

2018 Freeway Congestion & Reliability Report



Chapter 6 SOUTHWEST REGION SUMMARY



PROLOGUE

Since 2014, the Michigan Department of Transportation (MDOT) has used probe vehicle data to create an annual Freeway Congestion and Reliability Report. The probe vehicle data is collected anonymously from GPS enabled devices and in-vehicle telematics to provide real time speeds on roadways nationwide. Probe vehicles provide an enormous amount of data which can be difficult to manage, maintain, and analyze. The University of Maryland Center for Advanced Transportation Technology (CATT) Lab developed a visual analytics platform called the Regional Integrated Transportation Information System, or RITIS. This tool allows MDOT to monitor speeds, incidents, weather, special events, and many other data sources. Using the RITIS platform, data was downloaded, processed, and compiled into a report summarizing all freeway routes in Michigan.

This report is composed of eight chapters. The first chapter summarizes performance measures and statewide metrics. The remaining seven chapters use those performance metrics to characterize congestion in each of MDOT's seven regions. This document is for internal use to help MDOT regions, Transportation Service Centers (TSC), and planners understand how Michigan freeways are operating over time, as well as where potential improvement projects may be necessary. This report is typically used as a starting point for more detailed analysis incorporating additional probe data, as well as other MDOT resources. If your area has plans to share this information externally, please contact the Congestion and Reliability Unit to ensure the correct measures are being used.

The report was prepared by the Wayne State University Transportation Research Group under the guidance of the Congestion and Reliability Unit at MDOT. Please contact the Congestion and Reliability Unit if you have any questions/comments or would like to have the actual data for further analysis.

ACKNOWLEDGEMENTS



Jason Firman – Congestion and Reliability Manager

Lee Nederveld – Operations Engineer

John Engle – Operations Engineer

Kayla Smith – Student Assistant

Peggy Johnson – Departmental Analyst



WAYNE STATE UNIVERSITY

Jenna Kirsch – Graduate Research Assistant

Steve Remias – Assistant Professor





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INTRODUCTION

The purpose of this document is to provide a performance overview of Michigan freeways. Using probe vehicle data and systematic performance measures, a series of visualizations were created for each region in the state. Chapter 6 of this report provides an overview of the Southwest Region. Southwest Region is made up of 7 counties and contains the city of Kalamazoo. Five freeways are analyzed in the section below.





PERFORMANCE MEASURES DEFINITIONS

The probe data alone provides representative speeds on predefined segments of roadway every minute. Although this data is rich, it provides limited use to engineers and practitioners without well-defined aggregation techniques. 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. A summary of the performance measures used in this report can be seen in Table 1.

The goal of these performance measures is to quantify the congestion, delay, and reliability of the freeway network in Michigan. Numerous metrics were used in this report to quantify the performance of the road network, including a new delay index. Delay is quantified when the speed drops below 60 MPH, which is at least 10 MPH lower than the posted speed limit for the freeways (Figure 1). On segments with a speed limit of 55 MPH, delay is calculated when speed falls below that threshold. The delay index presented in this report represents the total delay on each segment if one vehicle were to drive that segment every ten minutes. The lower the value, the better the freeway segment is operating. The other element of interest is reliability. Reliability is a measure of the consistency of a travel time on a roadway. A roadway that has the same travel time every day is said to be reliable, whereas a roadway that has varying travel times is said to be unreliable. MDOT's goal is to provide reliable travel times with minimal delay. This is done through roadway improvement projects which can include additional lanes, pavement improvements, and intelligent transportation systems. These projects can reduce the travel time and also improve the travel time reliability. An example of this is shown in Figure 2.

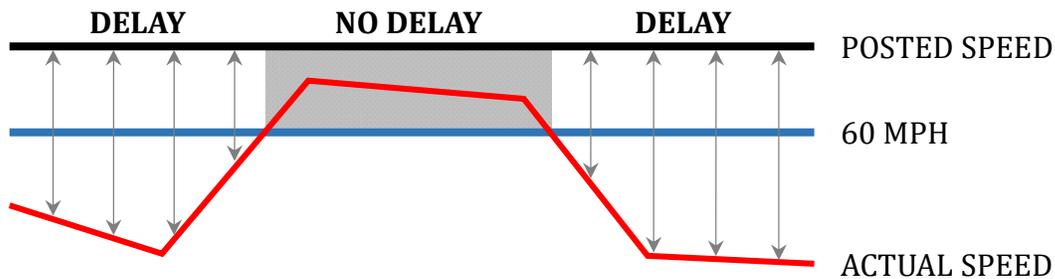


FIGURE 1. Delay Calculation



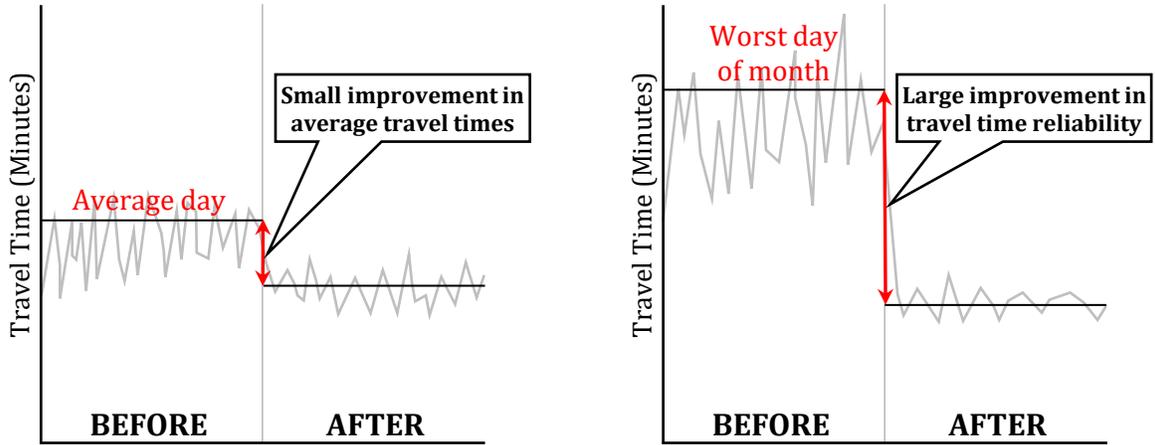


FIGURE 2. Travel Time Average and Reliability Improvements

**TABLE 1. Performance Measures of Interest**

PERFORMANCE MEASURE	Description
DELAY	Delay is calculated by taking the difference between actual speeds when they fall below 60 MPH and the posted speed limit. This is to take out the delay caused by the lower average speeds from commercial vehicles.
DELAY INDEX	Delay index is calculated by adding the delay if a probe vehicle drove every segment of roadway once every ten minutes. This value is then divided by the length of the roadway segment. This allows users to make comparisons between varying corridors and locate areas that cause the most delay.
MAXIMUM DELAY	Maximum delay is the maximum calculated delay per segment throughout a year.
AVERAGE SPEED	Average speed is determined by calculating the space mean speed of the worst ranked hour in the weekday AM peak (6:00 AM - 9:00 AM) and weekday PM peak (3:00 PM - 7:00 PM) periods for each segment of roadway. This is compared to the space mean speed of the previous five year period for the same hour.
CONGESTION SEVERITY	Congestion severity is calculated based on the worst hourly average speed experienced during the AM or PM peak period per traffic message channel (TMC) segment. A TMC segment is a standard for delivering real-time traffic information. They vary from tenths of a mile long to several miles long.
TRAVEL TIME RELIABILITY	Travel time reliability is a measure of travel time consistency over a period of time. When travel times are unreliable, customers are more likely to experience unexpected delays. Travel times are shown to be reliable when the 95 th percentile travel time remains close to the average travel time.
AVERAGE TRAVEL TIME	The amount of time a customer should budget to be on-time on average.
95TH PERCENTILE TRAVEL TIME	The amount of time a customer should budget to be on-time 19 out of 20 days (95% of the time). The 95 th percentile travel time is also known as the planning time.
LEVEL OF TRAVEL TIME RELIABILITY	Level of travel time reliability (LOTTR) is calculated as the ratio of the 80 th percentile travel time to a “normal” travel time (50 th percentile). LOTTR measures the consistency and dependability of road segments. The Federal Highway Administration (FHWA) deemed a road segment to be unreliable if its LOTTR value exceeds 1.50.

Note: May 1st through September 30th were used for the summer reliability calculations.





PERFORMANCE MEASURES VISUALIZATIONS

Performance measures visualizations provide an easy way to graphically represent the performance metrics listed above. In this report, five main visualizations are used. These five visualizations are explained in detail below.

DELAY INDEX

Figure 3 is an example of the delay index graph. This figure represents I-94 through Kalamazoo County in the Southwest Region. The delay index visualization displays which months are incurring the most delay, while comparing how delay patterns change from year-to-year. Figure 3 shows the following:

- a) Yearly delay index per mile totals (in minutes).
- b) Delay index per mile (in minutes).
- c) Month of year.
- d) Higher than normal delay index per mile values in January 2013 and January 2014.
- e) A delay index per mile value of over 70 minutes in December 2017.

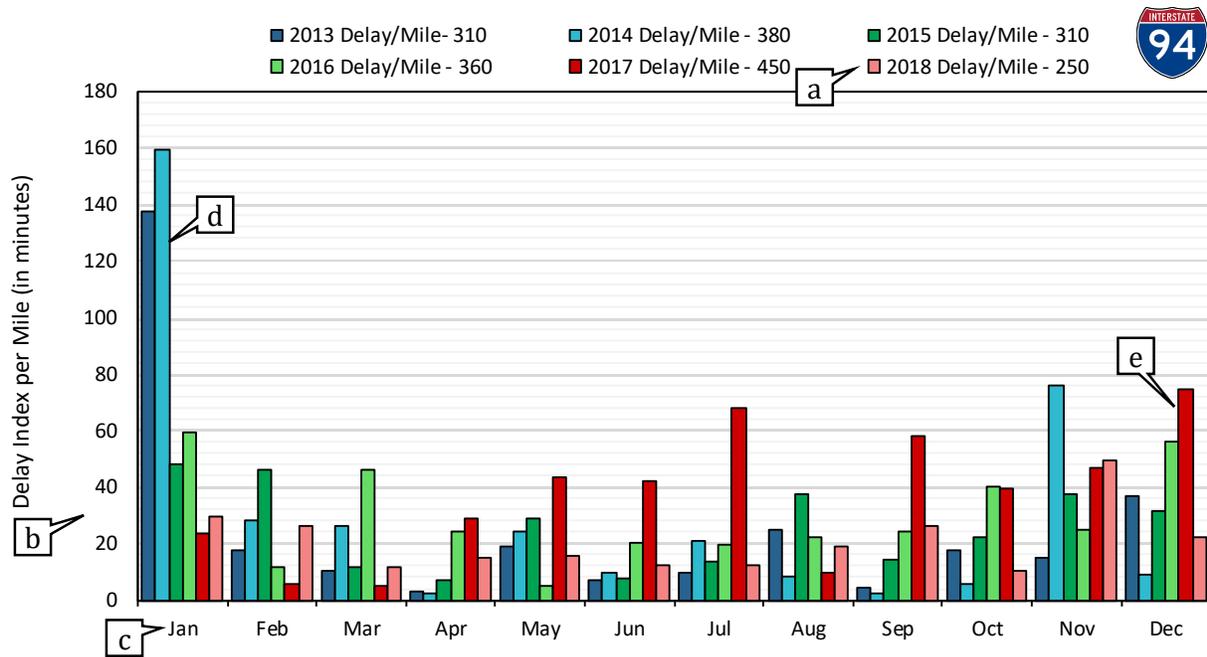


FIGURE 3. Example Delay Index Graph





AVERAGE SPEED

Figure 4 is an example of the average speed graph. This figure represents westbound I-94 through the Southwest Region. This performance metric visualizes the speeds on a given corridor during the AM and PM peak periods, along with a 5-year historical average of those speeds. Average speed graphs can display how morning and evening peak speeds can vary by time and magnitude. The following criteria was used in the making of these graphs:

- a) Only weekdays (Monday – Friday) are included in the calculations.
- b) The AM peak hour is the worst ranked hour between 6:00 AM – 9:00 AM.
- c) The PM peak hour is the worst ranked hour between 3:00 PM – 7:00 PM.
- d) The worst ranked hour is based on the lowest average speed and minimum speed experienced during the peak hours.

Figure 4 shows the following:

- a) Legend.
- b) Location of interchanges by exit/mile marker number.
- c) Specific significant interchanges.
- d) Direction of travel.
- e) Average speed in MPH.
- f) Example of low speed area during the PM peak while approaching US-131 interchange.
- g) Example of location where AM peak speeds are lower than PM peak speeds.
- h) Example of limited change in speed from year to year and time period to time period.
- i) 2018 AM peak average speed is approximately 67 MPH at Exit 85.
- j) Example of improvement in the current year as compared to the 5-year historical average.





AVERAGE SPEED

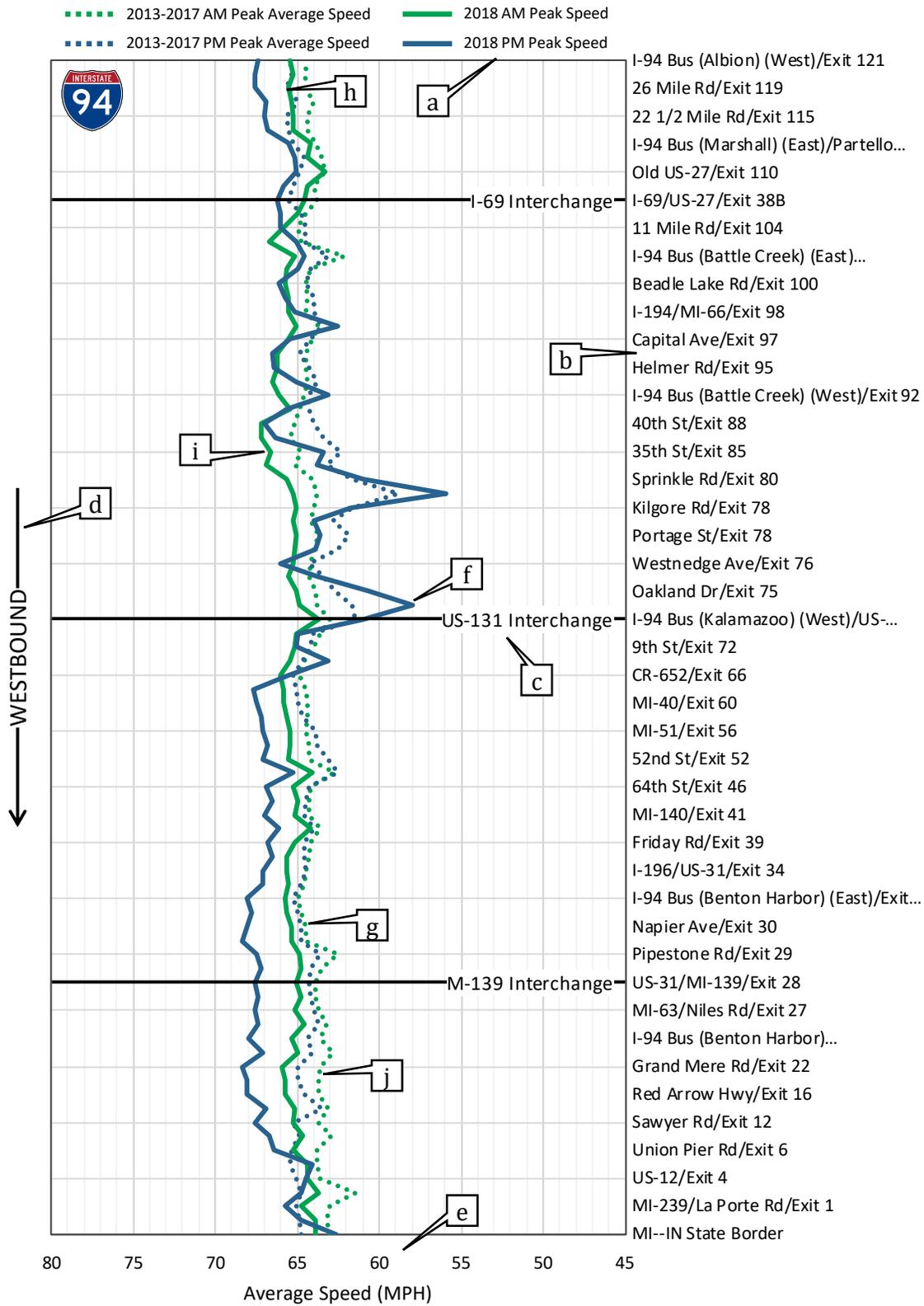


FIGURE 4. Example Average Speed Graph





CONGESTION SEVERITY

Figure 5 shows an example of the congestion severity map. This figure represents Southwest Region during the AM peak hour. This performance metric displays the amount of congestion on corridors during AM and PM peak periods by representing speeds in a color gradient. The color gradient consists of three different categories to distinguish severity levels:

- a) Low (≥ 55 MPH).
- b) Moderate (≥ 35 MPH & < 55 MPH).
- c) Severe (< 35 MPH).

Figure 5 shows the following:

- a) All roads are operating efficiently because there is low congestion.



FIGURE 5. Example Congestion Severity Map





TRAVEL TIME RELIABILITY

Figure 6 is an example of the travel time reliability graph. This figure represents a portion of westbound I-94 through the Southwest Region. This performance metric displays the reliability of a given corridor over time. A segment is deemed “reliable” when the average and 95th percentile travel times are constant. A segment is deemed “unreliable” when the average and 95th percentile travel times differ by a large amount of time. Figure 5 shows the following:

- a) The 95th percentile travel time reliability and the average (50th percentile) travel time reliability.
- b) Amount of time it will take a vehicle to drive the entire corridor in minutes.
- c) Time of day.
- d) Small difference between average and 95th percentile travel times (reliable).
- e) Large difference between average and 95th percentile travel times (unreliable).

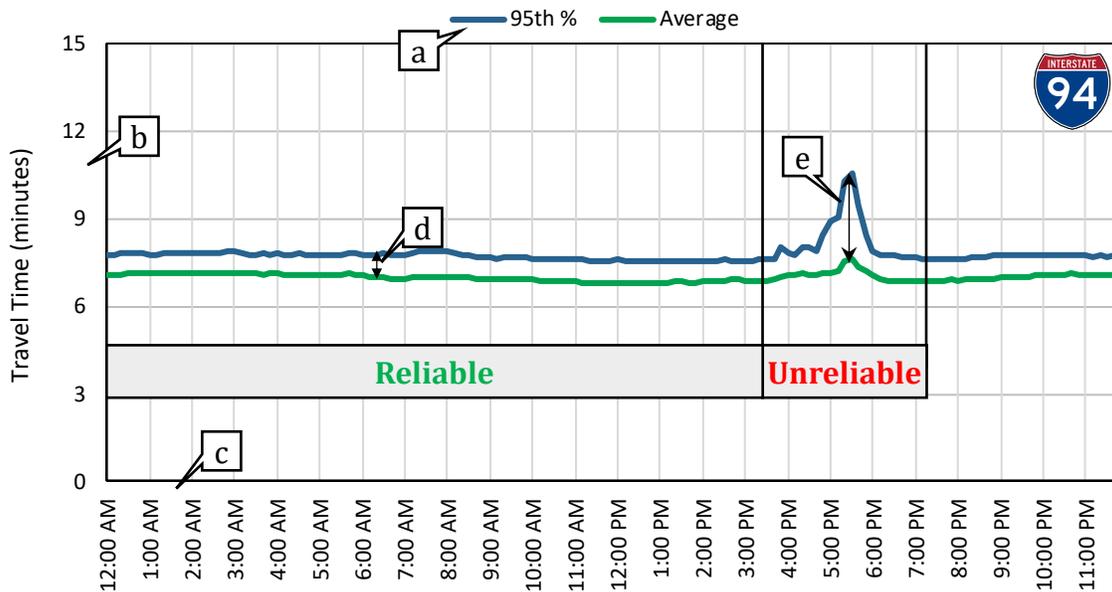


FIGURE 6. Example Travel Time Reliability Graph



LEVEL OF TRAVEL TIME RELIABILITY

Figure 7 shows an example of the level of travel time reliability (LOTTR) figure. This figure represents southbound I-69 through the Southwest Region. This performance metric displays the consistency and dependability of road segments by analyzing vehicular travel times from day-to-day or across different times of the day. LOTTR is defined as the ratio between the 80th-percentile travel time to the 50th-percentile travel time. In order to determine if a road segment has reliable travel times, LOTTR utilizes a threshold value of 1.50. Therefore, a segment providing a calculated LOTTR value less than 1.50 would claim to have reliable travel times. As delegated by FHWA, the following time periods were used in the making of these graphs:

- Weekdays between 6:00 AM – 10:00 AM.
- Weekdays between 10:00 AM – 4:00 PM.
- Weekdays between 4:00 PM – 8:00 PM.
- Weekends between 6:00 AM – 8:00 PM.

Figure 7 shows the following:

- a) Legend.
- b) Location of interchanges by exit/mile marker number.
- c) Specific significant interchanges.
- d) Direction of travel.
- e) Level of travel time reliability.
- f) Threshold value of 1.50.
- g) This section of roadway has reliable travel times because the LOTTR values of the four time periods are below 1.50.



LEVEL OF TRAVEL TIME RELIABILITY

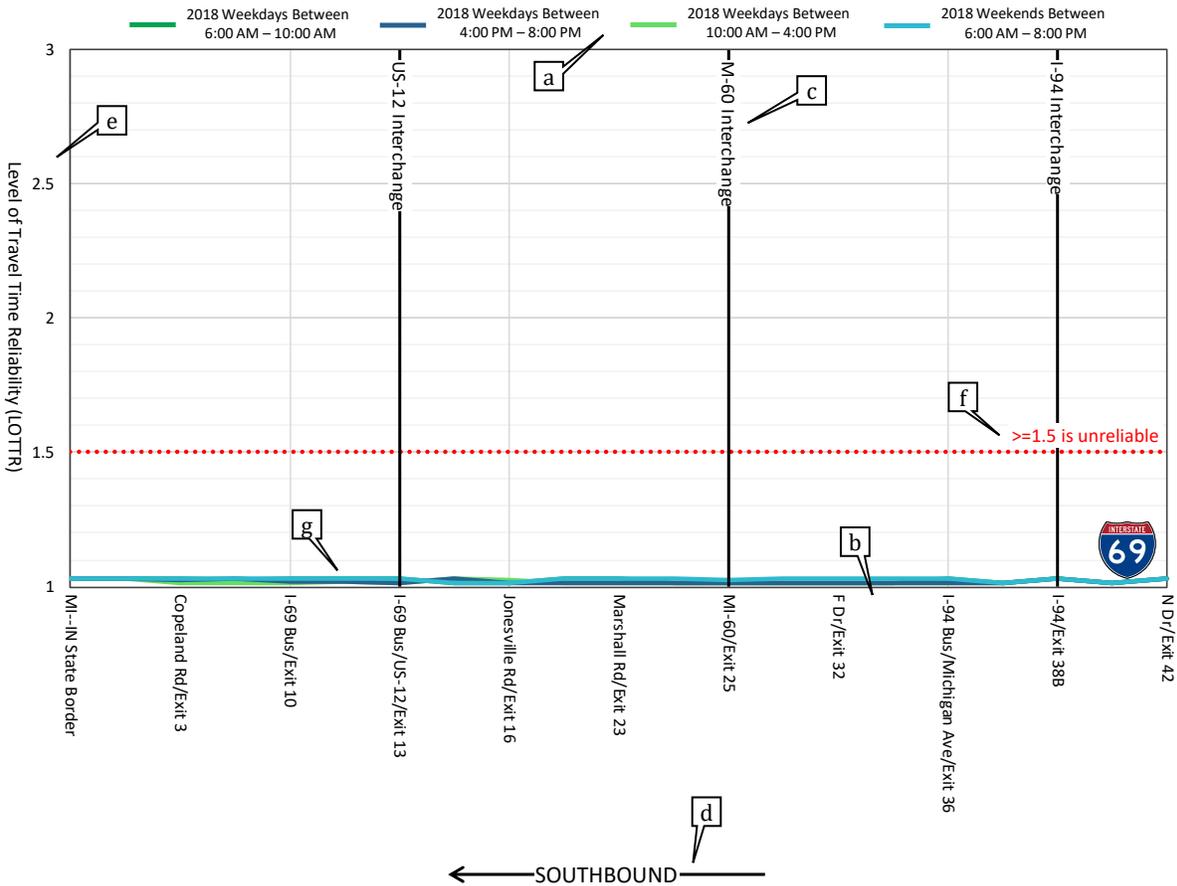


FIGURE 7. Example Level of Travel Time Reliability Figure

Figure 8 shows an example of the level of travel time reliability map. This figure represents Southwest Region during weekdays between 6:00 AM – 10:00 AM. This performance metric displays the level of travel time reliability on corridors during the four time periods mentioned above. LOTTR is represented in a color gradient that consists of three different categories to distinguish severity levels:

- Low (<1.25 LOTTR).
- Moderate (≥ 1.25 LOTTR & <1.50 LOTTR).
- Severe (≥ 1.50 LOTTR).

Figure 8 shows the following:

- All roads have very reliable travel times because the LOTTR values are below 1.25.



LEVEL OF TRAVEL TIME RELIABILITY

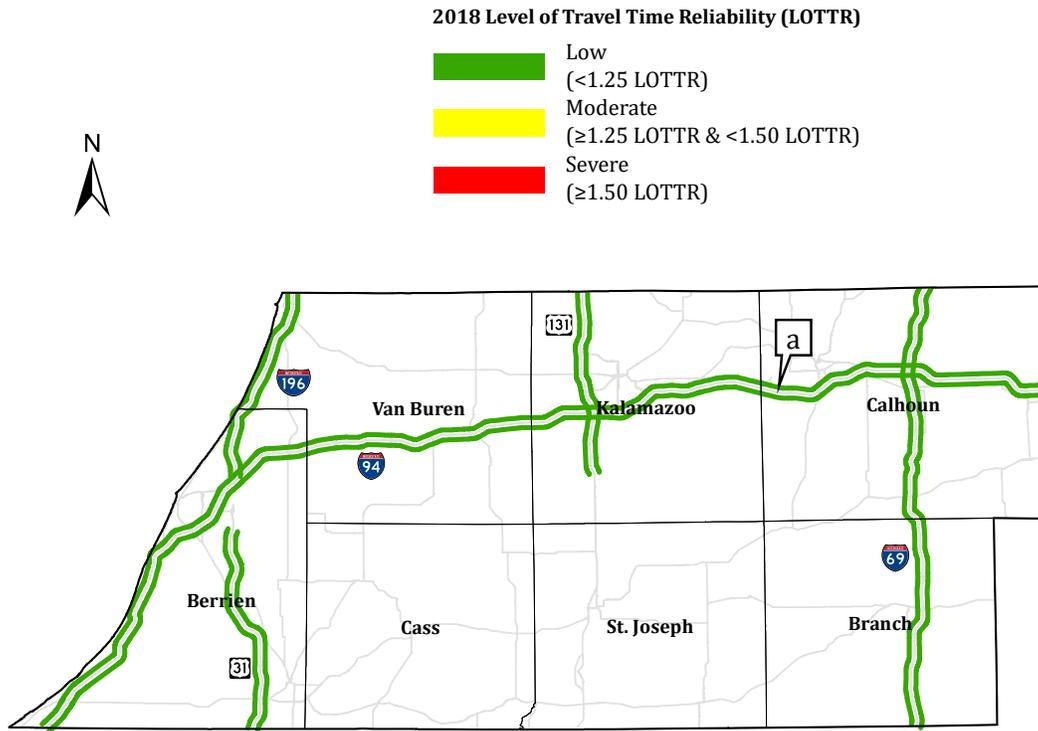


FIGURE 8. Example Level of Travel Time Reliability Map



SOUTHWEST REGION: OVERVIEW

SOUTHWEST REGION: DELAY INDEX

The following table ranks the Southwest Region freeways based on the delay index. Each freeway segment is presented on a countywide or TSC basis, as appropriate.

TABLE 2. 2018 Southwest Region Delay Index Data

Rank	Location (Route, County)	2018 Delay Index per Mile (in minutes)
1	US-131 – Kalamazoo County	341
2	US-31 – Berrien County	289
3	I-94 – Berrien County	285
4	I-94 – Kalamazoo County	250
5	I-94 – Calhoun County	222
6	I-196 – Berrien County	215
7	I-94 – Van Buren County	207
8	I-69 – Calhoun County	204
9	I-196 – Van Buren County	190
10	I-69 – Branch County	178



SOUTHWEST REGION: CONGESTION SEVERITY

The following tables display the amount of congestion miles per region that fall into each severity level. Table 3 shows this data during the AM peak and Table 4 shows this data during the PM peak. These tables can be utilized to compare the amount and severity of congestion across all regions. Figures 9-10 represent this information specifically in the Southwest Region. Figure 9 shows the congestion severity during the AM peak and Figure 10 shows the congestion severity during the PM peak.

TABLE 3. 2018 Congestion Miles by Severity - AM Peak

Region	Low	Moderate	Severe
Bay	772.9	0.0	0.0
Grand	668.9	36.8	0.0
Metro	405.1	139.9	32.4
North	358.2	0.3	0.0
Southwest	471.0	0.0	0.0
Superior	95.2	0.0	0.0
University	715.8	37.0	3.6
Total	3487.1	214.1	36.1

TABLE 4. 2018 Congestion Miles by Severity - PM Peak

Region	Low	Moderate	Severe
Bay	770.3	2.5	0.0
Grand	658.6	37.6	9.4
Metro	348.7	151.7	77.1
North	358.2	0.3	0.0
Southwest	471.0	0.0	0.0
Superior	95.2	0.0	0.0
University	719.9	24.7	11.8
Total	3422.0	216.9	98.3



SOUTHWEST REGION: CONGESTION SEVERITY

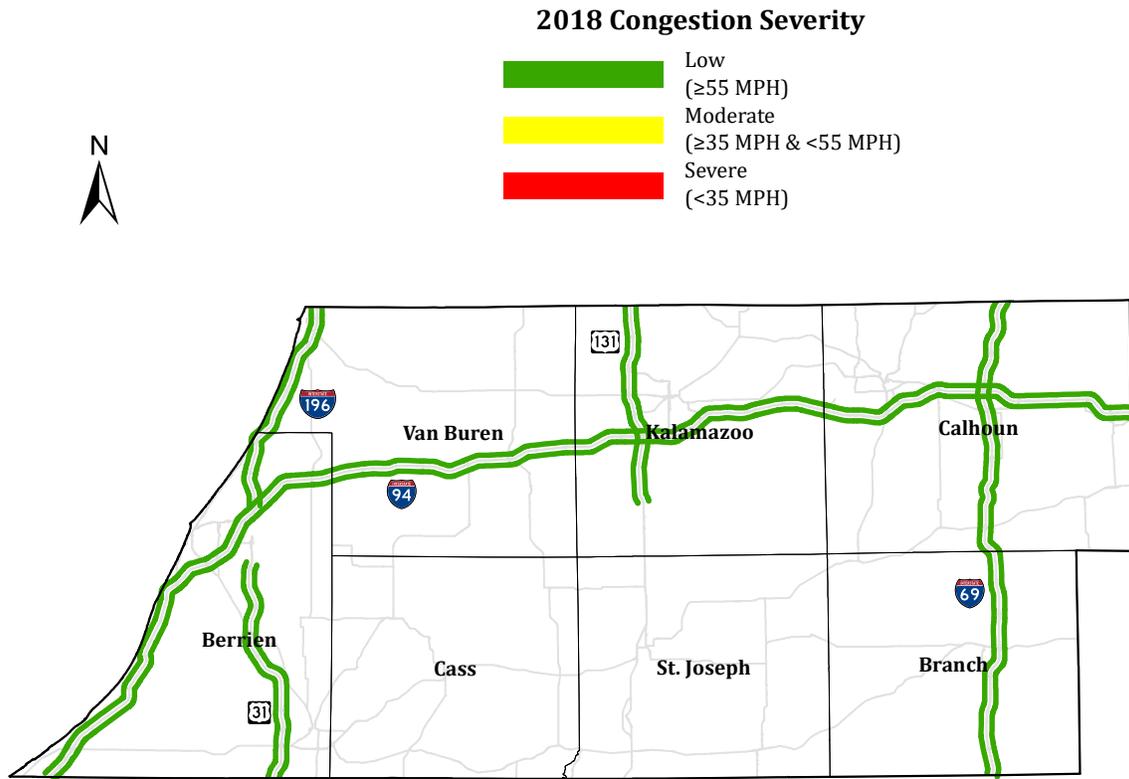


FIGURE 9. 2018 Southwest Region AM Peak Congestion Severity



SOUTHWEST REGION: CONGESTION SEVERITY



FIGURE 10. 2018 Southwest Region PM Peak Congestion Severity



SOUTHWEST REGION: LEVEL OF TRAVEL TIME RELIABILITY

The following figures display the level of travel time reliability (LOTTR) based on severity level in the Southwest Region. Figures 11-13 display the LOTTR during weekdays between 6:00 – 10:00 AM, 10:00 AM – 4:00 PM, and 4:00 PM – 8:00 PM, respectively. Figure 14 displays the LOTTR during weekends between 6:00 AM – 8:00 PM.

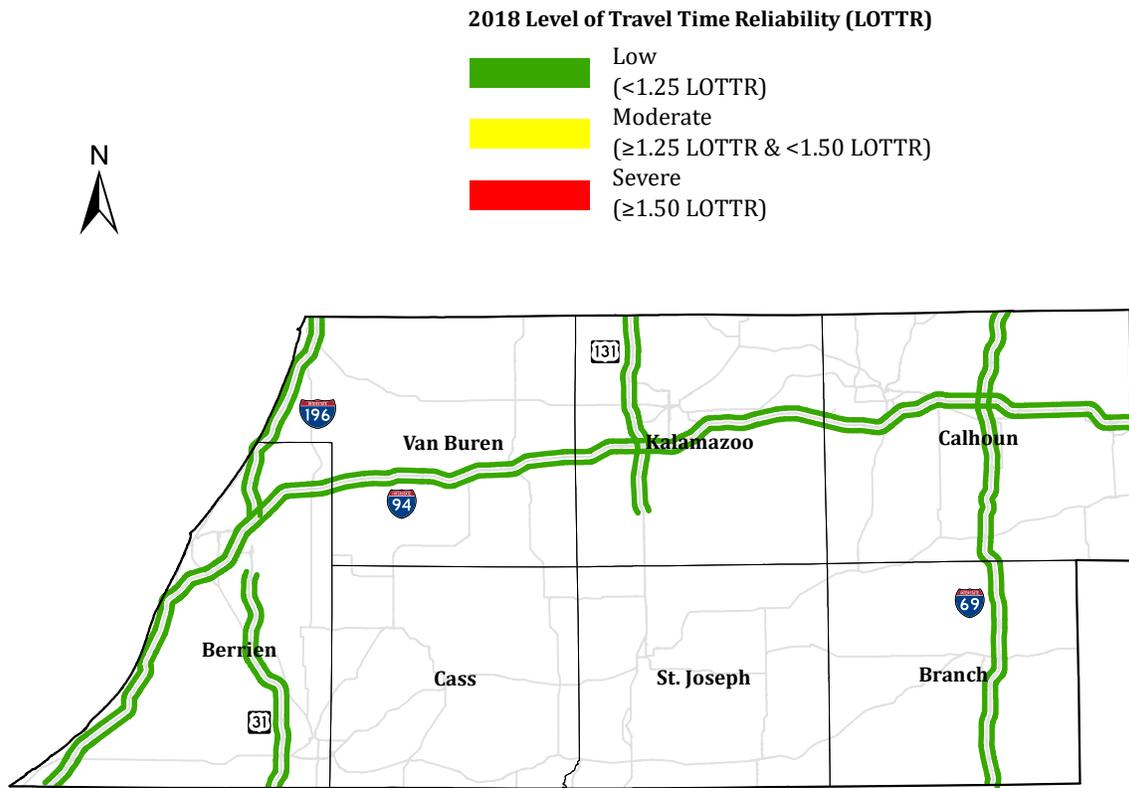
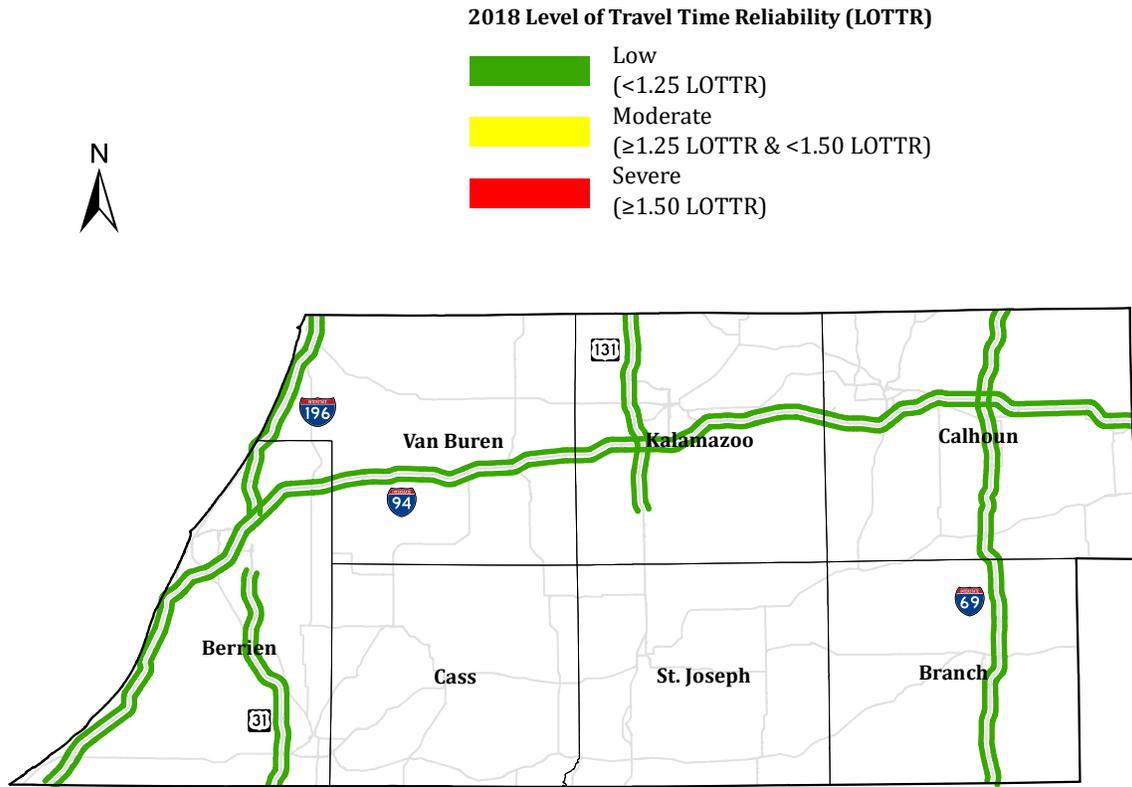


FIGURE 11. 2018 Southwest Region Level of Travel Time Reliability (Weekdays between 6:00 AM – 10:00 AM)



SOUTHWEST REGION: LEVEL OF TRAVEL TIME RELIABILITY



**FIGURE 12. 2018 Southwest Region Level of Travel Time Reliability
(Weekdays between 10:00 AM – 4:00 PM)**



SOUTHWEST REGION: LEVEL OF TRAVEL TIME RELIABILITY

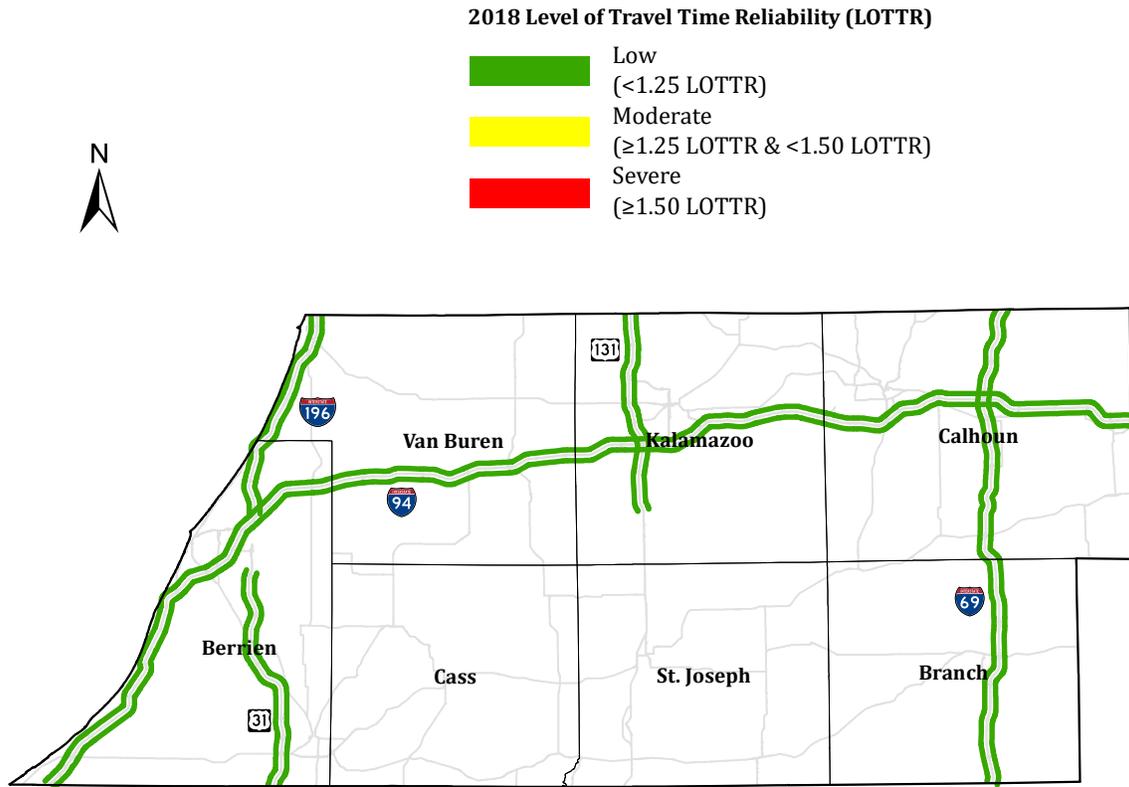


FIGURE 13. 2018 Southwest Region Level of Travel Time Reliability (Weekdays between 4:00 PM – 8:00 PM)



SOUTHWEST REGION: LEVEL OF TRAVEL TIME RELIABILITY

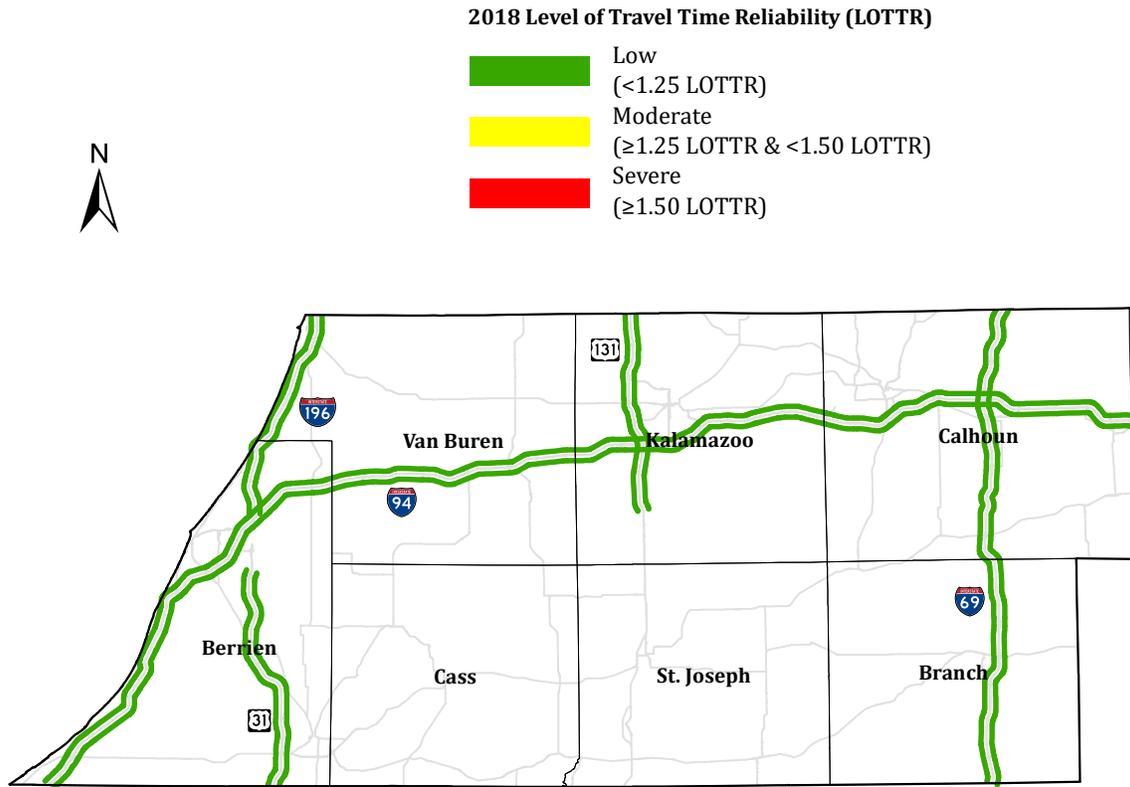
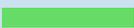


FIGURE 14. 2018 Southwest Region Level of Travel Time Reliability (Weekends between 6:00 AM – 8:00 PM)



SOUTHWEST REGION: CORRIDOR GLOSSARY



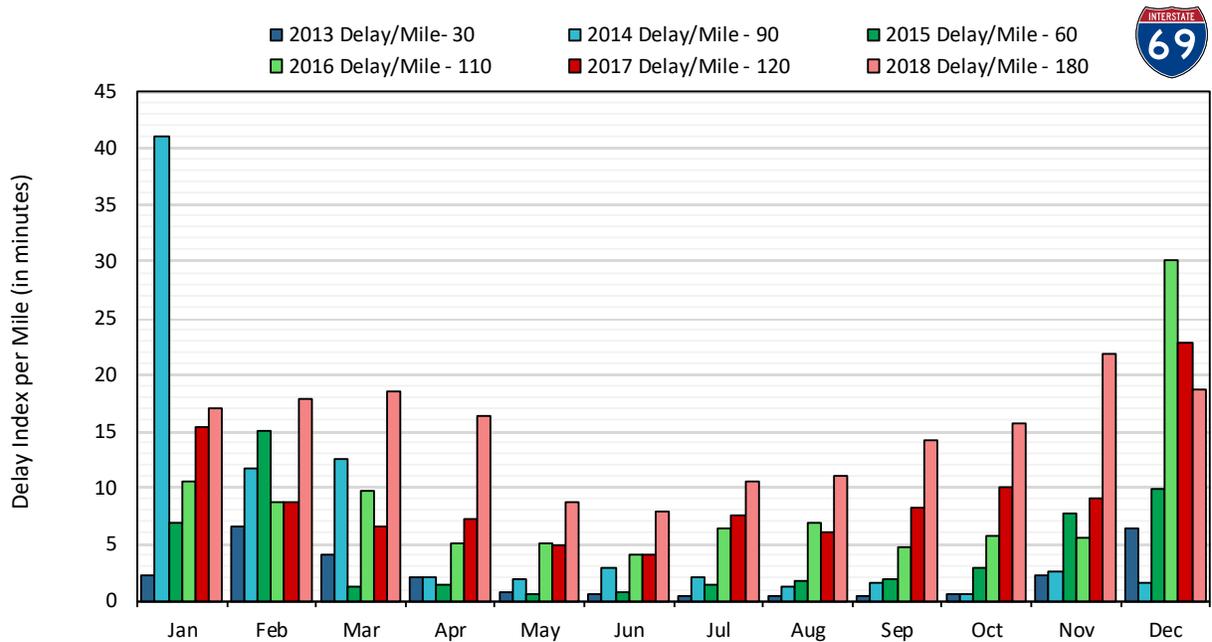
		I-69: Branch and Calhoun	<i>Pg. 25</i>
		I-94: Berrien, Van Buren, Kalamazoo, and Calhoun	<i>Pg. 31</i>
		I-196: Berrien and Van Buren	<i>Pg. 41</i>
		US-31: Berrien	<i>Pg. 47</i>
		US-131: Kalamazoo	<i>Pg. 52</i>



I-69: BRANCH COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 15. Branch County I-69 Corridor Delay Index

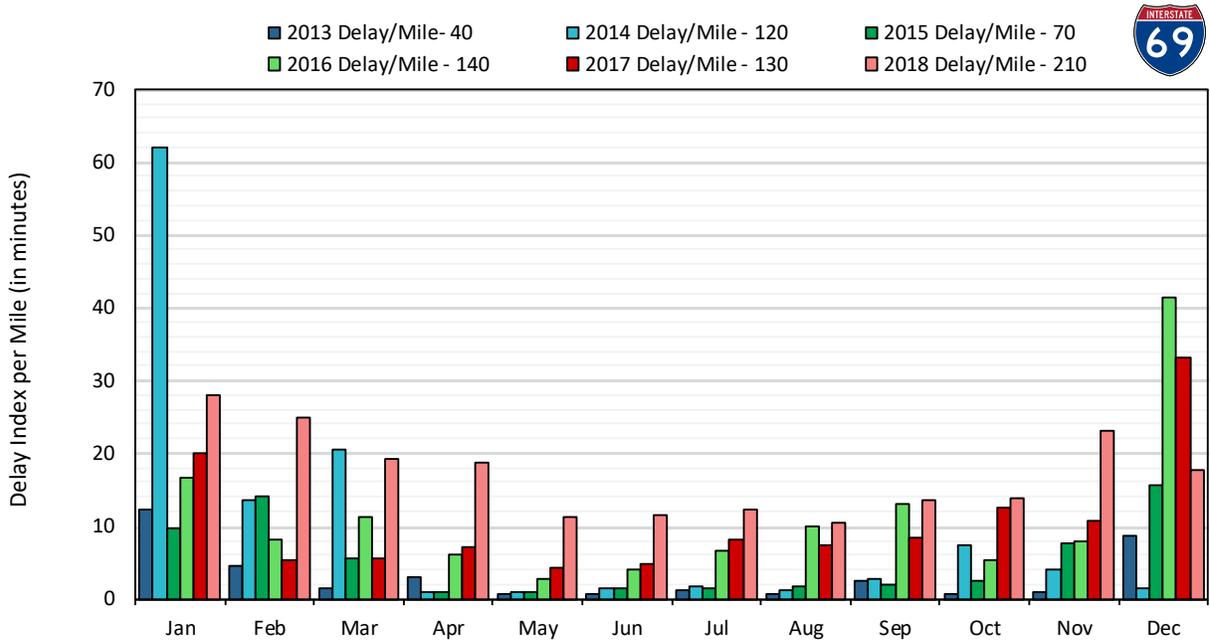




I-69: CALHOUN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 16. Calhoun County I-69 Corridor Delay Index





I-69: AVERAGE SPEED

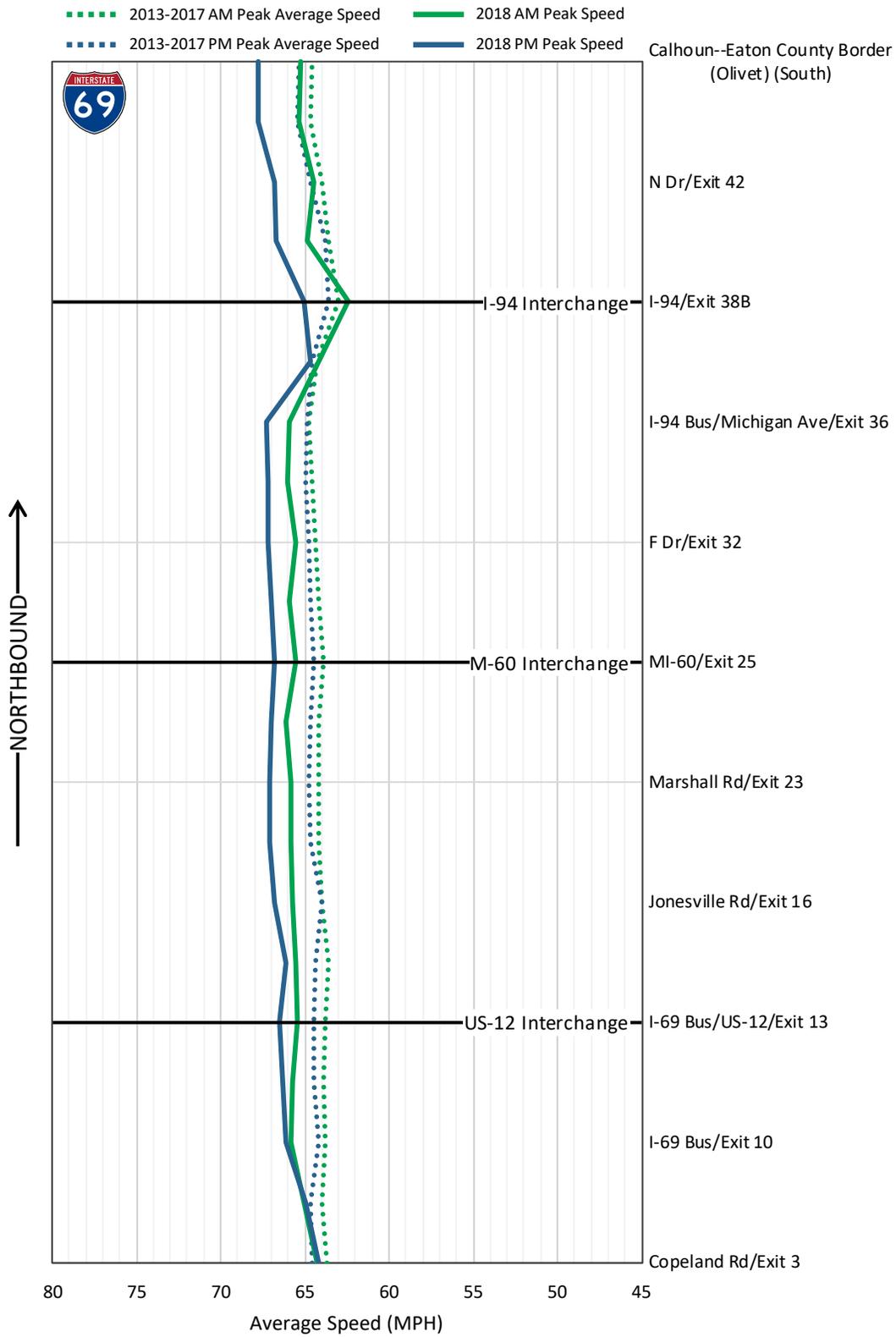


FIGURE 17. Southwest Region Northbound I-69 Average Speed





I-69: AVERAGE SPEED

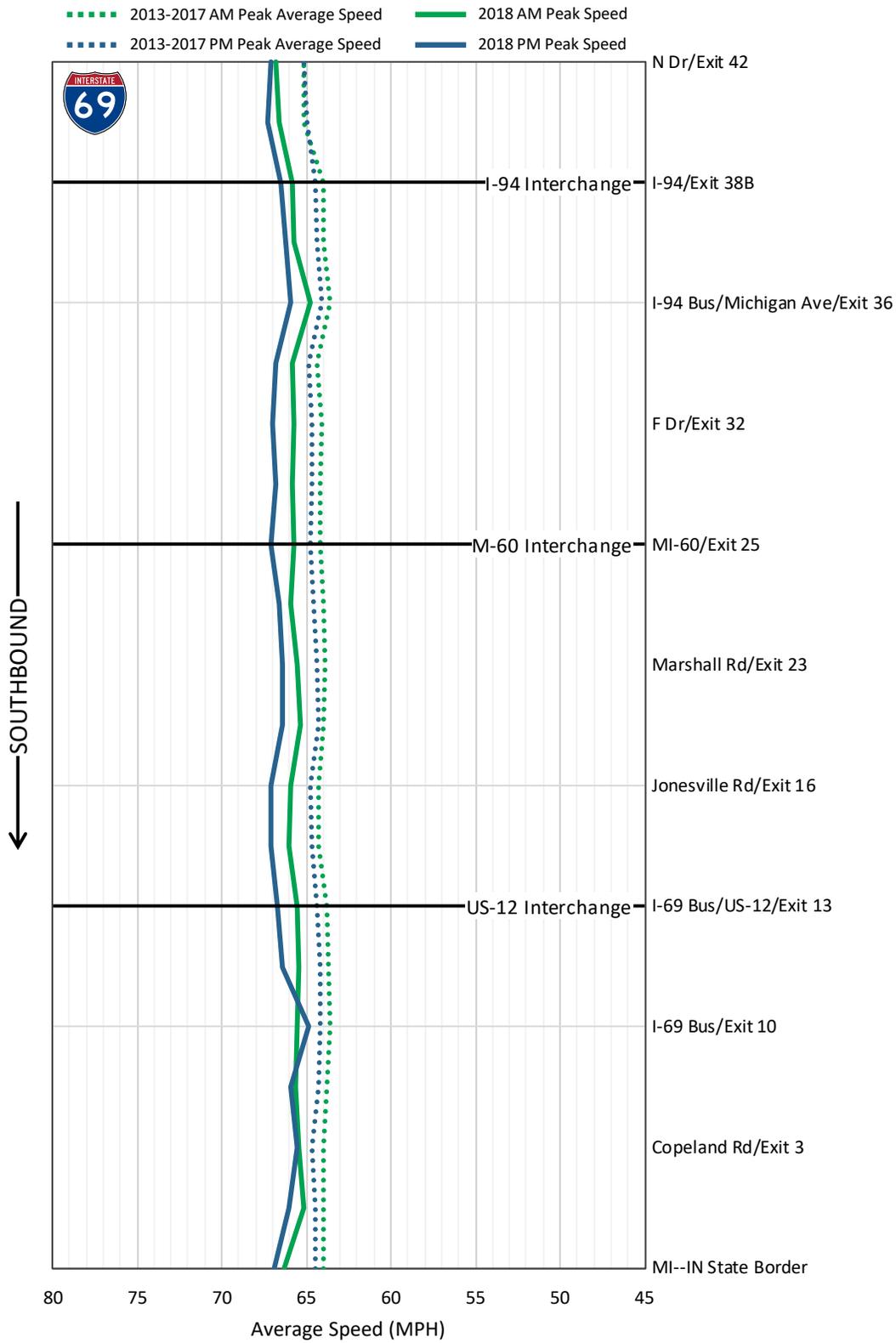


FIGURE 18. Southwest Region Southbound I-69 Average Speed





I-69: LEVEL OF TRAVEL TIME RELIABILITY

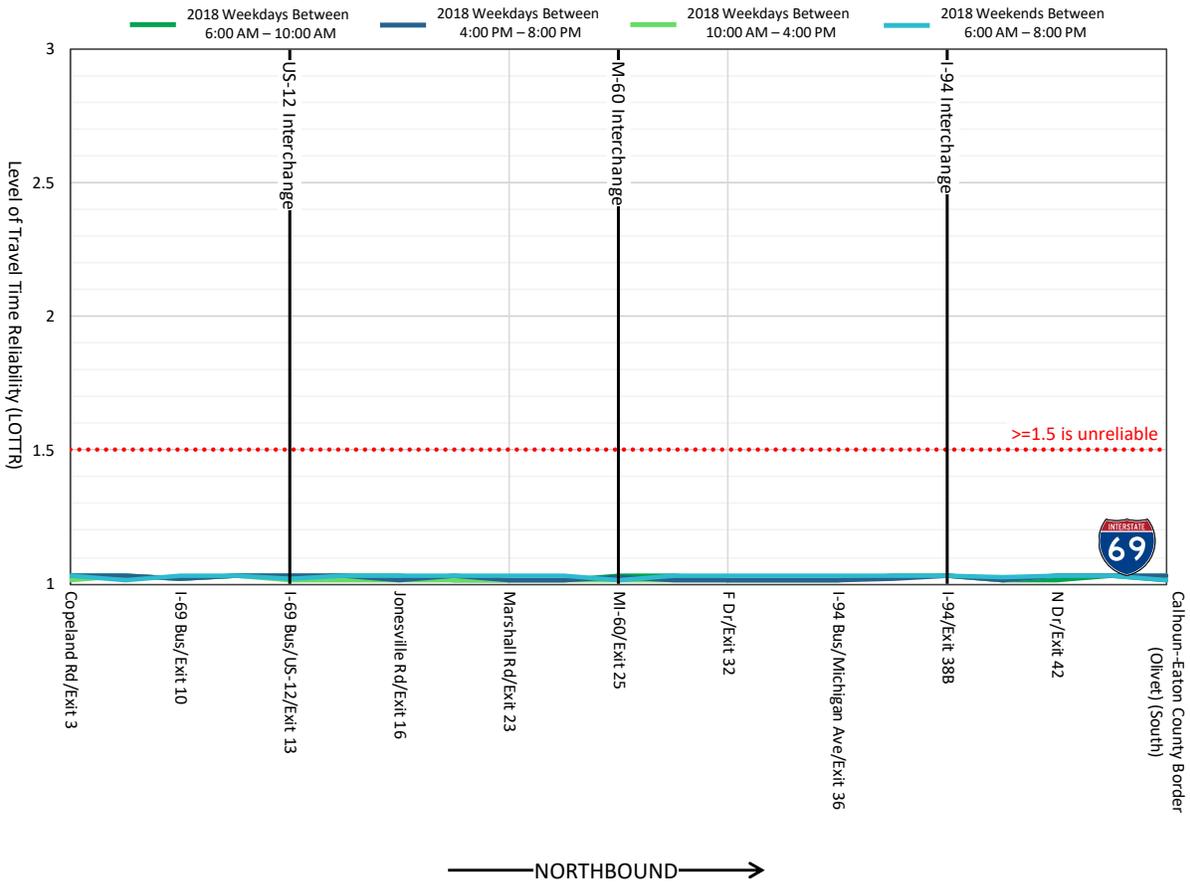


FIGURE 19. Southwest Region Northbound I-69 Level of Travel Time Reliability



I-69: LEVEL OF TRAVEL TIME RELIABILITY

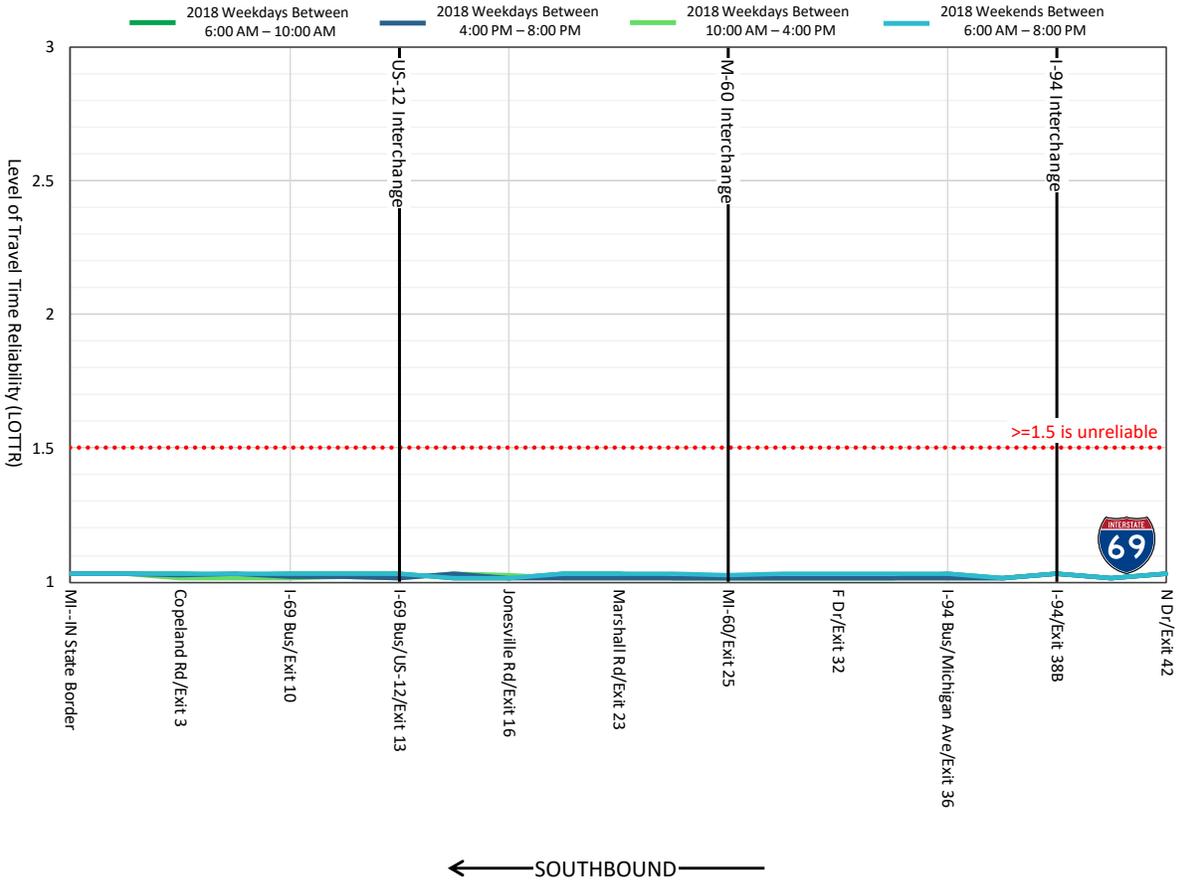


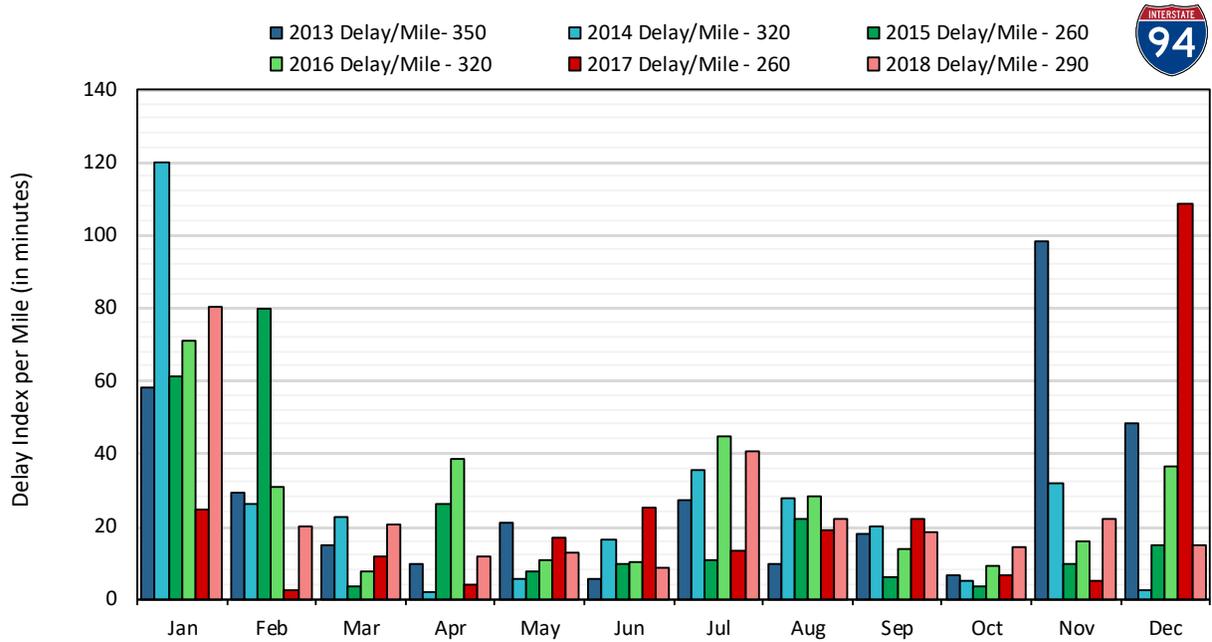
FIGURE 20. Southwest Region Southbound I-69 Level of Travel Time Reliability



I-94: BERRIEN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 21. Berrien County I-94 Corridor Delay Index

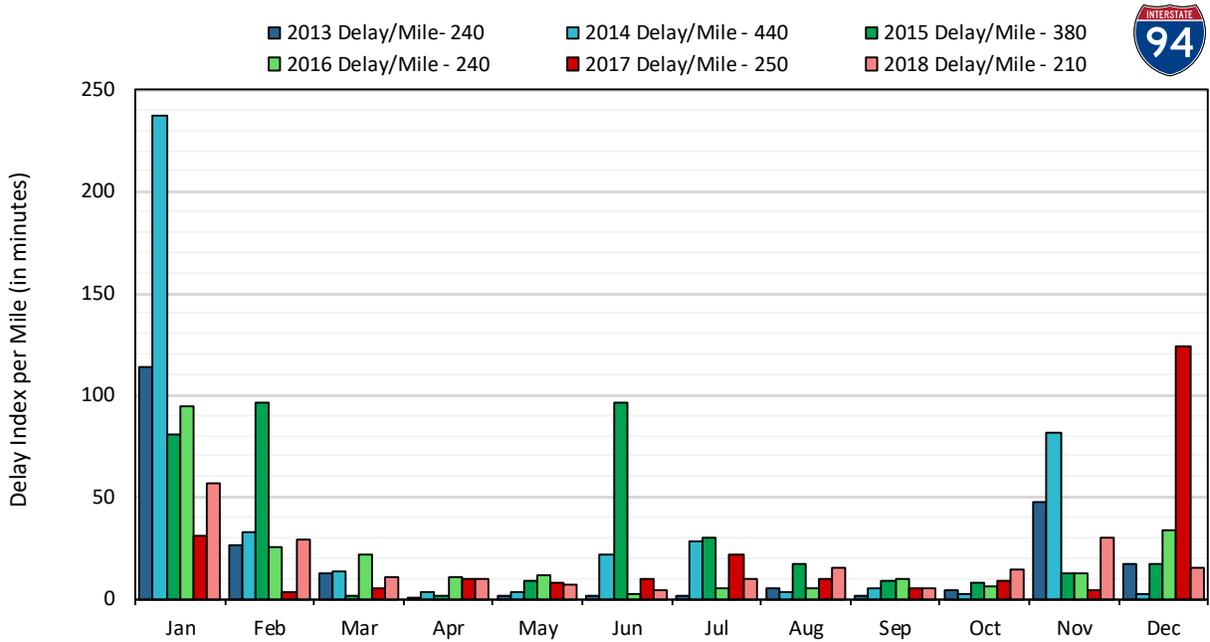




I-94: VAN BUREN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

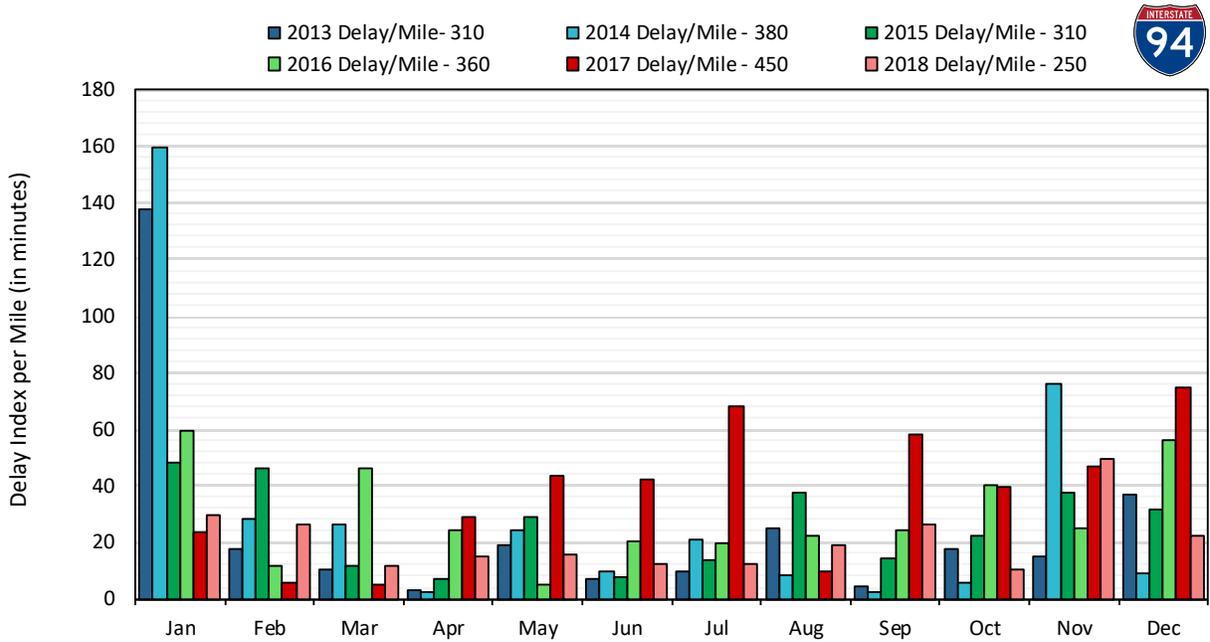
FIGURE 22. Van Buren County I-94 Corridor Delay Index



I-94: KALAMAZOO COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

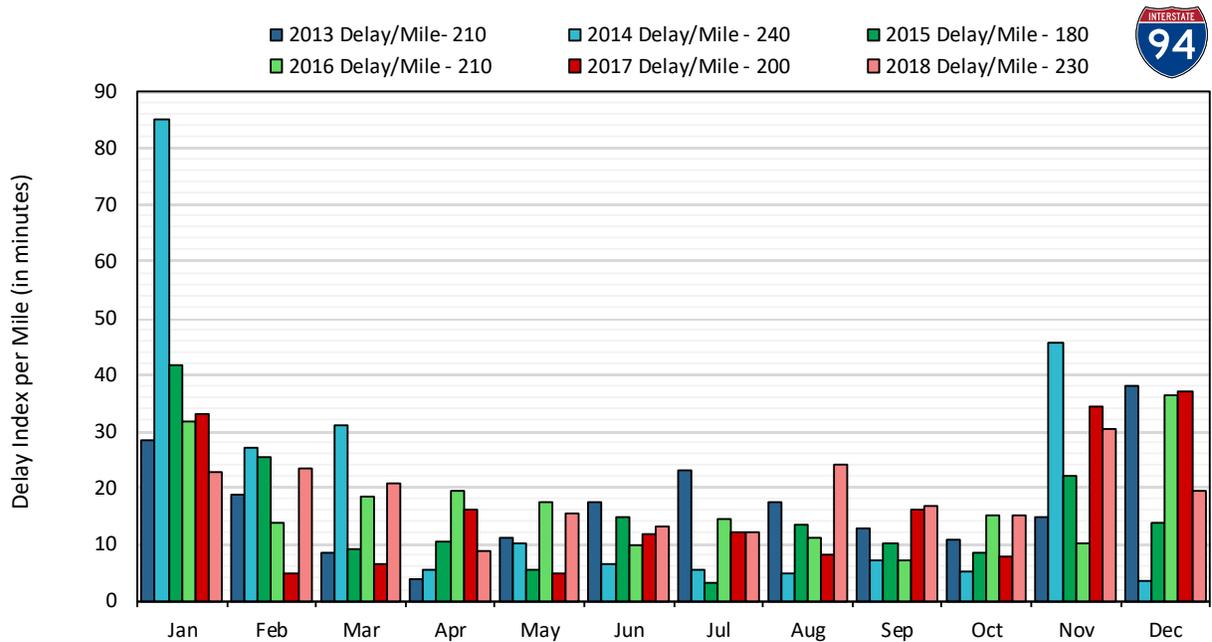
FIGURE 23. Kalamazoo County I-94 Corridor Delay Index



I-94: CALHOUN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 24. Calhoun County I-94 Corridor Delay Index





I-94: AVERAGE SPEED

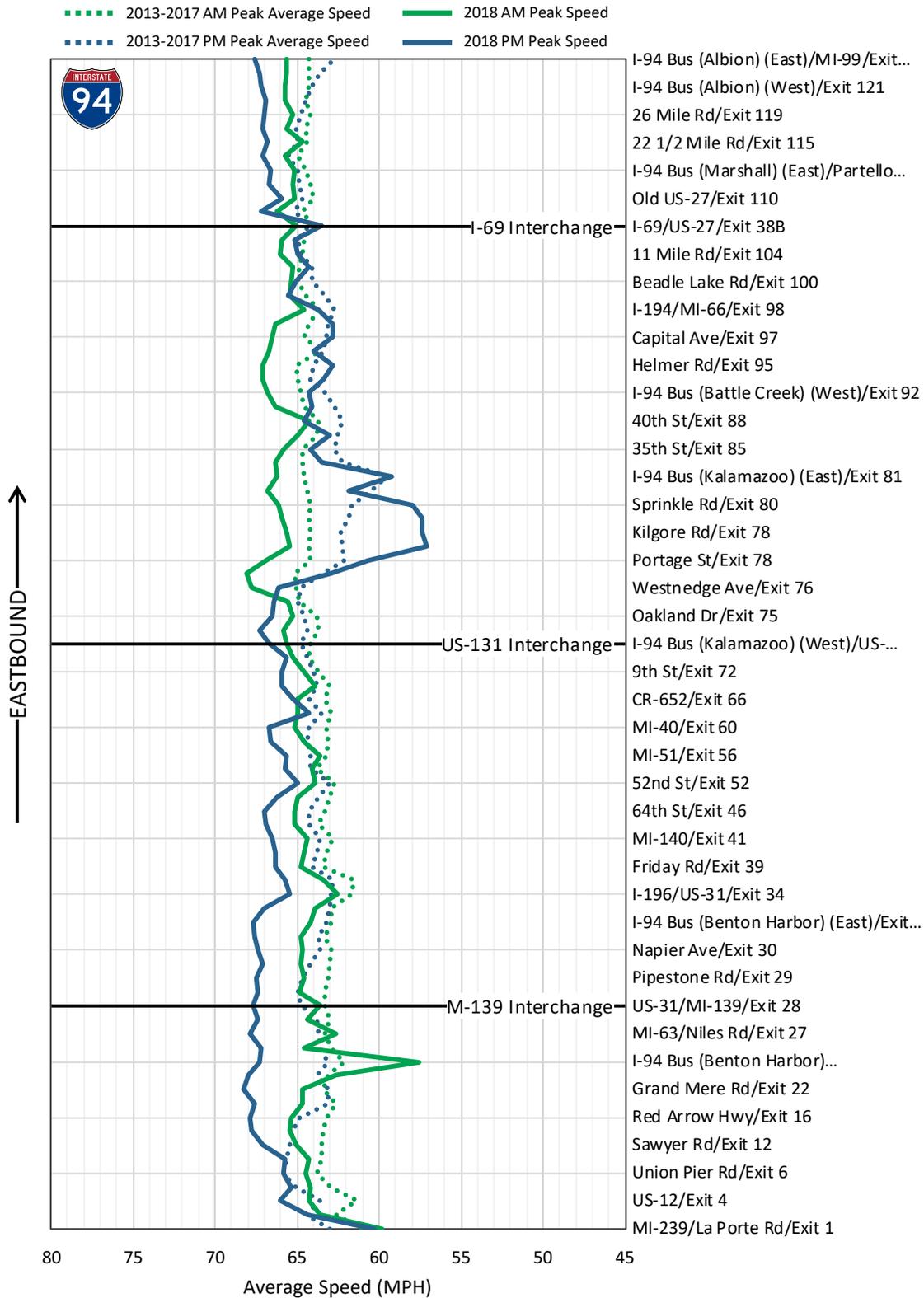


FIGURE 25. Southwest Region Eastbound I-94 Average Speed





I-94: AVERAGE SPEED

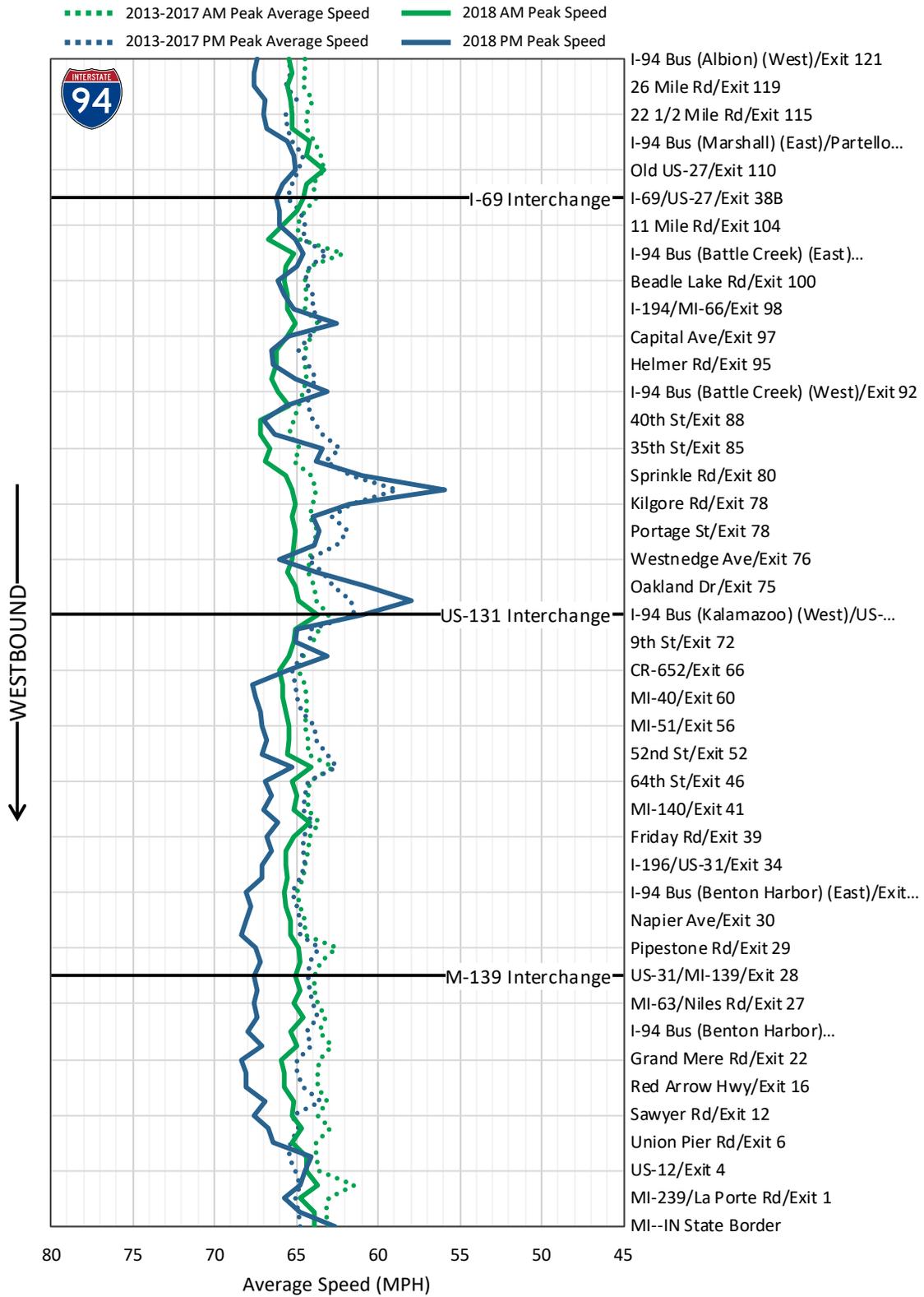


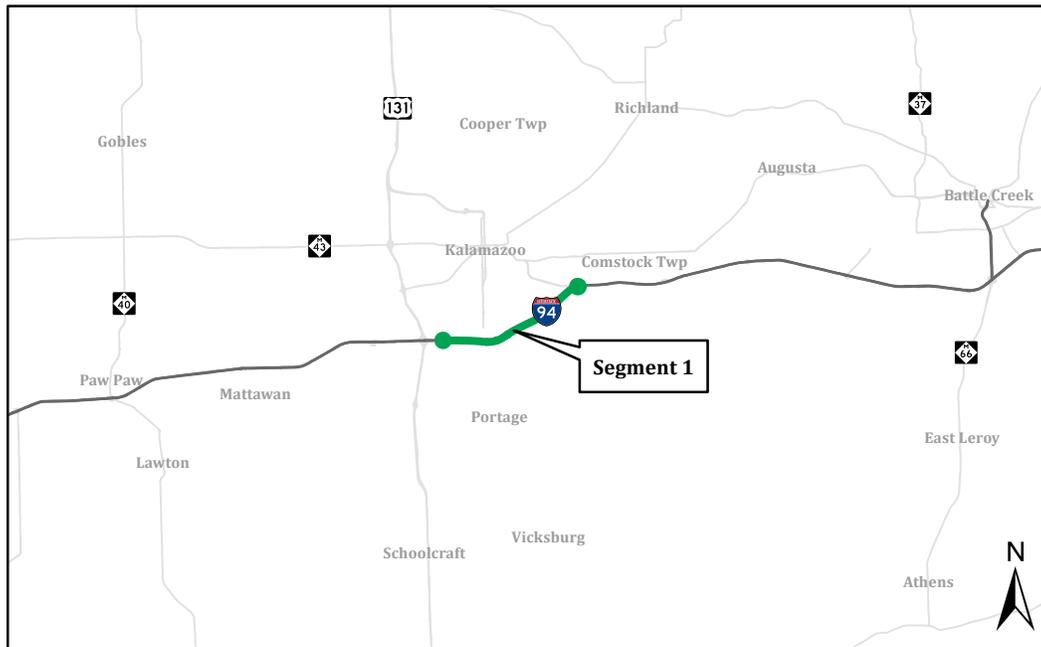
FIGURE 26. Southwest Region Westbound I-94 Average Speed



I-94: TRAVEL TIME RELIABILITY



a) Southwest Region

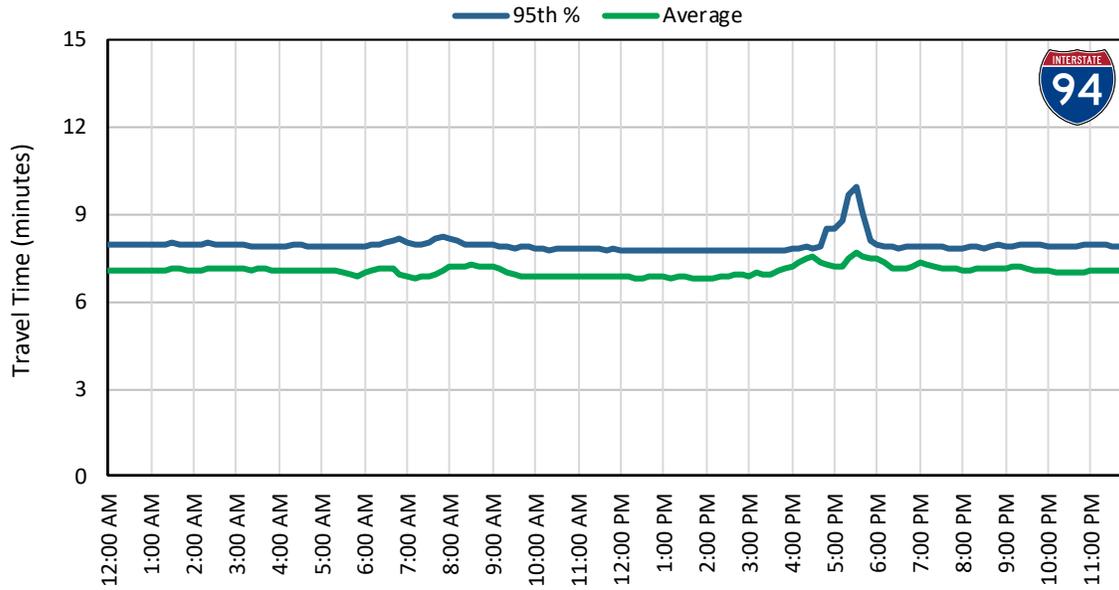


b) Kalamazoo, Michigan

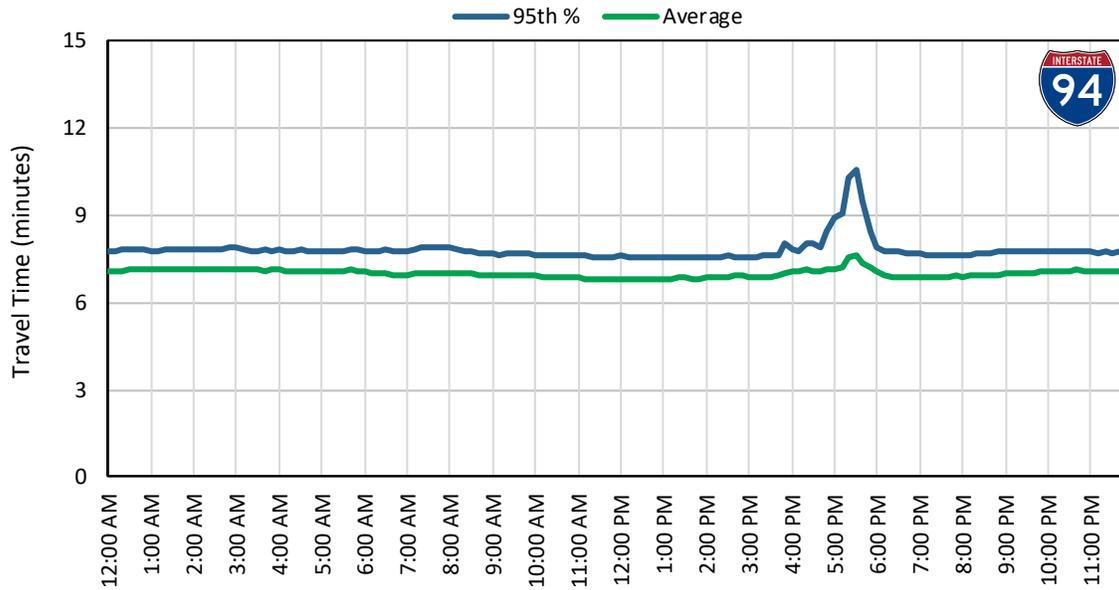
FIGURE 27. Travel Time Reliability: I-94



I-94: TRAVEL TIME RELIABILITY



a) Eastbound



b) Westbound

FIGURE 28. Segment 1 - I-94 between I-94/US-131/Exit 74 and I-94/Exit 81



I-94: LEVEL OF TRAVEL TIME RELIABILITY

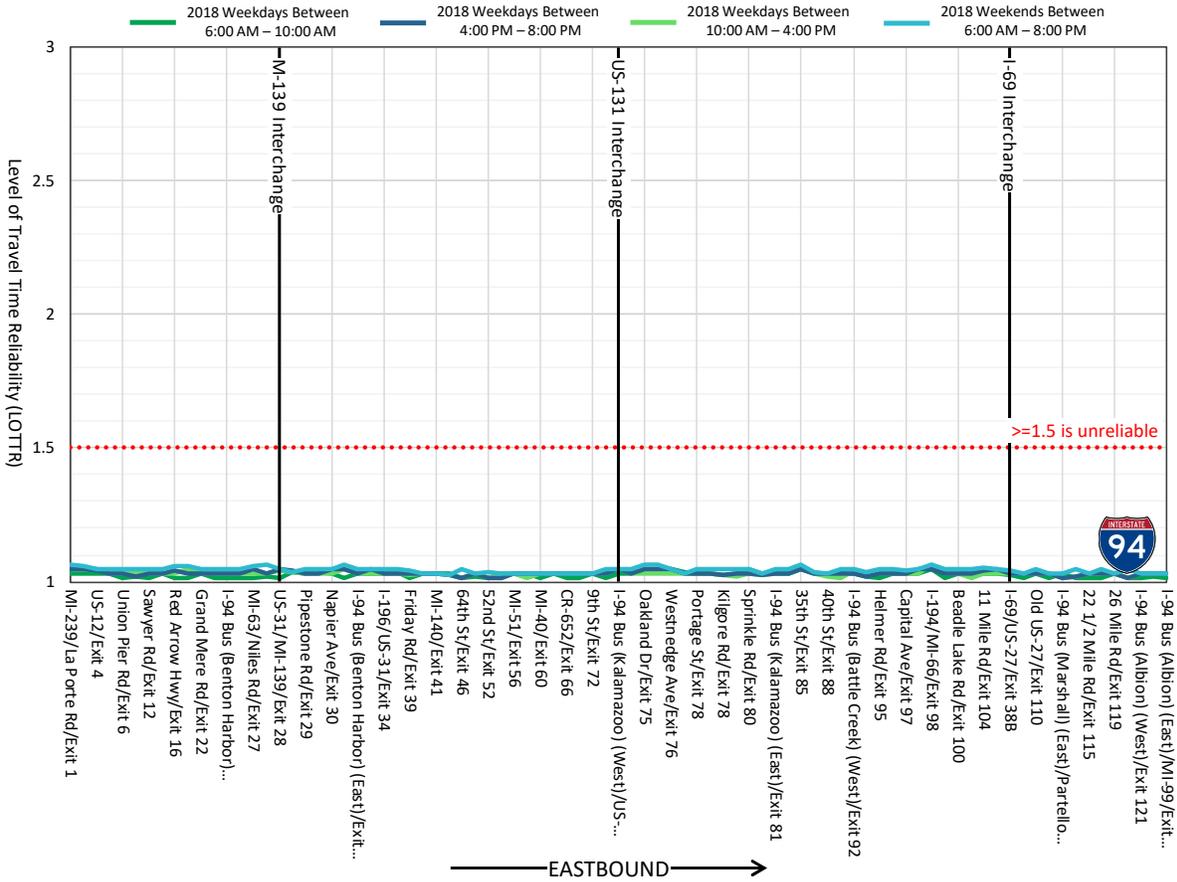


FIGURE 29. Southwest Region Eastbound I-94 Level of Travel Time Reliability



I-94: LEVEL OF TRAVEL TIME RELIABILITY

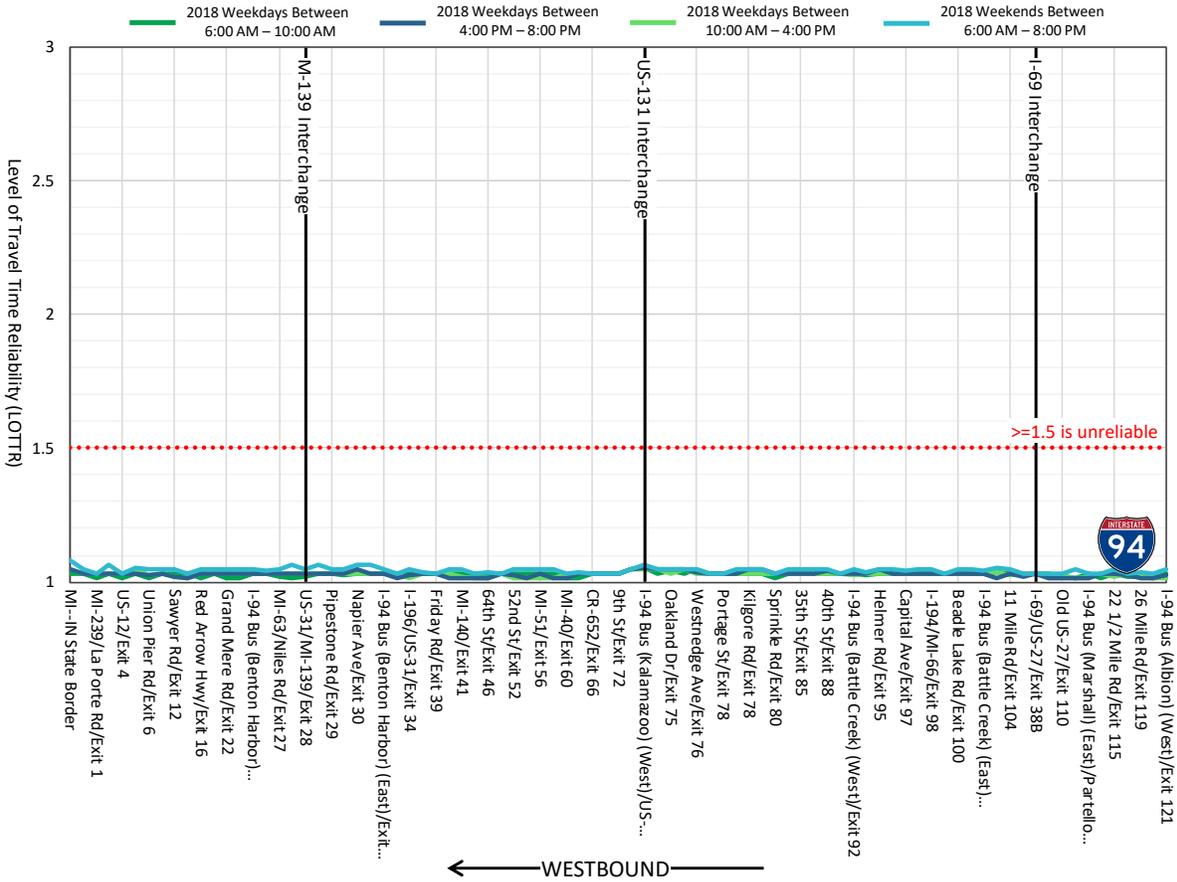


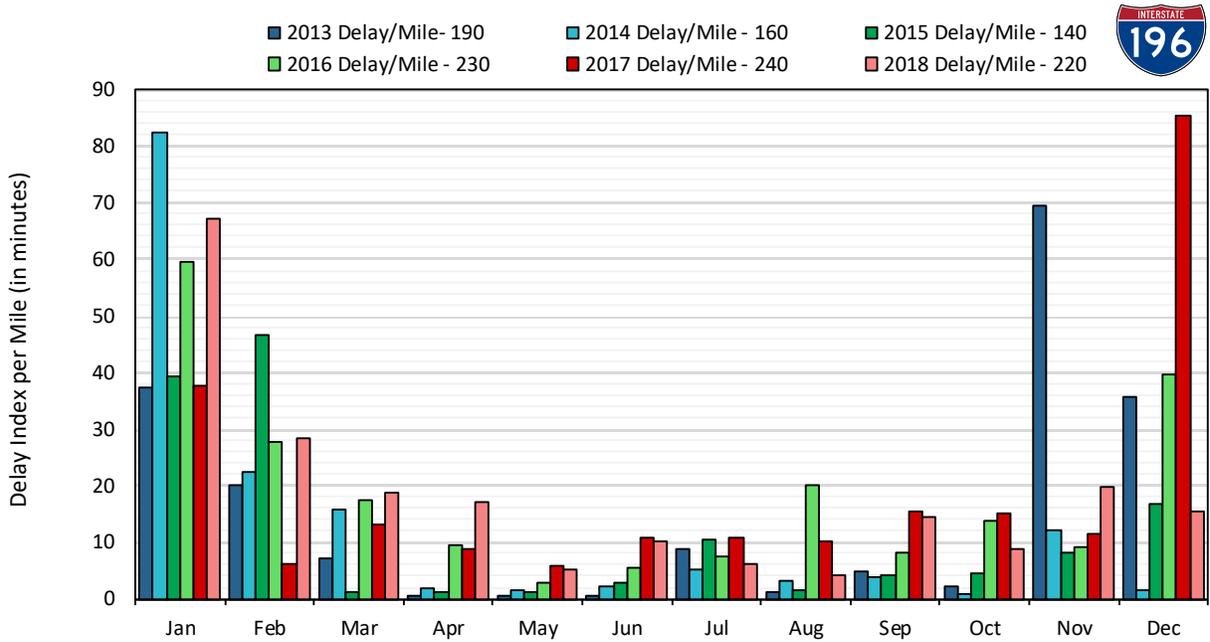
FIGURE 30. Southwest Region Westbound I-94 Level of Travel Time Reliability



I-196: BERRIEN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

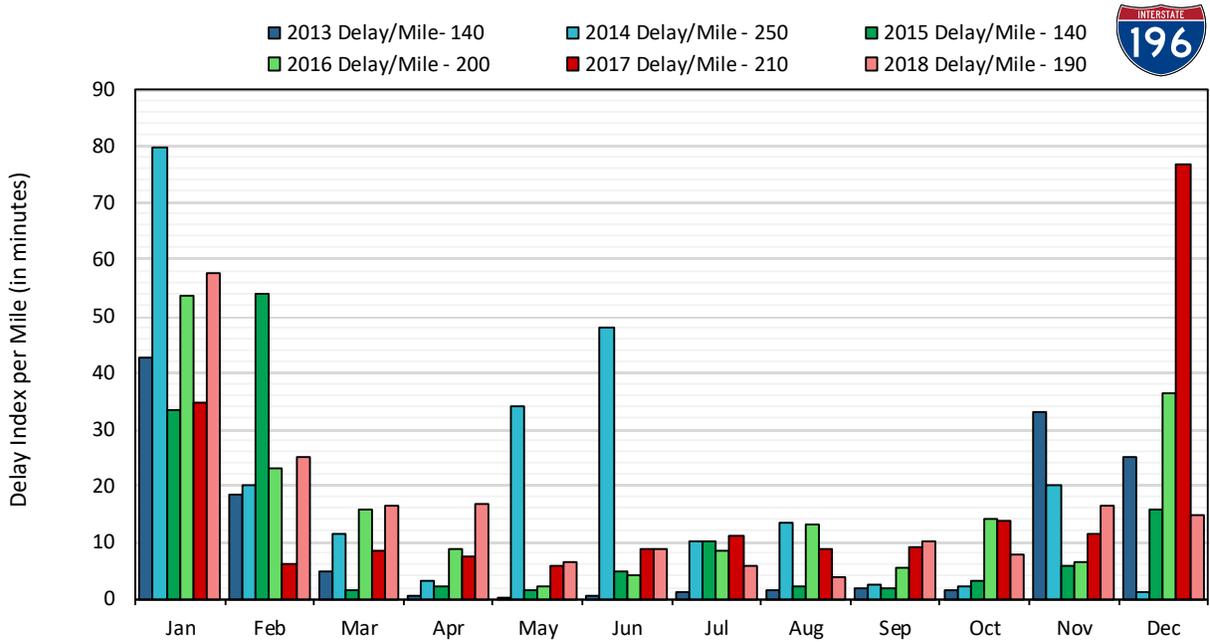
FIGURE 31. Berrien County I-196 Corridor Delay Index



I-196: VAN BUREN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 32. Van Buren County I-196 Corridor Delay Index





I-196: AVERAGE SPEED

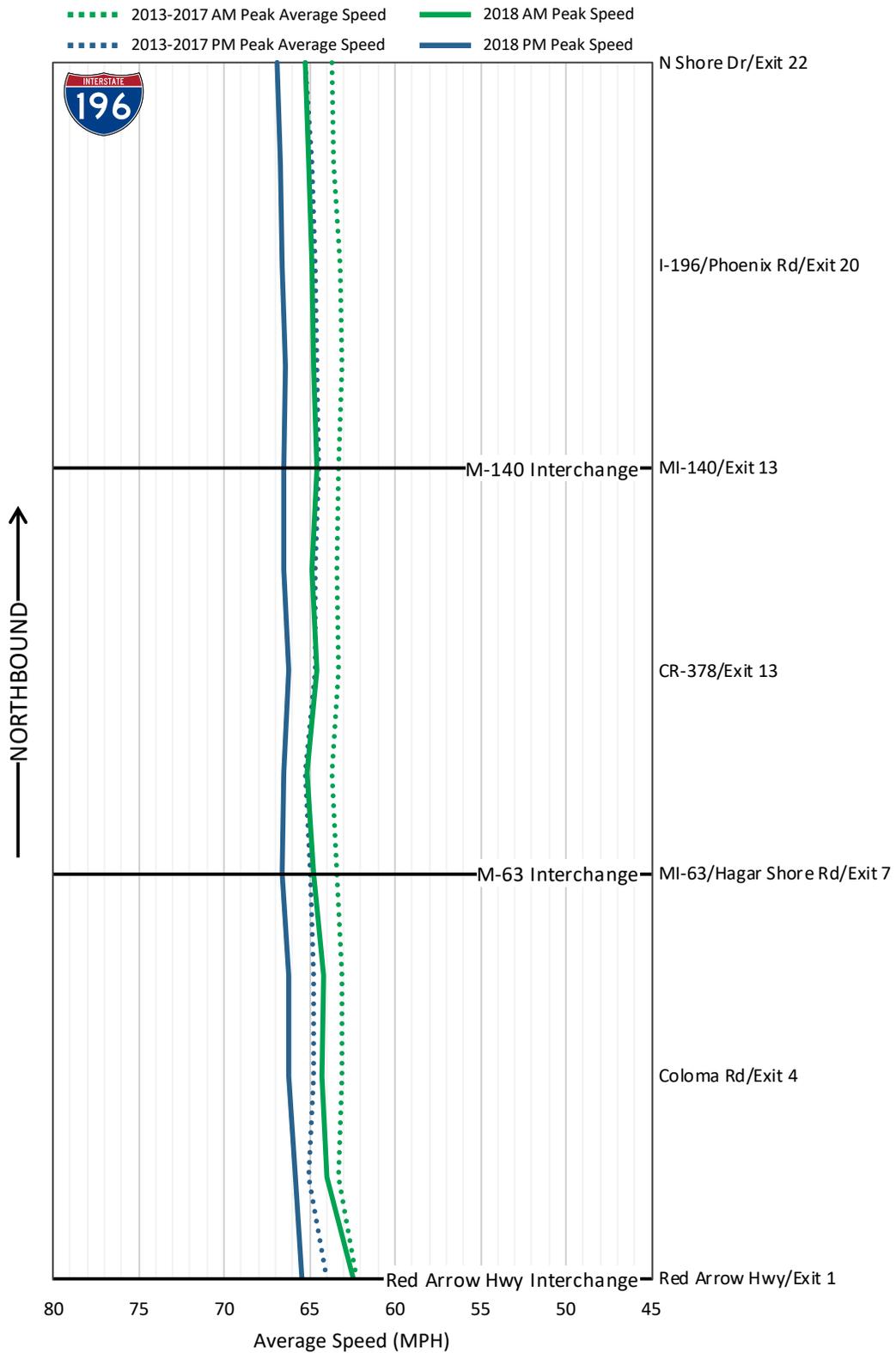


FIGURE 33. Southwest Region Northbound I-196 Average Speed





I-196: AVERAGE SPEED

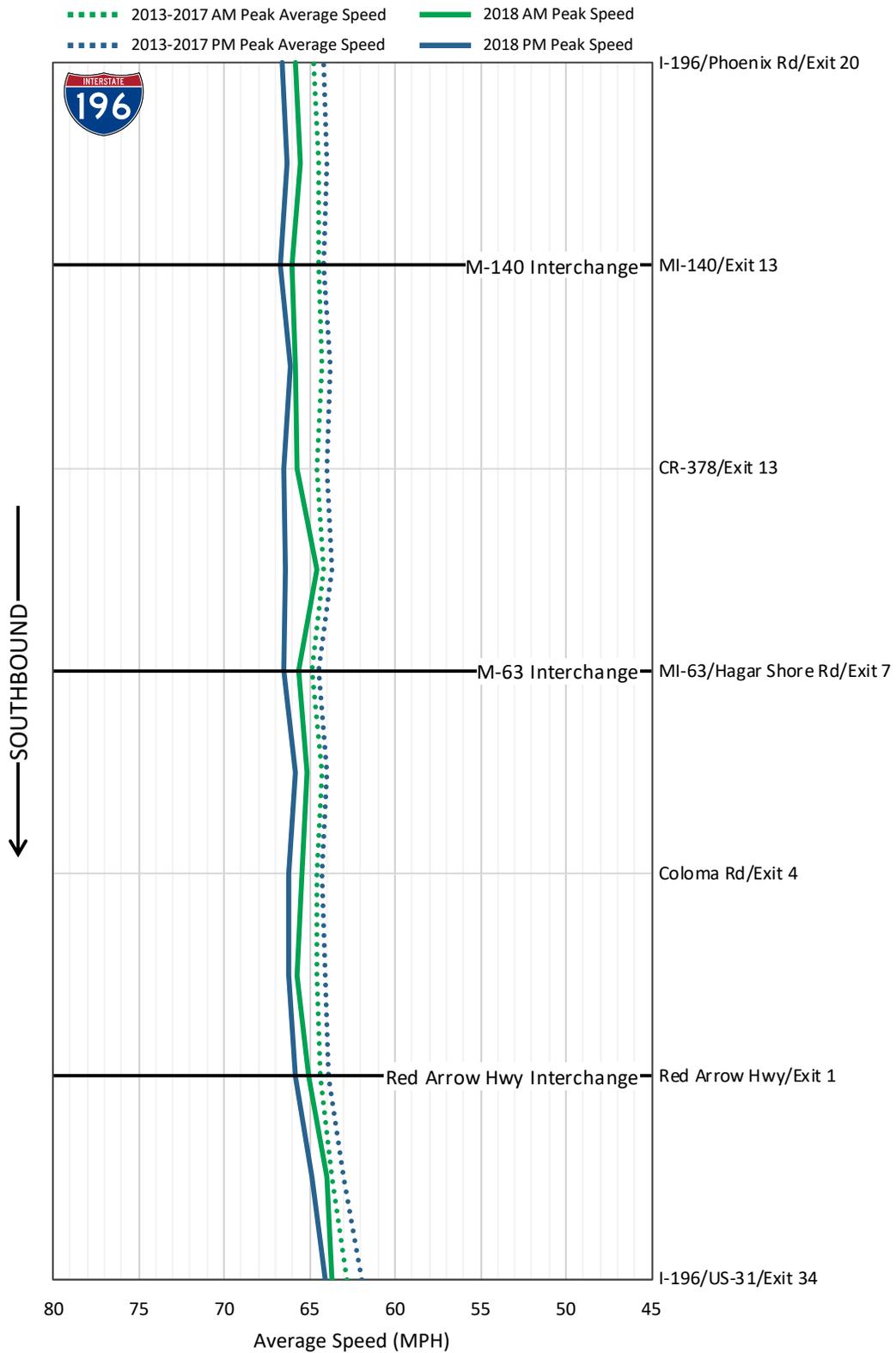


FIGURE 34. Southwest Region Southbound I-196 Average Speed





I-196: LEVEL OF TRAVEL TIME RELIABILITY

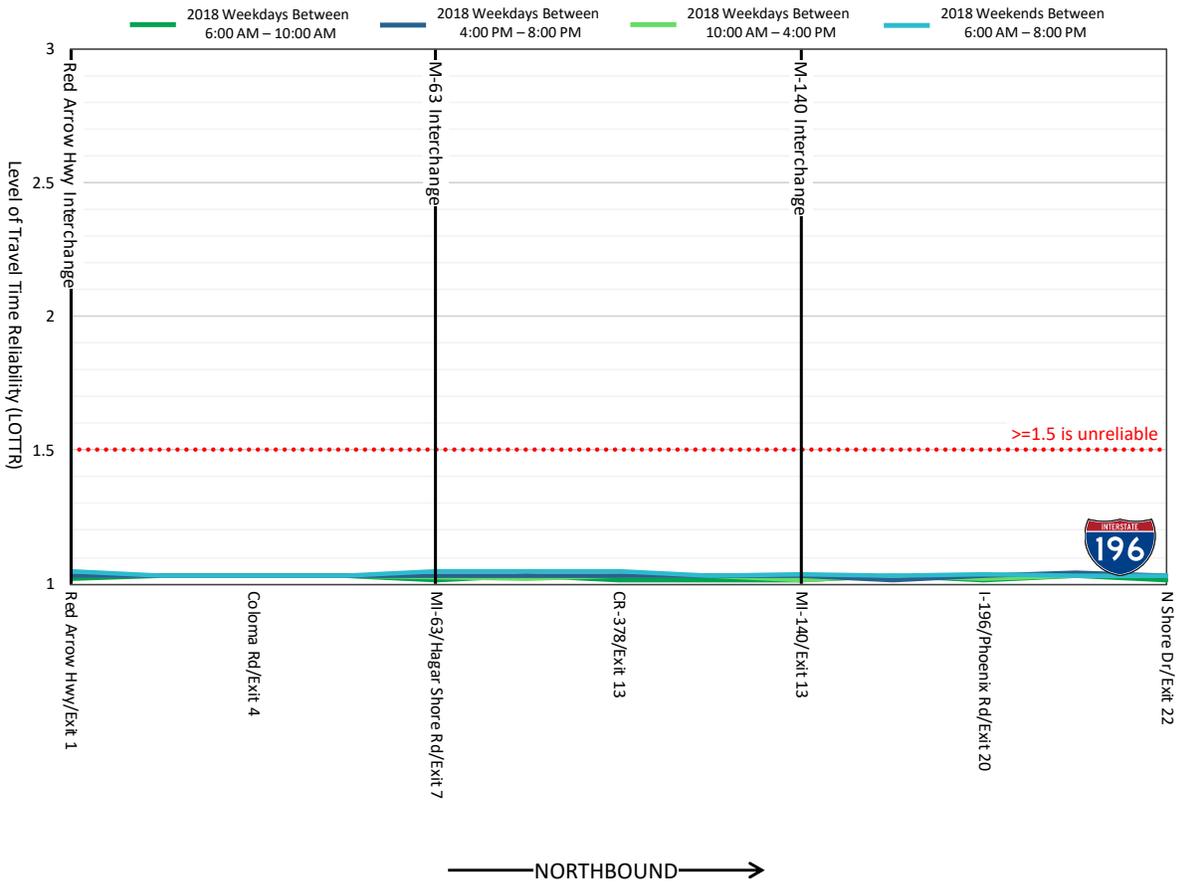


FIGURE 35. Southwest Region Northbound I-196 Level of Travel Time Reliability



I-196: LEVEL OF TRAVEL TIME RELIABILITY

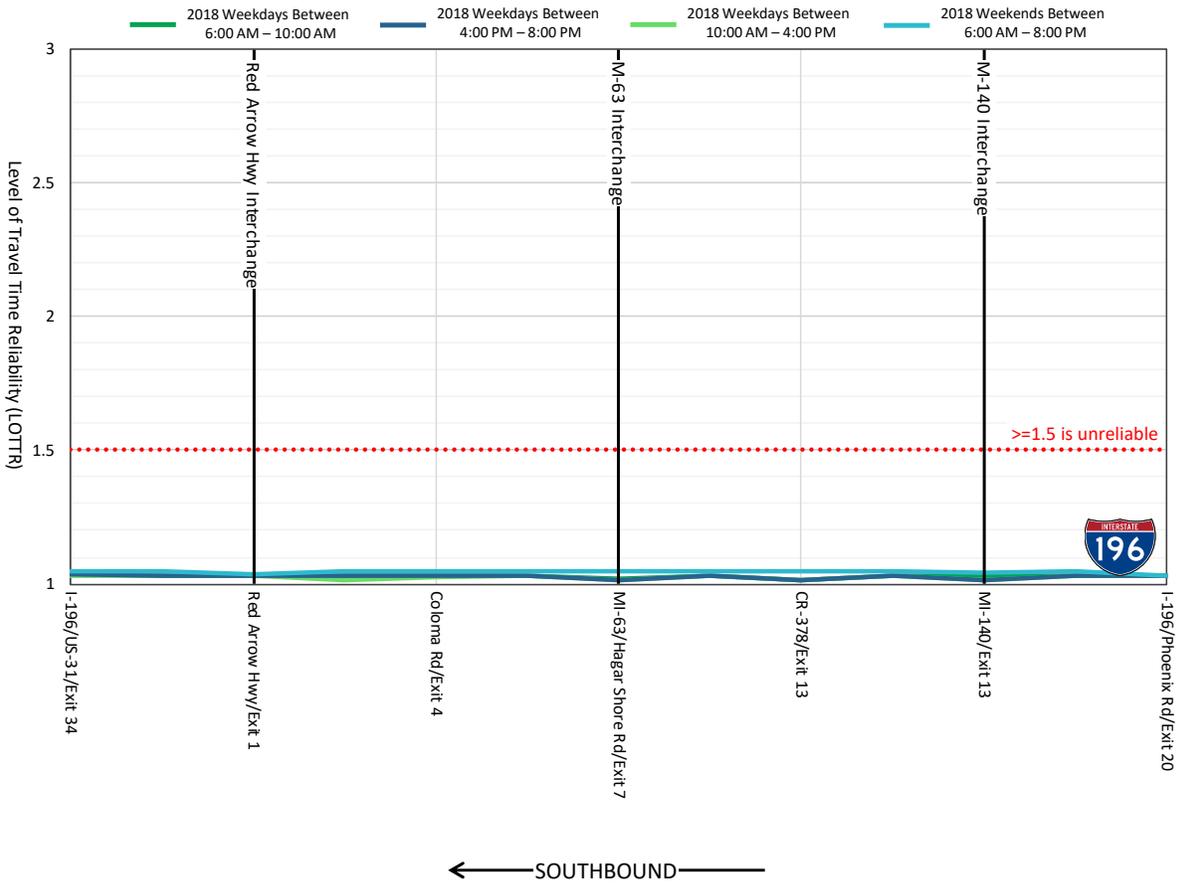


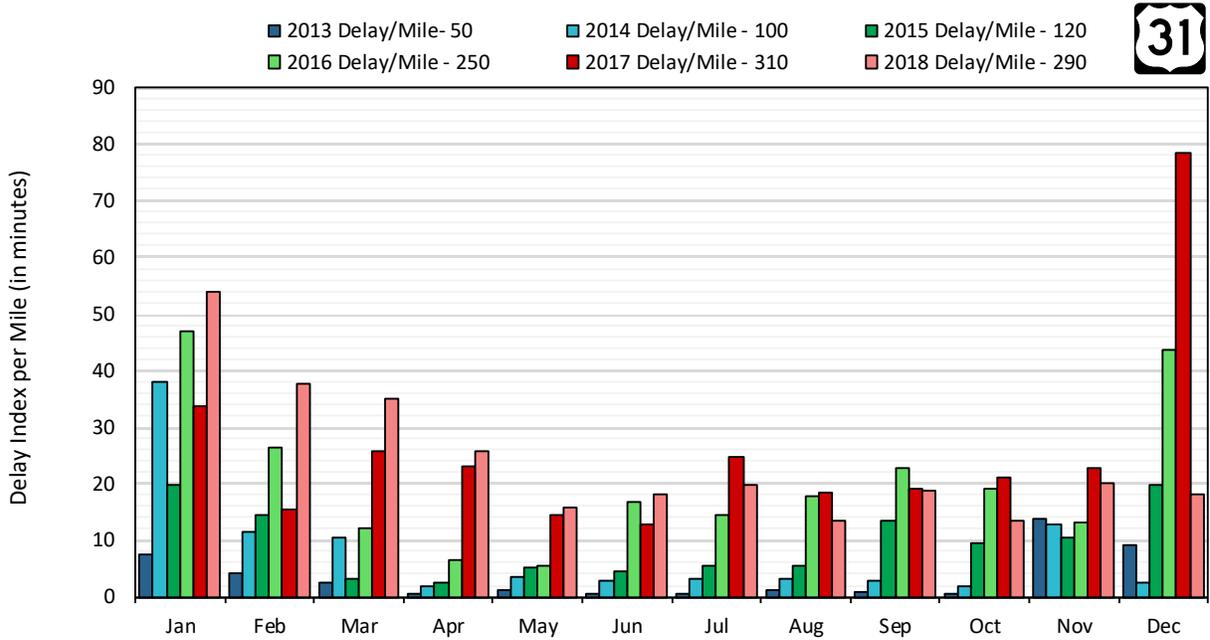
FIGURE 36. Southwest Region Southbound I-196 Level of Travel Time Reliability



US-31: BERRIEN COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 37. Berrien County US-31 Corridor Delay Index





US-31: AVERAGE SPEED

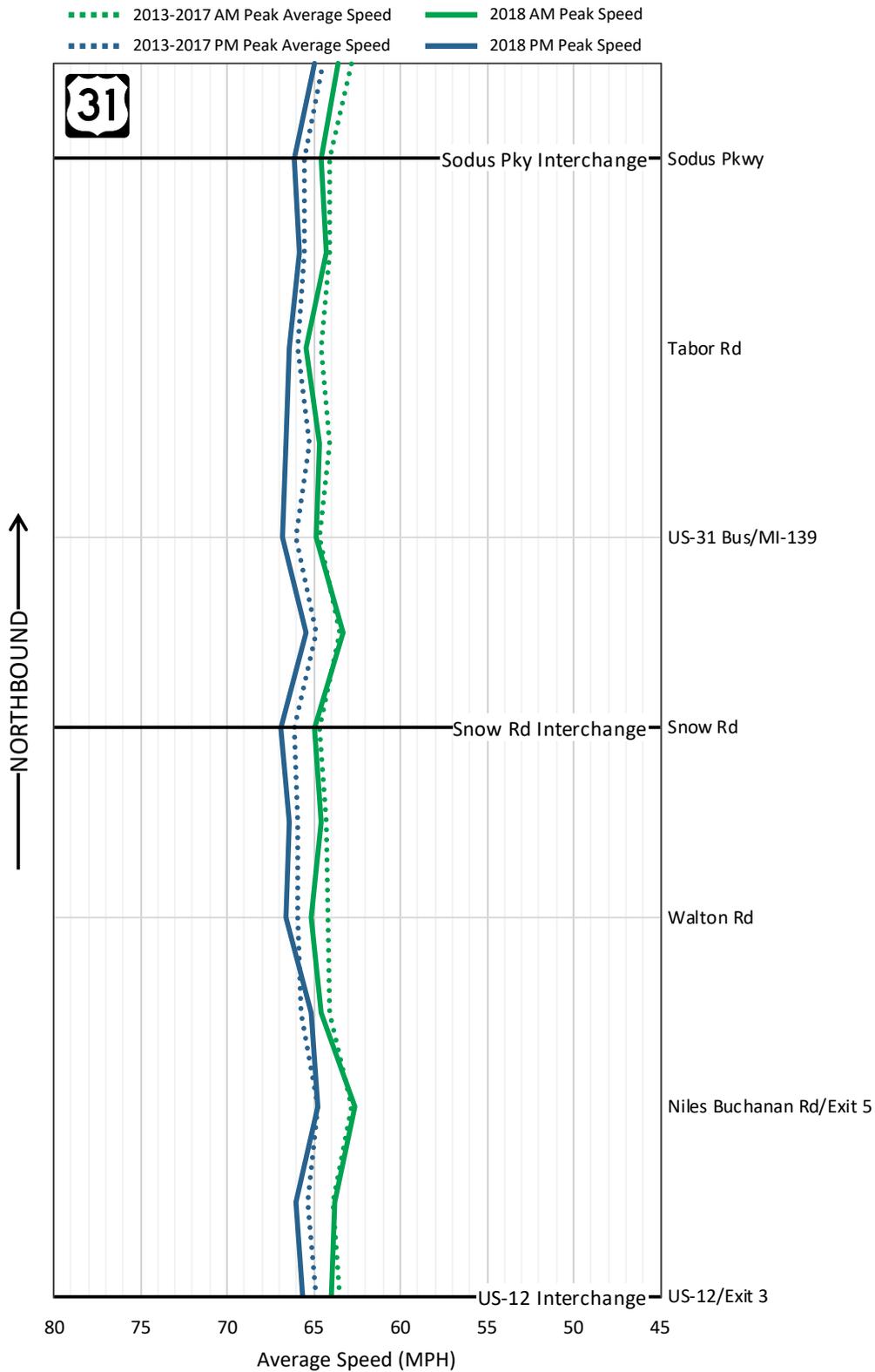


FIGURE 38. Southwest Region Northbound US-31 Average Speed





US-31: AVERAGE SPEED

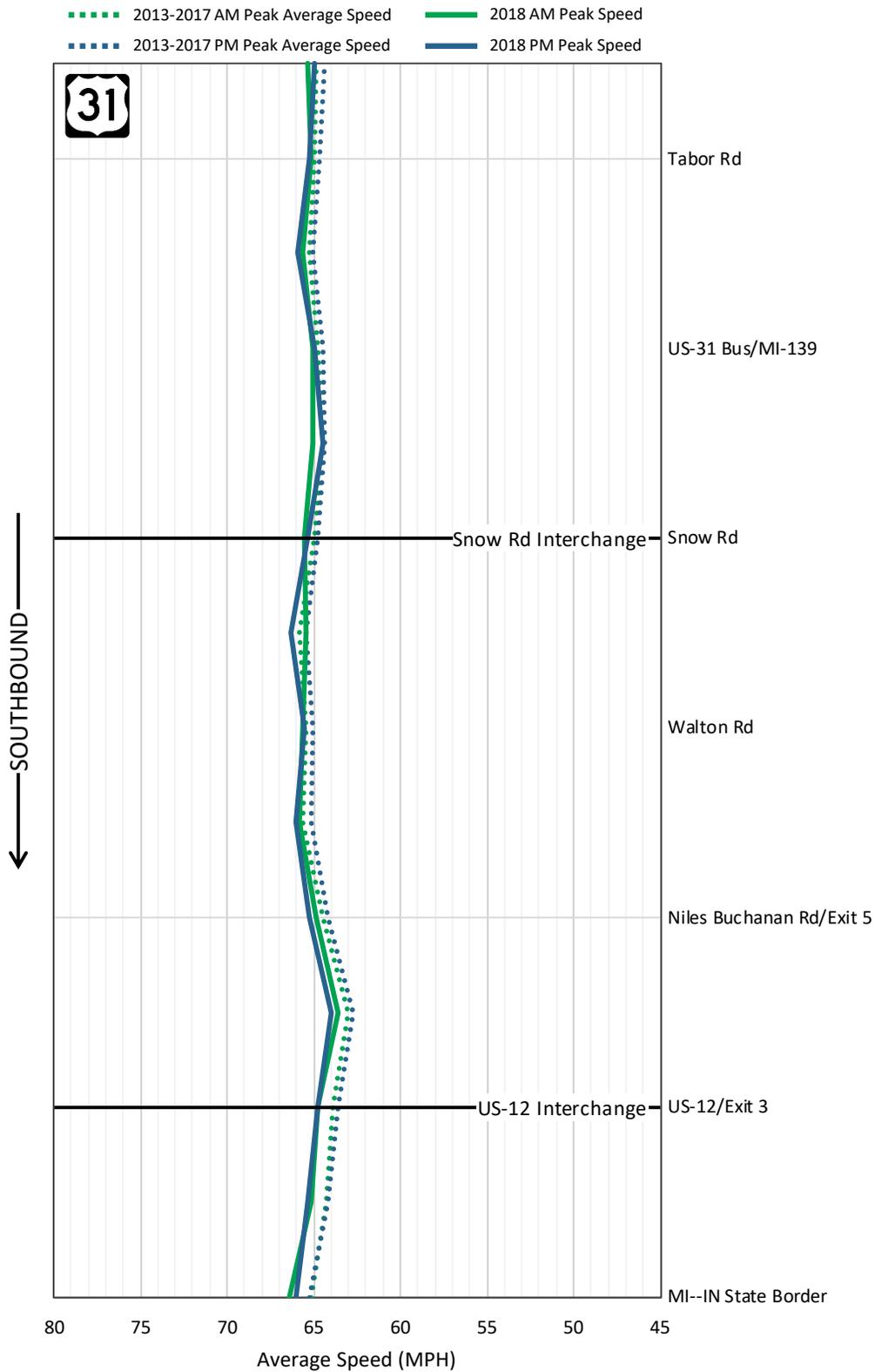


FIGURE 39. Southwest Region Southbound US-31 Average Speed





US-31: LEVEL OF TRAVEL TIME RELIABILITY

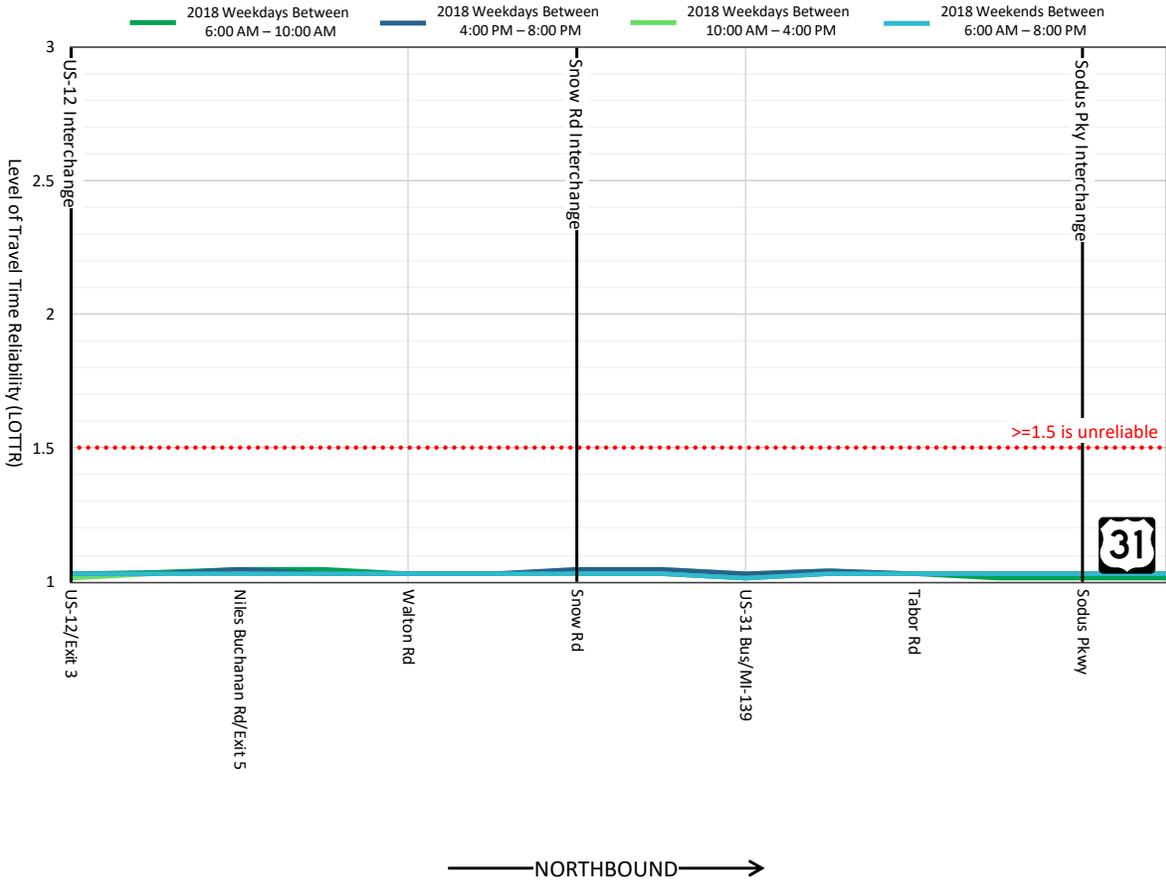


FIGURE 40. Southwest Region Northbound US-31 Level of Travel Time Reliability



US-31: LEVEL OF TRAVEL TIME RELIABILITY

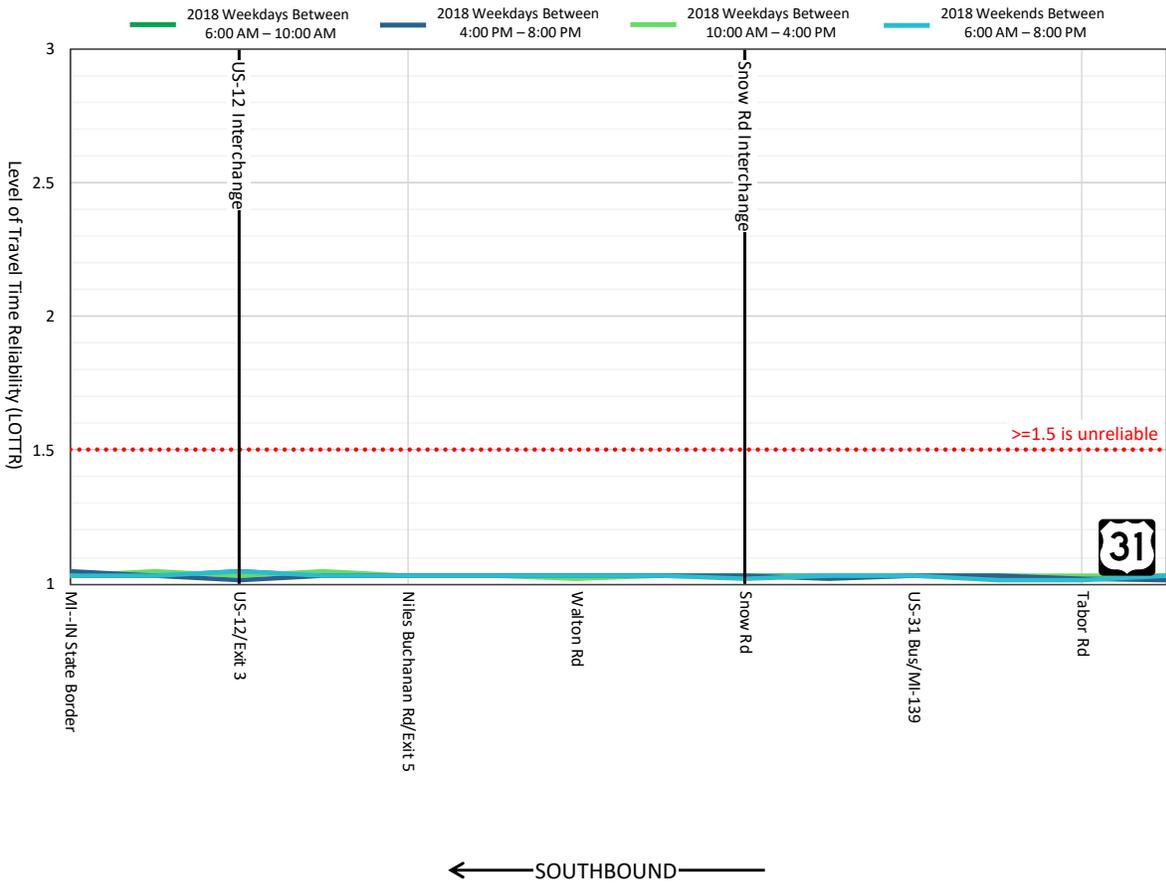


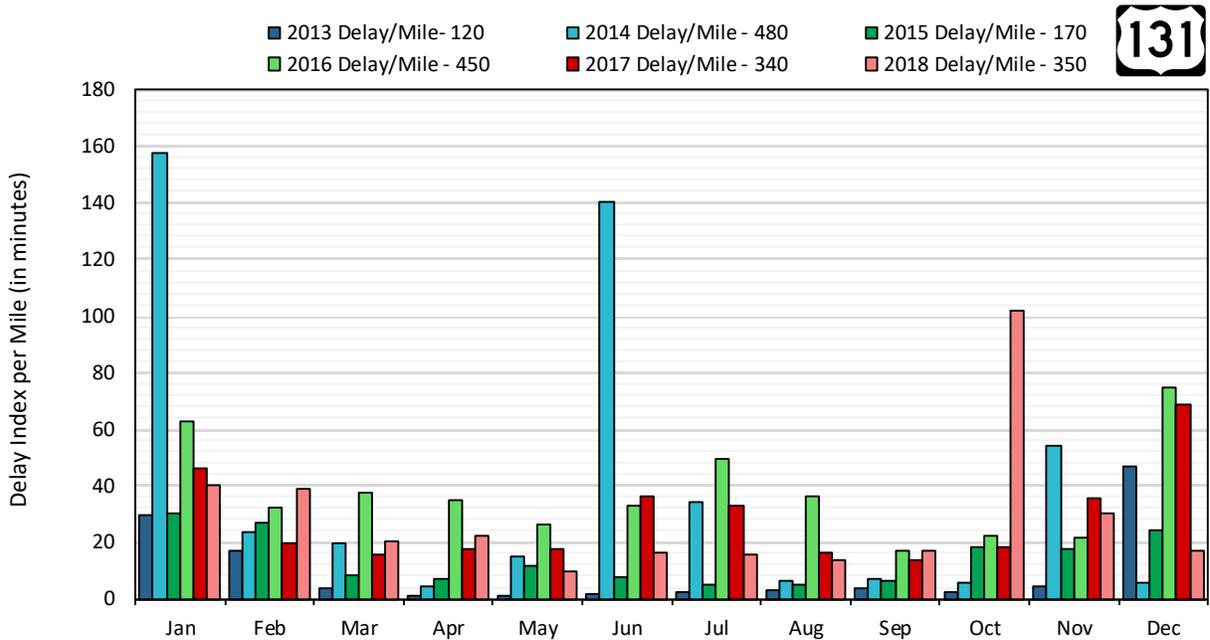
FIGURE 41. Southwest Region Southbound US-31 Level of Travel Time Reliability



US-131: KALAMAZOO COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 42. Kalamazoo County US-131 Corridor Delay Index





US-131: AVERAGE SPEED

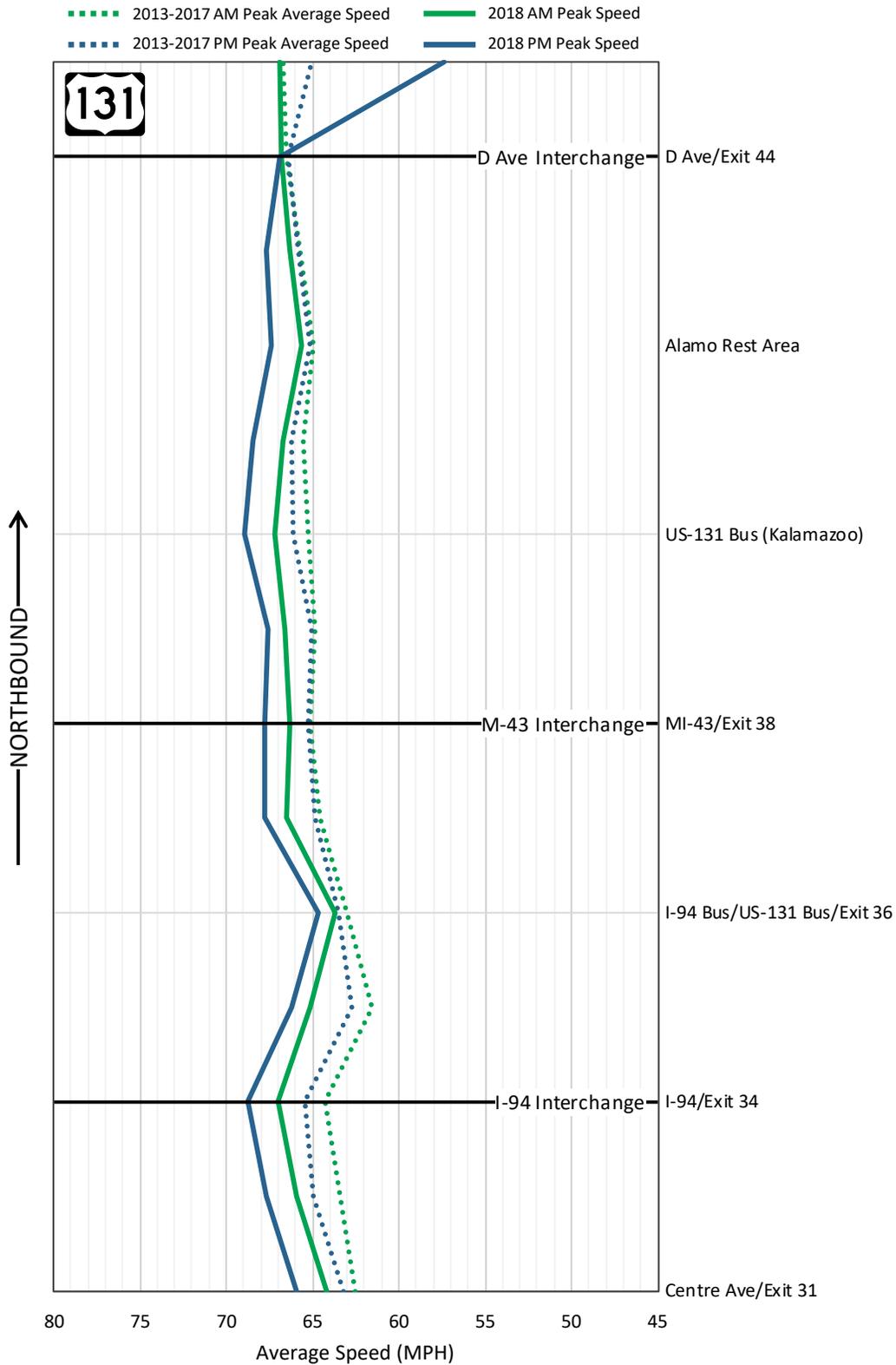


FIGURE 43. Southwest Region Northbound US-131 Average Speed





US-131: AVERAGE SPEED

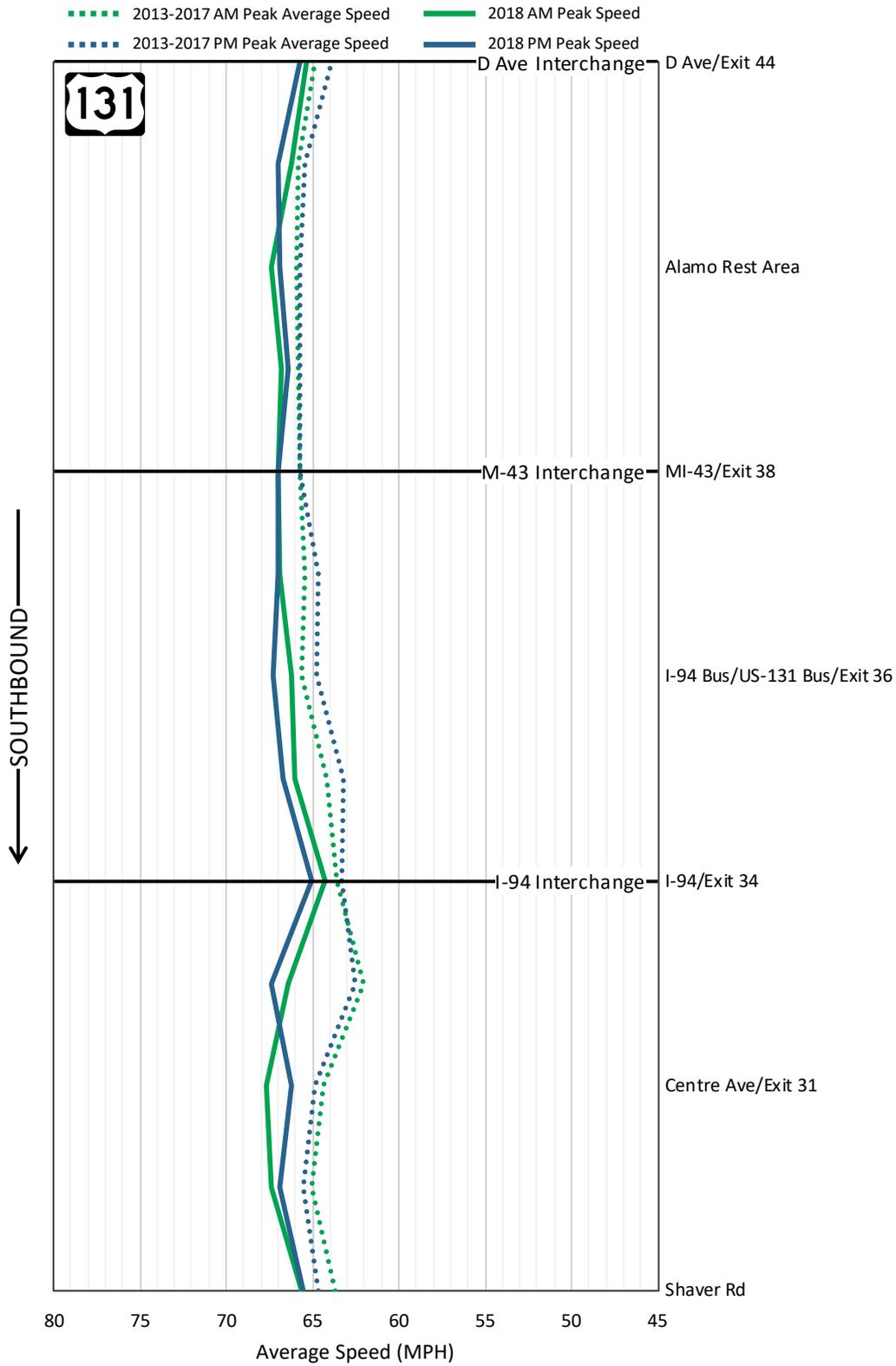


FIGURE 44. Southwest Region Southbound US-131 Average Speed





US-131: LEVEL OF TRAVEL TIME RELIABILITY

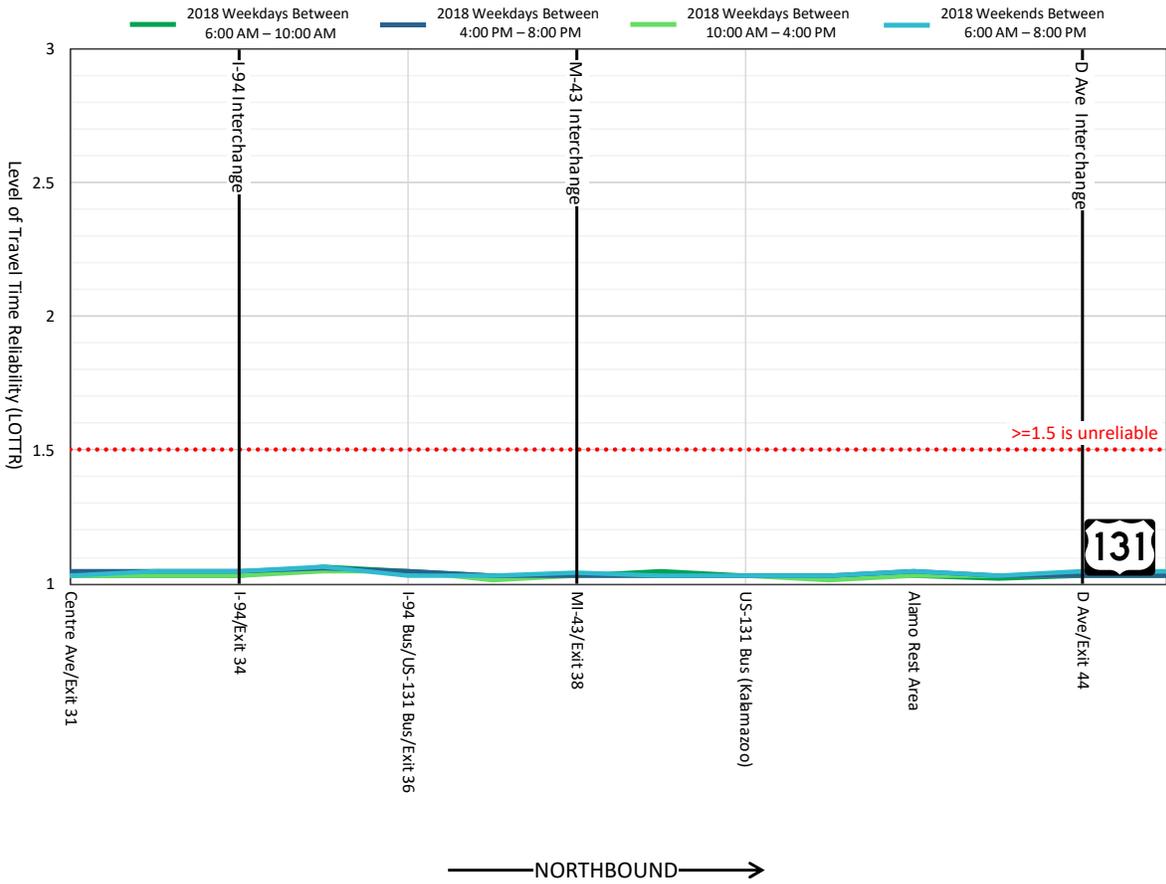


FIGURE 45. Southwest Region Northbound US-131 Level of Travel Time Reliability



US-131: LEVEL OF TRAVEL TIME RELIABILITY

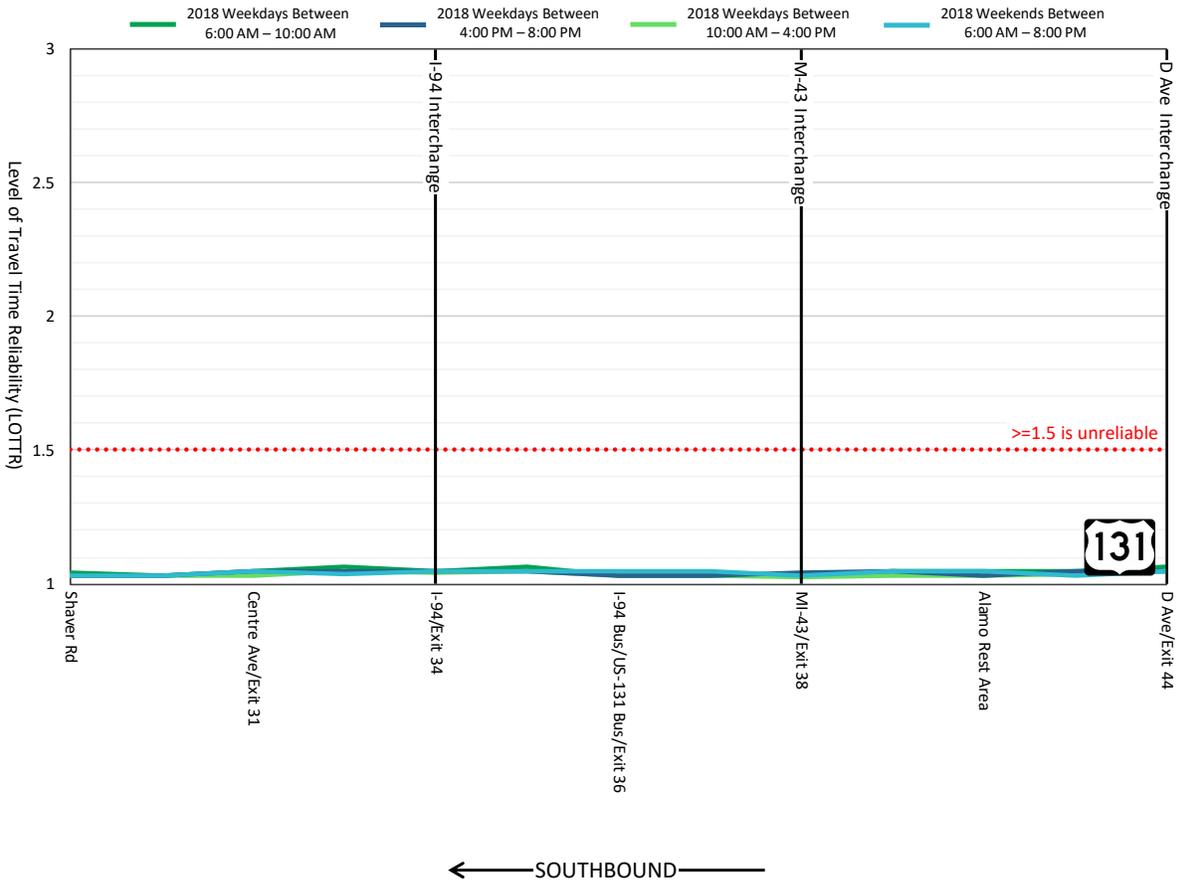


FIGURE 46. Southwest Region Southbound US-131 Level of Travel Time Reliability



CONCLUSION

This chapter summarizes the performance of the Southwest Region. It is the Congestion and Reliability 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. These metrics could be used to help prioritize projects, determine where and when problems are occurring, and how significant these problems 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 Reliability Unit welcomes any feedback on this report to help us improve it in the future and maximize its usefulness.

CONTACT INFORMATION

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

Jason Firman, Congestion and Reliability Manager

517-388-3378 | firmanj@michigan.gov

