how peak period speed trends change from year to year, and identify low speed areas. The following criteria were used for these charts:

- Weekday is Monday through Friday
- Morning peak hour is the worst ranked hour between 6 – 9 a.m.
- Evening peak hour is the worst ranked hour between 3 – 7 p.m.
- Worst ranked hour is based on the lowest average speed and minimum speed experienced during the peak hours

The following figures show how the morning and evening peak speeds can vary by time and magnitude on the same route.



Congestion

Congestion is being calculated as the number of hours below 45 mph per Traffic Message Channel (TMC). A TMC is a standard for delivering real-time traffic information. They vary from tenths of a mile long to several miles long.

Using speed and segment information provided by the probe data, the following performance measures were developed to analyze congestion on Michigan freeways.

- Congestion Hours: Number of hours a freeway segment has an average speed of less than 45 mph. This number is useful for plotting on a map to show congested areas.

The following maps display the 2014 congestion hours for Michigan freeways. In order to show more detail, the Metro Region is displayed separately and uses a different scale than the statewide map.

Figure 9. 2014 statewide congestion hours northbound/eastbound

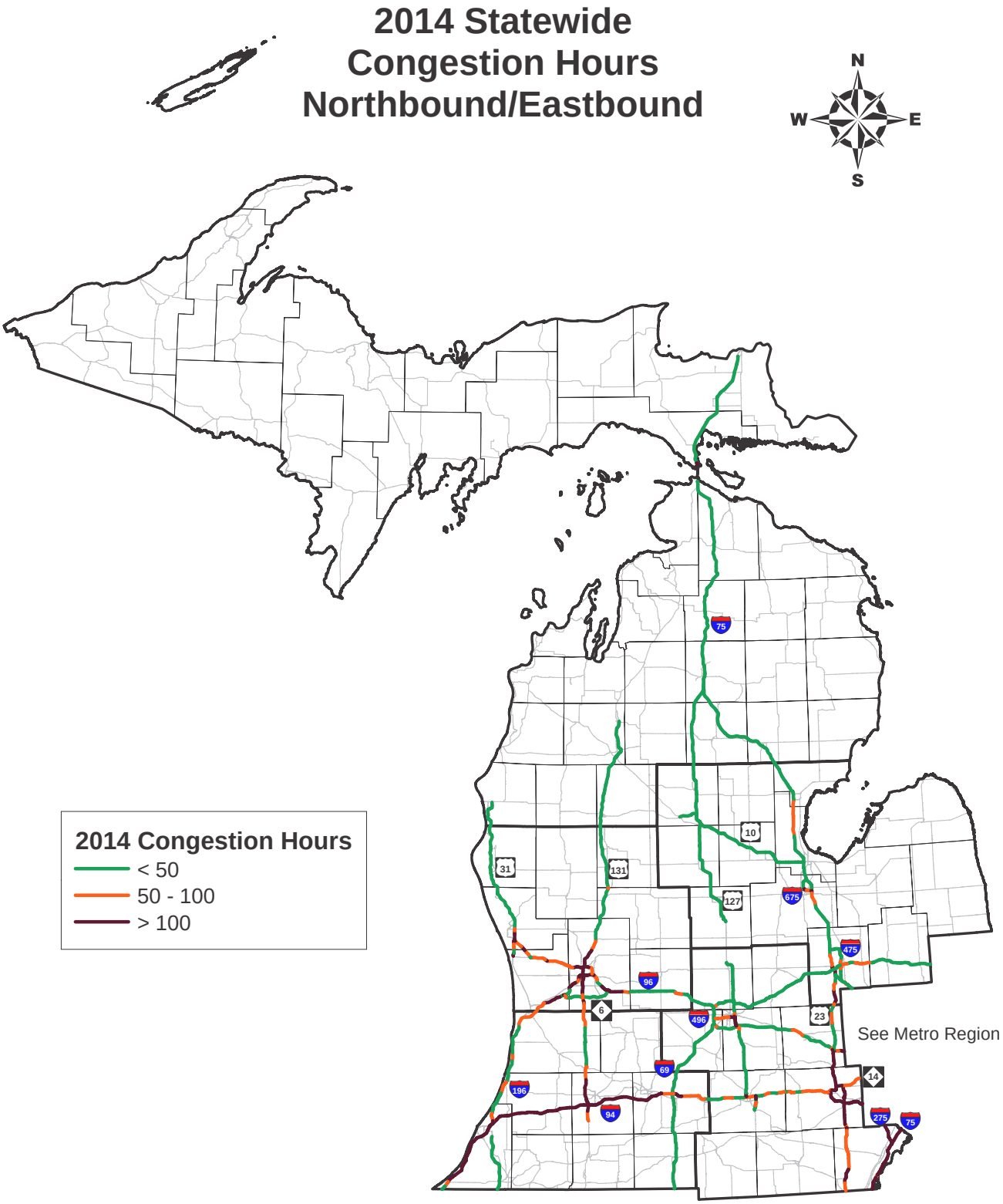


Figure 10. 2014 statewide congestion hours southbound/westbound

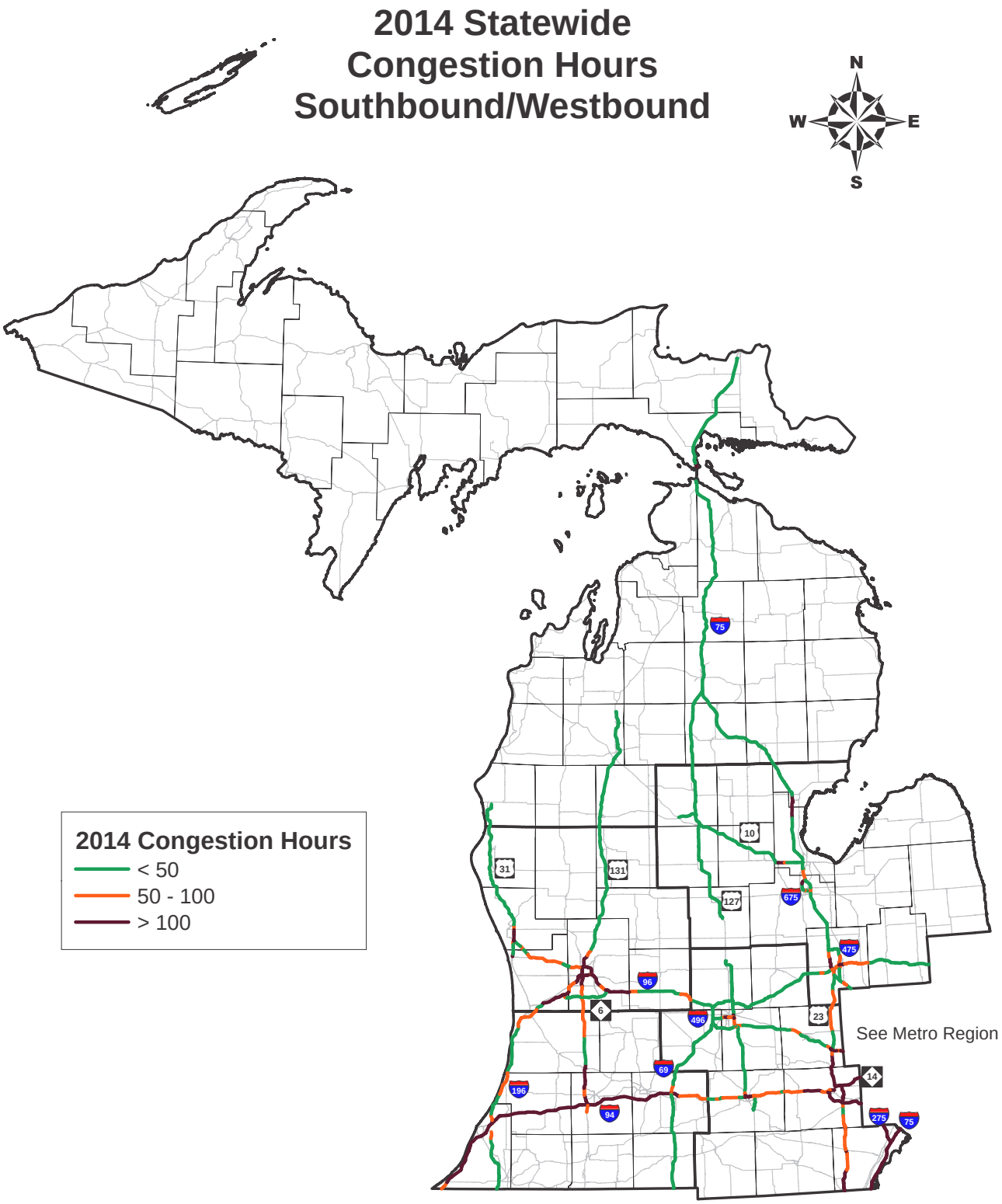


Figure 11. 2014 Metro Region congestion hours northbound/eastbound

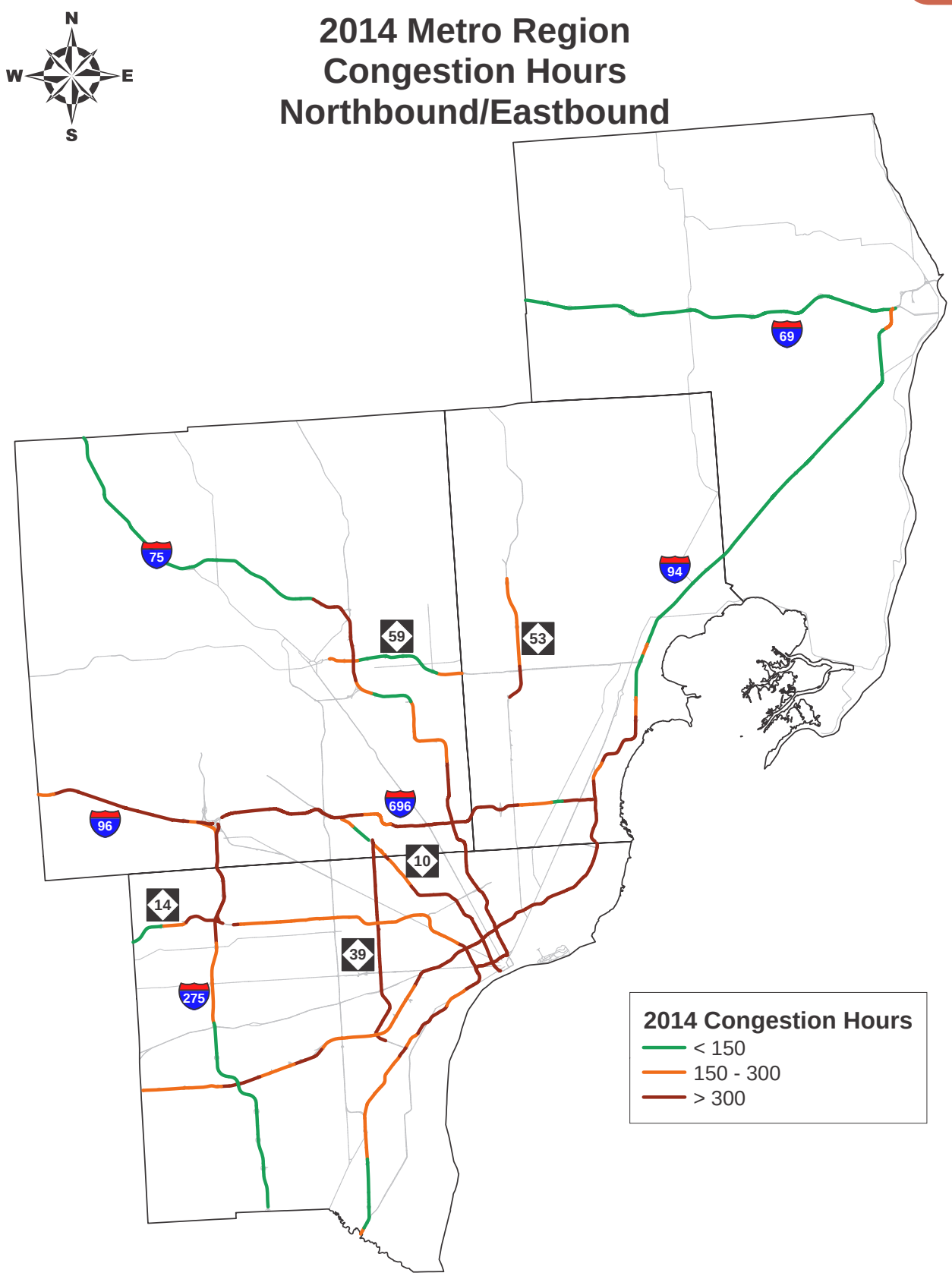
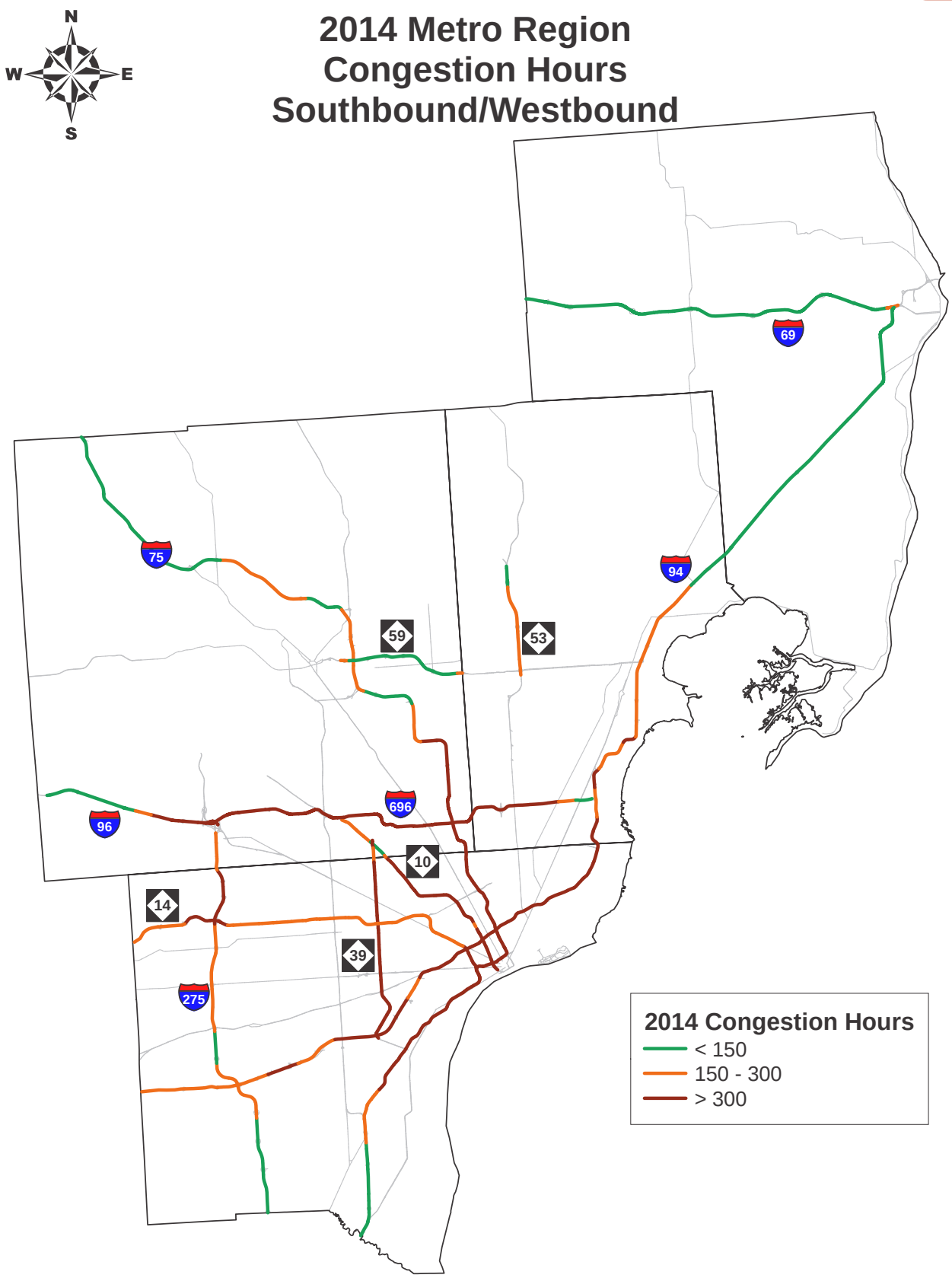


Figure 12. 2014 Metro Region congestion hours southbound/westbound



Conclusion

The main body of this report shows examples of each type of performance metric that was created using probe data and provides an explanation of their meaning. The Region Summary Chapters include all of the performance measures for each MDOT region. These are organized by region, TSC and route to make it easy to get to the information that is most useful.

It is the Congestion and Mobility Unit's goal that these performance measures are not just numbers and figures, but information to help MDOT personnel understand how traffic is operating on its freeways and make actionable decisions on improving traffic. They could be used to help prioritize projects, determine where and when problems are occurring, and how significant they are.

We intend to provide these performance measures on an annual basis to help identify trends on the system and to keep MDOT up to date on freeway operations. Various performance measures may change due to changing federal requirements or MDOT needs. As probe data improves, this may expand to non-freeway routes as well. The Congestion and Mobility Unit welcomes any feedback on this report to help us improve it in the future and maximize its usefulness.

Contact Info

Please contact the Congestion and Mobility unit if you have any questions/comments or would like to have the actual data for further analysis.

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Notes

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