NORTH LOMBARD STREET
MULTIMODAL SAFETY PROJECT
BEFORE-AFTER EVALUATION

Final Report

NORTH LOMBARD STREET MULTIMODAL SAFETY PROJECT BEFORE-AFTER EVALUATION

Final Report

by

Sirisha Kothuri, Ph.D.
Jason C. Anderson, Ph.D.
Elizabeth Yates
Portland State University

for

Oregon Department of Transportation
Research Section
555 13th Street NE, Suite 1
Salem OR 97301

and

Federal Highway Administration
1200 New Jersey Avenue SE
Washington, DC 20590

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16. Abstract

This report analyzes and summarizes the changes in conflicts, user volumes, speed, travel time, and vehicle throughput before and after a multimodal safety project on N Lombard St. Results show that changes in each metric were observed in the before and after conditions. The number of persons using crosswalks decreased between 2017 and 2019 and increased between 2019 and 2023. Comparing the overall crosswalk volumes between 2017 and 2023, there was a slight decrease. The majority of the crosswalk users in the before and after periods were pedestrians. Overall, 119 conflicts were observed with post- encroachment time (PETs) less than or equal to 5 sec and 39% had PETs less than or equal to 1.5 sec. There was a 25% reduction in conflicts overall in the after period compared to the before period. Average hourly speed and average hourly travel time experienced significant and oppositive effects in the after condition. Vehicle throughput was substantially reduced in the after period. Observations indicate that direction and time-of-day were primary factors when observed differences in the various metrics. Compared to similar segments, average hourly speed decreases and average hourly travel time increases were more on the segment in the project area. The report provides recommendations to consider when planning a before-after study.

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SI* (Modern Metric) Conversion Factors
Approximate Conversions to SI Units

Physical Quantity	Symbol	When You Know	Multiply By	To Find	Symbol
Length	n	inches	25.4	millimeters	mm
Length	ft	feet	0.305	meters	m
Length	yd	yards	0.914	meters	m
Length	mi	miles	1.61	kilometers	km
Area	in2	square inches	645.2	square millimeters	mm2
Area	ft2	square feet	0.093	square meters	m2
Area	yd2	square yard	0.836	square meters	m2
Area	ac	acres	0.405	hectares	ha
Area	mi2	square miles	2.59	square kilometers	km2
Volume	fl oz	fluid ounces	29.57	milliliters	mL
Volume	gal	gallons	3.785	liters **	L
Volume	ft3	cubic feet	0.028	cubic meters	m3
Volume	yd3	cubic yards	0.765	cubic meters	m3
Mass	oz	ounces	28.35	grams	g
Mass	lb	pounds	0.454	kilograms	kg
Mass	T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
Temperature (exact degrees)	oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	oC
Illumination	fc	foot-candles	10.76	lux	lx
Illumination	fl	foot-Lamberts	3.426	candela/m2	cd/m2
Force and Pressure or Stress	lbf	poundforce	4.45	newtons	N
Force and Pressure or Stress	lbf/in2	poundforce per square inch	6.89	kilopascals	kPa

*SI is the symbol for the International System of Measurement
** Volumes greater than 1000 L shall be shown in m^3

SI* (Modern Metric) Conversion Factors
Approximate Conversions from SI Units

Physical Quantity	Symbol	When You Know	Multiply By	To Find	Symbol
Length	mm	millimeters	0.039	inches	in
Length	m	meters	3.28	feet	ft
Length	m	meters	1.09	yards	yd
Length	km	kilometers	0.621	miles	mi
Area	mm2	square millimeters	0.0016	square inches	in2
Area	m2	square meters	10.764	square feet	ft2
Area	m2	square meters	1.195	square yards	yd2
Area	ha	hectares	2.47	acres	ac
Area	km2	square kilometers	0.386	square miles	mi2
Volume	mL	milliliters	0.034	fluid ounces	fl oz
Volume	L	liters	0.264	gallons	gal
Volume	m3	cubic meters	35.314	cubic feet	ft3
Volume	m3	cubic meters	1.307	cubic yards	yd3
Mass	g	grams	0.035	ounces	oz
Mass	kg	kilograms	2.202	pounds	lb
Mass	Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
Temperature (exact degrees)	oC	Celsius	1.8C+32	Fahrenheit	oF
Illumination	lx	lux	0.0929	foot-candles	fc
Illumination	cd/m2	candela/m2	0.2919	foot-Lamberts	fl
Force and Pressure or Stress	N	newtons	0.225	poundforce	lbf
Force and Pressure or Stress	kPa	kilopascals	0.145	poundforce per square inch	lbf/in2

For More Information see: https://www.fhwa.dot.gov/publications/convtabl.cfm

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DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report presents the findings of a before-after analysis performed on N Lombard Street corridor which underwent a reconfiguration to improve multimodal safety and accessibility for all users between N Fiske Ave and N Boston Ave. Included in this report are findings from the before-after evaluation focusing on changes in conflicts, speed, travel time, and vehicle throughput. The report also contains recommendations on techniques for data collection that will allow for before-after evaluations on future studies.

Overall, 5,109 crosswalk users were observed at the thirteen locations in the before and after periods. The number of crosswalk users observed during the AM (7-9 AM) and PM (4-6 PM) peak periods decreased between 2017 and 2019 (-27%) and increased between 2019 and 2023 (31%). Comparing the overall volumes between 2017 and 2023, there was a slight decrease (-5.3%). The majority of users in the before and after periods were pedestrians, followed by cyclists, scooters, wheelchair users, skateboarders, and others.

Conflicts were extracted for six intersections. Overall, 119 conflicts were observed with post-encroachment time (PETs) less than or equal to 5 sec. Of the 119 conflicts, 39% had PETs less than or equal to 1.5 sec, 37% had PETs between 1.5 and 3.5 sec, and 24.4% of the conflicts had PETs greater than 3.5 sec and less than or equal to 5 sec. There was a 25% reduction in conflicts overall in the after period compared to the before period. Minimum and average PETs decreased, and maximum PET increased in the after period as compared with the before period. Average crosswalk user delays decreased at three locations (Peninsula Crossing Trail, N Fortune Ave, and N Hurst Ave) and increased at two locations (N Emerald Ave and N Drummond Ave) in the after condition compared to the before condition.

Overall, average hourly travel time across the entire corridor remained relatively consistent from 2017 to 2019. However, moderate increases in average hourly travel time were observed from 2019 to 2023 (in the 30 seconds range). Larger increases were experienced in the eastbound direction (N Fiske Ave to N Delaware Ave), with increases taking place during the morning peak hours, the middays hours, and the evening peak hours. The westbound direction experienced moderate increases in average hourly travel time on weekdays during the morning peak hours and midday hours, while on weekends increases were primarily observed during the afternoon and early evening hours. Compared to similar and nearby segments, average hourly travel time increased more on the segment within the project area compared to segments outside of the project area. Overall, increases in average hourly speed for certain hours of the day from 2017 to 2019 were observed; these increases were most often observed during the late evening or early morning hours. From 2019 to 2023 (after project completion), decreases in average hourly speed were observed for most hours of the day, and in many cases, all hours of the day experienced decreases in average hourly speed.

Comparing vehicle through counts before and after project completion revealed that vehicle throughput decreased substantially in the after period, where the morning hours (7:00 a.m. to 9:00 a.m.) in the eastbound direction experienced the largest reductions. Also experiencing moderate decreases in vehicle throughput were the evening hours (4:00 p.m. to 6:00 p.m.) in the westbound direction.

The observed decreases in speed and conflicts in the after condition point to a potential improvement in safety. The relationship between speed and the likelihood of a vulnerable road user being seriously injured or killed is well-documented in the literature Based on this knowledge, speed trends were assessed to determine if the corridor is now safer for vulnerable road users based on vehicle operating speeds, where decreases in speed correlate to accomplishing safety goals and increasing safety of vulnerable road users. In reducing capacity, decreases in vehicle throughput are expected. Regarding safety, reducing throughput reduces exposure to vulnerable road users, which is a key input for safety performance functions and increases the expected number of crashes. By reducing exposure to vulnerable road users, potential conflicts and potential crashes may be reduced.

1.0 INTRODUCTION

N Lombard St/US 30 Bypass is a critical corridor in north Portland serving both commercial and residential interests. N Lombard St is also the 11th highest fatal and serious crash corridor in the City of Portland, with 53% of the crashes resulting in injury (Oregon Department of Transportation, 2022). The Oregon Department of Transportation (ODOT) along with the Portland Bureau of Transportation (PBOT) undertook the reconfiguration of N Lombard St to improve multimodal safety and accessibility for all users between N Fiske Ave and N Boston Ave, as shown in Figure 1.1.

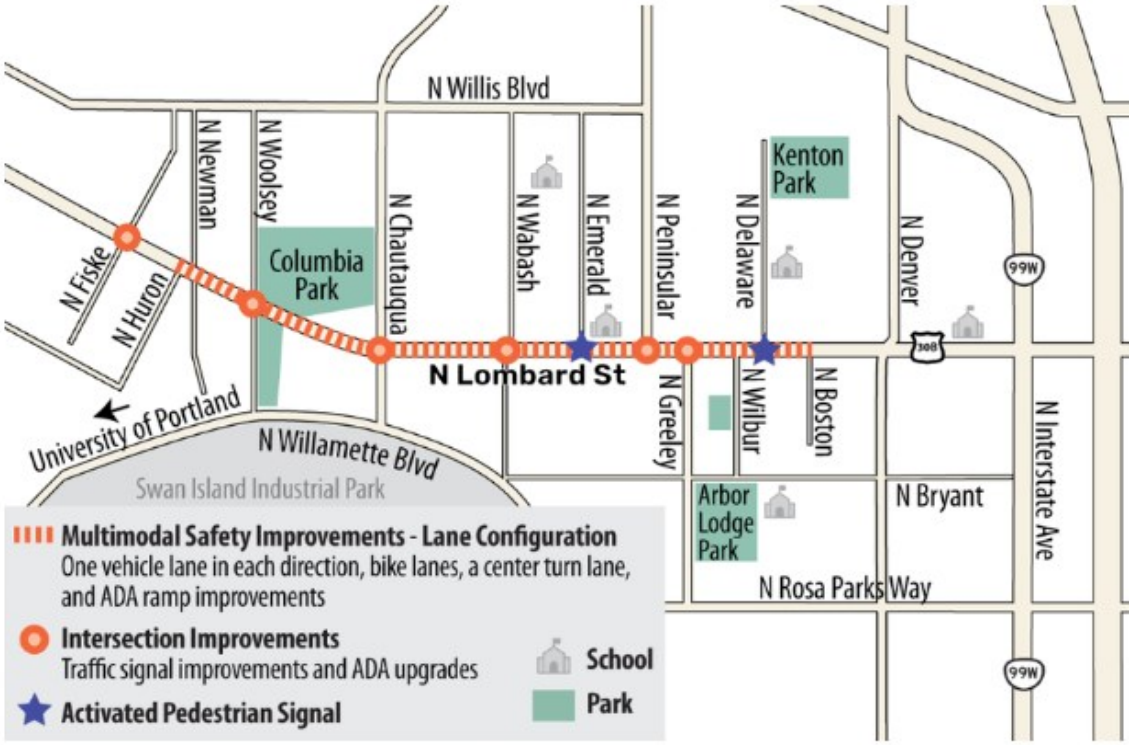


Figure 1.1: N Lombard St Project Scope (Source: ODOT)

The project added the following improvements

- 177 new curb ramps that meet ADA requirements
- 91 crosswalks
- 2.4 miles of new buffered bike lanes
- 1.3 miles of new pavement and center turn lanes
- 5 new traffic signals
- 2 rectangular rapid flashing beacons

The construction for this project was completed in 2022. Figure 1.2,Figure 1.3, and Figure 1.4 show pictures of before-after changes on N Lombard St.

Above: North Lombard Street between North Drummond Avenue and North Oatman Avenue before safety improvements.

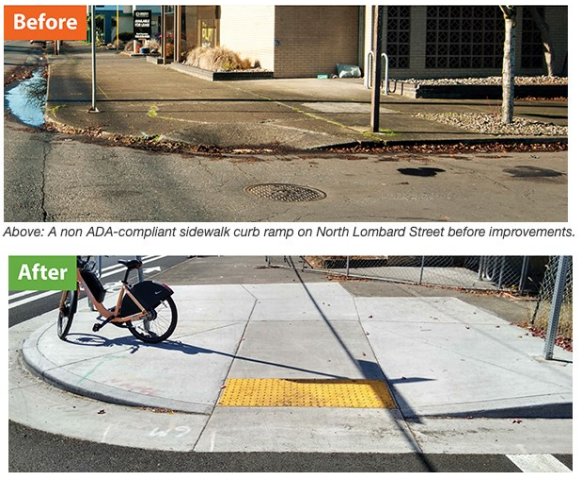
Above: North Lombard Street between North Drummond Avenue and North Oatman Avenue after safety improvements.

Figure 1.2: Before-After Improvements on N Lombard St (Source: ODOT)

Above: North Lombard street with no safe pedestrian crossings before safety improvements.

Above: A RRFB and median refuge island for safer and more visible pedestrian crossings after improvements.

Figure 1.3: Before-After Improvements on N Lombard St (Source: ODOT)



Above: A non ADA-compliant sidewalk curb ramp on North Lombard Street before improvements.

Above: Upgraded ADA accessible sidewalk curb ramps for greater safety for all users after improvements.

Figure 1.4: Before-After Improvements on N Lombard St (Source: ODOT)

The speed limit on this corridor is 35 mph. In 2023, a before-after evaluation of the safety and operational impacts was commissioned. This report details the findings from the before-after evaluation focusing on changes in conflicts, speed, travel time, and vehicle throughput. The report also contains recommendations on techniques for data collection that will allow for before-after evaluations on future studies. The remainder of this report is laid out in the following manner. Chapter 2 describes the data collection and methods, Chapter 3 outlines the analysis, Chapter 4 presents the conclusions and recommendations and Chapter 5 documents the references.

2.0 DATA COLLECTION AND METHODS

This chapter describes the before-after data collection and the methods used for analysis.

2.1 VIDEO DATA

The research team obtained before video data from ODOT and PBOT. Video data was available for 13 intersections along the Lombard corridor. Four of these intersections (Peninsula Crossing Trail, N Fortune Ave, N Denver Ave, and N Fenwick Ave) were outside of the study area (N Fiske Ave to N Boston Ave) on the Lombard corridor. However, the research team decided to include the four intersections in the analysis after consultations with the TAC, as there was interest in understanding the impacts upstream and downstream of the study area. Prior to determining the potential metrics that could be extracted from the before-after video data, the research team also made note of the operational changes at each location in the after period compared to the before period. At three locations, changes were observed in the after period compared to the before period. At N Emerald Ave, a RRFB was installed in the after period, whereas in the before period it was uncontrolled. At N Drummond Ave, a change was made to convert the location from signalized to uncontrolled. At N Delaware Ave, the location was converted from signalized to RRFB. **Error! Reference source not found.** shows a description of the locations and the changes observed.

Table 2.1: Location Description

Location	Description	Change
Peninsula Crossing Trail	In the before period this location is unsignalized, with marked crosswalk, median refuge island and static pedestrian crossing signs.	No change
N Fortune Ave	This location has a marked crosswalk, with a median refuge island in the before and after period.	No change
N Woolsey Ave	This location is a signalized intersection in the before and after period.	No change
N Hurst Ave	This location does not have a marked crosswalk and is unsignalized in the before and after periods.	No change
N Chautauqua Blvd	This location is a signalized intersection in the before and after periods.	No change
N Wabash Ave	This location is a signalized intersection in the before and after periods.	No change
N Emerald Ave	This location is uncontrolled and does not have a marked crosswalk in the before period. In the after period, a RRFB was installed.	Uncontrolled → RRFB
N Drummond Ave	This location is a signalized intersection in the before period. In the after period, it is an uncontrolled location.	Signalized → Uncontrolled
N Peninsular Ave	This location is a signalized intersection in the before and after period.	No change
N Greeley Ave	This location is a signalized intersection in the before and after periods.	No change
N Delaware Ave	This location is a signalized intersection in the before period. In the after period, the signals were removed and a RRFB was installed.	Signalized → RRFB
N Denver Ave	This location is a signalized intersection in the before and after periods.	No change
N Fenwick Ave	his location is a signalized intersection in the before and after period.	No change

Before video data was collected for 48 hours in 2019 at a few locations on N Lombard St. For a few of these locations, ODOT was able to also locate video collected in 2017. Additionally, the video collected in 2019 was reduced by Quality Counts and pedestrian and bicycle crossing volumes and vehicular volumes were extracted for peak periods, i.e., 7-9 AM, 4-6 PM. Both sets of videos and the extracted counts were made available to the research team. **Error! Reference source not found.** shows the before video availability, the metrics that were available, and the additional metrics that were extracted.

Table 2.2: Before Video Data Availability

Location	Available Video Data	Available Metrics	Additional Metrics Collected
Peninsula Crossing Trail	2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped delay
N Fortune Ave	2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped delay
N Woolsey Ave	2017	-	Ped and bike crossing volumes for 2017, PETs for pedestrian-vehicle conflicts
N Hurst Ave	2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped delay
N Chautauqua Blvd	2017, 2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019 only, vehicle volumes	Ped and bike crossing volumes for 2017, PETs for pedestrian-vehicle conflicts
N Wabash Ave	2017	-	Ped and bike crossing volumes for 2017, PETs for pedestrian-vehicle conflicts
N Emerald Ave	2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped delay
N Drummond Ave	2017	-	Ped and bike crossing volumes for 2017, ped delay
N Peninsular Ave	2017, 2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped and bike crossing volumes for 2017
N Greeley Ave	2017, 2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	PETs for pedestrian-vehicle conflicts in 2019
N Delaware Ave	2017, 2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	PETs for pedestrian-vehicle conflicts in 2017, Ped delay
N Denver Ave	2017, 2019	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2019, vehicle volumes	Ped and bike crossing volumes for 2017, PETs for pedestrian-vehicle conflicts in 2017 and 2019
N Fenwick Ave	2017	-	Ped and bike crossing volumes for 2017

- Indicates that available metrics were not available

At these thirteen locations, the after-video data was collected for 24 hours on June 7, 2023. **Error! Reference source not found.** shows the metrics that were extracted.

Table 2.3: After Video Data Availability

Location	Available Video Data	Metrics Collected
Peninsula Crossing Trail	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Fortune Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Woolsey Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, PETs for pedestrian -vehicle conflicts, Vehicle volumes
N Hurst Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Chautauqua Blvd	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, PETs for pedestrian -vehicle conflicts, Vehicle volumes
N Wabash Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, PETs for pedestrian -vehicle conflicts, Vehicle volumes
N Emerald Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Drummond Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Peninsular Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Vehicle volumes
N Greeley Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, PETs for pedestrian -vehicle conflicts, vehicle volumes
N Delaware Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, Ped delay, Vehicle volumes
N Denver Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023, PETs for pedestrian -vehicle conflicts
N Fenwick Ave	2023	Ped and bike crossing volumes 7-9 am; 4-6 pm for 2023

2.2 SPEED AND TRAVEL TIME DATA

To assess differences in speed and travel time before and after project completion, speed and travel time data were collected using the Regional Integrated Transportation Information System (RITIS). RITIS is an automated data sharing, dissemination, and archiving tool that includes various transportation-related metrics, dashboards, and downloadable data (Oregon Department of Transportation, n.d.-b; RITIS, n.d.). ODOT began an agreement to access RITIS data in May 2020. RITIS incorporates INRIX probe speed data from 2016 to present for all public roads in Oregon and Clark County, Washington (Oregon Department of Transportation, n.d.-b). ODOT has successfully used RITIS data for system operations and monitoring related to congestion (Oregon Department of Transportation, 2020, 2023) and COVID-19 traffic volume patterns (Oregon Department of Transportation, n.d.-a). RITIS also provides regular training sessions and

meetings to ensure RITIS users are up-to-date on current RITIS practices.[1] ODOT further provides documentation for frequently asked questions regarding RITIS.[2]

Despite limited studies found on the accuracy of RITIS data, work-zone related studies indicate RITIS speed and travel time as reliable sources (Federal Highway Administration, 2019; Mudge et al., 2013). These studies found that the higher the granularity, the more accurate the probe data. These studies also found that there can be scenarios in which alternate data may be preferred but emphasize that the use of such data is still young and provides a significant data opportunity moving forward. To this end, RITIS provides metrics with each data download. The first metric is the C-value, which indicates the probability that the current probe reading represents actual roadway conditions based on recent and historical trends (0 represents low probability and 100 represents high probability). This value, however, is only used when the RITIS confidence score is 30. The second metric is the confidence score. The confidence score has three levels:

- 30 – Real Time Data: any segment that has adequate data, at any time of day, will report real time data.
- 20 – Historical Average: Between 4 a.m. and 10 p.m., any segment without sufficient real time data will show the historical average for that segment during that daytime period (provided in 15-minute granularity).
- 10 – Reference Speed: From 10 p.m. to 4 a.m., any segment without sufficient real time data will show the reference speed for that segment. Any segment that does not have calculated historical averages will show the reference speed 24 hours a day if there is not sufficient real time data.

RITIS data was used for this study to have the same data format during the same time for the before-after periods. Project-related data provided to the research team consisted of short-term speed measurements in December 2018, while travel time measurements provided were collected from May 11, 2017 to May 27, 2017 (the second Thursday in May to the final Saturday in May). For consistency and comparison purposes, speed and travel time data corresponding to the approximately two-week period in May were considered. Additionally, the years of data collected were chosen based on years in which data was collected previously and years in which video data was available. Therefore, speed and travel time data for the following periods were extracted from RITIS and considered for analysis (each period corresponds to the second Thursday in May to the final Saturday in May):

- May 11, 2017 to May 27, 2017
- May 9, 2019 to May 25, 2019
- May 11, 2023 to May 27, 2023

[1] For additional information on RITIS use and ODOT, the reader is referred to ODOT's Regional Integrated Transportation Information System webpage (https://www.oregon.gov/odot/data/pages/ritis.aspx) and ODOT's RITIS Best Practices Handbook (https://www.oregon.gov/odot/Planning/Documents/RITIS_Handbook.pdf).
[2] RITIS Frequently Asked Questions (https://www.oregon.gov/odot/Planning/Documents/RITIS-FAQs.pdf).

Speed and travel time were disaggregated by segment within the project area, where the segments shown in **Error! Reference source not found.** were considered for analysis. The segments related to the project area are shown in Figure 2.1.

Table 2.4: Speed and Travel Time Analysis Segments

Segment	Length (mi)
N Fiske Ave ↔ N Woolsey Ave	0.262
N Woolsey Ave ↔ N Chautauqua Blvd	0.291
N Chautauqua Blvd ↔ N Wabash Ave	0.249
N Wabash Ave ↔ N Drummond Ave	0.184
N Drummond Ave ↔ N Peninsular Ave	0.081
N Peninsular Ave ↔ N Greeley Ave	0.084
N Greeley Ave ↔ N Delaware Ave	0.148

Options to download speed and travel time data from RITIS consist of some level of aggregation. Therefore, to minimize additional aggregations made during analysis, all speed measurements extracted from RITIS were average hourly speeds on the identified segments and all travel time measurements extracted from RITIS were average hourly travel times. Due to the nature of the speed data, speed metrics related to spot speed measurements were unable to be determined (e.g., 85th percentile speed, percentage of vehicles exceeding the speed limit, percentage of vehicles exceeding 5 mi/h, 10 mi/h, or 15 mi/h above the posted speed limit).

Figure 2.1: Segments Considered for Speed and Travel Time Analysis

2.3 METHODS

2.3.1 Volume Extraction

Pedestrian, bicyclist, and vehicular volumes were extracted from the recorded video in the after condition for peak hours (i.e., 7-9 am, 4-6 pm), which correspond to the hours for which data was extracted in the before condition. An Excel spreadsheet template was developed to record the observed volumes. Vehicular volumes were recorded for each movement (left, through, right) and then aggregated. For pedestrian and bicyclist volumes, data elements recorded included the crosswalk they were using, crossing direction, user type, number of users crossing, arrival time, and crossing start and end times.

2.3.2 Conflict Data Reduction

Although crashes are the most direct measure of safety, typically 3-5 years of crash data are evaluated for temporal stability. Since this evaluation is being conducted one year after construction, crash data were not available for analysis. Therefore, this study used conflicts for safety analysis. Conflicts between users in the crosswalk and turning vehicles at each location were manually extracted from the before and after videos, provided that the camera angles were favorable. The conflicts were measured using post encroachment time (PET), and conflicts with PETs of 5 sec or less were included in the analysis based on prior research (Russo et al., 2020, 2023). PET is defined as the time between the moment when the first road user leaves the conflict area and second road user enters the second area (Johnsson et al., 2018). PET is a measure of how close the two road users are to occupying the same space at the same time, and PETs closer to 0 indicate a more severe conflict. Figure 2.2 shows the concept of how PET is calculated.

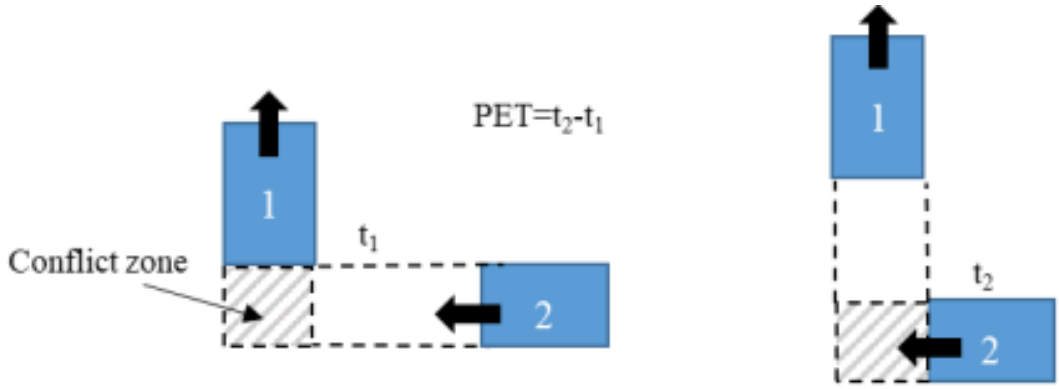


Figure 2.2: Concept of PET (Russo et al., 2020)

To aid in the conflict data collection, an annotated figure showing the conflict area was developed (Figure 2.3). The red box in the figure denotes the conflict area for northbound vehicles on N Greeley Ave turning right to go east onto N Lombard Ave. The numbers 1 and 2

represent the time that a right-turning vehicle enters and leaves the conflict area, while 3 and 4 represent the time the pedestrian enters and leaves the conflict area. To calculate PETs, the first user to arrive at the crosswalk, and conflict box arrival and departure time for both users were recorded. Based on these observations, PETs were calculated.

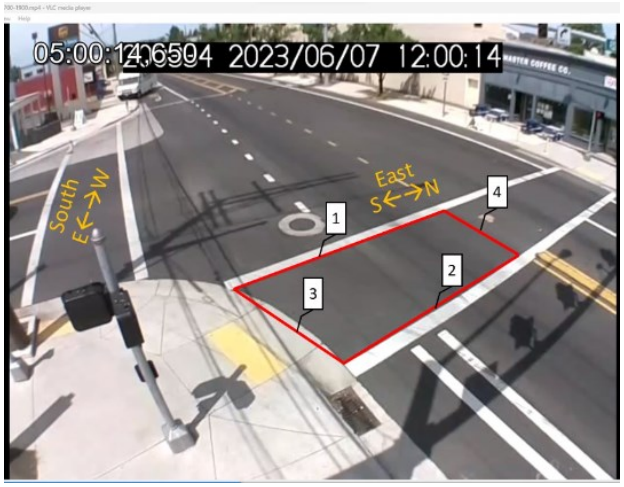


Figure 2.3: Annotated Figure for Conflict Data Reduction at N Greeley Ave and N Lombard St.

Due to the camera angles in the before period, PETs could not be collected at all locations and for all turning movements. PETs were only collected for particular movements at the following intersections: N Woolsey Ave, N Chautauqua Blvd, N Wabash Ave, N Greeley Ave, N Delaware Ave, and N Denver Ave. Appendix A shows the annotated figures for the movements at each location where PET was extracted for both before and after periods.

2.3.3 Travel Time and Speed

To assess speed and travel time, a descriptive analysis was conducted. The descriptive analysis consisted of tabular and visual statistics of average hourly speed and average hourly travel time. The segments were first analyzed holistically by considering the overall average across the time period considered.

The analysis was further conducted by segment, direction of travel (eastbound and westbound), day of the week (weekday and weekend), and time-of-day. In addition to the descriptive analysis, a series of t-tests were conducted to determine hours of the day that experienced significant increases or decreases in speed or travel time.

3.0 ANALYSIS

3.1 CROSSWALK VOLUMES

Before-after volumes of crosswalk users at each location were compared using the counts extracted from recorded videos. The observed counts in the before and after periods were collected during the morning (7-9 am) and evening (4-6 pm) peak periods. **Error! Reference source not found.** shows the before-after crosswalk user volumes. Overall, 5,109 crosswalk users were observed at the thirteen locations in the before and after periods. It is important to note that not all intersections were counted in both 2017 and 2019. The number of crosswalk users observed decreased between 2017 and 2019 (1,913 vs. 1,384, -27%) and increased between 2019 and 2023 (1,384 vs. 1,812, 31%). Comparing the overall volumes between 2017 and 2023, there was a slight decrease (1,913 vs. 1,812, 5.3%). Between 2017 and 2019, the highest reductions in crosswalk volumes were observed at N Chautauqua Blvd and N Delaware Ave. During this time period, the only location that showed an increase was N Fenwick Ave. Between 2019 and 2023, while the overall volumes increased, the trends were mixed at the individual locations. The highest percent decrease (-63.2%) in volumes was observed at the Peninsula Crossing Trail. This was because the trail appeared to be closed during the after period when the video was recorded, which potentially led to the decrease in volumes. In both before and after periods, this location is unsignalized, and has a marked crosswalk with a median refuge island and static pedestrian crossing signs. The largest percent increase (580%) in volumes was observed at N Emerald Ave. This can be attributed to the installation of a rectangular rapid flashing beacon (RRFB) in the after period and the addition of a new restaurant near the crosswalk. In the before period, this location was uncontrolled and did not have a marked crosswalk, as noted in **Error! Reference source not found.**. The addition of a RRFB at Delaware avenue also resulted in a significant increase in crosswalk volumes (80%) between 2019 and 2023, indicating that the addition of RRFBs have contributed to increased volumes in the peak periods. The crosswalk user volumes are shown in **Error! Reference source not found.**. Comparing volumes between 2017 and 2023 indicates that most locations had a decrease in volumes in 2023 compared to 2017. The one location which showed increases in volume between 2017 and 2023 was N Denver Ave. Figure 3.1 shows a plot of the crosswalk user volumes for the before-after periods. Figure 3.2 shows crosswalk user volumes in the before-after periods by time-of-day.

Table 3.1: Crosswalk User Volumes

Location	Before 2017/2018 AM	Before 2017/2018 PM	Before 2019 AM	Before 2019 PM	After 2023 AM	After 2023 PM	Before 2017/2018 Total	Before 2019 Total	After 2023 Total	2019-2017 Differences	2023-2019 Difference	2023-2017 Difference
Peninsula Crossing Trail	-	-	47	59	21	18	-	106	39	-	-67 (-63.2%)	-
N Fortune Ave	-	-	12	50	18	30	-	62	48	-	-14 (-22.6%)	-
N Woolsey Ave	77	175	-	-	118	140	252	-	258	-	-	6 (2.4%)
N Hurst Ave	-	-	11	32	31	30	-	43	61	-	18 (41.9%)	-
N Chautauqua Blvd	59	78	27	29	65	77	137	56	142	-81 (-59.1%)	86 (153.6%)	5 (3.7%)
N Wabash Ave	73	134	-	-	104	138	207	-	242	-	-	35 (16.9%)
N Emerald Ave	-	-	1	4	4	30	-	5	34	-	29 (580.0%)	-
N Drummond Ave	18	87	-	-	21	42	105	-	63	-	-	-42 (-40.0%)
N Peninsular Ave	62	226	39	142	42	131	288	181	173	-107 (-37.2%)	-8 (-4.4%)	-115 (-39.9%)
N Greeley Ave	-	-	36	104	61	85	-	140	146		6 (4.3%)	-
N Delaware Ave	126	139	74	58	112	125	265	132	237	-133 (-50.2%)	105 (79.6%)	-28 (-10.6%)
N Denver Ave	129	283	122	228	94	199	412	350	293	-62 (-35.1%)	-57 (-16.3%)	-119 (28.9%)

N Fenwick Ave	131	116	164	145	27	49	247	309	76	62 (25.1%)	-233 (-75.4%)	-171 (-69.2%)
Total	675	1238	533	851	718	1094	1913	1384	1812	-529 (-27.7%)	428 (30.9%)	-101 (-5.3%)

- Indicates that data was not available

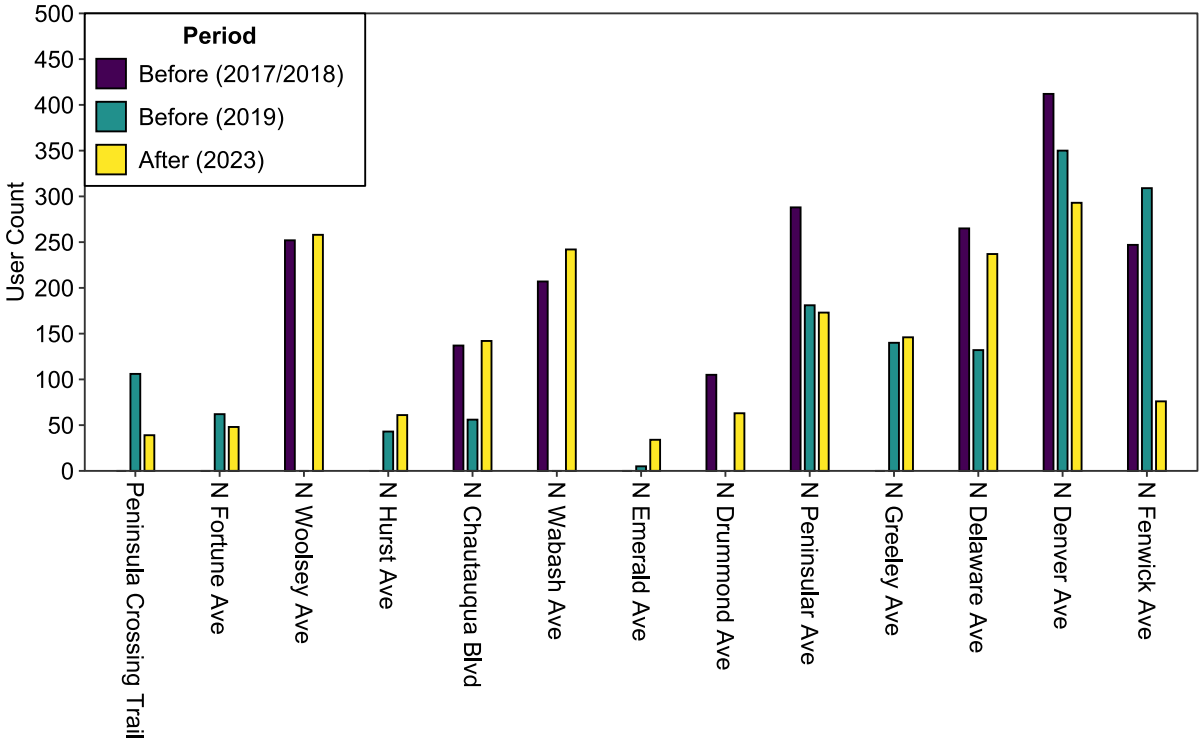


Figure 3.1: Total Crosswalk User Volumes

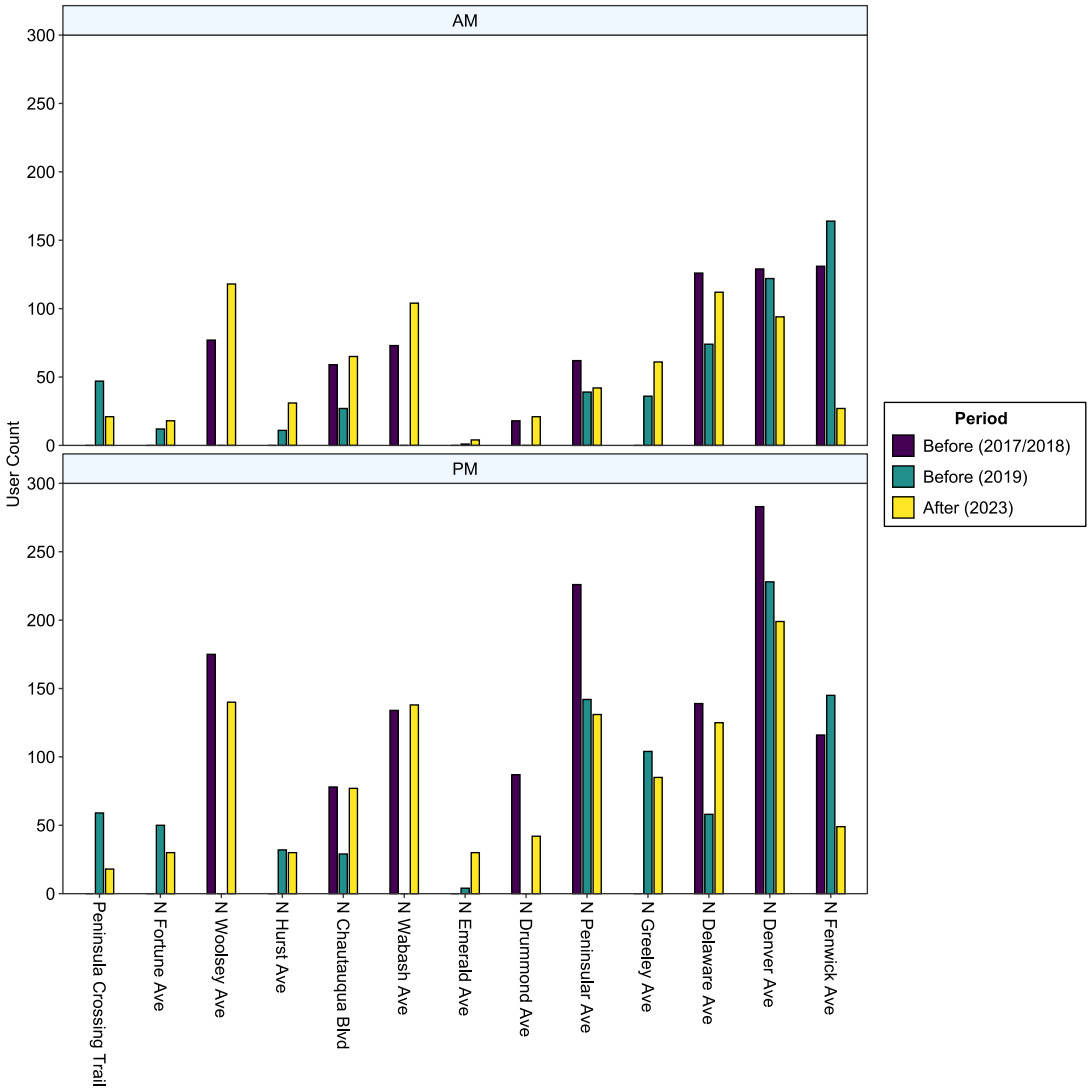


Figure 3.2: Crosswalk User Volumes Before and After Project Completion by Time-of-Day

Error! Reference source not found. shows the crosswalk user types and their volumes. The majority of the users in the before and after periods were pedestrians (68.4% - 71.5%), followed by cyclists (27.5% -29.6%), scooters (0.3% - 2.2%), wheelchair users (0.1%-0.3%), skateboarders (0.4% - 1.1%), and others (0.11% - 0.26%). Mirroring the overall trend, the volumes of pedestrians and cyclists decreased between 2017 and 2019 (-24% pedestrians, -33% cyclists) and increased between 2019 and 2023 (25% pedestrians, 36% cyclists). The trends seen here are similar to the trends seen with Portland bike counts, where bike counts in the North district (where N Lombard is located) decreased between 2016 to 2019 but are on an increasing trend since 2022 (PBOT, 2023). The volumes of scooters increased in 2023 compared to 2019 and 2017 (8.8%, 4.6%). This could be due to increase in supply and availability. The volumes of skateboarders decreased in 2019 and 2023 compared to 2017 (-0.8%, -0.6%). It should be noted that these volumes are peak period volumes and therefore it is possible that volumes could have shifted to other time periods.

Table 3.2: Crosswalk User Types and Volumes

Location	2017 Ped	2019 Ped	2023 Ped	2017 Cyc	2019 Cyc	2023 Cyc	2017 Sco	2019 Sco	2023 Sc0	2017 Wch	2019 Wch	2023 Wch	2017 Skb	2019 Skb	2023 Skb	2017 Oth	2019 Oth	2023 Oth
Peninsula Crossing Trail	-	57	26	-	48	12	-	1	0	-	0	1	-	0	0	-	0	0
N Fortune Ave	-	54	44	-	8	2	-	0	0	-	0	0	-	0	2	-	0	0
N Woolsey Ave	130	-	182	114	-	67	2	-	8	1	-	0	4	-	0	1	-	1
N Hurst Ave	-	24	41	-	17	17	-	1	3	-	0	0	-	1	0	-	0	0
N Chautauqua Blvd	95	28	93	40	28	44	1	0	5	0	0	0	1	0	0	0	0	0
N Wabash Ave	124	-	122	81	-	116	0	-	4	0	-	0	1	-	0	1	-	0
N Emerald Ave	-	5	32	-	0	1	-	0	0	-	0	0	-	0	0	-	0	1
N Drummond Ave	93	-	40	10	-	19	0	-	3	2	-	0	0	-	1	0	-	0
N Peninsular Ave	247	164	149	35	17	22	3	0	2	2	0	0	0	0	0	1	0	0
N Greeley Ave	-	114	124	--	24	18	-	1	3	-	1	1	-	0	0	-	0	0
N Delaware Ave	149	69	151	109	63	80	1	0	4	0	0	0	4	0	2	2	0	0
N Denver Ave	261	187	185	143	154	97	0	1	7	0	2	0	8	4	4	0	2	0
N Fenwick Ave	209	287	51	35	22	25	0	0	0	0	0	0	3	0	0	0	0	0
Total	1,308	989	1,240	567	381	520	7	4	39	5	3	2	21	5	9	5	2	2

Ped = Pedestrian
Cyc = Cyclists
Sco = Scooters
Wch = Wheelchairs

Oth = Other
- Indicates that data was not available

3.2 CONFLICT ANALYSIS

Table 3.3 shows the summary of the observed conflicts in the before and after periods. Overall, 119 conflicts were observed with PETs less than or equal to 5 sec. Of the 119 conflicts, 39% had PETs less than or equal to 1.5 sec, 37% had PETs between 1.5 and 3.5 sec, and 24.4% of the conflicts had PETs greater than 3.5 sec and less than or equal to 5 sec.

Table 3.4 shows the frequency of the observed conflicts in the before-after periods. There was a 25% reduction in conflicts overall in the after period compared to the before period. Decreases in the frequency of conflicts were also observed in the PET $\leq$ 1.5 sec and 1.5 < PET $\leq$ 3.5 sec categories, while a small increase was observed in the 3.5 < PET $\leq$ 5 sec in the after period as compared to the before period. It is unclear if the decrease is due to the lower volumes observed in the after period or other factors. Among the locations, the intersection of N Greeley Ave had the highest number of recorded conflicts (57%). At N Greeley Ave, 22% of the observed conflicts had PETs less than or equal to 1.5 sec. Video observation shows that the buses are causing queueing in both directions on N Lombard St, and vehicles were observed going around the stopped bus, especially in the eastbound direction. Vehicles on westbound N Lombard St, turning left onto N Greeley Ave southbound, were observed to not make the turn easily due to heavy oncoming traffic flow on N Lombard St eastbound. The general queueing observed may have led to the increase in the frequency of conflicts. Table 3.5shows the descriptive statistics for PETs. Overall, the mean PET in the before and after periods was 2.31 sec and 2.44 sec. Minimum PETs were 0.95 sec and 1.16 sec in the before and after periods and maximum PETs were 3.99 sec and 3.80 sec respectively. Minimum and average PETs decreased, and maximum PETs increased in the after period as compared with the before period.

Table 3.3: Summary of Observed Conflicts

Location	PET $\leq$ 1.5 sec	1.5 < PET $\leq$ 3.5 sec	3.5 < PET $\leq$ 5 sec	Total No. of Conflicts (PET $\leq$ 5 sec)
N Woolsey Ave	4	1	1	6
N Chautauqua Blvd	1	3	2	6
N Wabash Ave	1	0	0	1
N Greeley Ave	26	24	18	68
N Delaware Ave	3	2	0	5
N Denver Ave	11	14	8	33
Total	46 (38.6%)	44 (37.0%)	29 (24.4%)	119

Table 3.4: Frequency of Observed Conflict

Location	PET ≤ 1.5 sec Before	PET ≤ 1.5 sec After	1.5 < PET ≤ 3.5 sec Before	1.5 < PET ≤ 3.5 sec After	3.5 < PET ≤ 5 sec Before	3.5 < PET ≤ 5 sec After	Total No. of Conflicts (PET ≤ 5 sec) Before	Total No. of Conflicts (PET ≤ 5 sec) After
N Woolsey Ave	2	2	1	0	0	1	3	3
N Chautauqua Blvd	1	0	1	2	1	1	3	3
N Wabash Ave	0	1	0	0	0	0	0	1
N Greeley Ave	14	12	12	12	8	10	34	34
N Delaware Ave	3	NA	2	NA	0	NA	5	NA
N Denver Ave	9	2	11	3	5	3	25	8
Total	15	17	27	17	14	15	65*	49

*Total does not include conflicts at Delaware.

Table 3.5: Descriptive Statistics

Location	Min PET Before	Min PET After	Mean PET Before	Mean PET After	Max PET Before	Max PET After
N Woolsey Ave	1.42	1.20	2.13	2.65	2.84	4.10
N Chautauqua Blvd	1.40	2.38	2.64	3.22	4.83	4.48
N Wabash Ave	NA	0.71	NA	0.71	NA	0.71
N Greeley Ave	0.80	0.60	2.76	2.76	4.86	4.96
N Delaware Ave	0.57	NA	1.79	NA	2.48	NA
N Denver Ave	0.57	0.90	2.22	2.87	4.93	4.77
Average	0.95	1.16	2.31	2.44	3.99	3.80

3.3 CROSSWALK USER DELAY

At uncontrolled locations, crosswalk user delay was calculated. Table 3.6 shows the weighted average delay for the uncontrolled locations. Average delays reduced at all locations except one (N Emerald Ave) in the after condition compared to the before condition. In the before condition, N Emerald Ave had no marked crosswalk. Video observations showed that pedestrians looked for gaps in the traffic and crossed. In the after condition, a RRFB was installed. Video observations showed that people pushed the button to activate in the after condition, which led to the increased delay.

Table 3.6: Crosswalk User Delay Statistics

Location	Average Delay (in seconds) Before	Average Delay (in seconds) After
Peninsula Crossing	4.88	2.79
N Fortune Ave	4.71	4.04
N Hurst Ave	0.28	0.20
N Emerald Ave	1.00	4.53
N Drummond Ave	1.85	0.42
N Delaware Ave	5.19	2.42

3.4 SPEED AND TRAVEL TIME ANALYSIS

3.4.1 Travel Time Analysis

The travel time analysis was conducted holistically (by direction of travel and day of the week), by segment, by direction of travel (eastbound and westbound), day of the week, and time-of-day. The following sections will present the holistic analysis, followed by the segment-based analysis.

3.4.1.1 Corridor-Level Analysis

A corridor-level analysis was first conducted, as shown in Table 3.7**Error! Reference source not found.** and Table 3.8. Results show that the largest decreases (2017 to 2019) and increases (2019 to 2023) in average hourly travel time occurred within the project area (N Fiske Ave ↔ N Delaware Ave) in the eastbound direction, which was true for both weekday and weekend trends. Specifically, from 2017 to 2019 in the eastbound direction, the project area experienced a decrease in average hourly weekday travel time of 10.1 seconds and a decrease in average hourly weekend travel time of 10.0 seconds. Extending the corridor to N Denver Ave and N Interstate Ave results in a reduction of approximately 5 seconds on weekdays and 4 seconds (N Interstate Ave) to approximately 6 seconds (N Denver Ave) on weekends. Extending the corridor to N Denver Ave and N Interstate Ave, decreases in average hourly travel time in the eastbound direction were notably less (approximately one-half of the project area corridor); this is true for both weekday and weekend average hourly travel times. From 2019 to 2023, increases in average hourly travel time were observed for both weekday and weekend time periods on each corridor. Still, the largest increases were observed within the project area (N Fiske Ave ↔ N Delaware Ave) with about a 30 second increase.

In the westbound direction, decreases were observed from 2017 to 2019, where the smallest decrease in average hourly travel time on weekdays happened on the corridor within the project area (N Fiske Ave ↔ N Delaware Ave). When extending the corridor beyond the project area, average hourly travel time continued to decrease as the corridor length increased on weekdays. On weekends, decreases were consistent with the exception of the N Fiske Ave ↔ N Interstate Ave, which remained essentially the same with a decrease of 0.4 seconds. Increases in average hourly travel time in the westbound direction remained consistent on both weekdays and weekends.

Table 3.7: Eastbound Change in Average Hourly Travel Time (sec) Over Entire Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-10.1	31.2	-10.0	28.1
N Fiske Ave ↔ N Denver Ave	-5.2	28.5	-5.7	25.9
N Fiske Ave ↔ N Interstate Ave	-5.2	23.6	-4.1	24.1

Table 3.8: Westbound Change in Average Hourly Travel Time (sec) Over Entire Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-4.1	17.0	-2.1	13.9
N Fiske Ave ↔ N Denver Ave	-5.7	19.1	-2.0	13.4
N Fiske Ave ↔ N Interstate Ave	-7.6	19.2	-0.4	14.1

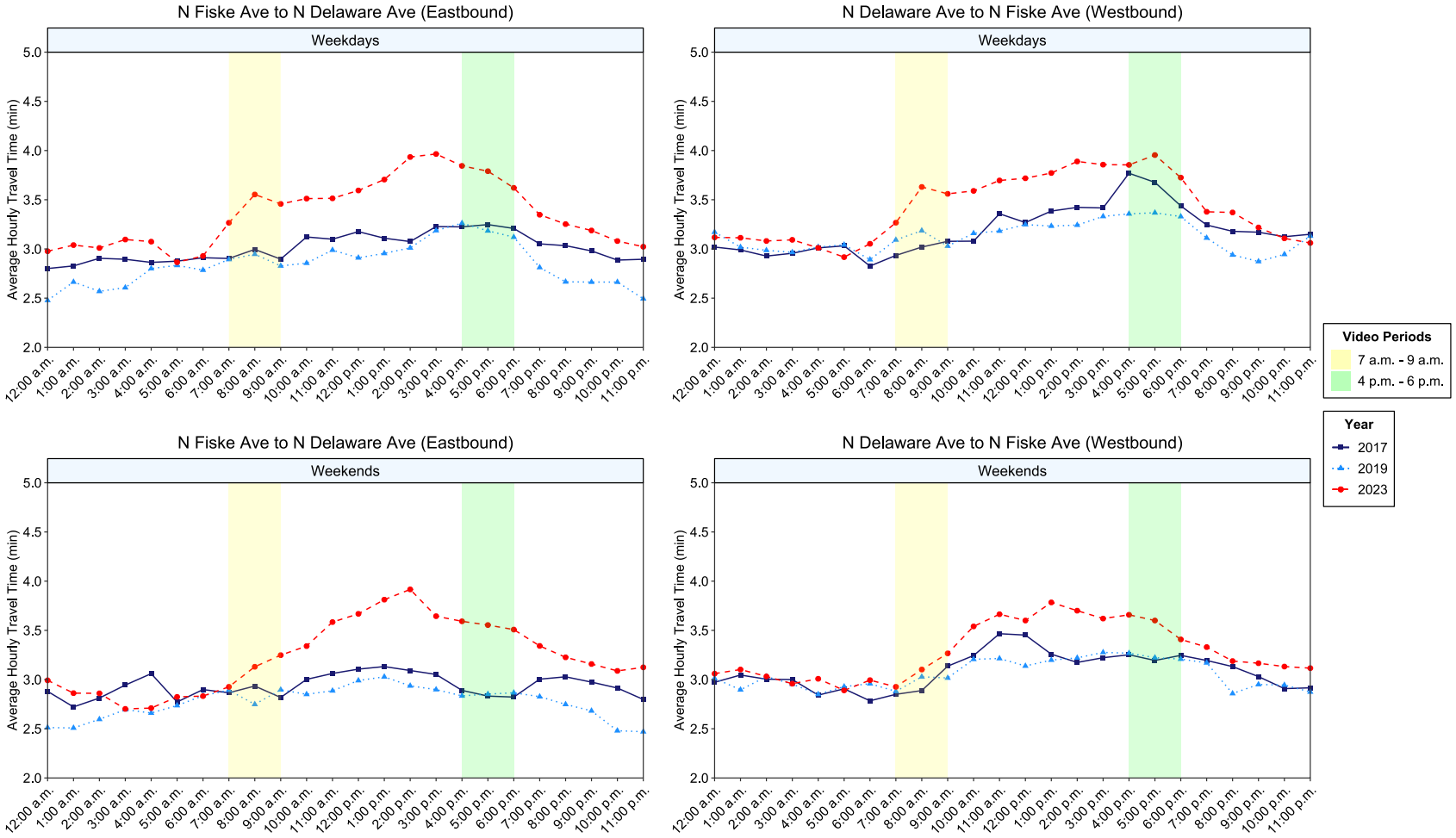


Figure 3.3: Average Hourly Travel Time from N Fiske Ave ↔ N Delaware Ave

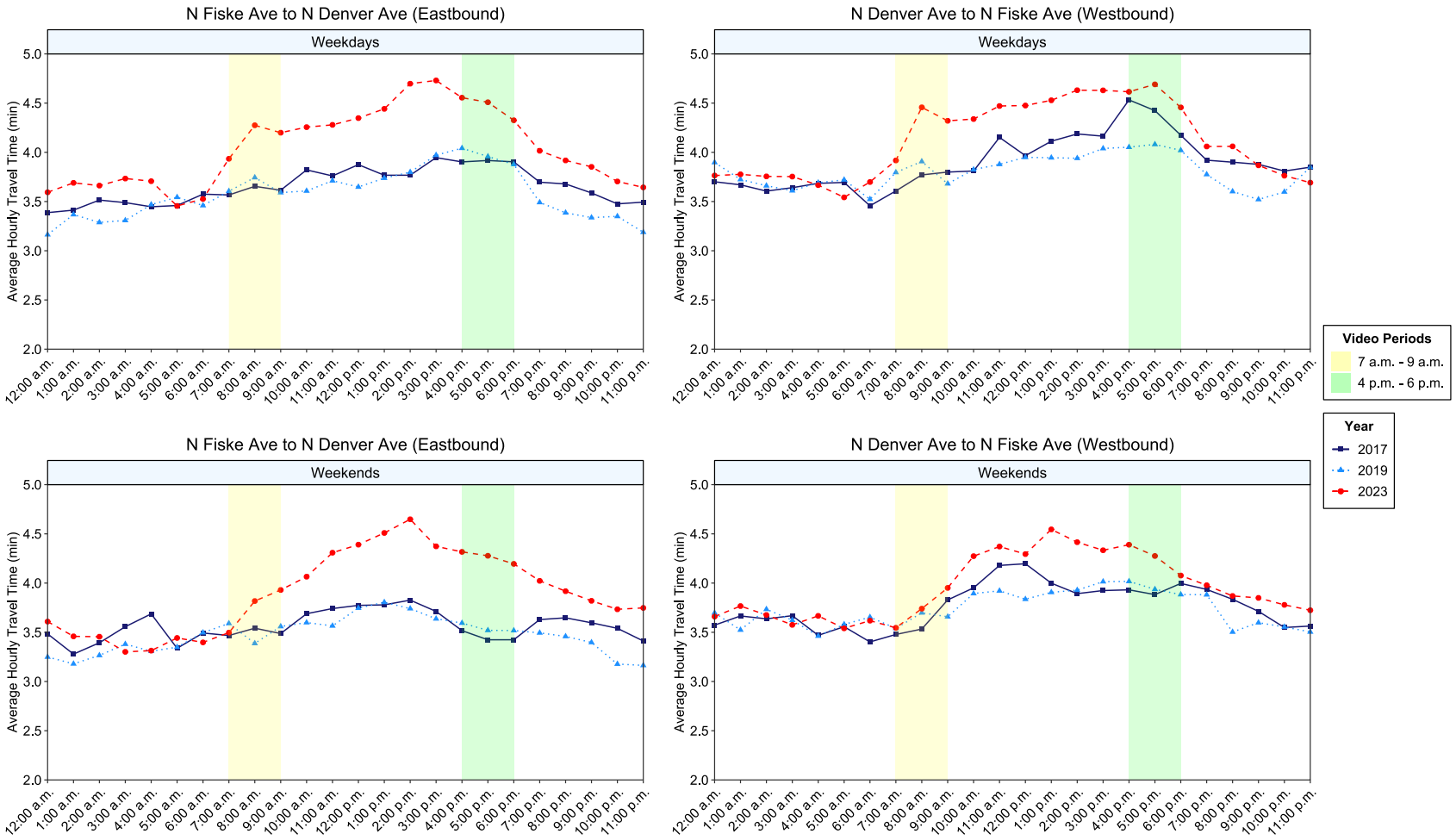


Figure 3.4: Average Hourly Travel Time from N Fiske Ave ↔ N Denver Ave

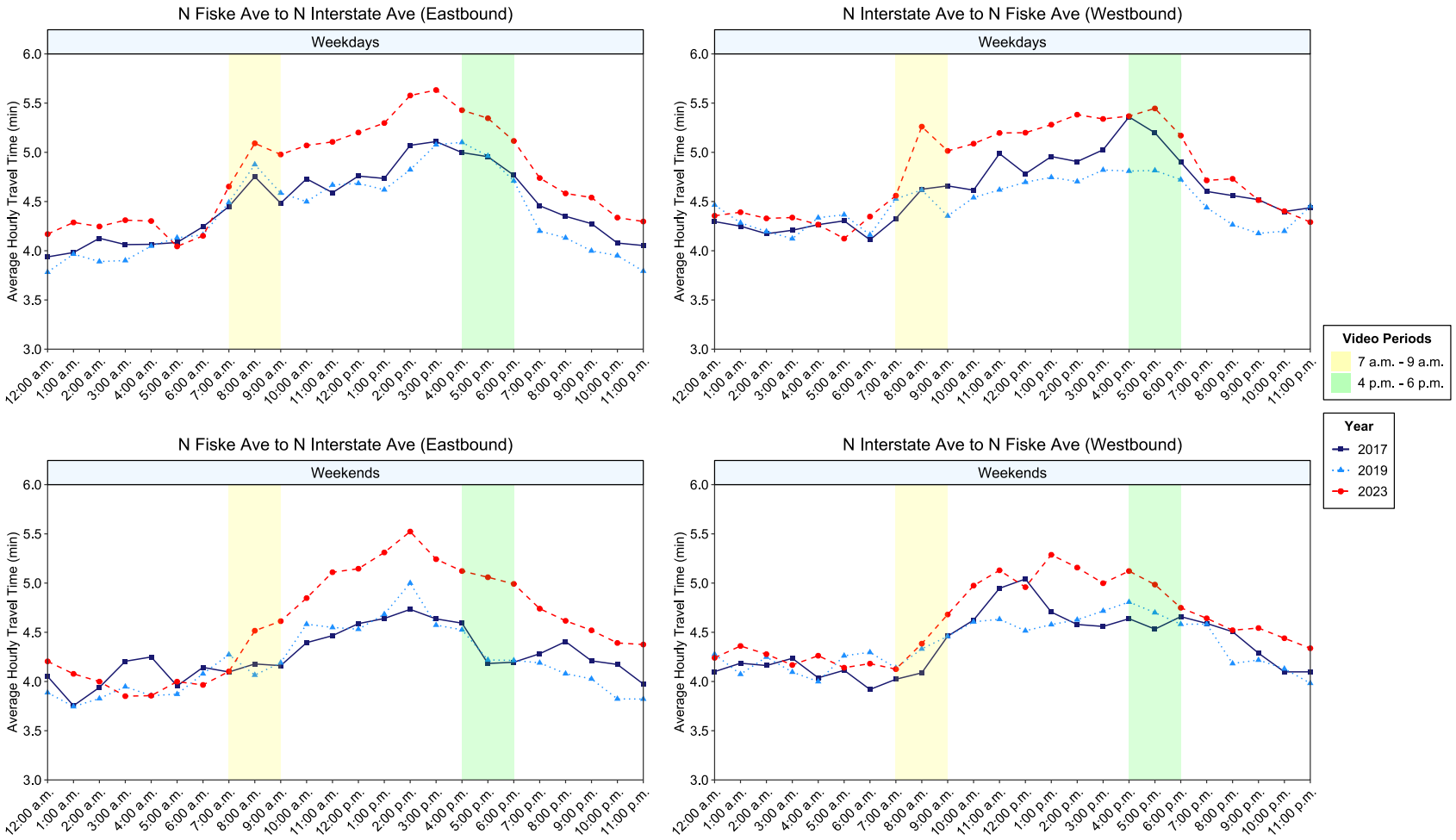


Figure 3.5: Average Hourly Travel Time from N Fiske Ave ↔ N Interstate Ave

3.4.1.2 Segment-Level Analysis

To better understand travel time behavior on each segment, travel times were considered by day of the week (weekday and weekend) and hour of the day. In addition to a descriptive analysis, significant changes in mean travel times were assessed through both an independent t-test and a paired t-test. Table 3.9 provides an example of the analysis results for the N Drummond Ave ↔ N Peninsular Ave segment considering direction, day of the week (weekend and weekday), and time-of-day. Results for each segment can be found in Appendix B.

3.4.1.3 N Fiske Ave ↔ N Woolsey Ave

Figure 3.6 shows the average hourly travel time trends for the N Fiske Ave ↔ N Woolsey Ave segment.

In the eastbound direction on weekdays, the early morning and late evening hours experienced significant decreases in average hourly travel time from 2017 to 2019. In addition, the 7:00 a.m. hour had a significant increase in average hourly travel time. From 2019 to 2023, the 12:00 a.m. hour through the 3:00 a.m. hour had significant increases in average hourly travel time, the 4:00 a.m. hour and the 5:00 a.m. hour had significant decreases in average hourly travel time, the 7:00 a.m. hour through the 3:00 p.m. hour had significant increases in average hourly travel time, and the 5:00 p.m. hour through the 11:00 p.m. hour had significant increases in average hourly travel time. The 6:00 a.m. hour and 4:00 p.m. hour were the only two hours that did have significant differences.

In the westbound direction on weekdays, trends were similar. From 2017 to 2019, the early morning and evening hours experienced significant decreases in average hourly travel time. Also experiencing significant decreases in average hourly travel time was the 2:00 p.m. hour through the 5:00 p.m. hour. From 2019 to 2023, all significant differences were increases in average hourly travel time, with the exception of the 5:00 a.m., which experienced a significant decrease in average hourly travel time.

On weekends, in the eastbound direction, significant differences were all decreases from 2017 to 2019. Experiencing significant decreases in average hourly travel time were the 12:00 a.m. hour and 1:00 a.m. hour, the 3:00 a.m. hour, and the 10:00 p.m. hour and the 11:00 p.m. hour. From 2019 to 2023, all significant differences represented increases in average hourly travel time, including early morning hours, midday hours, the 2:00 p.m. hour through the 6:00 p.m. hour, and late evening hours.

On weekends, in the westbound direction, hours with significant differences were similar to those in the eastbound direction. From 2017 to 2019, all significant differences were decreases in average hourly travel time, where the hours with significant differences varied throughout the day. From 2019 to 2023, all significant differences were increases in average hourly travel time, which consisted of the early morning hours, the 10:00 a.m. hour through the 6:00 p.m. hour, and the 11:00 p.m. hour.

Table 3.9: Average Hourly Weekday Travel Time (min) from N Drummond Ave to N Peninsular Ave to (Eastbound)

Time-of-Day	2017 Mean	Change Icon	2019 Change from 2017	2019 Mean	Change Icon	2023 Change from 2019	2023 Mean	2017 - 2019[a] *p*-value	2017 - 2019[a] *p*-value[c]	2019 - 2023[a] *p*-value[b]	2019 - 2023[a] *p*-value[c]	2017 - 2023[a] *p*-value[b]	2017 - 2023[a] *p*-value[c]
12:00 a.m.	0.174	↓	-0.021	0.153	↑	0.048	0.201	0.000	0.000	0.000	0.000	0.000	0.000
1:00 a.m.	0.176	↓	-0.011	0.165	↑	0.035	0.200	0.027	0.041	0.000	0.000	0.000	0.000
2:00 a.m.	0.183	↓	-0.024	0.159	↑	0.040	0.199	0.000	0.000	0.000	0.000	0.004	0.004
3:00 a.m.	0.177	↓	-0.016	0.161	↑	0.042	0.203	0.007	0.001	0.000	0.000	0.000	0.001
4:00 a.m.	0.179	↓	-0.010	0.169	↑	0.033	0.202	0.004	0.001	0.000	0.000	0.000	0.001
5:00 a.m.	0.177	↓	-0.008	0.168	↑	0.023	0.191	0.007	0.011	0.000	0.000	0.002	0.001
6:00 a.m.	0.197	↓	-0.023	0.173	↑	0.033	0.207	0.216	0.223	0.000	0.000	0.598	0.533
7:00 a.m.	0.189	↑	0.018	0.207	↑	0.023	0.230	0.033	0.023	0.019	0.026	0.000	0.000
8:00 a.m.	0.201	↑	0.000	0.201	↑	0.073	0.273	1.000	1.000	0.000	0.000	0.000	0.000
9:00 a.m.	0.186	↑	0.006	0.192	↑	0.066	0.258	0.328	0.253	0.000	0.000	0.000	0.000
10:00 a.m.	0.202	↓	-0.007	0.195	↑	0.082	0.277	0.462	0.500	0.000	0.000	0.000	0.000
11:00 a.m.	0.226	↑	0.003	0.229	↑	0.048	0.278	0.890	0.902	0.039	0.048	0.006	0.030
12:00 p.m.	0.263	↓	-0.063	0.200	↑	0.093	0.293	0.066	0.075	0.000	0.000	0.356	0.373

Time-of-Day	2017 Mean	Change Icon	2019 Change from 2017	2019 Mean	Change Icon	2023 Change from 2019	2023 Mean	2017 - 2019[a] *p*-value	2017 - 2019[a] *p*-value[c]	2019 - 2023[a] *p*-value[b]	2019 - 2023[a] *p*-value[c]	2017 - 2023[a] *p*-value[b]	2017 - 2023[a] *p*-value[c]
1:00 p.m.	0.255	↓	-0.047	0.208	↑	0.110	0.318	0.184	0.126	0.000	0.000	0.075	0.084
2:00 p.m.	0.213	↓	-0.007	0.206	↑	0.144	0.350	0.605	0.588	0.000	0.000	0.000	0.000
3:00 p.m.	0.216	↓	-0.003	0.213	↑	0.135	0.348	0.811	0.820	0.000	0.000	0.000	0.000
4:00 p.m.	0.229	↓	-0.003	0.226	↑	0.108	0.334	0.854	0.813	0.000	0.000	0.000	0.001
5:00 p.m.	0.218	↓	-0.002	0.217	↑	0.126	0.343	0.918	0.918	0.000	0.000	0.000	0.000
6:00 p.m.	0.210	↑	0.002	0.212	↑	0.088	0.300	0.886	0.886	0.000	0.000	0.000	0.000
7:00 p.m.	0.203	↓	-0.008	0.194	↑	0.068	0.263	0.534	0.418	0.000	0.001	0.000	0.000
8:00 p.m.	0.189	↓	-0.022	0.168	↑	0.074	0.242	0.000	0.000	0.000	0.000	0.000	0.000
9:00 p.m.	0.185	↓	-0.016	0.169	↑	0.067	0.236	0.002	0.002	0.000	0.000	0.000	0.000
10:00 p.m.	0.179	↓	-0.010	0.169	↑	0.065	0.234	0.025	0.032	0.000	0.000	0.000	0.000
11:00 p.m.	0.179	↓	-0.016	0.163	↑	0.045	0.208	0.196	0.182	0.002	0.003	0.000	0.000

[a] Highlighted cells indicate significant differences in average hourly speed with at least 95% confidence
[b] Independent t-test
[c] Paired t-test

Figure 3.6: Average Hourly Travel Time Trends on N Fiske Ave ↔ N Woolsey Ave

3.4.1.4 N Woolsey Ave ↔ N Chautauqua Blvd

Figure 3.7 shows the average hourly travel time trends for the N Woolsey Ave ↔ N Chautauqua Blvd segment.

In the eastbound direction on weekdays, the early morning hours and the mid-to-late evening hours experienced significant differences in average hourly speed from 2017 to 2019, all of which were significant decreases. The 10:00 a.m. and 2:00 p.m. hours also experienced significant decreases in average hourly travel time. From 2019 to 2023, all hours experienced an increase in average hourly travel time, where all differences were significant with the exception of the 6:00 a.m. hour and the 4:00 p.m. hour.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early morning hours experienced significant decreases in average hourly travel time (the 1:00 a.m. hour through the 3:00 a.m. hour), as did the 11:00 a.m. hour through the 5:00 p.m. hour and the 7:00 p.m. hour through the 11:00 p.m. From 2019 to 2023, early morning hours experienced significant increases in average hourly travel time. In addition, each hour from 6:00 a.m. to 5:00 p.m. experienced significant increases, as well as the 7:00 p.m. hour through the 11:00 p.m. hour.

On weekends, in the eastbound direction, significant differences varied from 2017 to 2019. Experiencing significant decreases in average hourly travel time was the 12:00 a.m. hour, the 3:00 a.m. hour, the 7:00 a.m. and 8:00 a.m. hours, the 10:00 a.m. hour, the 3:00 p.m. hour, and the 9:00 p.m. hour through the 11:00 p.m. hour. From 2019 to 2023, hours with significant differences were significant increases and included the 2:00 a.m. hour, the 8:00 a.m. hour, 10:00 a.m. through the 8:00 p.m. hour, and the 10:00 p.m. and 11:00 p.m. hours.

Significant differences also varied on weekends in the westbound direction. Several hours experienced significant decreases in average hourly travel time from 2017 to 2019, including early morning hours, midday hours, and evening hours. From 2019 to 2023, significant differences varied more, where only the 3:00 a.m. hour in the morning experienced a significant difference in average hourly travel time (increase). Most differences were observed from the 11:00 a.m. hour through the 3:00 p.m. hour (all significant increases), while significant increases were also observed in the 5:00 p.m. hour, the 6:00 p.m. hour, and the 11:00 p.m. hour.

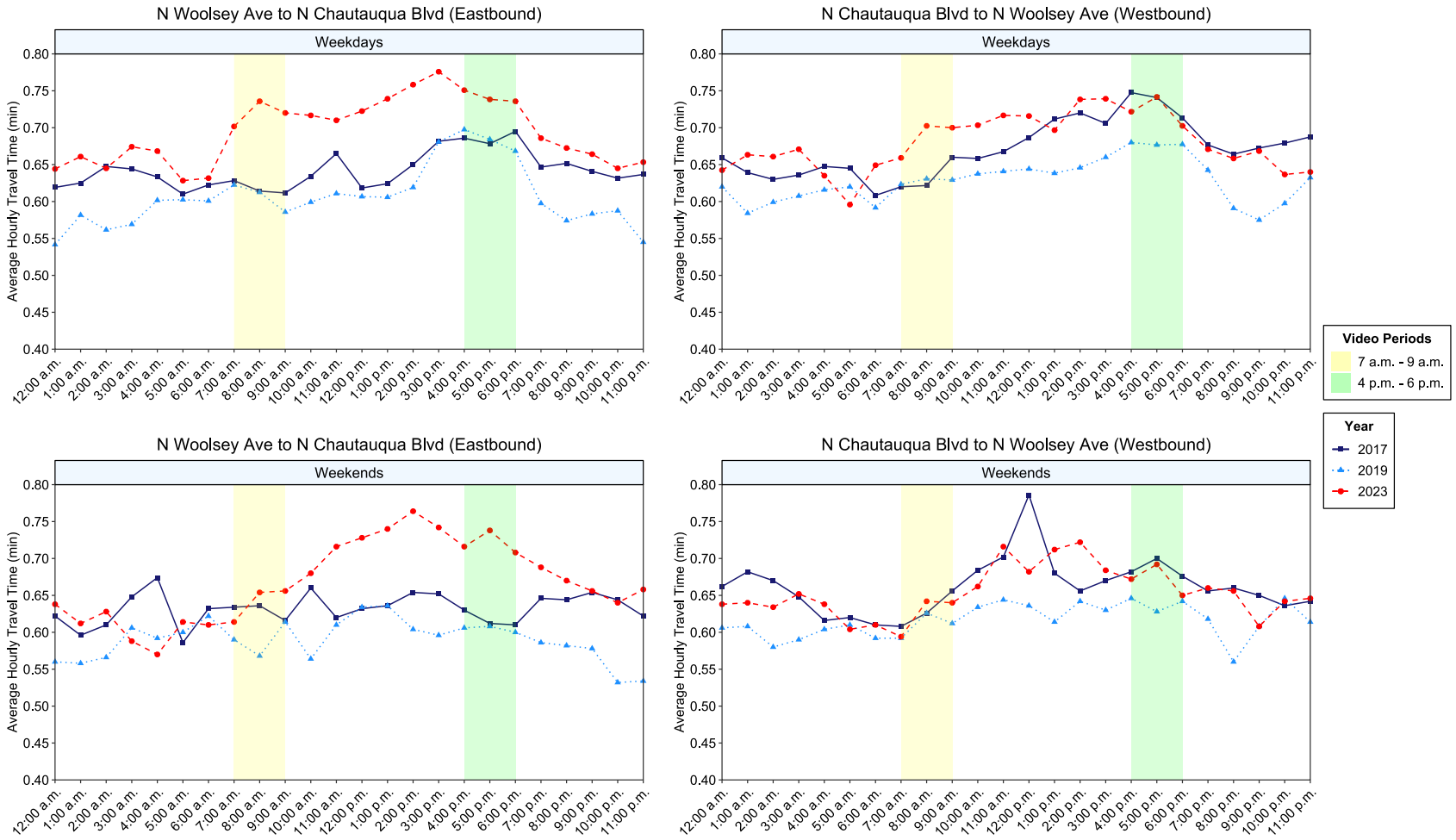


Figure 3.7: Average Hourly Travel Time on N Woolsey Ave ↔ N Chautauqua Blvd

3.4.1.5 N Chautauqua Blvd ↔ N Wabash Ave

Figure 3.8 shows the average hourly travel time trends for the N Chautauqua Blvd ↔ N Wabash Ave segment.

In the eastbound direction on weekdays, the early morning hours and the mid-to-late evening hours experienced significant differences in average hourly travel time from 2017 to 2019, all of which were significant decreases. From 2019 to 2023, each hour experienced an increase in average hourly travel time, where all differences were significant.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early-to-mid morning hours (the 12:00 a.m. hour though the 8:00 a.m. hour) experienced significant increases in average hourly travel time. The 8:00 p.m. hour and the 11:00 p.m. hour also experienced a significant increase. From 2019 to 2023, significant changes in average hourly travel time varied. The 12:00 a.m. hour and the 5:00 a.m. hour experienced significant decreases in average hourly travel time, while the 8:00 a.m. hour through the 9:00 p.m. hour all experienced significant increases in average hourly travel time.

On weekends, in the eastbound direction, significant differences were all decreases in average hourly travel time from 2017 to 2019. Experiencing significant decreases in average hourly travel time were the 12:00 a.m. hour, the 3:00 a.m. hour, the 7:00 a.m. and 8:00 a.m. hours, the 3:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour. From 2019 to 2023, all significant differences represented increases in average hourly travel time, including the 2:00 a.m. hour and the 8:00 a.m. hour through the 11:00 p.m. hour.

Significant differences varied on weekends in the westbound direction, with fewer hours experiencing significant differences in average hourly travel time. From 2017 to 2019, all significant differences were increases in average hourly travel time, including the 12:00 a.m. hour, the 3:00 a.m., the 7:00 a.m. hour and the 8:00 a.m. hour, the 10:00 a.m. hour, the 2:00 p.m. hour and 3:00 p.m. hour, and the 6:00 p.m. hour. From 2019 to 2023, this segment experienced the fewest significant differences in average hourly travel time. Specifically, just two hours (the 12:00 p.m. hour and the 5:00 p.m. hour) experienced significant differences in average hourly travel time. Significance was also contingent on the test being conducted.

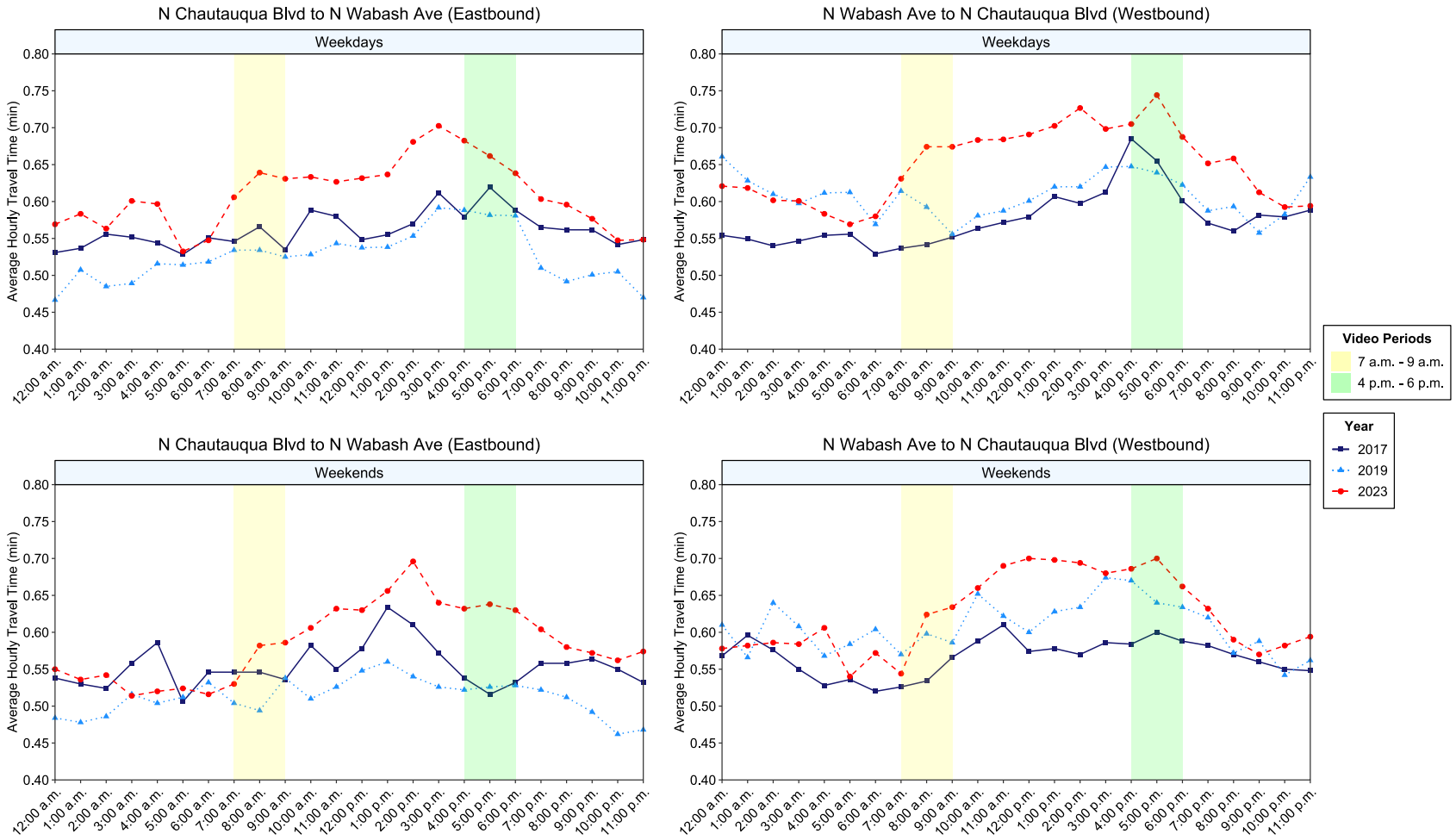


Figure 3.8: Average Hourly Travel Time Trends on N Chautauqua Blvd ↔ N Wabash Ave

3.4.1.6 N Wabash Ave ↔ N Drummond Ave

Figure 3.9 shows the average hourly speed trends for the N Wabash Ave ↔ N Drummond Ave segment.

In the eastbound direction on weekdays, the early morning and late evening hours experienced significant decreases in average hourly travel time from 2017 to 2019. In addition, the 7:00 a.m. hour and the 12:00 p.m. experienced significant decreases in average hourly travel time. From 2019 to 2023, each hour experienced a significant increase in average hourly travel time, with the exception of the 1:00 a.m. hour and the 9:00 a.m. hour.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early-to-mid morning hours (the 12:00 a.m. hour though the 8:00 a.m. hour) experienced significant increases in average hourly travel time. The 12:00 p.m. hour and the 11:00 p.m. hour also experienced a significant increase in average hourly travel time. From 2019 to 2023, significant changes in average hourly travel time varied. The 12:00 a.m. hour experienced a significant decrease in average hourly travel time, as did the 5:00 a.m. hour. The 8:00 a.m. hour through the 9:00 p.m. all experienced significant increases in average hourly travel time.

On weekends, in the eastbound direction, significant differences were all decreases from 2017 to 2019. Experiencing significant decreases in average hourly travel time was the 12:00 a.m. hour, the 3:00 a.m. hour and 4:00 a.m. hour, the 7:00 a.m. hour and the 8:00 a.m. hour, and the late evening hours (the 8:00 p.m. hour through the 11:00 p.m. hour). From 2019 to 2023, all significant differences represented increases in average hourly travel time, including the 12:00 a.m. hour and the 7:00 a.m. hour through the 11:00 p.m. hour.

Significant differences varied on weekends in the westbound direction. From 2017 to 2019, all significant differences were increases in average hourly travel time, including the 12:00 a.m. hour, the 2:00 a.m. hour through the 4:00 a.m. hour, the 7:00 a.m. hour and the 8:00 a.m. hour, and the 7:00 p.m. hour. From 2019 to 2023, a significant decrease in average hourly travel time was observed in the 7:00 a.m. hour, while significant increases were observed in the 11:00 a.m. hour, the 12:00 p.m. hour, the 4:00 p.m. hour, and the 5:00 p.m. hour.

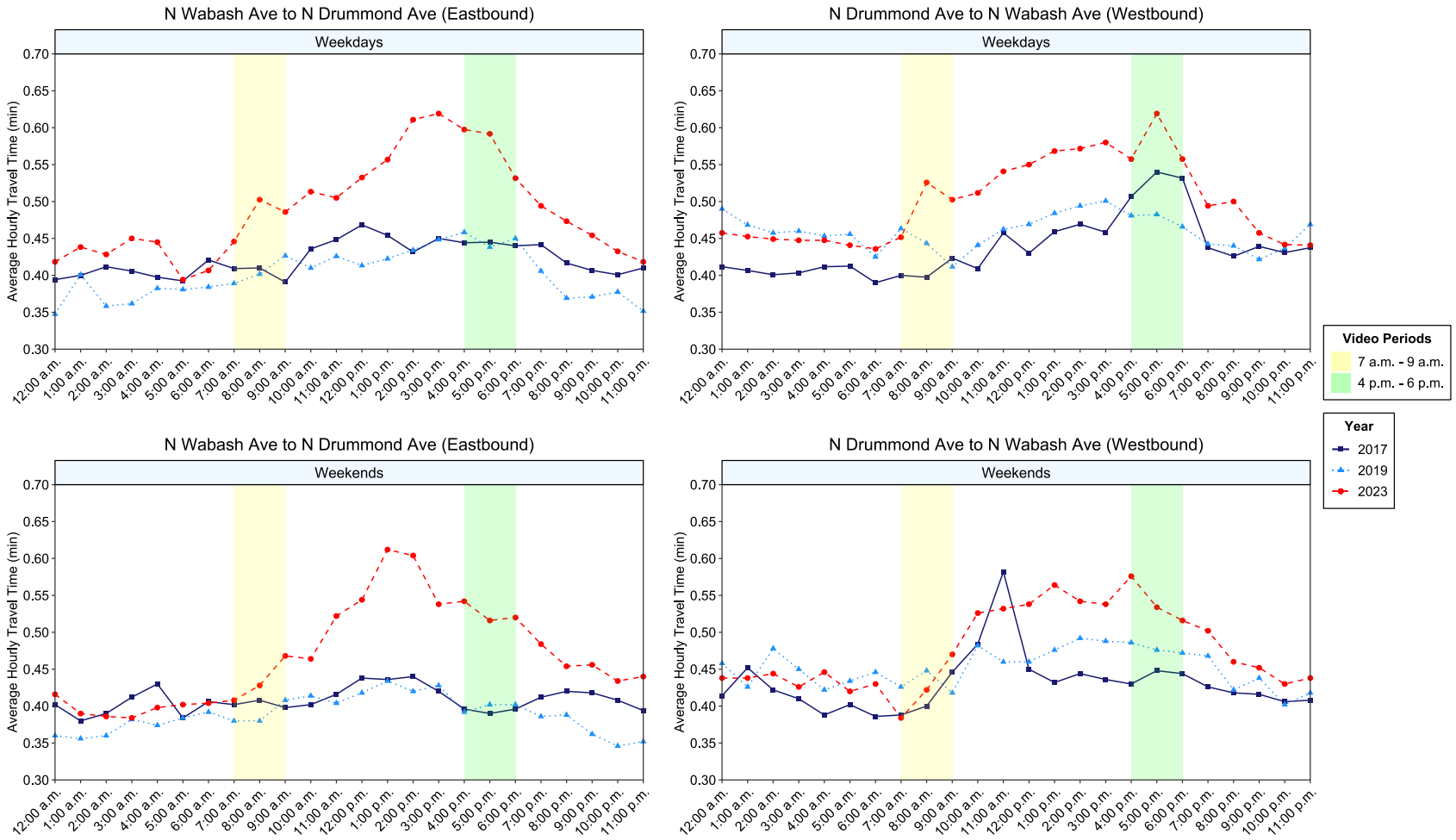


Figure 3.9: Average Hourly Travel Time Trends on N Wabash Ave ↔ N Drummond Ave

3.4.1.7 N Drummond Ave ↔ N Peninsular Ave

Figure 3.10 shows the average hourly speed trends for the N Drummond Ave ↔ N Peninsular Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant decreases in average hourly travel time from 2017 to 2019, as did the 7:00 a.m. hour. From 2019 to 2023, each hour experienced a significant increase in average hourly travel time.

In the westbound direction on weekdays, there were significant increases in average hourly speed in the 12:00 a.m. hour, the 7:00 a.m. hour, and a significant decrease in average hourly travel time in the 8:00 p.m. hour. From 2019 to 2023, significant increases in average hourly speed were observed in the 8:00 a.m. hour through the 11:00 a.m. hour and the 1:00 p.m. hour through the 8:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all decreases from 2017 to 2019. Experiencing significant decreases in average hourly travel time were the 12:00 a.m. hour, the 3:00 a.m. hour and the 4:00 a.m. hour, and the 9:00 p.m. hour and the 10:00 p.m. hour. From 2019 to 2023, all significant differences represented increases in average hourly travel time, which included the majority of hours throughout the day.

On weekends, in the westbound direction, the 12:00 a.m. hour through the 2:00 a.m. hour and the 5:00 p.m. hour had significant increases in average hourly travel time. With significant decreases were the 8:00 p.m. hour and the 10:00 p.m. hour. From 2019 to 2023, all significant differences were increases in average hourly travel time. This included the 10:00 a.m. hour through the 12:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour.

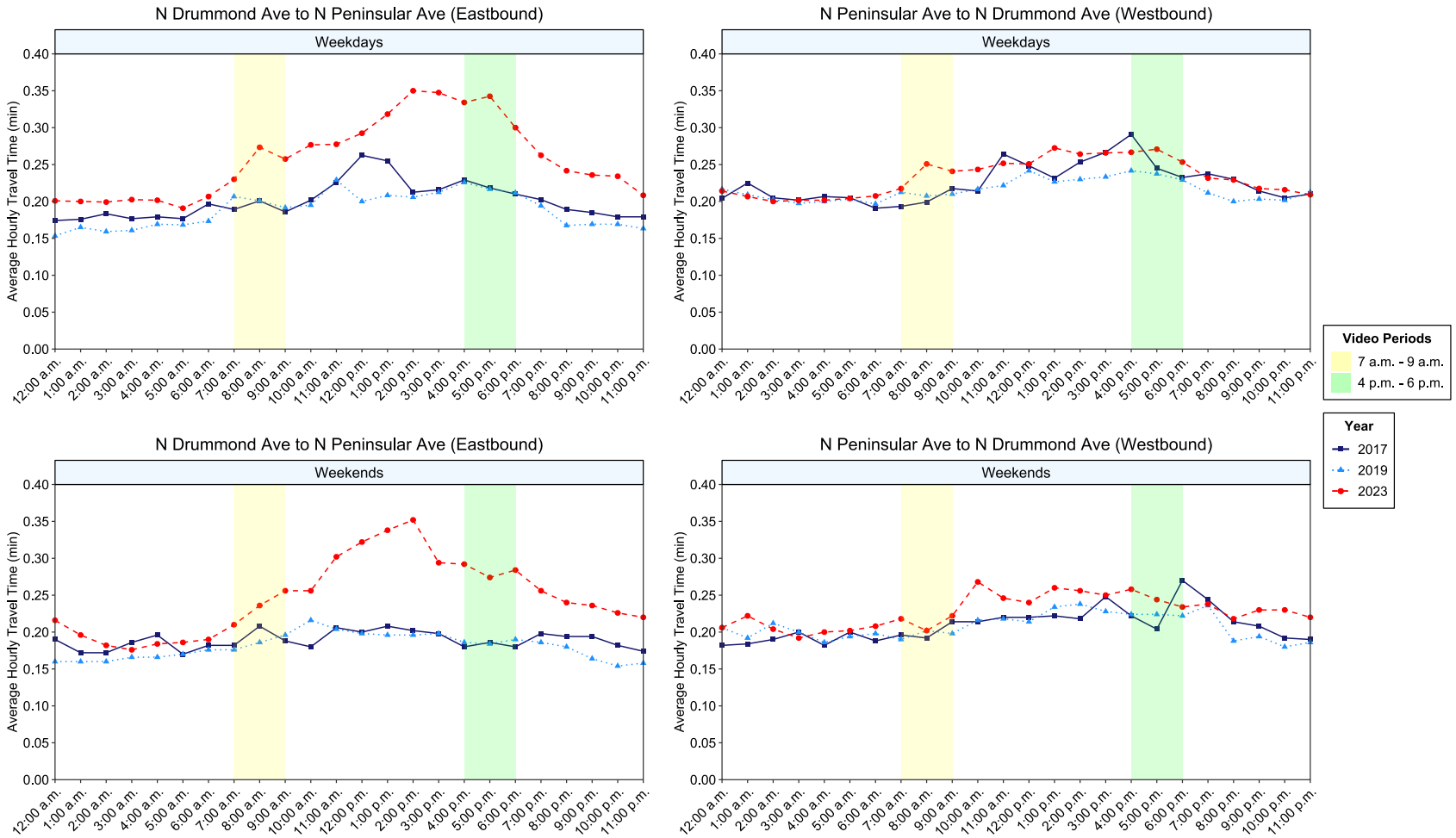


Figure 3.10: Average Hourly Travel Time Trends on N Drummond Ave ↔ N Peninsular Ave

3.4.1.8 N Peninsular Ave ↔ N Greeley Ave

Figure 3.11 shows the average hourly speed trends for the N Peninsular Ave ↔ N Greeley Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant decreases in average hourly travel time from 2017 to 2019. The 12:00 p.m. hour also experienced a significant difference in average hourly travel time (a decrease). From 2019 to 2023, each hour experienced a significant increase in average hourly travel time, with the exception of the 8:00 a.m. (the difference was not significant).

In the westbound direction on weekdays, there were far fewer significant differences in average hourly travel time from 2017 to 2019. The 3:00 a.m. hour and the 4:00 a.m. hour experienced a significant decrease in average hourly travel time, while the 3:00 p.m. hour also experienced a significant decrease in average hourly travel time. From 2019 to 2023, significant increases in average hourly travel time were observed in the 3:00 a.m. hour, the 7:00 a.m. hour through the 10:00 a.m. hour, and the 1:00 p.m. hour through the 8:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all decreases from 2017 to 2019. Experiencing significant decreases in average hourly travel time were the 12:00 a.m. hour, the 3:00 a.m. and 4:00 a.m. hours, and the 9:00 p.m. hour. From 2019 to 2023, all differences represented increases in average hourly travel time. All hours but the 3:00 a.m. hour, the 7:00 a.m. and 8:00 a.m. hours, and the 10:00 a.m. had significant differences.

On weekends, in the westbound direction, just two hours experienced significant differences from 2017 to 2019; the 4:00 a.m. hour had a significant decrease in average hourly travel time and the 8:00 p.m. hour had a significant decrease in average hourly travel time. From 2019 to 2023, all significant differences were increases in average hourly travel time. This included the 1:00 a.m. hour, the 4:00 a.m. hour, the 10:00 a.m. hour through the 2:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour.

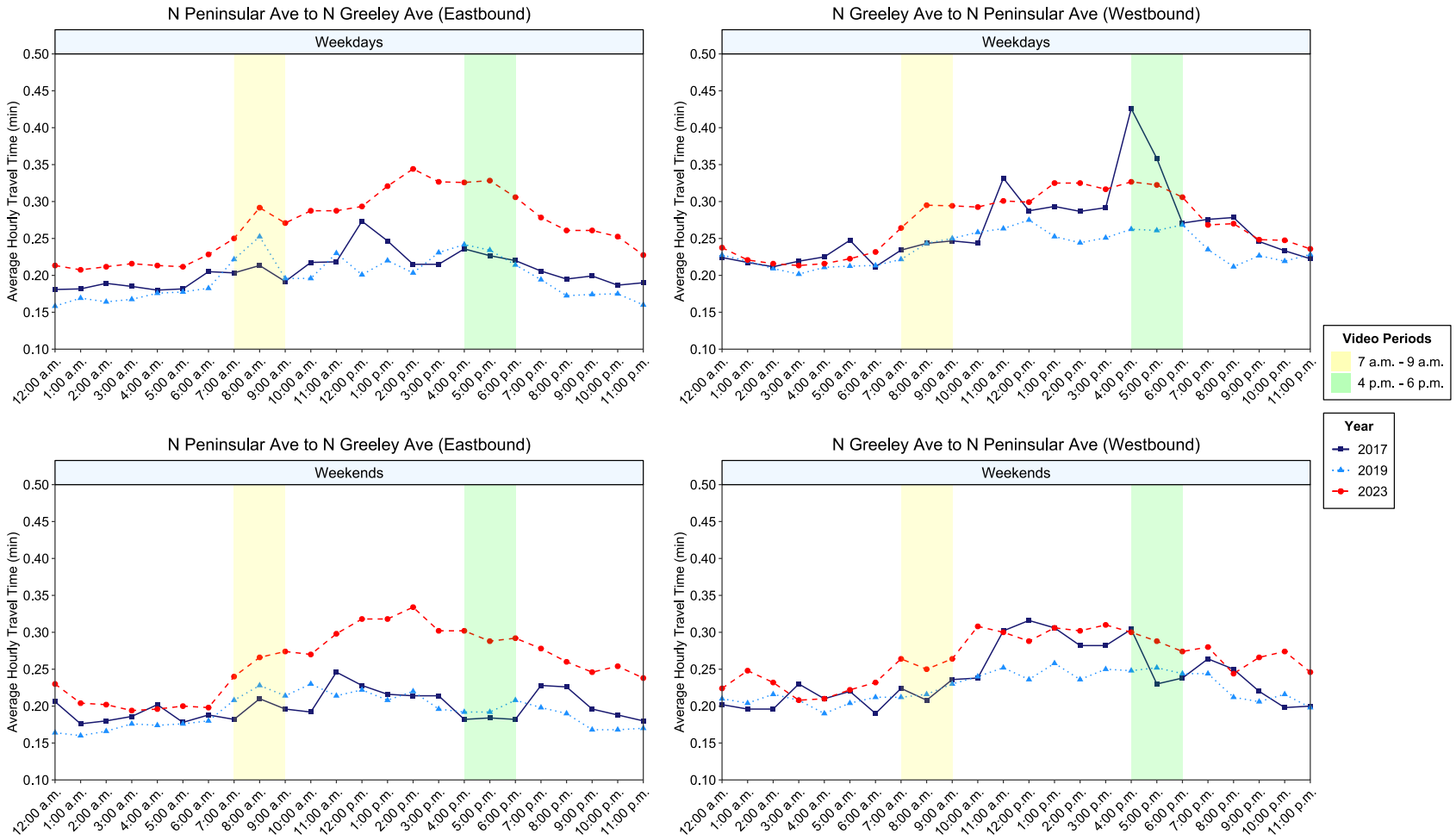


Figure 3.11: Average Hourly Travel Time Trends on N Peninsular Ave ↔ N Greeley Ave

3.4.1.9 N Greeley Ave ↔ N Delaware Ave

Figure 3.12 shows the average hourly speed trends for the N Greeley Ave ↔ N Delaware Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant decreases in average hourly travel time from 2017 to 2019. Some midday hours also experienced significant decreases in average hourly travel time. From 2019 to 2023, each hour experienced a significant increase in average hourly travel time.

In the westbound direction on weekdays, there were far fewer significant differences in average hourly travel time from 2017 to 2019. The 12:00 a.m. hour had a significant increase and the 3:00 a.m. hour a significant decrease. Also with significant decreases were the 2:00 p.m. hour, the 8:00 p.m. hour, and the 9:00 p.m. hour. From 2019 to 2023, significant decreases in average hourly travel time were observed in the 12:00 a.m. and 11:00 p.m. hours, while significant increases in average hourly travel time were observed in the 3:00 a.m. hour and the 9:00 a.m. hour through the 9:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all decreases from 2017 to 2019. Experiencing significant decreases in average hourly travel time were the 12:00 a.m. hour, the 2:00 a.m. hour through the 4:00 a.m. hour, the 11:00 a.m. hour, and the 7:00 p.m. hour through the 11:00 p.m. hour. From 2019 to 2023, all significant differences represent increases in average hourly travel time

On weekends, in the westbound direction, the 2:00 a.m. hour and the 5:00 p.m. hour experienced a significant increase in average hourly travel time, while the 8:00 p.m. hour experienced a significant decrease from 2017 to 2019. From 2019 to 2023, the 1:00 a.m. hour had a significant increase, the 3:00 a.m. hour had a significant decrease, the 12:00 p.m. hour through the 3:00 p.m. hour had significant increases, and the 5:00 p.m. hour had a significance increase.

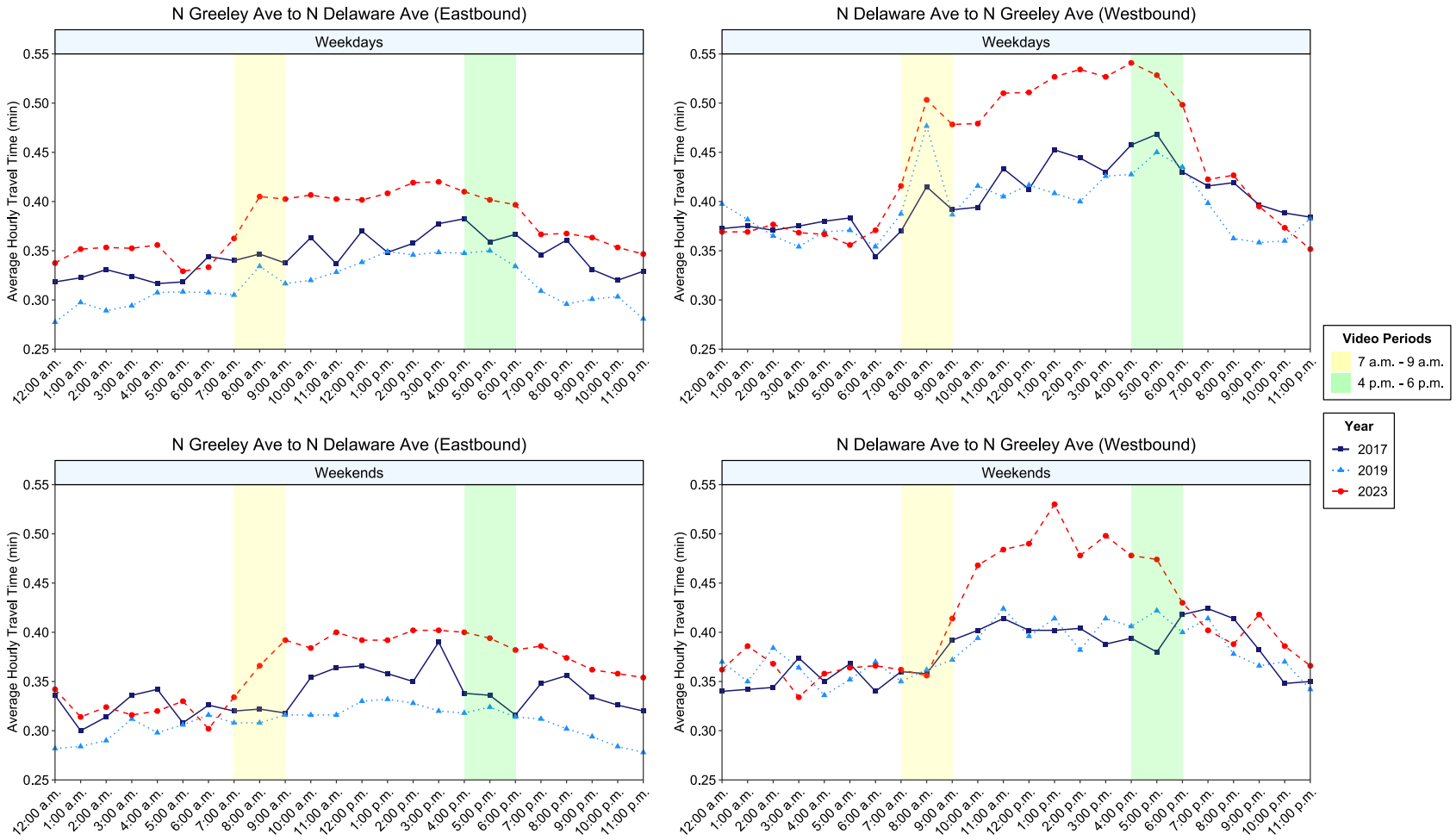


Figure 3.12: Average Hourly Travel Time Trends on N Greeley Ave ↔ N Delaware Ave

3.4.2 Travel Time Analysis Summary

3.4.2.1 Corridor-Level Summary

A corridor-level travel time analysis was conducted, as shown in Table 3.10 and Table 3.11 .Results show that the largest decreases and increases in average hourly travel time occurred within the project area (N Fiske Ave ↔ N Delaware Ave). When considering a corridor that extends beyond the project area to N Denver Ave and N Interstate Ave, decreases in the eastbound direction were notably less (approximately one-half of the project area corridor); this is true for both weekday and weekend average hourly travel times. From 2019 to 2023, increases in average hourly travel time were observed for both weekday and weekend time periods, as well as each corridor length considered. Still, the largest increases were observed within the project area (about a 30 second increase).

In the westbound direction, decreases were observed from 2017 to 2019, where the smallest decrease in average hourly travel time on weekdays happened on the corridor within the project area. On weekends, decreases were consistent with the exception of the N Fiske Ave ↔ N Interstate Ave, which remained essentially the same with a decrease of 0.4 seconds. Increases in average hourly travel time in the westbound direction remained consistent on both weekdays and weekends.

Table 3.10: Eastbound Change in Average Hourly Travel Time (sec) Over Entire Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-10.1	31.2	-10.0	28.1
N Fiske Ave ↔ N Denver Ave	-5.2	28.5	-5.7	25.9
N Fiske Ave ↔ N Interstate Ave	-5.2	23.6	-4.1	24.1

Table 3.11: Westbound Change in Average Hourly Travel Time (sec) Over Entire Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-4.1	17.0	-2.1	13.9
N Fiske Ave ↔ N Denver Ave	-5.7	19.1	-2.0	13.4
N Fiske Ave ↔ N Interstate Ave	-7.6	19.2	-0.4	14.1

3.4.2.2 Segment-Level Summary

Considering travel in the eastbound direction, **Error! Reference source not found.**, **Error! Reference source not found.**,**Error! Reference source not found.** and Figure 3.13 show that from 2017 to 2019 each segment experienced a reduction in average hourly travel time, with the maximum reduction in average hourly travel time being 2.3 seconds and the minimum reduction in travel time being 0.5 seconds. In terms of percent decrease, the maximum was just over 8% (associated with a nominal decrease of 1.7 seconds) and the minimum was approximately 3.75% (associated with a nominal decrease of 1.4 seconds). Overall, longer segments experienced higher nominal decreases and shorter segments experienced higher percent decreases. In subsequent years, average hourly travel time experienced an increase on each segment considered (increase from 2019 to 2023 and an increase overall from 2017 to 2023). Nominally, the increases were small, ranging from 3.2 seconds to 5.2 seconds. In terms of percentage increase, the increases were fairly substantial, with shorter segments experiencing higher percent increases; however, despite large percent increases, the nominal changes have little practical significance. Average hourly travel time for each of the segments within the project area increased in the after condition.

Travel time in the westbound direction experienced similar trends. Five of the seven segments experienced a decrease in average hourly travel time from 2017 to 2019. Of the five segments that experienced a decrease in average hourly travel time, the maximum reduction was 2.6 seconds (associated with at 6.58% decrease) and the minimum reduction was 0.3 seconds (associated with a 1.5% increase). All segments experienced an increase from 2019 to 2023 ranging from 1.1 seconds to 3.7 seconds. All segments also experienced an increase from 2017 to 2023.

Figure 3.13 shows that travel time across the entire segment remained relatively consistent from 2017 to 2019, then experienced increases from 2019 to 2023. Larger increases were observed in the eastbound direction, while most increases happened in the morning peak hours through the evening peak hours.

Table 3.12: Eastbound Average Hourly Travel Time (sec) by Segment

Segment	2017	2019	2023	Change 2017 to 2019	% Change 2017 to 2019	Change 2019 to 2023	% Change 2019 to 2023	Change 2017 to 2023	% Change 2017 to 2023
N Fiske Ave ↔ N Woolsey Ave	37.7	36.3	39.5	-1.4	-3.75%	3.2	8.85%	1.8	4.77%
N Woolsey Ave ↔ N Chautauqua Blvd	38.3	36.1	41.2	-2.3	-5.91%	5.2	14.30%	2.9	7.55%
N Chautauqua Blvd ↔ N Wabash Ave	33.5	31.3	36.2	-2.2	-6.68%	4.9	15.56%	2.6	7.84%
N Wabash Ave ↔ N Drummond Ave	25.1	23.8	29.0	-1.3	-5.03%	5.2	21.67%	3.9	15.55%
N Drummond Ave ↔ N Peninsular Ave	11.8	11.2	15.3	-0.7	-5.55%	4.1	36.92%	3.5	29.32%
N Peninsular Ave ↔ N Greeley Ave	12.3	11.7	15.9	-0.5	-4.47%	4.2	35.57%	3.6	29.50%
N Greeley Ave ↔ N Delaware Ave	20.5	18.8	22.4	-1.7	-8.14%	3.6	18.88%	1.9	9.20%

Table 3.13: Westbound Average Hourly Travel Time (sec) by Segment

Segment	2017	2019	2023	Change 2017 to 2019	% Change 2017 to 2019	Change 2019 to 2023	% Change 2019 to 2023	Change 2017 to 2023	% Change 2017 to 2023
N Fiske Ave ↔ N Woolsey Ave	36.5	34.5	38.2	-2.0	-5.50%	3.7	10.81%	1.7	4.71%
N Woolsey Ave ↔ N Chautauqua Blvd	40.1	37.4	40.4	-2.6	-6.58%	2.9	7.77%	0.3	0.68%
N Chautauqua Blvd ↔ N Wabash Ave	34.4	36.4	38.5	2.1	6.01%	2.1	5.75%	4.2	12.11%
N Wabash Ave ↔ N Drummond Ave	26.1	27.4	29.6	1.3	5.02%	2.2	7.99%	3.5	13.41%
N Drummond Ave ↔ N Peninsular Ave	13.2	12.8	13.9	-0.4	-3.24%	1.1	8.67%	0.7	5.15%
N Peninsular Ave ↔ N Greeley Ave	15.4	14.0	16.1	-1.4	-9.23%	2.2	15.46%	0.7	4.80%
N Greeley Ave ↔ N Delaware Ave	23.8	23.5	26.0	-0.3	-1.46%	2.6	10.94%	2.2	9.31%

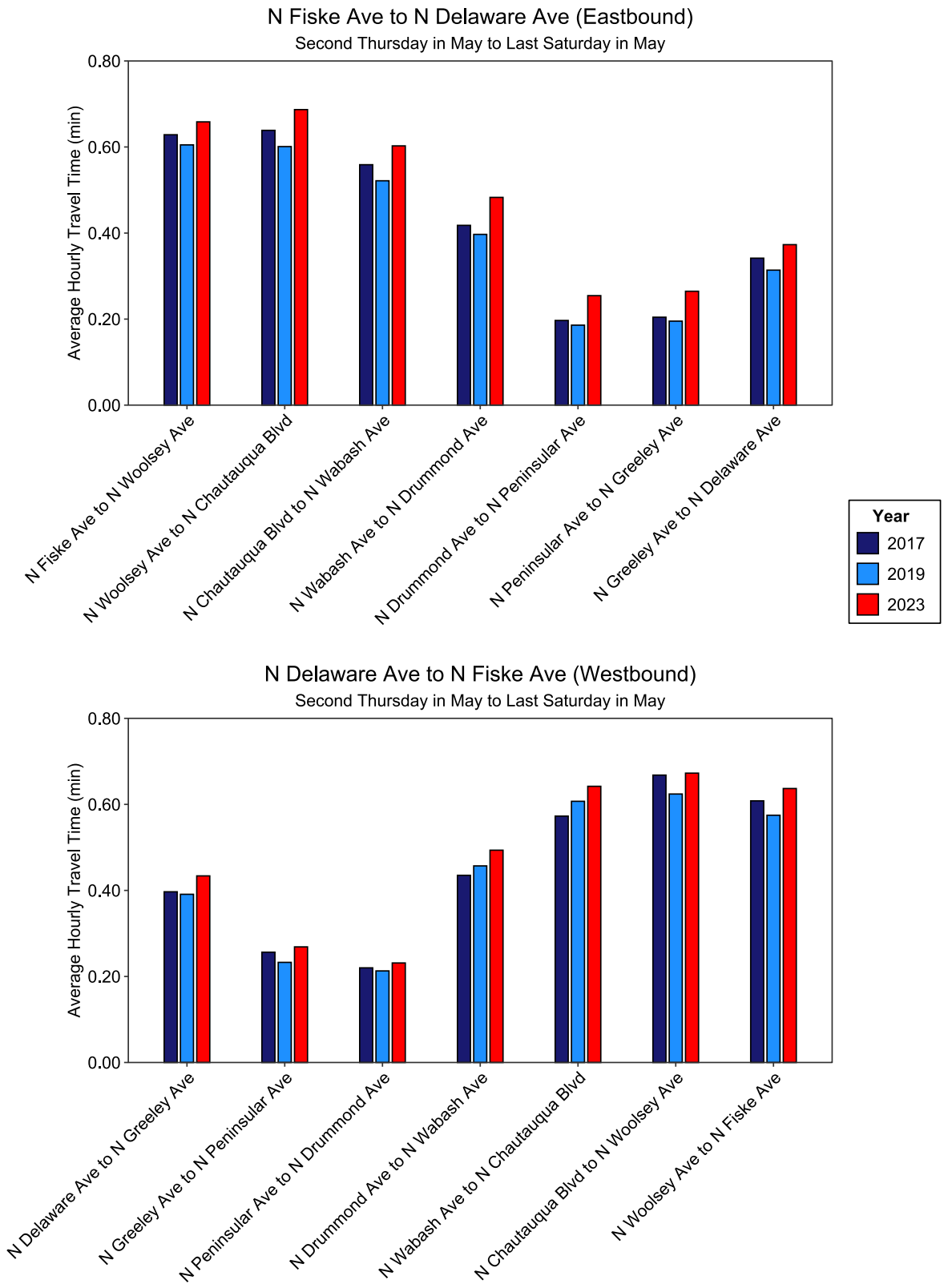


Figure 3.13: Average Hourly Travel Time on N Lombard St by Segment

3.4.3 Speed Analysis

A key element of Vision Zero programs, Complete Streets programs, and the Safe Systems approach is safe speed (i.e., lower vehicle operating speeds along multi-modal corridors). This can be due to lowering posted speed limits, speed reduction treatments (e.g., speed humps), or roadway design (e.g., reconfiguration). The relationship between speed and the likelihood of a vulnerable road user being seriously injured or killed is well-documented in the literature (Abdel-Aty and Keller, 2005; Chandler et al., 2023; Coleman and Mizenko, 2018; Leaf and Preusser, 1999; Limpert, 1994; Litman and Fitzroy, 2024; Renski et al., 1999; Rosén et al., 2011; Tefft, 2013; Turner et al., 2017; World Health Organization, 2004). Based on this knowledge, speed trends were assessed to determine if the corridor is now safer for vulnerable road users based on vehicle operating speeds, where decreases in speed correlate to accomplishing safety elements of the aforementioned programs and increasing safety of vulnerable road users.

Due to the nature of the speed data (i.e., space-mean speed as opposed to per vehicle spot speed measurements), the speed analysis was conducted by segment, as well as direction of travel (eastbound and westbound), day of the week, and time-of-day. The nature of the speed data also prohibited the ability to determine percentile speeds and the percentage of vehicles exceeding a given speed threshold (e.g., posted speed limit, 10 mi/h over the posted speed limit).

3.4.3.1 Segment Level Speed Analysis

To better understand speed behavior on each segment, speeds were considered by day of the week (weekday and weekend) and hour of the day. In addition to a descriptive analysis, significant changes in mean speeds were assessed through both an independent t-test and a paired t-test. Table 3.14**Error! Reference source not found.** provides an example of the analysis results for the N Drummond Ave ↔ N Peninsular Ave segment considering direction, day of the week (weekend and weekday), and time-of-day. Results for each segment can be found in Appendix C.

Table 3.14: Average Hourly Weekday Speed (mi/h) from N Drummond Ave to N Peninsular Ave to (Eastbound)

Time-of-Day	2017 Mean	Change Icon	2019 Change from 2017	2019 Mean	Change Icon	2023 Change from 2019	2023 Mean	2017 - 2019[a] *p*-value[b]	2017 - 2019[a] *p*-value[c]	2019 - 2023[a] *p*-value[b]	2019 - 2023[a] *p*-value[c]	2017 - 2023[a] *p*-value[b]	2017 - 2023[a] *p*-value[c]
12:00 a.m.	28.05	↑	4.14	32.20	↓	-7.93	24.27	0.000	0.000	0.000	0.000	0.000	0.000
1:00 a.m.	27.79	↑	2.15	29.94	↓	-5.50	24.44	0.014	0.027	0.000	0.000	0.000	0.000
2:00 a.m.	26.90	↑	3.84	30.74	↓	-6.32	24.42	0.000	0.000	0.000	0.000	0.001	0.001
3:00 a.m.	27.34	↑	3.46	30.80	↓	-6.71	24.09	0.009	0.003	0.000	0.001	0.000	0.001
4:00 a.m.	27.74	↑	0.98	28.72	↓	-4.56	24.17	0.042	0.051	0.000	0.000	0.000	0.000
5:00 a.m.	27.81	↑	0.79	28.59	↓	-3.15	25.44	0.085	0.089	0.000	0.000	0.000	0.000
6:00 a.m.	26.10	↑	1.99	28.09	↓	-4.27	23.82	0.144	0.154	0.000	0.000	0.118	0.058
7:00 a.m.	25.77	↓	-1.90	23.87	↓	-2.53	21.34	0.036	0.031	0.015	0.024	0.000	0.000
8:00 a.m.	24.57	↓	-0.06	24.51	↓	-6.59	17.91	0.929	0.947	0.000	0.000	0.000	0.000
9:00 a.m.	26.30	↓	-0.70	25.60	↓	-6.53	19.07	0.344	0.308	0.000	0.000	0.000	0.000
10:00 a.m.	24.46	↑	0.77	25.22	↓	-7.47	17.76	0.419	0.442	0.000	0.000	0.000	0.000
11:00 a.m.	22.20	↑	0.43	22.63	↓	-4.77	17.86	0.816	0.836	0.007	0.011	0.003	0.018
12:00 p.m.	20.40	↑	4.33	24.72	↓	-7.91	16.82	0.024	0.035	0.000	0.000	0.049	0.055
1:00 p.m.	21.43	↑	2.45	23.88	↓	-8.48	15.39	0.236	0.164	0.000	0.000	0.005	0.007
2:00 p.m.	23.40	↑	0.47	23.87	↓	-9.88	13.99	0.688	0.661	0.000	0.000	0.000	0.000
3:00 p.m.	22.86	↑	0.60	23.47	↓	-9.22	14.24	0.598	0.615	0.000	0.000	0.000	0.000
4:00 p.m.	21.95	↑	0.04	21.99	↓	-7.16	14.83	0.975	0.973	0.000	0.000	0.000	0.000
5:00 p.m.	22.86	↑	0.28	23.14	↓	-8.79	14.35	0.838	0.837	0.000	0.000	0.000	0.000
6:00 p.m.	23.44	↓	-0.03	23.42	↓	-7.03	16.38	0.980	0.979	0.000	0.000	0.000	0.000
7:00 p.m.	24.22	↑	1.42	25.64	↓	-6.91	18.73	0.301	0.209	0.000	0.000	0.000	0.000
8:00 p.m.	25.80	↑	3.36	29.16	↓	-8.99	20.17	0.000	0.000	0.000	0.000	0.000	0.000
9:00 p.m.	26.50	↑	2.56	29.06	↓	-8.37	20.69	0.002	0.001	0.000	0.000	0.000	0.000
10:00 p.m.	27.37	↑	1.31	28.68	↓	-7.69	20.99	0.034	0.031	0.000	0.000	0.000	0.000
11:00 p.m.	27.19	↑	3.58	30.77	↓	-7.18	23.59	0.027	0.019	0.000	0.000	0.000	0.000

[a] Highlighted cells indicate significant differences in average hourly speed with at least 95% confidence

[b] Independent t-test

[c] Paired t-test

3.4.3.2 N Fiske Ave ↔ N Woolsey Ave

Figure 3.14 shows the average hourly speed trends for the N Fiske Ave ↔ N Woolsey Ave segment.

In the eastbound direction on weekdays, the majority of hours experienced an increase in average hourly speed from 2017 to 2019, where significant differences were primarily observed in the early morning hours and late evening hours. In addition, there was a significant decrease in average hourly speed for the 6:00 a.m. and 7:00 a.m. hours. From 2019 to 2023, the only hour to not experience a significant difference in average hourly speed was the 6:00 a.m. hour. Further, all differences were significant decreases in average hourly speed, with the exception of the 4:00 a.m. and 5:00 a.m. hours (these had significant increases in average hourly speed). Similar trends were observed in the westbound direction, where significant differences from 2017 to 2019 were primarily in the early morning hours and late evening hours. However, in the westbound direction, there were significant differences in average hourly speed from 1:00 p.m. through 5:00 p.m. From 2019 to 2023, all but three hours experienced significant differences in average hourly speed, where the 5:00 a.m. hour was the only significant increase (all others were significant decreases in average hourly speed).

Speed on weekends showed different trends. In the eastbound direction, from 2017 to 2019, significant differences were observed only in the early morning and late evening hours. From 2019 to 2023, more hours experienced significant differences, with early morning and late evening hours, midday hours (10:00 a.m. to 1:00 p.m.), and late afternoon to evening hours (2:00 p.m. to 7:00 p.m.) all having significant differences in average hourly speed. All differences from 2019 to 2023 were significant decreases. In the westbound direction, similar trends were observed. From 2017 to 2019, there were significant increases in average hourly speed in the late evening and early morning hours, as well as significant increases in the midday hours. From 2019 to 2023, all significant differences in average hourly speed were decreases, which included early morning hours, late evening hours, and 10:00 a.m. to 7:00 p.m. (the 8:00 p.m. hour also experienced a significant decrease in average hourly speed).

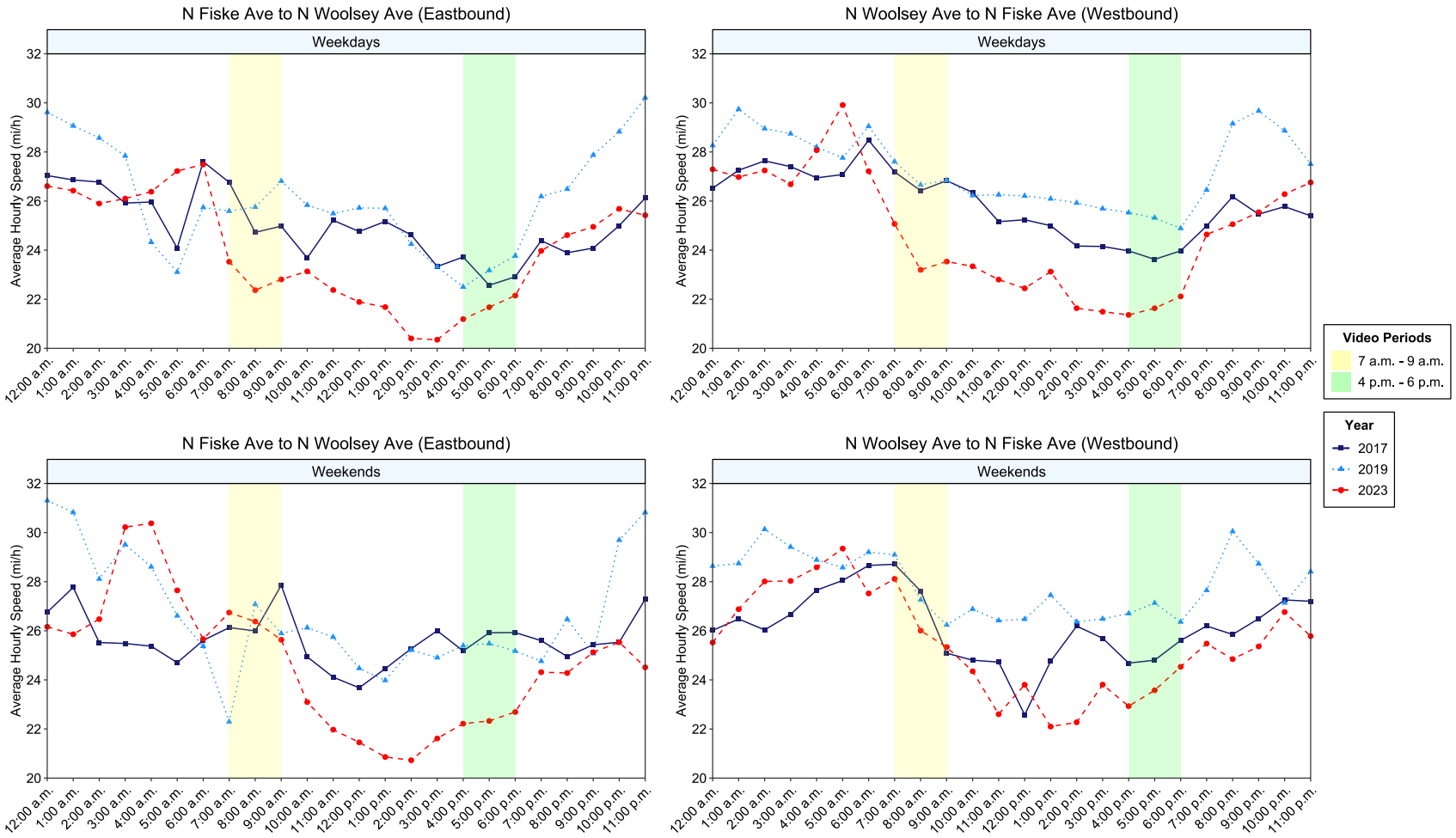


Figure 3.14: Average Hourly Speed Trends on N Fiske Ave ↔ N Woolsey Ave

3.4.3.3 N Woolsey Ave ↔ N Chautauqua Blvd

Figure 3.15 shows the average hourly speed trends for the N Woolsey Ave ↔ N Chautauqua Blvd segment.

In the eastbound direction on weekdays, the early morning hours and the mid-to-late evening hours experienced significant differences in average hourly speed from 2017 to 2019, all of which were significant increases. The 10:00 a.m. and 2:00 p.m. hours also experienced significant increases in average hourly speed. From 2019 to 2023, each hour experienced a decrease in average hourly speed, where all differences were significant with the exception of the 5:00 a.m. hour and the 6:00 a.m. hour.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early morning hours experienced significant increases in average hourly speed and each hour from 11:00 a.m. to 11:00 p.m. also experienced significant increases. From 2019 to 2023, early morning hours experienced significant decreases in average hourly speed. Additionally, each hour from 6:00 a.m. to 5:00 p.m. experienced significant decreases, as well as the 7:00 p.m. to 9:00 p.m. hours.

On weekends, in the eastbound direction, significant differences varied from 2017 to 2019. Experiencing significant increases in average hourly speed were the 3:00 a.m. and 4:00 a.m. hours, the 7:00 a.m. and 8:00 a.m. hours, the 10:00 a.m. hour, the 3:00 p.m. hour, and the late evening to night hours (8:00 a.m. to 11:00 p.m.). From 2019 to 2023, hours with significant differences were significant decreases and included the 2:00 a.m. hour, the 8:00 a.m. hour, 10:00 a.m. through the 8:00 p.m. hours, and the 10:00 p.m. and 11:00 p.m. hours.

Significant differences also varied on weekends in the westbound direction. Several hours experienced significant increases in average hourly speed from 2017 to 2019, including early morning hours, midday hours, and evening hours. From 2019 to 2023, significant differences varied more, where only the 3:00 a.m. hour in the morning experienced a significant difference in average hourly speed (decrease). Most differences were observed from the 11:00 a.m. hour through the 3:00 p.m. hour (all significant decreases), while significant decreases were also observed in the 5:00 p.m. hour, 7:00 p.m. and 8:00 p.m. hours, and the 11:00 p.m. hour.

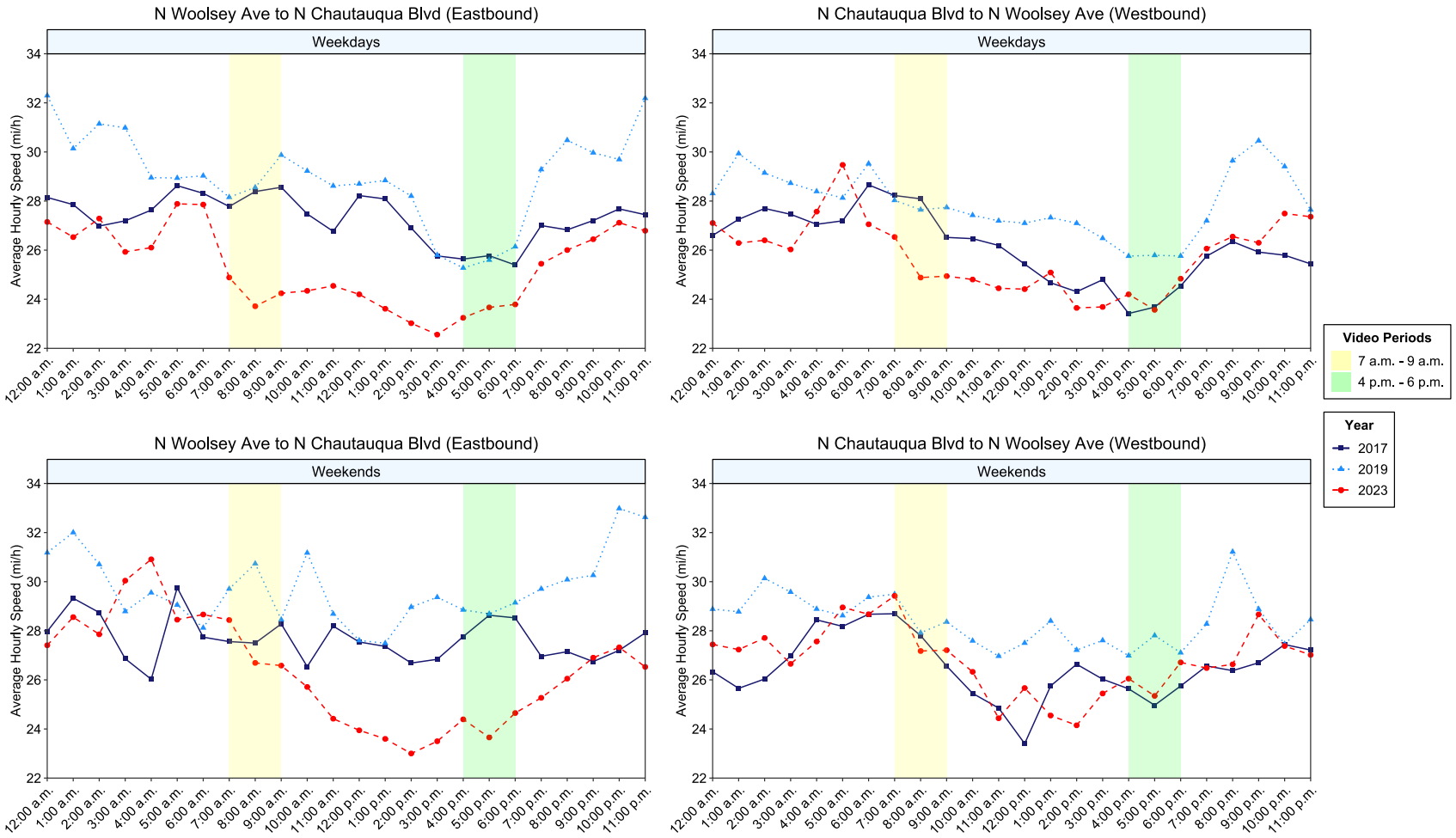


Figure 3.15: Average Hourly Speed Trends on N Woolsey Ave ↔ N Chautauqua Blvd

3.4.3.4 N Chautauqua Blvd ↔ N Wabash Ave

Figure 3.16 shows the average hourly speed trends for the N Chautauqua Blvd ↔ N Wabash Ave segment.

In the eastbound direction on weekdays, the early morning hours and the mid-to-late evening hours experienced significant differences in average hourly speed from 2017 to 2019, all of which were significant increases. From 2019 to 2023, each hour experienced a decrease in average hourly speed, where all differences were significant with the exception of the 5:00 a.m. hour.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early-to-mid morning hours (the 12:00 a.m. hour though the 8:00 a.m. hour) experienced significant decreases in average hourly speed. The 11:00 p.m. hour also experienced a significant decrease. From 2019 to 2023, significant changes in average hourly speed varied. The 12:00 a.m. hour, the 5:00 a.m. hour, and the 11:00 p.m. hour experienced significant increases in average hourly speed, while the 8:00 a.m. hour through the 9:00 p.m. hour all experienced significant decreases in average hourly speed.

On weekends, in the eastbound direction, significant differences were all increases from 2017 to 2019. Experiencing significant increases in average hourly speed were the 12:00 a.m. hour, the 3:00 a.m. hour, the 7:00 a.m. and 8:00 a.m. hours, the 3:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour. From 2019 to 2023, all significant differences represented decreases in average hourly speed, including the 2:00 a.m. hour and the 8:00 hour through the 11:00 p.m. hour.

Significant differences varied on weekends in the westbound direction, with fewer hours experiencing significant differences in average hourly speed. From 2017 to 2019, all significant differences were decreases in average hourly speed, including the 12:00 a.m. hour, the 2:00 a.m. hour through the 4:00 hour, the 6:00 a.m. hour through the 8:00 a.m. hour, the 10:00 a.m. hour, the 2:00 p.m. hour and 3:00 p.m. hour, and the 6:00 p.m. hour. From 2019 to 2023, this segment experienced the fewest significant differences in average hourly speed. Specifically, just three hours (the 3:00 a.m. hour, the 12:00 p.m. hour, and the 5:00 hour) experienced significant differences in average hourly speed. Significance was also contingent on the test being conducted.

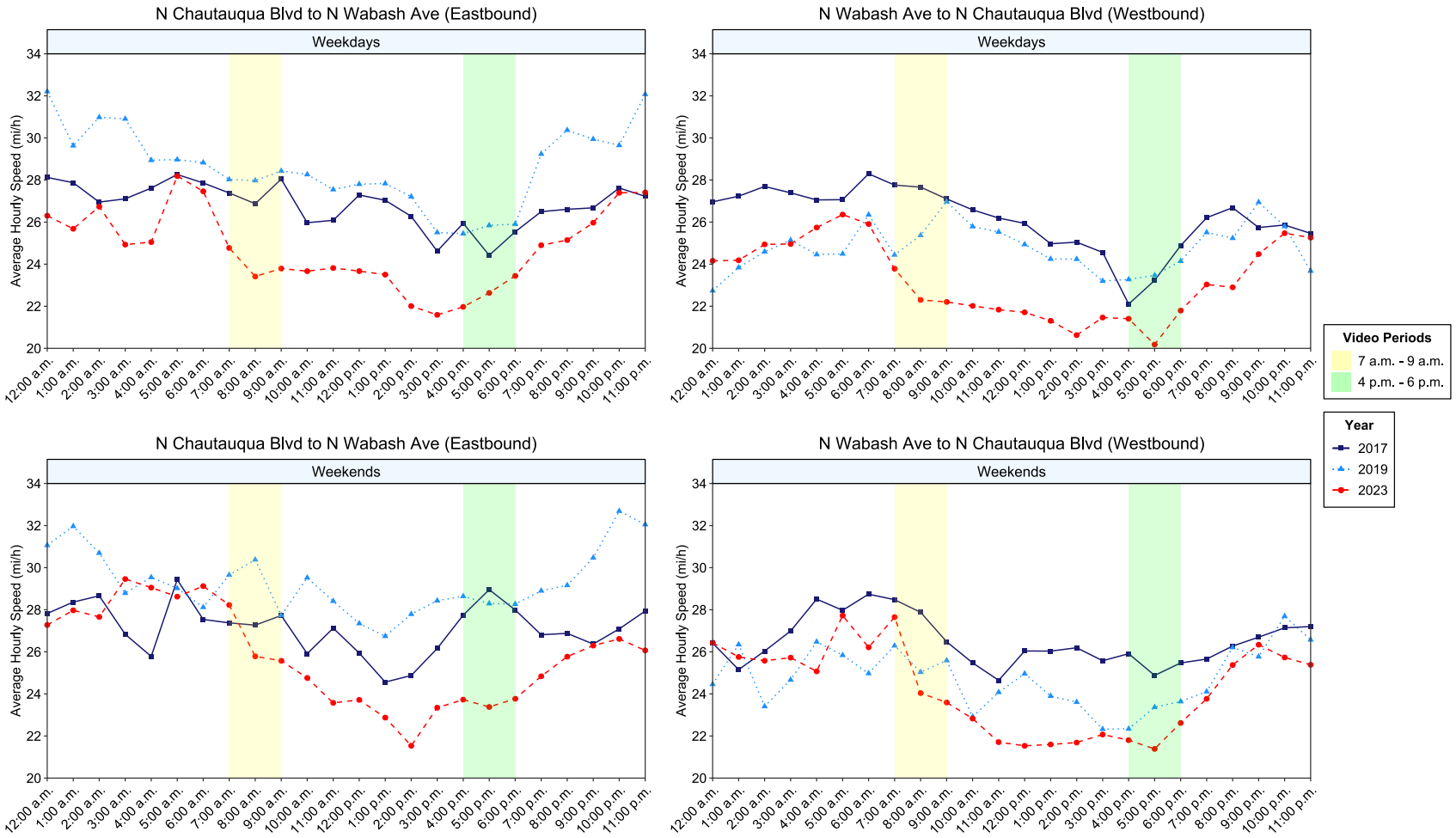


Figure 3.16: Average Hourly Speed Trends on N Chautauqua Blvd ↔ N Wabash Ave

3.4.3.5 N Wabash Ave ↔ N Drummond Ave

Figure 3.17 shows the average hourly speed trends for the N Wabash Ave ↔ N Drummond Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant increases in average hourly speed from 2017 to 2019. In addition, the 7:00 a.m. hour and the 12:00 p.m. experienced significant increases in average hourly speed. From 2019 to 2023, each hour experienced a significant decrease in average hourly speed.

In the westbound direction on weekdays, there were more significant differences observed from 2017 to 2019. The early-to-mid morning hours (the 12:00 a.m. hour though the 8:00 a.m. hour) experienced significant decreases in average hourly speed. The 12:00 p.m. hour, the 3:00 p.m. hour, and the 11:00 p.m. hour also experienced a significant decrease in average hourly speed. From 2019 to 2023, significant changes in average hourly speed varied. The 12:00 a.m. hour experienced a significant increase in average hourly speed, as did the 5:00 a.m. and 11:00 p.m. hour. The 8:00 a.m. hour through the 9:00 p.m. all experienced significant decreases in average hourly speed. The trends observed here were similar to those observed on the N Chautauqua Blvd ↔ N Wabash Ave segment.

On weekends, in the eastbound direction, significant differences were all increases from 2017 to 2019. Experiencing significant increases in average hourly speed were the 12:00 a.m. hour, the 3:00 a.m. hour and 4:00 a.m. hour, the 8:00 a.m. hour, and the late evening hours (the 8:00 p.m. hour through the 11:00 p.m. hour). From 2019 to 2023, all significant differences represented decreases in average hourly speed, including the 12:00 a.m. hour and the 8:00 a.m. hour through the 11:00 p.m. hour.

Significant differences varied on weekends in the westbound direction. From 2017 to 2019, all significant differences were decreases in average hourly speed, including the 12:00 a.m. hour, the 2:00 a.m. hour and 3:00 a.m. hour, the 7:00 a.m. hour and the 8:00 a.m. hour, and the 7:00 p.m. hour. From 2019 to 2023, this segment experienced a small number of significant differences relative to other segments. Specifically, just four hours (the 7:00 a.m. hour, the 11:00 a.m. and 12:00 p.m. hours, and the 4:00 p.m. hour) experienced significant differences in average hourly speed. Similar to the N Chautauqua Blvd ↔ N Wabash Ave segment, significance was contingent on the test being conducted.

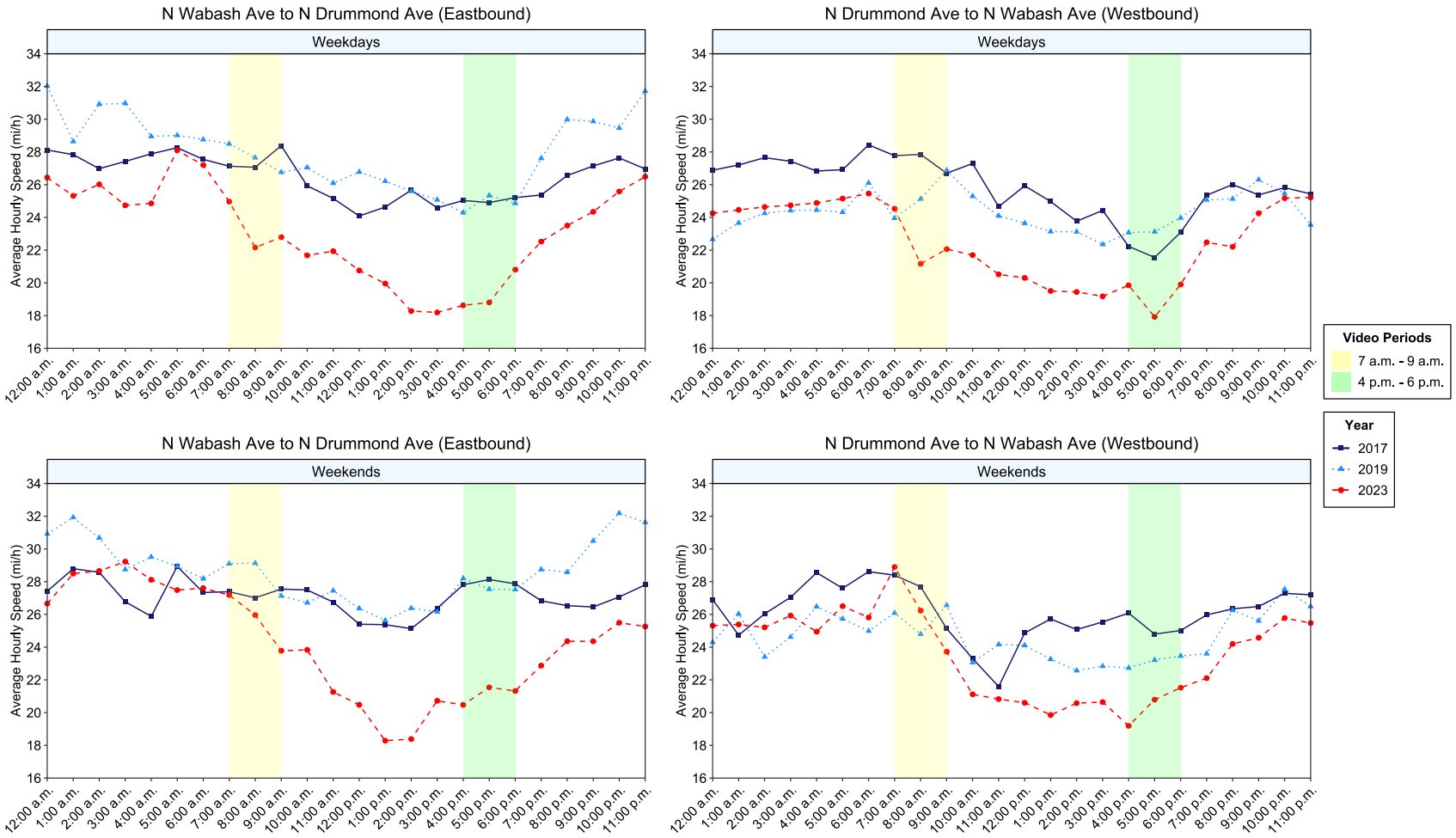


Figure 3.17: Average Hourly Speed Trends on N Wabash Ave ↔ N Drummond Ave

3.4.3.6 N Drummond Ave ↔ N Peninsular Ave

Figure 3.18 shows the average hourly speed trends for the N Drummond Ave ↔ N Peninsular Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant increases in average hourly speed from 2017 to 2019. The 12:00 p.m. hour also experienced a significant increase in average hourly speeds. From 2019 to 2023, each hour experienced a significant decrease in average hourly speed.

In the westbound direction on weekdays, there were significant increases in average hourly speed in the 3:00 a.m. hour and 4:00 a.m. hour, the 2:00 p.m. hour through the 5:00 p.m. hour, and the 7:00 p.m. hour and the 8:00 p.m. hour from 2017 to 2019. From 2019 to 2023, significant decreases in average hourly speed were observed in the 3:00 a.m. hour, the 7:00 a.m. hour through the 11:00 a.m. hour, and the 1:00 p.m. hour through the 9:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all increases from 2017 to 2019. Experiencing significant increases in average hourly speed were the 12:00 a.m. hour, the 2:00 a.m. hour through the 4:00 a.m. hour, and the 9:00 p.m. hour. From 2019 to 2023, all significant differences represented decreases in average hourly speed, with the exception of the 3:00 a.m. hour, the 7:00 a.m. and 8:00 a.m. hours, and the 10:00 a.m. hour, all of which did not have significant differences.

On weekends, in the westbound direction, just two hours experienced significant differences from 2017 to 2019; the 2:00 a.m. hour experienced a significant decrease and the 8:00 p.m. hour experienced a significant increase. From 2019 to 2023, all significant differences were decreases in average hourly speed. This included the 1:00 a.m. hour, the 10:00 a.m. hour through the 2:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour.

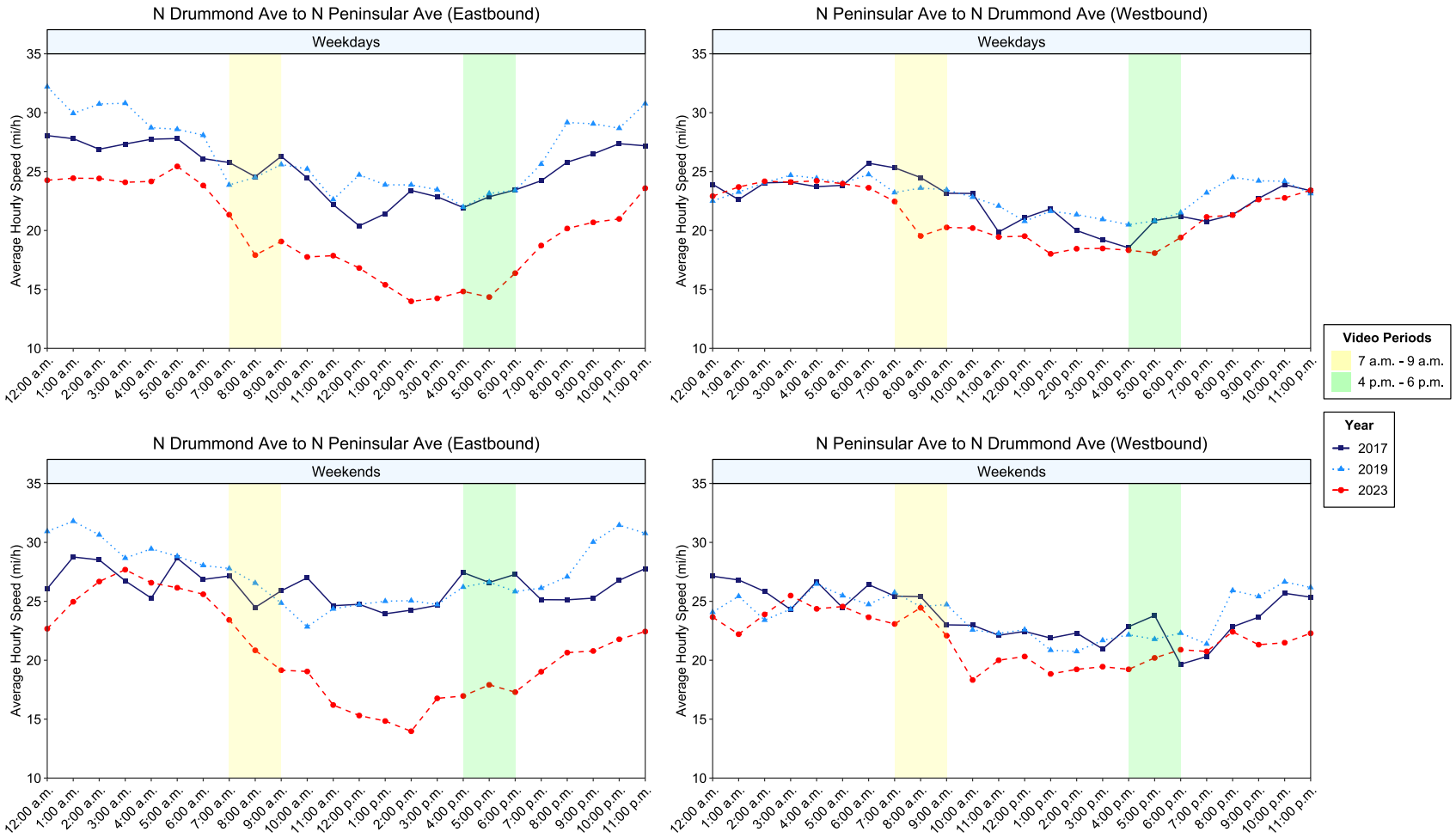


Figure 3.18: Average Hourly Speed Trends on N Drummond Ave ↔ N Peninsular Ave

3.4.3.7 N Peninsular Ave ↔ N Greeley Ave

Figure 3.19 shows the average hourly speed trends for the N Peninsular Ave ↔ N Greeley Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant increases in average hourly speed from 2017 to 2019. The 7:00 a.m. hour also experienced a significant difference in average hourly speeds (a decrease), as well as the 12:00 p.m. hour (an increase). From 2019 to 2023, each hour experienced a significant decrease in average hourly speed.

In the westbound direction on weekdays, there were far fewer significant differences in average hourly speed from 2017 to 2019. The 12:00 a.m. hour and the 7:00 a.m. hour experienced a significant decrease in average hourly speed, while the 8:00 p.m. hour experienced a significant increase in average hourly speed. From 2019 to 2023, significant decreases in average hourly speed were observed from the 8:00 a.m. hour through the 11:00 a.m. hour and the 1:00 p.m. hour through the 8:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all increases from 2017 to 2019. Experiencing significant increases in average hourly speed were the 3:00 a.m. hour, the 9:00 p.m. hour, and the 10:00 p.m. hour. From 2019 to 2023, all significant differences represented decreases in average hourly speed, with the exception of the 3:00 a.m. hour and the 10:00 a.m., both of which did not have significant differences.

On weekends, in the westbound direction, the 12:00 a.m. hour through the 2:00 hour experienced significant decreases in average hourly speed from 2017 to 2019, while the 8:00 p.m. hour experienced a significant increase. From 2019 to 2023, all significant differences were decreases in average hourly speed. This included the 1:00 a.m. hour, the 10:00 a.m. hour through the 12:00 p.m. hour, and the 8:00 p.m. hour through the 11:00 p.m. hour.

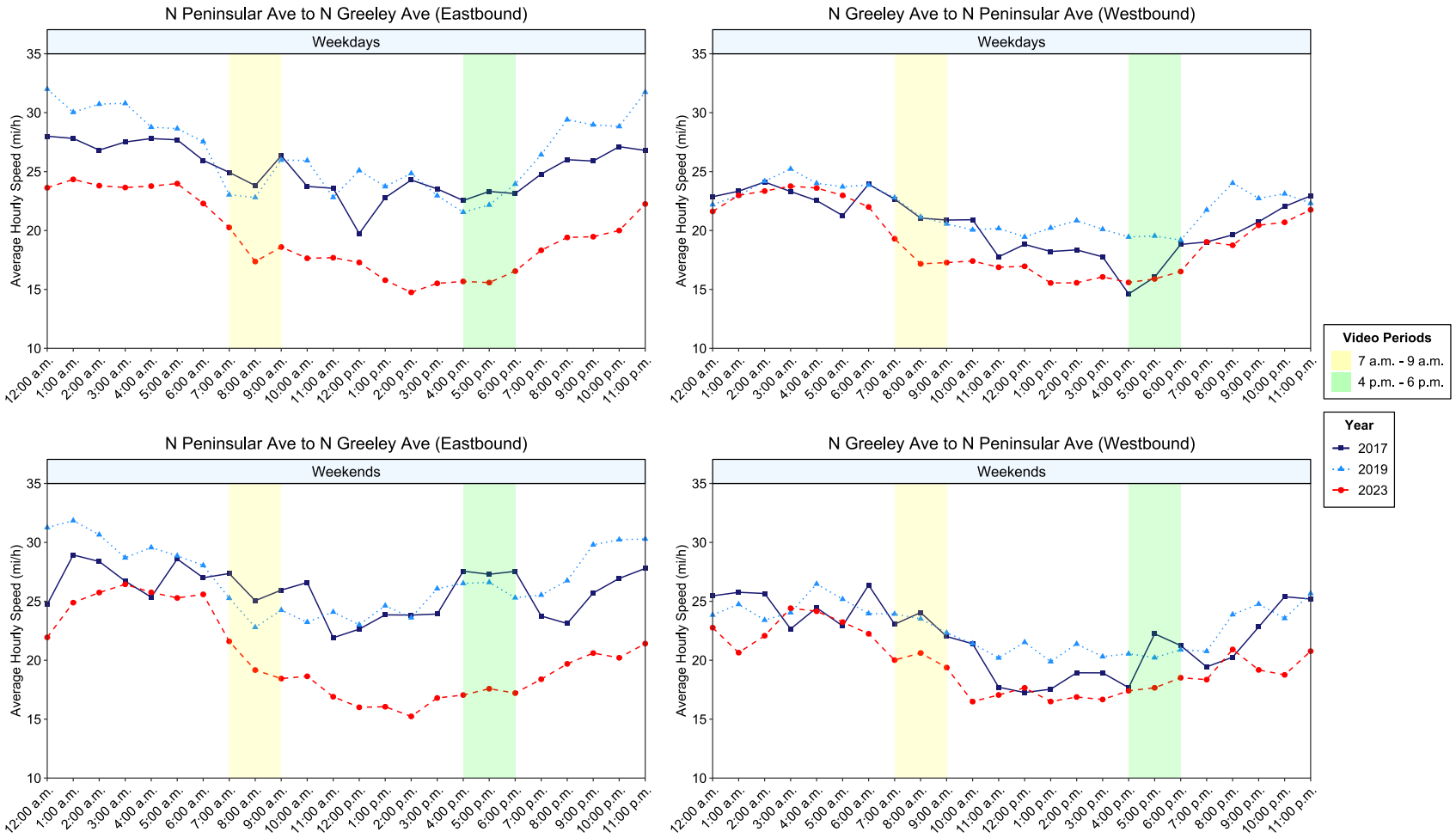


Figure 3.19: Average Hourly Speed Trends on N Peninsular Ave ↔ N Greeley Ave

3.4.3.8 N Greeley Ave ↔ N Delaware Ave

Figure 3.20 shows the average hourly speed trends for the N Greeley Ave ↔ N Delaware Ave segment.

In the eastbound direction on weekdays, the early morning and mid-to-late evening hours experienced significant increases in average hourly speed from 2017 to 2019. Some midday hours also experienced significant increases in average hourly speed. From 2019 to 2023, each hour experienced a significant decrease in average hourly speed.

In the westbound direction on weekdays, there were far fewer significant differences in average hourly speed from 2017 to 2019. The 12:00 a.m. hour had a significant decrease and the 3:00 a.m. hour a significant increase. Also with significant increases were the 2:00 p.m. hour, the 8:00 p.m. hour, and the 9:00 p.m. hour. From 2019 to 2023, significant increases in average hourly speeds were observed in the 12:00 a.m. and 11:00 p.m. hours, while significant decreases in average hourly speeds were observed in the 3:00 a.m. hour and the 9:00 a.m. hour through the 9:00 p.m. hour.

On weekends, in the eastbound direction, significant differences were all increases from 2017 to 2019. Experiencing significant increases in average hourly speed were the 12:00 a.m. hour, the 2:00 a.m. hour through the 4:00 a.m. hour, the 11:00 a.m. hour, and the 7:00 p.m. hour through the 11:00 p.m. hour. From 2019 to 2023, all significant differences represented decreases in average hourly speed, with the exception of the 1:00 a.m. hour through the 6:00 a.m. hour.

On weekends, in the westbound direction, the 2:00 a.m. hour experienced a significant decrease in average hourly speed and the 8:00 p.m. hour experienced a significant increase from 2017 to 2019. From 2019 to 2023, the 1:00 a.m. hour had a significant decrease, the 3:00 a.m. hour had a significant increase, the 12:00 p.m. hour through the 3:00 p.m. hour had significant decreases, and the 5:00 p.m. hour had significance decreases.

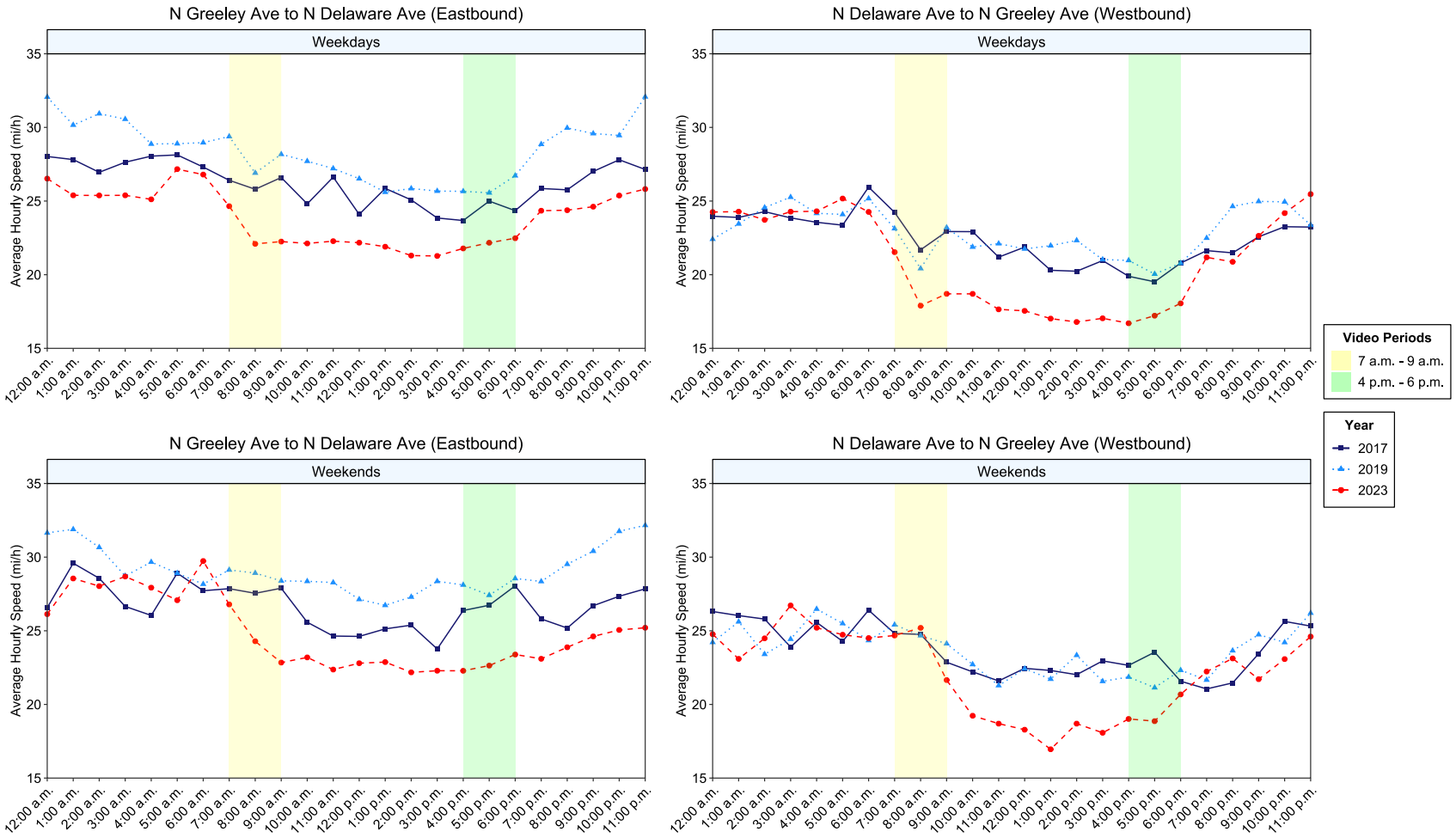


Figure 3.20: Average Hourly Speed Trends on N Greeley Ave ↔ N Delaware Ave

3.4.4 Speed Analysis Summary

Overall, increases in average hourly speed for certain hours of the day from 2017 to 2019 were observed; these increases were most often observed during the late evening or early morning hours. From 2019 to 2023 (after project completion), decreases in average hourly speed were observed for most hours of the day, and in many cases, all hours of the day experienced decreases in average hourly speed.

Table 3.15, Table 3.16**Error! Reference source not found.**, and

2017, 2019 n

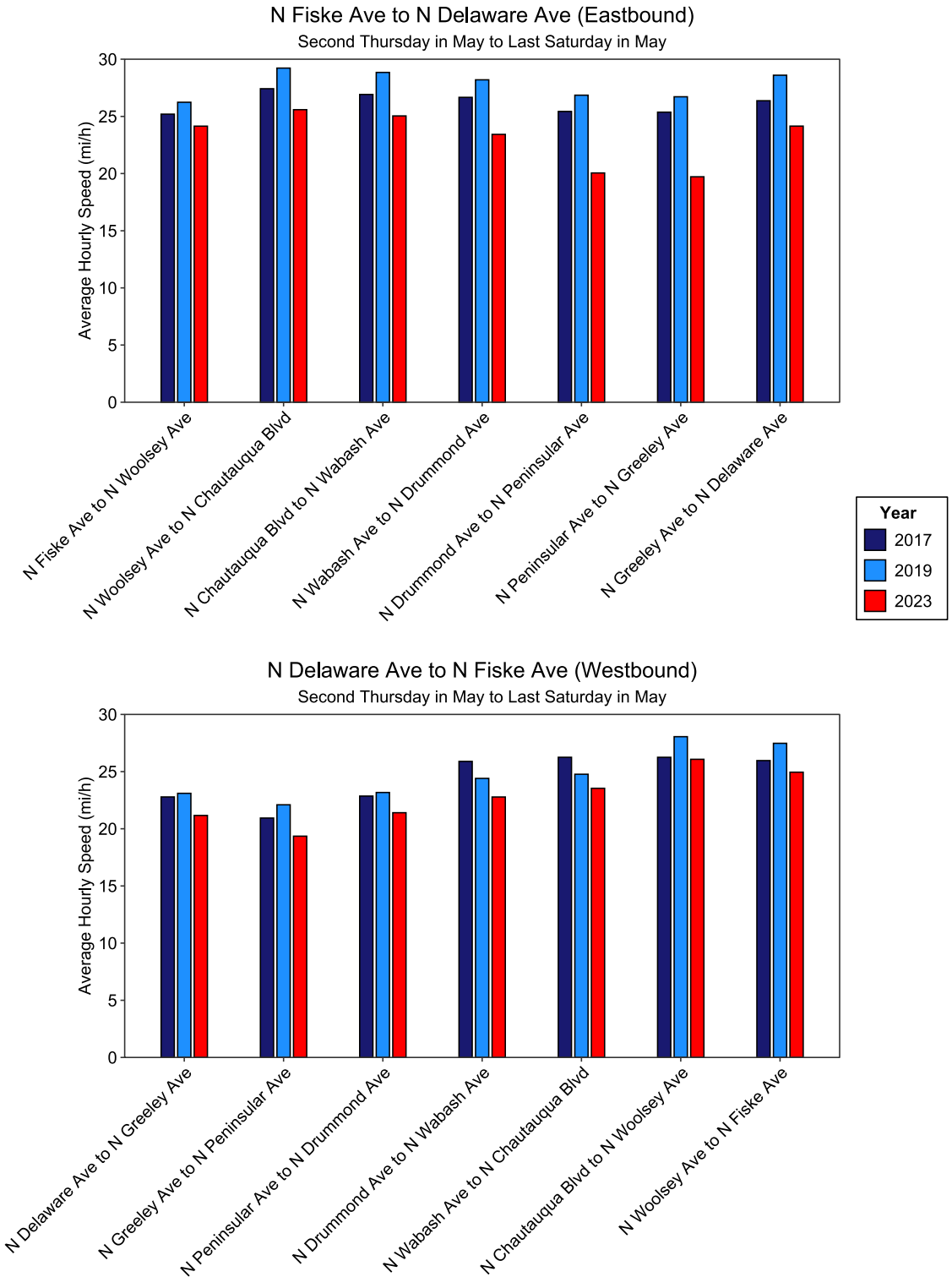


Figure 3.21 provide a summary of the segment-level analysis. Considering travel in the eastbound direction, from 2017 to 2019 each segment experienced an increase in average hourly

speed, with the maximum increase in average hourly speed being 2.2 mi/h (associated with a 8.5% increase) and the minimum increase in average hourly speed being 1.0 mi/h (associated with a 4.1% increase). In subsequent years, average hourly speed decreased for each segment considered (a decrease from 2019 to 2023 and an overall decrease from 2017 to 2023). The decreases in average hourly speed ranged from 2.1 mi/h to 7.0 mi/h, where shorter segments experienced higher decreases.

Speed in the westbound direction experienced similar trends. Five of the seven segments experienced an increase in average hourly speed from 2017 to 2019. Of the five segments that experienced an increase in average hourly speed, the maximum increase was 1.8 mi/h (associated with a 6.9% increase) and the minimum increase was 0.3 mi/h for two segments (associated with a 1.4% increase). All segments experienced a decrease from 2019 to 2023 ranging from 1.2 mi/h to 2.7 mi/h.

Table 3.15: Eastbound Average Hourly Speed (mi/h) by Segment

Segment	2017	2019	2023	Change 2017 to 2019	% Change 2017 to 2019	Change 2019 to 2023	% Change 2019 to 2023	Change 2017 to 2023	% Change 2017 to 2023
N Fiske Ave ↔ N Woolsey Ave	25.2	26.2	24.1	1.0	4.1%	-2.1	-8.0%	-1.0	-4.2%
N Woolsey Ave ↔ N Chautauqua Blvd	27.4	29.2	25.6	1.8	6.6%	-3.6	-12.4%	-1.8	-6.7%
N Chautauqua Blvd ↔ N Wabash Ave	26.9	28.8	25.0	1.9	7.2%	-3.8	-13.2%	-1.9	-7.0%
N Wabash Ave ↔ N Drummond Ave	26.7	28.2	23.4	1.5	5.7%	-4.8	-16.9%	-3.2	-12.1%
N Drummond Ave ↔ N Peninsular Ave	25.4	26.9	20.1	1.4	5.6%	-6.8	-25.3%	-5.4	-21.1%
N Peninsular Ave ↔ N Greeley Ave	25.4	26.7	19.7	1.3	5.3%	-7.0	-26.2%	-5.7	-22.3%
N Greeley Ave ↔ N Delaware Ave	26.4	28.6	24.1	2.2	8.5%	-4.5	-15.6%	-2.2	-8.4%

Table 3.16: Westbound Average Hourly Speed (mi/h) by Segment

Segment	2017	2019	2023	Change 2017 to 2019	% Change 2017 to 2019	Change 2019 to 2023	% Change 2019 to 2023	Change 2017 to 2023	% Change 2017 to 2023
N Fiske Ave ↔ N Woolsey Ave	26.0	27.5	24.9	1.5	5.8%	-2.5	-9.2%	-1.0	-3.9%
N Woolsey Ave ↔ N Chautauqua Blvd	26.3	28.1	26.1	1.8	6.9%	-2.0	-7.0%	-0.2	-0.7%
N Chautauqua Blvd ↔ N Wabash Ave	26.3	24.8	23.5	-1.5	-5.7%	-1.2	-5.0%	-2.7	-10.3%
N Wabash Ave ↔ N Drummond Ave	25.9	24.4	22.8	-1.5	-5.7%	-1.6	-6.7%	-3.1	-12.0%
N Drummond Ave ↔ N Peninsular Ave	22.9	23.2	21.4	0.3	1.4%	-1.8	-7.6%	-1.5	-6.4%
N Peninsular Ave ↔ N Greeley Ave	20.9	22.1	19.4	1.2	5.5%	-2.7	-12.4%	-1.6	-7.6%
N Greeley Ave ↔ N Delaware Ave	22.8	23.1	21.2	0.3	1.4%	-1.9	-8.4%	-1.6	-7.1%

2017, 2019 n

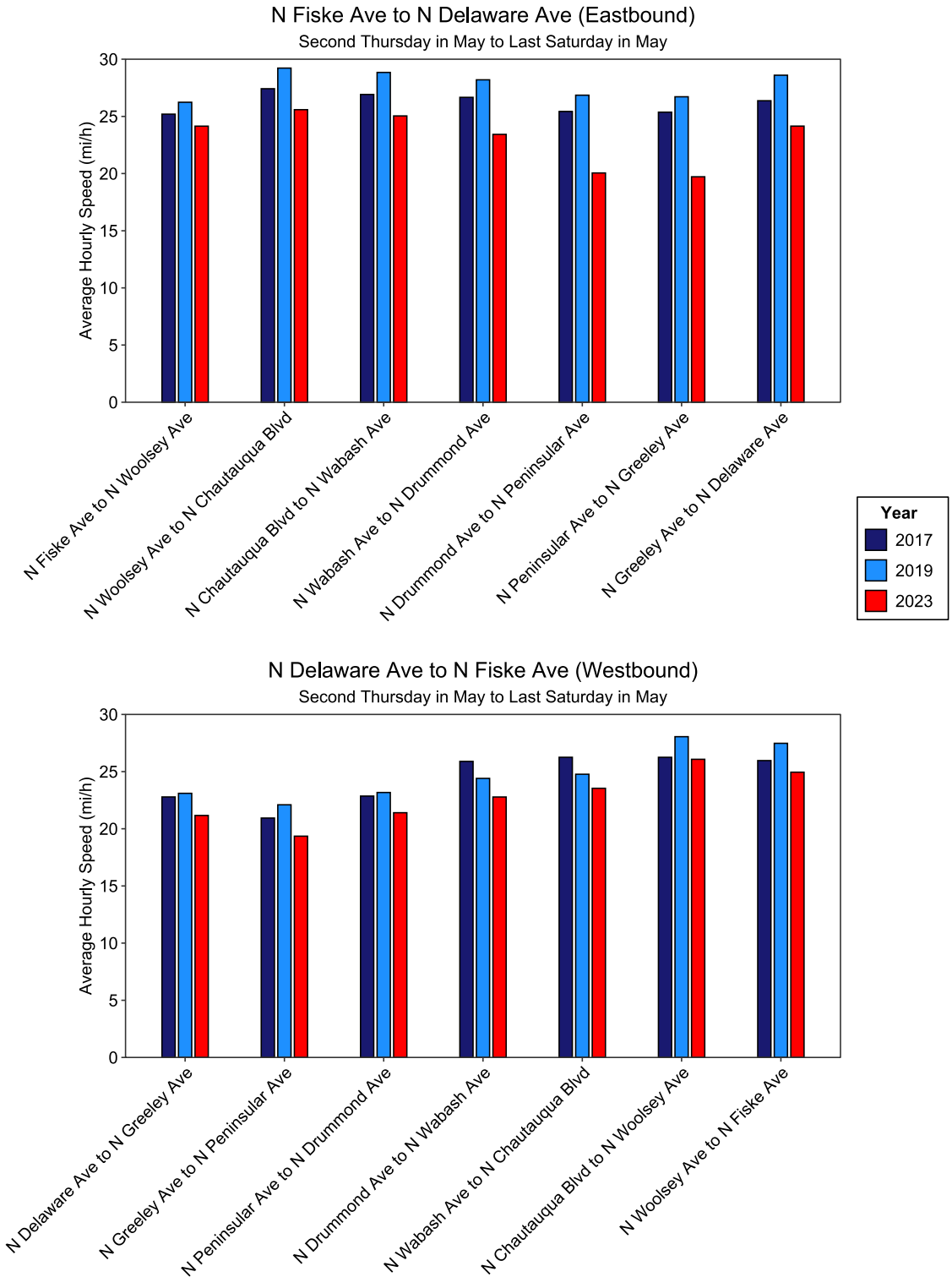


Figure 3.21: Average Hourly Speed on N Lombard St by Segment

3.4.5 Travel Time on Similar Segments

In addition to assessing speed and travel time in the project area, two additional segments were chosen to determine if similar trends were observed over the same time period. The focus here was on travel time, as travel times at the corridor-level can be compared. One segment was N Lombard St west of the project area, and one segment was on N Columbia Blvd. The N Lombard St segment considered was N Oswego Ave ↔ N Fiske Ave and the N Columbia Blvd segment considered was N Portsmouth Ave ↔ N Tyndall Ave. These segments in relation to the project area is shown in Figure 3.22. Results for each segment can be found in Appendix D.

Figure 3.23 and Figure 3.24 show the average hourly travel time on N Oswego Ave ↔ N Fiske Ave and N Portsmouth Ave ↔ N Tyndall Ave.

On N Oswego Ave ↔ N Fiske Ave, in the eastbound direction on weekdays, average hourly travel time remained relatively consistent from 2017 to 2019, with moderate increases in travel time from 2019 to 2023. The increases in travel time, although significant, were less compared to the project area. In the eastbound direction, on weekends, similar trends were observed.

In the westbound direction, on both weekdays and weekends, average hourly travel time remained mostly consistent year-to-year for the years considered, compared to significant increases in travel time within the project area. Overall, despite N Oswego Ave ↔ N Fiske Ave also experiencing significant differences in travel time, the segment within the project area experienced larger increases in travel time.

On N Portsmouth Ave ↔ N Tyndall Ave (N Columbia Blvd), significant decreases in travel time were observed in 2023 compared to previous years. These trends are in stark contrast to those observed along N Lombard St within the project area. Average hourly travel times decreased year-to-year during the years considered, as shown in **Error! Reference source not found.** and Table 3.18.

Table 3.17: Eastbound Change in Average Hourly Travel Time (sec) Along Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-10.1	31.1	-10.0	28.0
N Oswego Ave ↔ N Fiske Ave (N Lombard St)	-6.7	10.7	-2.8	12.1
N Portsmouth Ave ↔ N Tyndall Ave (N Columbia Blvd)	-3.6	-15.3	-4.8	-11.8

Table 3.18 Westbound Change in Average Hourly Travel Time (sec) Along Corridor

Segment	Average Weekday Change 2017 to 2019	Average Weekday Change 2019 to 2023	Average Weekend Change 2017 to 2019	Average Weekend Change 2019 to 2023
N Fiske Ave ↔ N Delaware Ave	-4.1	17.9	-2.0	13.9
N Oswego Ave ↔ N Fiske Ave (N Lombard St)	-20.5	16.4	-20.3	14.9
N Portsmouth Ave ↔ N Tyndall Ave (N Columbia Blvd)	-8.9	-10.1	-5.8	-10.7

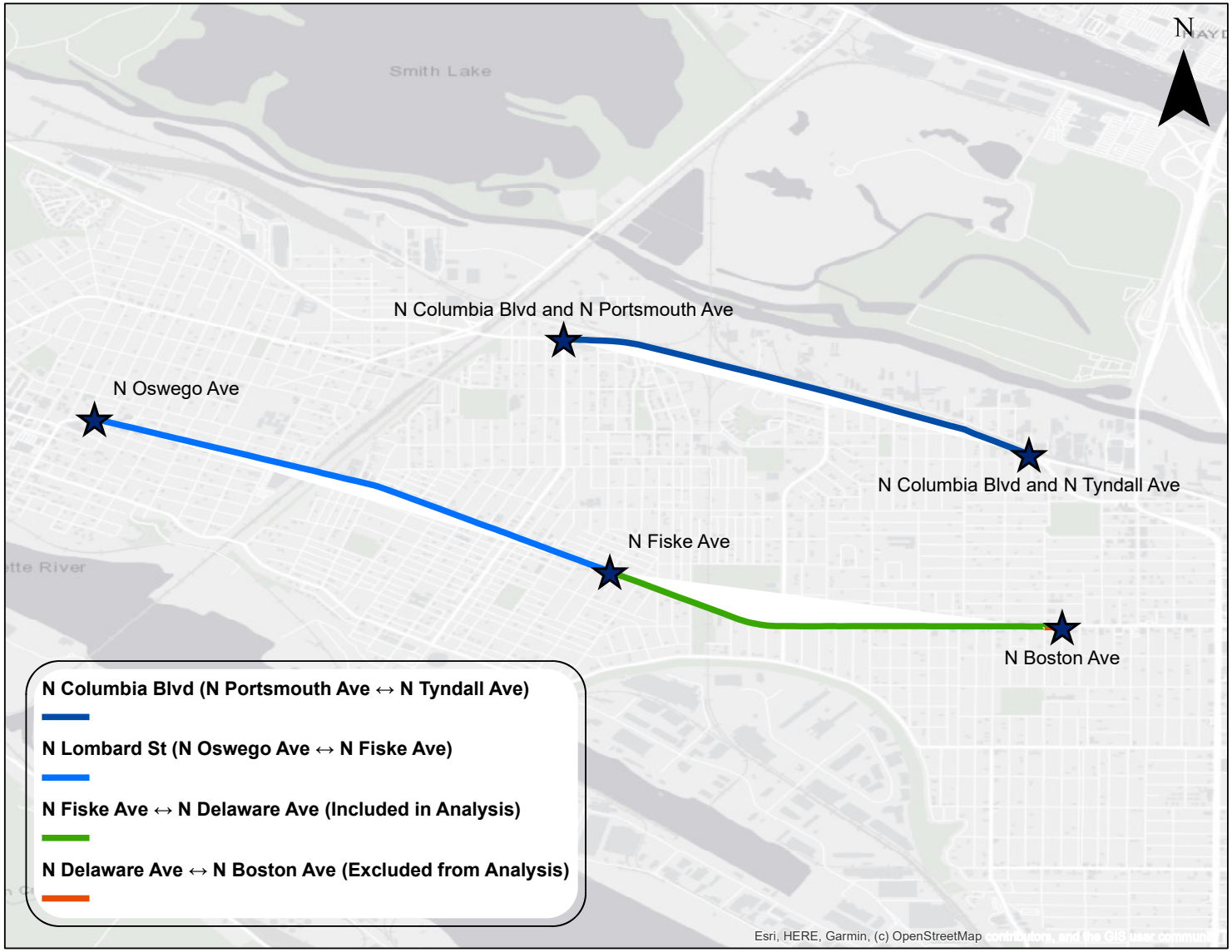


Figure 3.22: N Lombard St and N Columbia Blvd Segments Considered for Speed and Travel Time Comparison

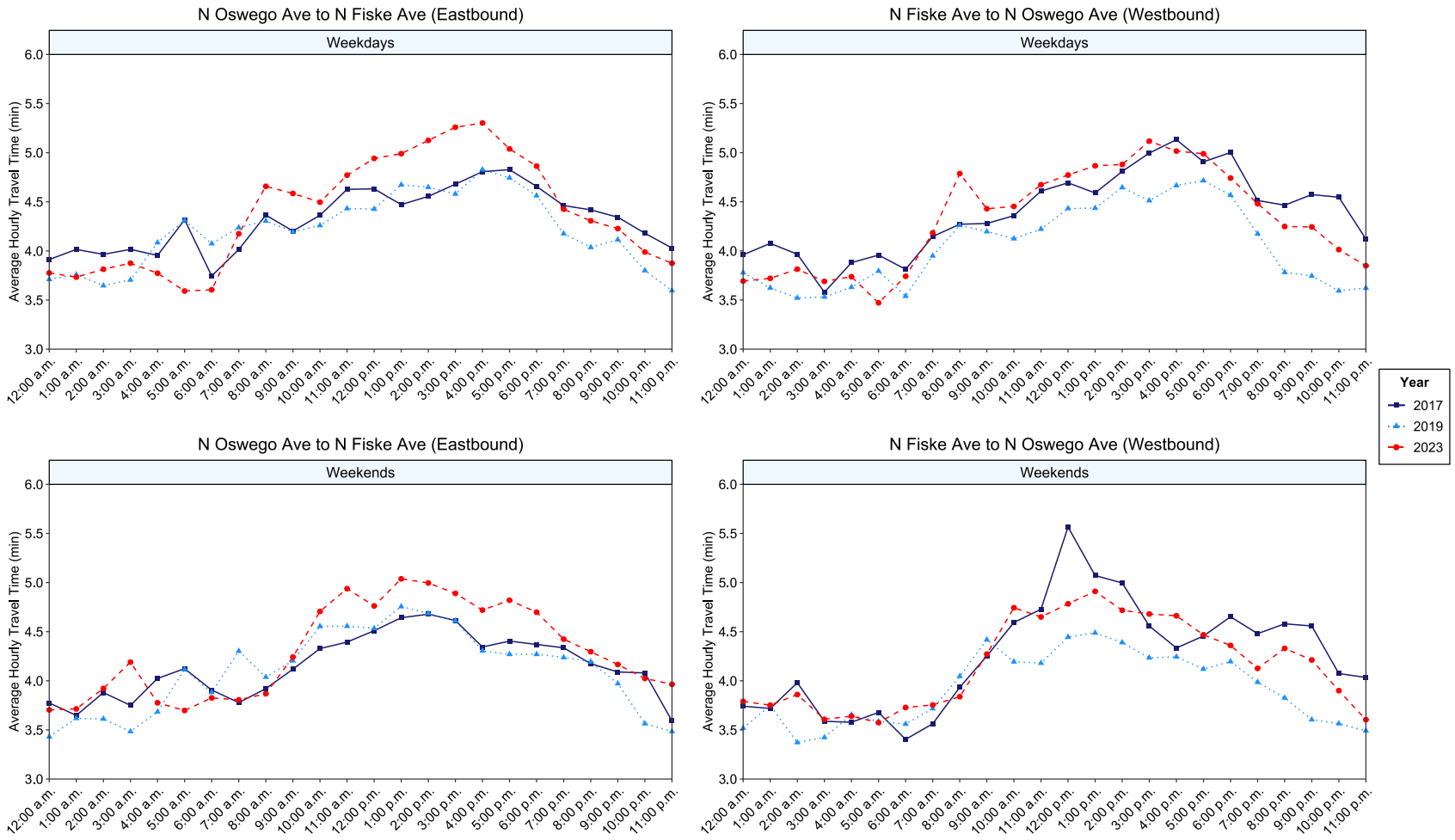


Figure 3.23: Average Hourly Travel Time on N Lombard St from N Oswego Ave ↔ N Fiske Ave

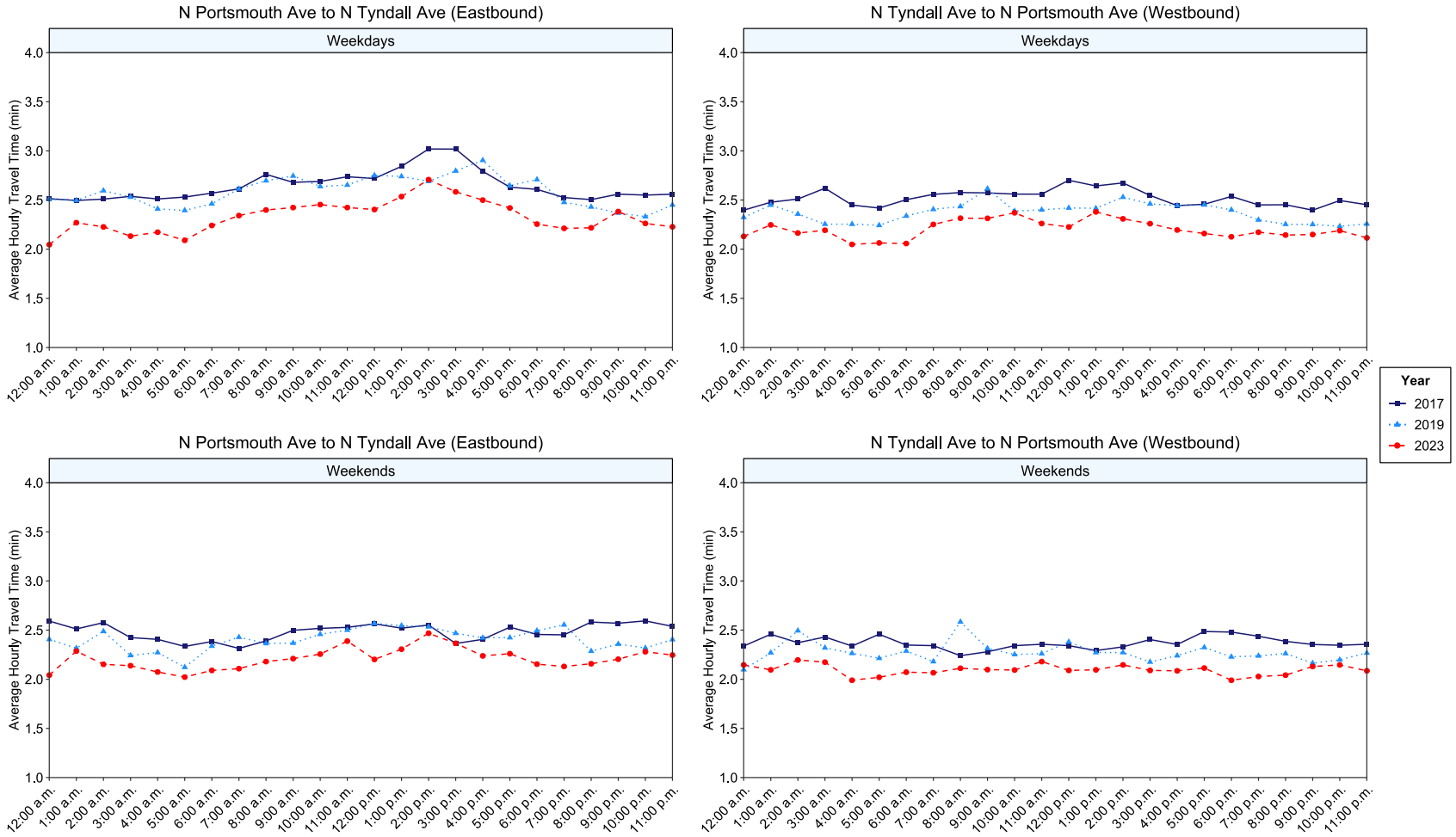


Figure 3.24: Average Hourly Travel Time on N Columbia Blvd from N Portsmouth Ave ↔ N Tyndall Ave

3.5 VEHICLE MILES TRAVELED AND PEAK PERIOD TRAVEL TIMES

This section details the changes in vehicle miles traveled (VMT) and peak period traffic counts. The VMT in the corridor are analyzed to understand diversion and overall throughout changes by comparing with nearby corridors while the peak period counts only compare counts in the corridor using counts collected before and after construction.

3.5.1 Vehicle Miles Traveled

This section documents the changes in VMT in the study corridor and compares with nearby corridors to document changes. North Columbia as well as N. Willamette Boulevard are used as comparison corridors since they are the only other major east-west roads and would be likely recipients of diverted traffic and also serve as control corridors to compare to the study corridor. Figure 3.25 below shows these corridors within the larger context of North Portland.

VMT is measured by ODOT's Traffic Data Section for reporting to the Highway Performance Monitoring System (HPMS). HPMS data is collected for each state to report on traffic volumes for use in travel monitoring and related agency efforts like safety analysis and represents the data of record for VMT.

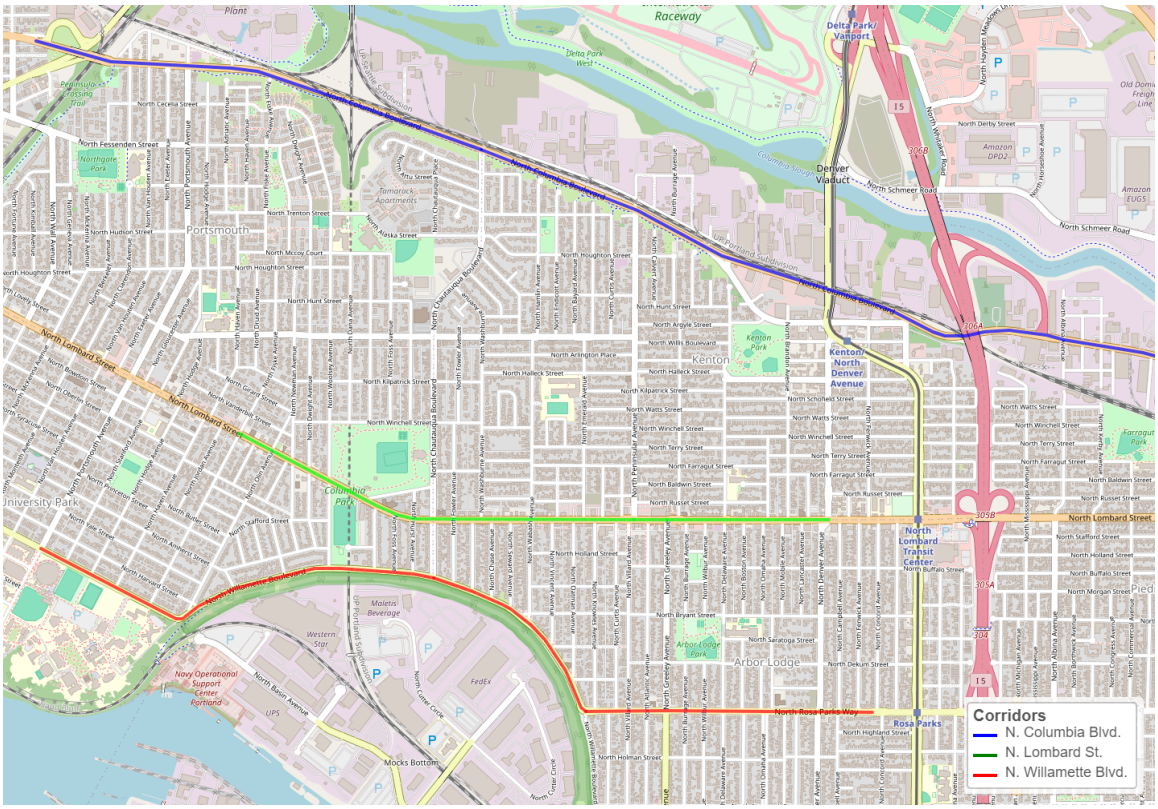


Figure 3.25: Study Corridor and Comparison Corridors Used in VMT Analysis

Table 3.19 below summarize the total annual VMT for the study corridor and the comparison corridors for 2019 and 2023 as well as the percent change. In addition to the study corridors, the total Portland area arterial VMT and total all road VMT is summarized for additional comparison. The N. Lombard corridor experiences a decline in VMT of 20.5% while the comparison corridors N. Columbia and Willamette Blvd. experienced a reduction of 5.7% and 3.6% respectively. Both figures are a larger reduction than the Portland Metro urbanized area arterial system and the Portland road system as a whole with reductions of 1.6% and 2.8% respectively.

Table 3.19: Number of Through Vehicles on N Lombard St

Corridor	Annual Vehicle Miles Traveled 2019	Annual Vehicle Miles Traveled 2023	% Chang
N. Lombard St.	10,820,919	8,603,716	-20.5%
N. Columbia Blvd.	27,771,014	26,175,627	-5.7%
Willamette Blvd.	15,082,052	14,532,892	-3.6%
PDX Metro Arterial VMT	2,175,551,868	2,141,618,083	-1.6%
PDX Metro VMT	11,336,097,475	11,016,013,119	-2.8%

It's not clear if the larger reduction in VMT on the N. Lombard corridor is related to roadway reconfiguration since VMT would be a function of roadway supply but also population, employment and other economic conditions in Portland. It is well known that travel patterns have changed in the post COVID-19 pandemic with more people working from home, which explain the consistent decrease in VMT across corridors and areas in the table, but further analysis would be necessary to explain the differences in VMT changes across corridors.

3.5.2 Peak Period Travel Times

Vehicle counts extracted from the after video were compared to vehicle counts obtained from Quality Counts using the before video. For comparison, only vehicles that were determined to be traveling through the intersection were considered. **Error! Reference source not found. Error! Reference source not found.** and a 7:00 a.m. to 9:00 a.m.
b 4:00 p.m. to 6:00 p.m.

Table 3.21and Figure 3.26 show the number of through vehicles by intersection in the before and after periods by direction and time-of-day. At each location, a decrease in the number of through vehicles was observed. The largest decreases were observed during the morning hours in the eastbound direction, where seven of the nine intersections had decreases of more than 30% in the number of through vehicles. The morning hours in the westbound direction experienced the smallest decreases in through vehicles with a maximum decrease of 16.1% and a minimum decrease of 1.5%.

Table 3.20: Eastbound Number of Through Vehicles on N Lombard St

Location	Morning[a] Before	Morning[a] After	Morning[a] Change	Evening[b] Before	Evening[b] After	Evening[b] Change
Peninsula Crossing Trail	920	802	-118 (-12.8%)	1,404	1,214	-190 (-13.5%)
N Fortune Ave	963	828	-135 (-14.0%)	1,389	1,253	-136 (-9.8%)
N Hurst Ave	1,183	815	-368 (-31.1%)	1,198	1,042	-156 (-13.0%)
N Chautauqua Ave	1,125	785	-340 (-30.2%)	1,165	986	-179 (-15.4%)
N Emerald Ave	1,467	973	-494 (-33.7%)	1,484	1,195	-289 (-19.5%)
N Peninsular Ave	1,448	953	-495 (-34.2%)	1,430	1,158	-272 (-19.0%)
N Greeley Ave	1,547	938	-609 (-39.4%)	1,530	1,136	-394 (-25.8%)
N Delaware Ave	1,571	966	-605 (-38.5%)	1,638	1,274	-364 (-22.2%)
N Denver Ave	1,388	942	-446 (-32.1%)	1,363	1,103	-260 (-19.1%)

a 7:00 a.m. to 9:00 a.m.
b 4:00 p.m. to 6:00 p.m.

Table 3.21 Westbound Number of Through Vehicles on N Lombard St

Location	Morning[a] Before	Morning[a] After	Morning[a] Change	Evening[b] Before	Evening[b] After	Evening[b] Change
Peninsula Crossing Trail	963	911	-52 (-5.4%)	1,228	1,193	-35 (-2.9%)
N Fortune Ave	953	939	-14 (-1.5%)	1,267	1,222	-45 (-3.6%)
N Hurst Ave	807	749	-58 (-7.2%)	1,237	1,055	-182 (-14.7%)
N Chautauqua Ave	780	691	-89 (-11.4%)	1,169	986	-183 (-15.7%)
N Emerald Ave	936	834	-102 (-10.9%)	1,442	1,096	-346 (-24.0%)
N Peninsular Ave	922	790	-132 (-14.3%)	1,443	1,114	-329 (-22.8%)
N Greeley Ave	930	793	-137 (-14.7%)	1,476	1,060	-416 (-28.2%)
N Delaware Ave	1,025	860	-165 (-16.1%)	1,559	1,131	-428 (-27.5%)
N Denver Ave	979	835	-144 (-14.7%)	1,284	973	-311 (-24.2%)

[a] 7:00 a.m. to 9:00 a.m.
[b] 4:00 p.m. to 6:00 p.m.

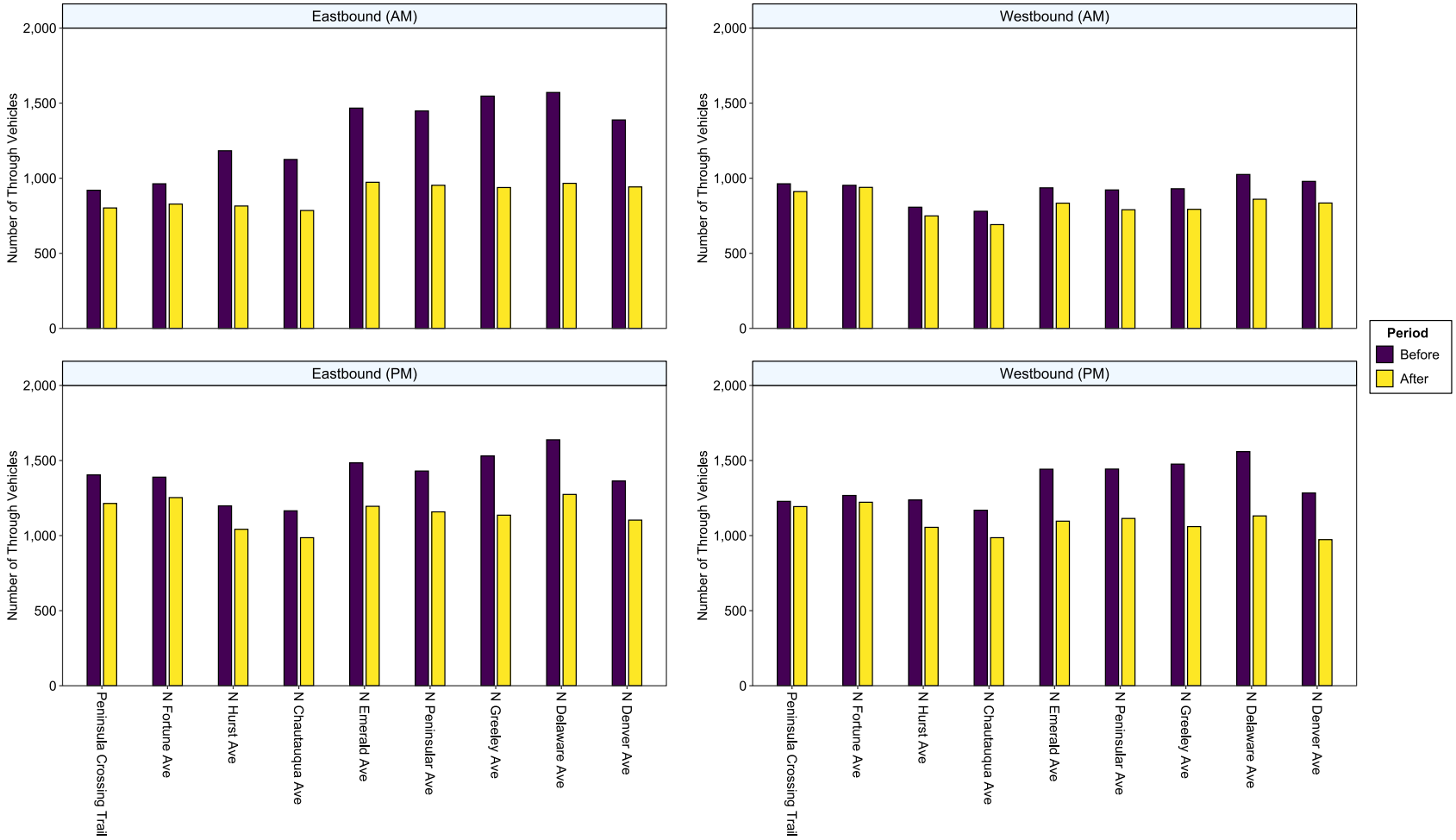


Figure 3.26: Number of Through Vehicles by Intersection, Direction, and Time-of-Day

3.6 ANALYSIS SUMMARY

3.6.1 Multimodal Analysis

Overall, 5,109 crosswalk users were observed at the thirteen locations in the before and after periods. The number of crosswalk users observed decreased between 2017 and 2019 (1,913 vs. 1,384, -27%) and increased between 2019 and 2023 (1,384 vs. 1,812, 31%). Comparing the overall volumes between 2017 and 2023, there was a slight decrease (1,913 vs. 1,812, -5.3%). The majority of users in the before and after periods were pedestrians (68.37% - 71.46%), followed by cyclists (27.5% -29.6%), scooters (0.3% - 2.2%), wheelchair users (0.1%-0.3%), skateboarders (0.4% - 1.1%), and others (0.1% - 0.3%). Mirroring the overall trend, the volumes of pedestrians and cyclists decreased between 2017 and 2019 (-24% pedestrians, -33% cyclists) and increased between 2019 and 2023 (25% pedestrians, 36% cyclists).

Overall, across the six intersections where conflicts were measured, 119 conflicts were observed with PETs less than or equal to 5 sec. Of the 119 conflicts, 39% had PETs less than or equal to 1.5 sec, 37% had PETs between 1.5 and 3.5 sec, and 24.4% of the conflicts had PETs greater than 3.5 sec and less than or equal to 5 sec. **Error! Reference source not found.** shows the frequency of the observed conflicts in the before-after periods. There was a 25% reduction in conflicts overall in the after period compared to the before period. Decreases in the frequency of conflicts were also observed in the PET $\leq$ 1.5 sec and 1.5 < PET $\leq$ 3.5 sec categories, while a small increase was observed in the 3.5 < PET $\leq$ 5 sec in the after period as compared to the before period. Minimum and average PETs decreased, and maximum PET increased in the after period as compared with the before period. Average crosswalk user delays decreased at three locations (Peninsula Crossing Trail, N Fortune Ave, and N Hurst Ave) and increased at two locations (N Emerald Ave and N Drummond Ave) in the after condition compared to the before condition.

3.6.2 Travel Time and Speed Analysis

Due to the inherent relationship between speed and travel time, similar but opposite trends were observed. For the corridor-level analysis, the largest increases in average hourly travel time were observed in the eastbound direction and on the corridor within the project area. In the westbound direction, increases in average hourly travel time after project completion were less pronounced and consistent across each of the three corridors. Overall, moderate increases in average hourly travel time were observed after project completion (in the 30 seconds range). In the eastbound direction, increases primarily took place during the morning peak hours, the midday hours, and evening peak hours, while in the westbound direction increases occurred during morning peak hours and midday hours (weekdays) and afternoon/early evening hours (weekends).

Compared to similar and nearby segments, average hourly travel time increased more on the segment within the project area compared to segments outside of the project area.

For the segment-level analysis, all segments experienced an increase in average hourly travel time from 2019 to 2023 in the eastbound direction, while the same trend was observed in the westbound direction.

For the segment-level speed analysis, the same yet opposite trends were observed (i.e., increases in average hourly travel time were decrease in average hourly speed, and vice-versa).

3.6.3 Vehicle Throughput

Vehicle throughput decreased at each location considered on N Lombard St from N Fiske Ave to N Boston Ave, with direction and time-of-day having an impact on reduction in throughput. The largest decreases in throughput were observed in the morning hours (7:00 a.m. to 9:00 a.m.) in the eastbound direction and the smallest decreases in the morning hours (7:00 a.m. to 9:00 a.m.) in the westbound direction. The vehicle throughput counts may be capturing commuter behavior on this route (more individuals traveling eastbound in the morning to work compared to westbound), as the morning hours in the eastbound direction experienced the largest reduction in vehicle throughput and the evening hours (4:00 p.m. to 6:00 p.m.) in the westbound direction also experiencing moderate decreases in vehicle throughput. These changes could be a result of post-covid commute patterns, as several people still work remotely and have not returned to regular commuting.

In reducing capacity, decreases in vehicle throughput are expected. Regarding safety, reducing throughput reduces exposure to vulnerable road users, which is a key input for safety performance functions and increases the expected number of crashes. By reducing exposure to vulnerable road users, potential conflicts and potential crashes may be reduced.

Regarding average annual daily traffic (AADT) changes near the project area, trends indicate lower AADT in 2023 compared to 2019 to the east of the project area (on N Lombard St), while to the west of the project area (on N Lombard St) AADT is about the same as 2019 or greater. This variation is also observed on the N Columbia Blvd segment that was compared to the project area for travel time, where one location has experienced a decrease in AADT and another an increase.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The objective of this study was to understand the safety and operational impacts of corridor reconfiguration on N Lombard St. To achieve the research objectives, a before-after evaluation was performed. Before-after video data was recorded at thirteen intersections along the Lombard corridor and performance metrics such as vehicle volumes, crosswalk volumes, conflict frequency and potential severity were extracted. Before-after speeds and travel times were collected using RITIS.

Overall, 5,109 crosswalk users were observed at the thirteen locations in the before and after periods. The number of crosswalk users observed decreased between 2017 and 2019 (1,913 vs. 1,384, -27%) and increased between 2019 and 2023 (1,384 vs. 1,812, 31%). Comparing the overall volumes between 2017 and 2023, there was a slight decrease (1913 vs. 1,812, 5.3%).

Majority of the crosswalk users in the before and after periods were pedestrians. Overall, across the six intersections where conflicts were measured, 119 conflicts were observed with PETs less than or equal to 5 sec. Thirty-nine percent of the conflicts had PETs less than or equal to 1.5 sec, 37% had PETs between 1.5 and 3.5 sec, and 24.4% of the conflicts had PETs greater than 3.5 sec and less than or equal to 5 sec. Minimum and average PETs decreased and maximum PET increased in the after period as compared with the before period, which is a positive trend. Before-after comparison of crosswalk user delays at uncontrolled locations showed mixed results, with average delays reducing at some locations and increasing at other locations.

The overall trend for speed and travel time consisted of decreases in average hourly speed and increases in average hourly travel time after project completion, where all segments in the eastbound direction experienced significant differences and moderate to large decreases (average hourly speed) and increases (average hourly travel time). Differences in the westbound direction were less pronounced, but present still. In general, from 2017 to 2019 (before the project), all segments experienced an increase in average hourly speed and a decrease in average hourly travel time, and from 2019 to 2023 a decrease in average hourly speed and an increase in average hourly travel time. The exceptions were the N Chautauqua Blvd ↔ N Wabash Ave and N Wabash Ave ↔ N Drummond Ave segments, both of which experienced a decrease in average hourly speed and increase in average hourly travel time from 2017 to 2019 and from 2019 to 2023. Compared to N Lombard St west of the project area (N Oswego Ave ↔ N Fiske Ave), there were larger increases in average hourly travel time despite N Oswego Ave ↔ N Fiske Ave also experiencing increases in average hourly travel time. Compared to N Columbia Blvd (N Portsmouth Ave ↔ N Tyndall Ave), there were increases in average hourly travel time while average hourly travel time on N Portsmouth Ave ↔ N Tyndall Ave decreased.

Comparing vehicle through counts before and after project completion revealed that vehicle throughput decreased substantially in the after period, where the morning hours (7:00 a.m. to 9:00 a.m.) in the eastbound direction experienced the largest reductions. Also experiencing

moderate decreases in vehicle throughput were the evening hours (4:00 p.m. to 6:00 p.m.) in the westbound direction.

4.2 RECOMMENDATIONS

Before-After analysis is one of the methods employed to assess the impacts of changes on a facility by observing the conditions after the changes have been made and comparing them to the before conditions. However, to perform this assessment well, it is necessary to carefully design the analysis approach before the changes are implemented, such that relevant before-after data can be collected. Specifically, to evaluate changes made to a facility, it is important to lay out the performance measures that will be studied, determine the data collection method, and identify the data sources that will be used in the analysis. It is also important to determine if the data being collected will be used for other purposes. Below are specific considerations for each data category along with some general considerations.

4.2.1 Data Types

4.2.1.1 Volumes

For collecting before-after volume data, it is important to identify the types of users (e.g., vehicles, heavy vehicles, multimodal (peds, bikes, scooters etc.)) that volumes will be collected for. Determine the movements to count (e.g., turning movement vs. through volumes). Determine if short-term counts are appropriate or longer-term counts are needed based on the study objectives. The study should also consider if probe data volumes can be used instead of actual counts.

4.2.1.2 Safety

The study should determine what safety metrics should be assessed and for what modes. Other considerations for safety measures include the types of data sources needed to assess the safety metrics (e.g., crash data, conflict data, driver yielding, compliance, etc.) and defining the period and type of safety study (e.g., a conflict-based study can be done in a shorter time period as compared to a crash-based study). If the intent is to do a full before-after study using crash data, then a longer study period (3-5 years after the treatment has been installed) is needed.

4.2.1.3 Travel Time and Speed

It is important to consider how the data will be collected (e.g., travel time runs vs. probe data) and the strengths and limitations of each data type. The level of aggregation (per-vehicle-records, 1 min, 5 min, average for the segment, etc.) and time period (peak or off-peak hours, daytime vs. nighttime, weekday vs. weekend) should also be considered.

4.2.2 General Considerations

4.2.2.1 Technologies

Based on the data types and performance measures outlined for the study, what are the available technologies and their strengths and limitations? Which technology would be best suited to collect the different user types and data types (e.g., conflicts) considering accuracy, reliability, and cost?

4.2.2.2 Time periods

The study should consider which time periods should the data be collected for to be most representative of the operating conditions (e.g., season (spring, summer, fall, winter), time-of-day (peak or off-peak hours, daytime vs. nighttime, weekday vs. weekend), etc.)

4.2.2.3 Aggregation levels

Considerations for data aggregation include determining what aggregation level is best suited for the analysis (e.g., per vehicle, or aggregated to different intervals (5 min, 15 min, hourly)). This could be dependent on the data collection equipment that is being used. Generally, it is recommended to collect the data at the lowest level (i.e., not aggregated) and any aggregation can be conducted at the analysis stage if required.

4.2.2.4 Storage of data

Determine where and how the data will be stored. Consider the storage size implications (e.g., storing the files locally vs. in a cloud) especially when large amounts of data are being collected. How long should the raw data be stored before it is aggregated and/or archived. It is important to store the data carefully, so that it can be retrieved easily for future analysis.

4.2.2.5 Sharing the data

Determine how the data will be shared for the analysis (e.g., FTP vs. a cloud-based service).

4.2.2.6 Documentation of metadata

It is important to document the metadata for the different types of data that are collected and stored. The level of detail for the metadata is also important. In general, it is recommended that as much detail as possible be provided to the analyst.

4.2.2.7 Data formatting

Since many different types of data will be collected, it is important to think about the formats for each data type. Generally, data should be formatted in a way that is reproducible and easy to understand (e.g., format the data in csv or other formats that are compatible with programming software). Typically, for data analysis, extracting the data

from PDFs can be cumbersome and therefore sharing the data through PDFs is not recommended.

4.2.2.8 Consistency

It is vital to stay consistent with the data collection, storage, sharing, documentation, and formats in the before-after periods. Any changes may result in the data not being useful for comparison and lead to less meaningful results. If it is not possible to stay fully consistent across all the elements, it is recommended to remain as consistent as possible to the before conditions for useful analysis.

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