VALIDATION OF THE NEW SPEED ZONING METHOD FOR URBAN ARTERIALS AND HIGH-SPEED ROADWAYS IN TERMS OF SPEED COMPLIANCE AND SAFETY OUTCOMES

Final Report

PROJECT SPR-854

Oregon Department of Transportation

VALIDATION OF THE NEW SPEED ZONING METHOD FOR URBAN ARTERIALS AND HIGH-SPEED ROADWAYS IN TERMS OF SPEED COMPLIANCE AND SAFETY OUTCOMES

Final Report

PROJECT SPR-854

by

Jason C. Anderson, Ph.D.
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

June 2024

Technical Report Documentation Page

1. Report No. FHWA-OR-RD-25-04	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Validation of the New Speed Zoning Method for Urban Arterials and High-Speed Roadways in terms of Speed Compliance and Safety Outcomes		5. Report Date April 2024 6. Performing Organization Code
7. Author(s) Jason C. Anderson		8. Performing Organization Report No.
9. Performing Organization Name and Address Portland State University P.O. Box 751 Portland, OR 97207		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Oregon Dept. of Transportation Research Section 555 13th Street NE, Suite 1 Salem, OR 97301 Federal Highway Admin. 1200 New Jersey Avenue SE Washington, DC 20590		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This study presents the results of an analysis on the effects of Oregon's speed zoning method on speed compliance and safety outcomes. Speed zones were selected in an urban area based on the availability of before and after speed data. Data for roadway context was collected, which included population, equity, land use, roadway, and exposure characteristics. The speed data was used to conduct a descriptive analysis that focused on key speed metrics to determine if the speed zone had an impact on speed compliance. A series of speed models were developed to identify significant relationships between observed speed and available explanatory variables. Lastly, Oregon crash data was used to assess the safety outcomes of the selected speed zones after the new speed limit sign was installed. This study concludes by providing a comprehensive conclusion and specific recommendations related to the results of the speed and safety analysis.

17. Key Words	18. Distribution Statement Copies available from NTIS, and online at www.oregon.gov/ODOT/TD/TP_RES/		
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 254	22. Price

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
~NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

ACKNOWLEDGEMENTS

The authors want to thank the Oregon Department of Transportation for funding this study. The authors also want to thank the Research Coordinator for this project for effective and efficient project management, Greg Griffin. The authors further thank Tom Jensen from the Portland Bureau of Transportation for both providing and collecting spot speed data. For valuable feedback, guidance, and site selection, the authors want to thank the Technical Advisory Committee members:

- Laura Prusakiewicz, Traffic Speed Zone Engineer (ODOT)
- Scott Baston, Vision Zero Traffic Engineer (PBOT)
- Nicholas Fortey, Traffic Safety Engineer (FHWA)

DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Operating speeds of vehicles have long been a concern for Oregon cities. Previous research has shown that vehicles traveling above posted speeds are overrepresented in crashes. For vulnerable users, the survivability of a crash depends on the collision's speed; therefore, setting appropriate speeds that motorists will respect, reducing variations in speed and reducing operating speed (e.g., mean speed, median speed, 85th percentile speed), is important for reducing crashes and crash severity outcomes. Achieving lower operating speeds that improve the survivability of vulnerable users on the roadway is also important for decreasing pedestrian and other active transportation user crashes. From 2009 to 2018, pedestrian fatalities increased by 53% after decreasing for approximately three decades. The proportion of all traffic fatalities that were pedestrian increased from 12% to 17%. High-speed roadways and urban arterials are major risk factors.

In light of this, the Oregon Department of Transportation (ODOT) has implemented a new method of speed setting in urban areas. Prior to that, ODOT worked with the City of Portland to pilot a new urban speed zoning method. Both efforts aim at improving safety in urban areas, particularly for active transportation users. NCHRP Synthesis 535 analyzed known strategies and measures to improve pedestrian safety. The synthesis found that there was a need for greater clarity about the speed setting process and greater collaboration between state and local agencies on state roads through urban areas. It is necessary to evaluate the new ODOT methodology to determine if the process improves safety and if drivers are inclined to lower operating speeds when lower speed limits are posted.

1.1 OBJECTIVES

The evaluation of the current ODOT methodology will focus on higher speed roadways, such as arterials and roadways that are prone to more severe injury outcomes. This will require investigating ways agencies have found to balance local safety needs and mobility of vehicles on urban arterials and high-speed roadways, as well as considering the advantages and disadvantages of different procedures and criteria to set reasonable and safe speed zones. This is accomplished through a review of state speed zoning and speed management policies and practices.

Specific research objectives include: (a) Identify any other cities or states across the nation that may be using innovative methods for setting speeds, (b) Determine if drivers are inclined to lower operating speeds when lower speeds are posted, (c) Evaluate the current ODOT methodology to determine if the process improves safety, and (d) Provide recommendations based on the research findings.

Due to speed limit setting being inherently linked to roadway safety, ODOT undertook an effort to modernize Oregon’s methods of speed limit setting by developing a new process that recognizes differences between urban and rural settings. Urban area methodologies, specifically, were changed substantially to address the balance between reasonable speeds and protecting vulnerable road users. To determine if the speed zoning method is working, this research collects and analyzes

spot speed data at various locations on speed zones in the Portland Metropolitan area. Additionally, to understand the safety implications of the new speed zones, a crash data analysis is conducted using Oregon crash data. Lastly, to identify significant relationships between observed speeds and different factors (notably after the speed zone was implemented and site-level variables), a series of speed models are developed. Based on the findings, this study provides recommendations as regards speed zone assessment and future analyses.

It is important to note that the intent of this study is to evaluate the new speed zoning approach, not necessarily validate. As discussed in later chapters, at the time of study, speed zones were new, which led to limitations on sample size and data availability (for the crash analysis). This work does, however, provide some evidence in support of the new speed zoning method.

1.2 ORGANIZATION OF REPORT

This report first presents the findings from a comprehensive review of speed zoning and speed management practices used throughout the United States. After the review, the analysis locations and context of each spot speed location are presented. This includes the location of the speed zone, demographics and population characteristics, roadway characteristics, adjacent land use designations, and traffic volume.

After providing the analysis locations and their context, speed compliance is assessed through a comprehensive descriptive analysis that summarizes mean speed, median speed, 85th percentile speed, the proportion of vehicles speeding, the proportion of vehicles exceeding 5 mi/h over the posted speed limit, the proportion of vehicles exceeding 10 mi/h over the posted speed limit, and the proportion of vehicles exceeding 15 mi/h over the posted speed limit for before and after speed zone implementation (after is defined as after the new speed limit sign was installed). The next analysis presents the results from a safety assessment that uses a simple before-after approach, which is then followed by a suite of speed models to identify significant associations between available explanatory variables and observed speed. It should be noted that the intent of the models is not to make causal inference; rather, the models are explanatory in nature. For each analysis, results and summaries are presented.

This report closes with conclusions and recommendations.

2.0 SPEED ZONING AND SPEED MANAGEMENT PRACTICES

Chapter 2.0 summarizes speed zoning and speed management practices across the United States. Summaries are provided for states where a speed zoning manual, speed management manual, or closely related study was found. If states are not summarized, a speed zoning or speed management manual, or closely related study, was not found. Chapter 2.0 first summarizes state speed zoning or speed management practices, followed by a summary of Oregon's speed zoning approach, and then an overall summary.

2.1 SPEED ZONING AND SPEED MANAGEMENT BY STATE

2.1.1 Alabama

In 2015, the Alabama Department of Transportation published a speed management manual with the purpose of providing guidelines and a framework for establishing realistic and credible speed zones on the state highway system (Alabama Department of Transportation, 2015). This was developed as part of Alabama's speed policy initiatives, which identifies cost-effective strategies for decreasing speed-related crashes, such as using multi-agency and multi-disciplinary processes, assessments, techniques, and methodologies. The initiative also includes multi-disciplinary field investigations of locations with a high number of speeding-related fatal and serious injury crashes, providing public information and education on the risks and consequences of speeding, proposing legislation, fair and consistent adjudication of speeding citations, and modifying or reinforcing speed management programs based on results of impact and effectiveness. The manual itself details the speed study procedures, the process of approval, and speed modification options.

In Alabama, all speed limits are determined through a comprehensive engineering and traffic study, which applies to both the Department of Transportation and local agencies when establishing speed limits on state roadways. Therefore, local agencies are advised to use the methods outlined in the manual as the recommended practice.

In Alabama, the Alabama Department of Transportation Maintenance is responsible for reviewing and approving region-level speed zoning recommendations. Alabama Department of Transportation Regions is responsible for conducting the engineering study to assess if speed zones should be established. Municipalities must request that the corresponding region conduct an engineering study, as are counties, should municipalities or counties need to assess if speed zones should be established on State routes.

Alabama does grant local municipalities and counties the authority to change speed limits on non-State roadways within their jurisdiction, but not above the statutory limit. Approval from the Alabama Department of Transportation is not required under these considerations. It is recommended that local agencies and counties apply the procedures outlined in the manual, although it is optional.

2.1.2 California

Although California does not have an explicit speed zoning or speed management manual, California does have a comprehensive manual on setting speed limits (California Department of Transportation, 2020). California defines the following speed zones: regulatory, advisory, temporary, school, truck, private facilities, special weather conditions, and variable. Regulatory speed zones must be established by an engineering and traffic study, where under California Law, engineering and traffic studies are valid for five years and may be valid longer under specific conditions or circumstances.

Speed zone design in California is described by the following:

- Speed zone changes need to be coordinated with changes in roadway conditions, development, and land use.
- Speed zones of less than 0.50 miles should be avoided.
- Create separate speed zones at City, County, or other jurisdictional boundaries.
- Set speed limits can be reduced by 5 mi/h if justification is provided through an engineering and traffic study and approved by a registered Civil or Traffic Engineer.
- The speed zone must be assessed through trial runs, where drives are conducted through the speed zone at the chosen speed limit to confirm if the proposed speed limit is appropriate for that location. This is done to identify any irregularities in the speed zone that may need adjustment.

After an engineering and traffic study, law enforcement and other relevant engineering agencies are contacted to discuss findings as part of the speed zone approval and distribution process. Suppose findings indicate a need to change the speed limit. In that case, a letter is sent to local officials to allow for a public hearing, where results should be considered, and any new concerns and non-apparent conditions are investigated. In addition, the California Department of Transportation must consult with state and local police and engineers and consider their recommendations before changing the speed limit. The premise behind this step is to bring to light any non-apparent conditions, collision data, and level of opposition to the speed limit change. California Department of Transportation (2020) states that these discussions can help locate the beginning and end of individual speed zones.

California Department of Transportation (2020) further states that crash data and non-apparent conditions can be used to justify a 5 mi/h reduction. However, if a 5 mi/h reduction is applied, additional conditions do not justify additional reductions. California Department of Transportation (2020) is clear that public and political opinions are not reasons to change the results of an engineering and traffic study and cannot be used as justification to change the speed limit.

2.1.3 Colorado

Due to the Colorado Strategic Highway Safety Plan not including speeding-related crashes as one of its emphasis areas, a Colorado Speed Management Action Plan was developed to improve safety by reducing speeds (Clark et al., 2017). The Colorado Speed Management Action Plan addresses two main aspects: (1) Updating speeding-related policies and programs and (2) Improving the process for identifying speeding-related crash locations. The plan was developed in conjunction with a workshop that included Colorado's critical safety and speed management stakeholders, such as Colorado Department of Transportation representatives, local agencies, and law enforcement. Topics discussed during the workshop included:

- Data collection and analysis methods.
- Speed setting policies.
- Roadway design policies and speed.
- Communication, collaboration, and outreach policies.
- Countermeasures:
  - Roadway departure.
  - Intersection.
  - Pedestrian and bicycle.
- Plan development.

Workshop attendees shared practices related to speed management, such as practices for setting speed limits, policies and guidance, collaboration between agencies and disciplines, speed enforcement, countermeasures, and data analysis. The key themes from the workshop included: (1) guidance and support, (2) countermeasure implementation, (3) stakeholder coordination, and (4) systemic data analysis and countermeasure selection.

Clark et al. (2017) emphasized that the plan be treated as a living document, where practices are re-examined as new technology and methods emerge, and innovative strategies come to light. A key focus of the plan was summarizing challenges and proposed solutions, as shown in Table 2.1 to Table 2.3. Clark et al. (2017) further outlined a systemic data analysis process, as shown in Figure 2.1.

Table 2.1: Guidance and Support Challenges and Recommendations

Challenge	Recommendation
1. Lack of a unified and consistent process or criteria for establishing speed limits, including those within special areas or zones.	1. Establish consistent and appropriate speed limits through statewide policy; communicate the statewide policy, both internally and with local agencies
2. Limited formal guidelines or criteria for determining when State and local engineering should reassess and update speeds.	2a. Determine when State and local engineers should reassess and update speed limits and incorporate these criteria into the procedure for setting speed limits.
	2b. Educate local agencies on the speed limit reevaluation process.
3. Alignment of design speed with future posted speed limits	3a. Review and update existing design manuals and guidance, as needed, to ensure designers and planners align design speed with future posted speed limits; educate internal staff.
	3b. Capitalize on reconstruction opportunities to align design and posted speed limits.
4. Vehicle speeds in crash reports were only marginally reliable. Inaccurate speeding-related data may lead to ineffective use of funding.	4. Review and redefine speed-related fields in crash data.
Source: Clark et al. (2017)	

Table 2.2: Countermeasure Implementation Challenges and Recommendations

Challenge	Recommendation
1. Communication among maintenance division, traffic operations, law enforcement, and snow patrol during winter weather; and communication from these groups to road users.	1. Explore various weather responsive traffic management strategies that can be implemented to help prevent speeding-related crashes during inclement weather.
2. Practices for reducing speeds in "special use areas" are not effective.	2a. Consider interactive speed countermeasures and continue using automated enforcement in "special use areas."
	2b. Consider use of VSL in select work zones.
3. Local agencies believe they have little opportunity to change operating speeds or posted speed limits.	3a. Consider empowering local agencies with opportunities to install traffic calming measures and provide appropriate guidance.
	3b. Proactively identify corridors where traffic calming measures may be suitable and coordinate with local agencies to apply guidance.
Source: Clark et al. (2017)	

Table 2.3: Stakeholder Coordination Challenges and Recommendations

Challenge	Recommendation
1. Stakeholder collaboration and coordination is not being conducted to its full potential.	1a. Capitalize on existing stakeholder meetings or develop a speed management task force. 1b. Expand current partnerships and build new ones. 1c. Promote a safe speed culture.

Source: Clark et al. (2017)

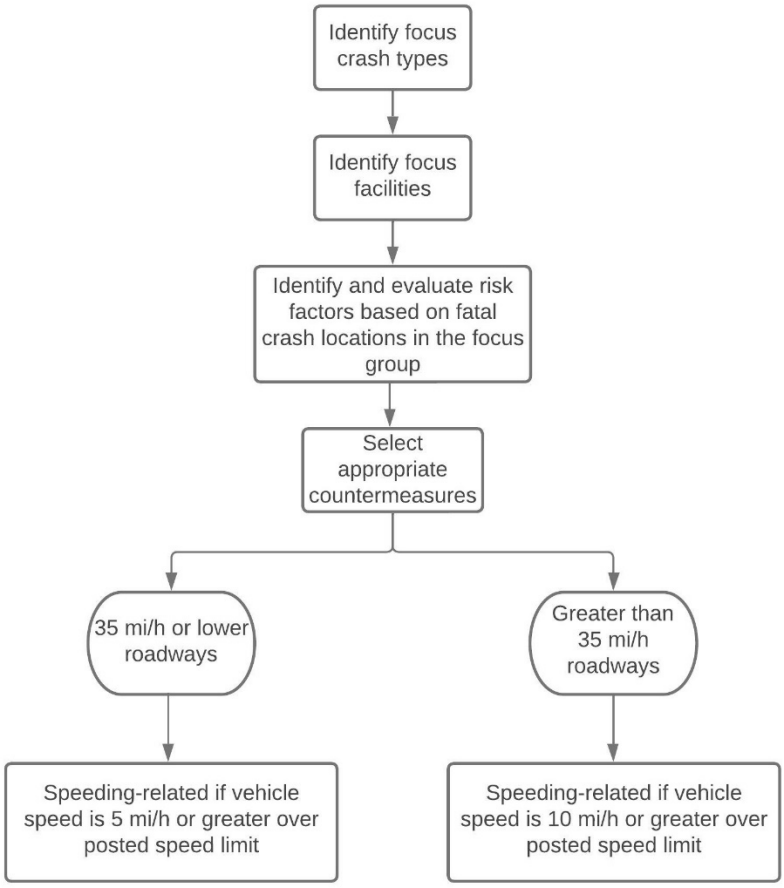


Figure 2.1: Systemic Data Analysis Process (Clark et al., 2017)

2.1.4 Connecticut

The Connecticut Department of Transportation has a manual to establish consistent speed limit setting policies statewide (Connecticut Department of Transportation, 2021). Per Section 14-219 of the Connecticut General Statutes, a speed limit of 55 mi/h is set for any public roadway that does not have an established speed zone by the Connecticut Office of the State Traffic Administration or the Local Traffic Authority. The Connecticut Department of Transportation emphasizes that under these considerations, "*the statutory limit does not relieve drivers from the*

duty of decreasing speed when special hazards exist with respect to pedestrians or other traffic or because of weather or highway conditions."

Requests to change speed limits on roadways owned by the State must come from a municipality's Local Traffic Authority. The engineering and traffic study is conducted by the Connecticut Office of the State Traffic Administration based on the latest federal standards and federally approved tools. Recommendations are then given to the Connecticut Office of the State Traffic Administration investigators.

For individual speed zones, the Connecticut Department of Transportation follows the requirements detailed in the Manual on Uniform Traffic Control Devices, engineering and traffic study results, the Federal Highway Administration USLIMITS2 tool, and engineering judgment.

2.1.5 Florida

The Florida Department of Transportation developed a speed zoning manual with the intent of providing guidelines and recommended procedures for establishing uniform speed zones on state, municipal, and county roadways across Florida (Florida Department of Transportation, 2018). In Florida, any change in speed limits must be based on an engineering and traffic investigation. In addition, the consideration of crash data is emphasized. Florida Department of Transportation (2018) states the following regarding crash data considerations:

- It is important to understand how speed impacts safety, as a variety of road designs and operating characteristics can obscure the precise relationship between speed and crash occurrences.
- Urban areas have the most pronounced relationship between speed and crash occurrences.
- When the mean speed of traffic is reduced, the number of crashes and severity almost always reduce.

Florida Department of Transportation (2018) also presents a relationship between mean travel speed and the occurrence of crashes:

$$\mathbf{CMF} = \left(\frac{\boldsymbol{V_a}}{\boldsymbol{V_b}}\right)^{\boldsymbol{x}} \tag{2.1}$$

where CMF is the crash modification factor, V_a is the mean speed in the after condition, V_b is the mean speed in the before condition, and x takes different values for the severity of the crash, number of fatalities, and number of personal injuries.

The manual also focuses on safety gains/losses in maintaining reasonable mobility and other system objectives. Some examples include the following (Florida Department of Transportation, 2018):

- If posted speed limits decrease, the percentage of violators increase; if posted speed limits increase, the percentage decreases.

- Before-after studies are a valid means of measuring the degree of success or failure of a speed limit change. Still, the time span must be considered to mitigate the possibility of false conclusions.

- The fact that crashes may increase on some roads and decrease on others after a speed limit is lowered should be considered when applying crash data toward the choice of the speed limit.

In Florida, there is no minimum length for speed zones, yet traffic engineering judgment should be applied for zones that are short to the extent that a driver must apply brakes to comply with the posted speed limit. Specifically, exceeding a 10 mi/h change in speed from one speed zone to another is discouraged and violates the purpose of providing smooth transitions in realistic graduated speed restrictions. Speed zones on county or city roadways need to be approved by the action of a commission or council and entered into records, and the records should include a speed zone map or straight-line diagram.

2.1.6 Idaho

In Idaho, District Traffic Engineers are responsible for the engineering and traffic investigation when evaluating speed zones (Sablan, 2019). When preparing documentation to be reviewed for a speed zone change, Idaho requires the following:

- Was there a previous study? If so, what data was collected, and what were the recommendations of the study?

- What is the statutory speed limit of the highway or roadway being studied?

- Full description of the study area (e.g., roadway name/number, mile markers, descriptive features). The report should include the extents of the study area and why those extents were chosen.

- A recorded speed distribution of free-flowing vehicles and a detailed description of how the study was conducted. The description should include information on the following:

    - How were non-free-flowing vehicles excluded from the data?

    - The 85th percentile speed and observed pace.

    - If a previous study was conducted, compare and give the reasoning for observed differences.

- Investigation of crash data in the study area for at least 12 months, three to five years, is preferred.

    - Idaho also requires that crash rates for all crashes and fatal/injury crashes be calculated.

- Provide a detailed description of highway or roadway characteristics (e.g., lane widths, curbs, shoulders, grade, alignment, median, sight distance).

    - Idaho emphasizes that roadway characteristics are not reasons for lowering speed limits.

- Provide a detailed description of the highway or roadway context, such as roadside development and environment. Idaho requires that the number of driveways, land use, functional classification, parking practices, and the presence of sidewalks/bicycle facilities be included.

- Provide a detailed description of non-motorized road user activity.

Upon completion of these items, the speed limit recommendation is made. When making the speed limit recommendation, a primary goal is to strive to minimize the differential in vehicle speeds and promote smoother, uniform traffic flow. Idaho also requires that the proposed speed zone extents be described and why the boundaries were selected. The final step is to use USLIMITS2 to check the speed limit recommendation. If the recommendation differs from the results of USLIMITS2, the speed limit recommendation should be reconsidered.

2.1.7 Illinois

In Illinois, the Illinois Vehicle Code does not require local agencies to obtain Illinois Department of Transportation approval for speed zones on roadways under their respective jurisdictions (Illinois Department of Transportation, 2011). Any changes in speed limits must be based on an engineering and traffic study. If local agencies conduct an engineering and traffic study to establish speed zones, the Illinois Department of Transportation provides recommendations for the procedure; however, local agencies are not required to follow the format or criteria recommended.

Illinois Department of Transportation (2011) describes the basic step for establishing a speed zone as determining the prevailing speed of free-flow traffic. This is done by computing the average of the 85th percentile speed, the upper limit of the 10 mi/h pace, and the test run speed. Illinois Department of Transportation (2011) also describes supplementary investigations, such as high crash locations and/or access control. In regard to crashes, if an area being studied contains a portion of a high crash segment or a high crash intersection, as shown on the most recent 5% report, prevailing speed may be reduced by 10%. For access control, the Illinois Department of Transportation (2011) details reductions in speed based on access conflicts per mile. Prevailing speeds may also be reduced based on pedestrian activity. For example, if no sidewalks are present, or in locations where sidewalks are located immediately behind a curve, and the total pedestrian traffic exceeds 10 per hour for any three hours within eight hours, prevailing speed may be reduced by 5%. Prevailing speed may also be reduced where parking is permitted adjacent to travel lanes. Illinois also permits miscellaneous factors to be considered based on engineering judgment.

After determining the prevailing speed, and any adjustments that can be made based on the factors discussed previously, the altered speed limit for a speed zone can be determined. Illinois then requires a comparison between the proposed speed limit and the speeds collected during analysis, where the anticipated violation rate should be determined. If the violation rate is more than 50%, the proposed speed limit should be revised in 5 mi/h increments until the violation rate is less than or equal to 50%. Illinois Department of Transportation (2011) further states that differences in adjacent speed zones should not be more than 10 mi/h.

2.1.8 Iowa

In Iowa, establishing speed zones is the responsibility of the Iowa Department of Transportation (Iowa Department of Transportation, 2006). Any jurisdiction, or individual, can request a review of an existing speed zone to determine if a change is appropriate. The speed zone review process consists of a thorough traffic and engineering study that includes detailed information on the following:

- Road type and surface (curve, hill, etc.).
- Location and type of access points (intersections, driveways, entrances).
- Existing traffic control devices along the segment.
- Crash history of the segment.
- Traffic volume of the segment.
- Sight distances along the segment.
- Pedestrian activity along the segment.
- Results of a field review and a speed study.

2.1.9 Kansas

Kansas Statutes, Section 8-1559, base speed zones on an engineering and traffic investigation (Kansas Department of Transportation, 2016). Speed zoning in Kansas is based on setting speed limits as near as practical to the speed at or below which 85% percent of drivers are traveling (the 85th percentile speed). Speed zones in Kansas are subject to revision based on crash experience, roadway geometrics, adjacent parking, pedestrian activity, curves, adjacent development, and engineering judgment. For all speed zoning and corresponding studies, Kansas follows the practices outlined in the Manual on Uniform Traffic Control Devices.

2.1.10 Kentucky

In Kentucky, all speed limit changes must be approved by the Secretary of the Transportation Cabinet, except those covered by statute or administrative regulation (Kentucky Transportation Cabinet, 2021). Any new or modified speed zone requires a traffic and engineering study.

Kentucky Transportation Cabinet (2021) states that speed zones should not be implemented or instituted without first having given the corresponding local agency an opportunity to review and comment upon the speed zone proposal.

Requests for speed limit revisions or speed zones are reviewed by the Kentucky Transportation District in which the location is located after the appropriate Kentucky Transportation Cabinet District conducts an engineering and traffic study per Section 2B.13 of the Manual on Uniform Traffic Control Devices. If the Kentucky Transportation Cabinet District that conducted the study feels that a speed limit revision or speed zone is justified based on the results, it forwards information on speed study results (including 85th percentile speeds), crash history over a three-year period, and detailed descriptions of the location(s) being considered for speed zoning to the Secretary of Transportation for final review and recommendation.

2.1.11 Massachusetts

To provide safe and efficient traffic flow in the Commonwealth of Massachusetts, the Massachusetts Department of Transportation (MassDOT) developed a speed zoning procedure guide (Massachusetts Department of Transportation, 2021). Massachusetts Department of Transportation (2021) emphasize that modifying a speed limit without additional changes will likely have little to no effect on reducing speeds. Instead, it is part of a broader strategy that includes geometric changes and educational and enforcement initiatives. Unlike many other states reviewed, MassDOT has empowered communities to establish statutory speed limits under certain circumstances without requiring further authority. However, regulatory speed limits can only be established after a study is conducted in compliance with Section 1A.09 and Section 2B.13 of the Manual on Uniform Traffic Control Devices.

The process for establishing new speed limits for locally owned roadways consists of the city or town requesting a new Special Speed Regulation in writing to their MassDOT District Office. The request should consist of a completed engineering and traffic study, which allows for the use of USLIMITS2. The MassDOT District Office will review for accuracy and provide a recommendation or response. For state-owned roadways, speed limit revisions are established by request from the local municipality or at the discretion of the MassDOT District Office if roadway characteristics have resulted in changes in driver behavior. For requests that come from cities or towns, MassDOT has the discretion to review for reasonability, which can include changes to roadway geometrics, road users, traffic control devices, adjacent land use, and/or crash history. Figure 2.2 shows the process of speed limit procedures on municipal roadways in Massachusetts.

Massachusetts Department of Transportation (2021) provides a comprehensive list of the data required for setting speed limits and speed zoning, as shown in Table 2.4.

Table 2.4: Data Required for Setting Speed Limits and Speed Zoning in Massachusetts

Roadway Information
• Section length (mi) • Adverse alignment (horizontal/vertical curves) • One or two-way roadway • Divided or undivided roadway • Number of through lanes • Area type (residential, commercial, developed, undeveloped) • Number of driveways • Number of signals or other controlled approaches to intersections • On-street parking activity and usage • Pedestrian and bicycle activity • Average annual daily traffic • Functional classification
Speed Information
• 85th percentile speed • 50th percentile speed • Mean speed, mode speed, and 10 mi/h pace
Crash Information
• Number of crashes during most recent five-year period • Number of injury crashes during most recent five-year period • Crash rate (in crashes per 100-million VMT) • Injury crash rate (in crashes per 100-million VMT) • Average crash rate for similar roadways • Average injury crash rate for similar roadways
Source: Massachusetts Department of Transportation (2021)

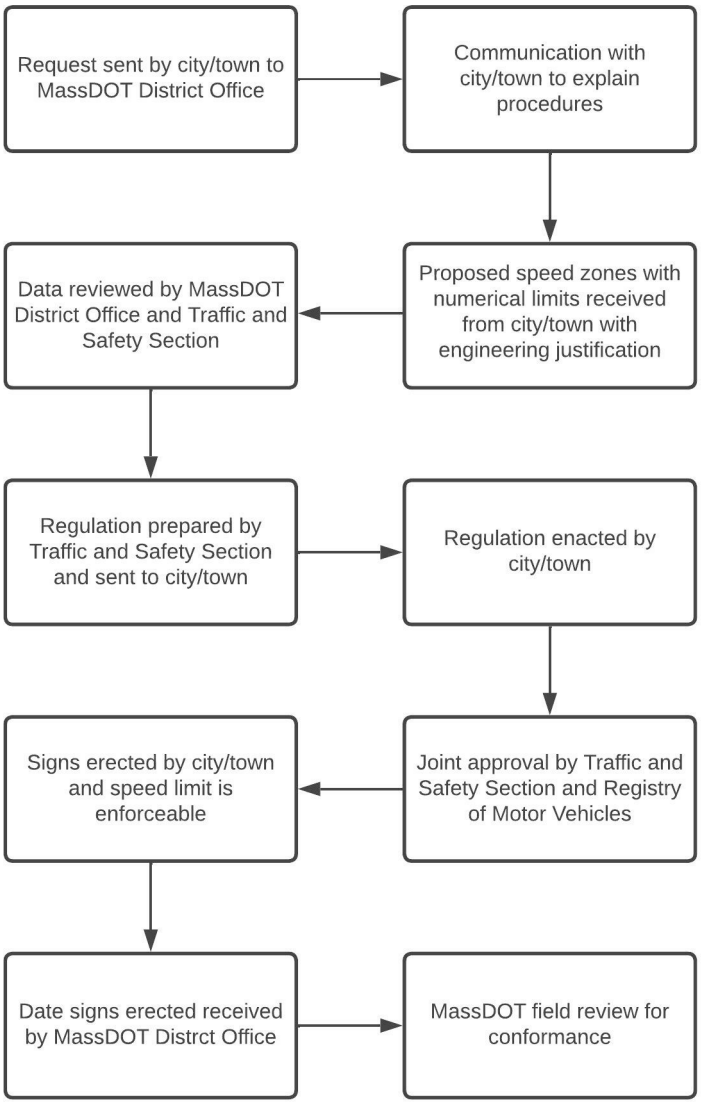


Figure 2.2: Speed Limit Procedures on Municipal Roads in Massachusetts (Source: Massachusetts Department of Transportation (2021))

After a speed zone is established, at least one trial run should be made over the entire length of the speed zone; this should be completed by engineers and/or law enforcement. For this process, the Massachusetts Department of Transportation (2021) states that at least three different drivers should be used for a minimum of three runs. An observer should sit directly behind the driver and record speeds from the speedometer every tenth of a mile. During the runs, the location of any traffic control devices that may impact free-flow speeds should be noted. Any roadway characteristics obtained from an actual or virtual driver should be verified during the trial runs. After the three trial runs, the median speed at each tenth of a mile is used to generate a speed curve. Lastly, after all data has been collected, conditions should be mapped.

Once the proposed speed limits and zone lengths are determined, trial speed runs are repeated for verification. After the speed runs, the Massachusetts Department of Transportation (2021) recommends using USLIMITS2 to validate the proposed speed zone(s). After the new speed limit signs have been erected for six months, the Massachusetts Department of Transportation (2021) states that it may be beneficial to conduct a follow-up study to determine the effectiveness of the speed zone and evaluate any changes in speed patterns. After one year, the Massachusetts Department of Transportation (2021) recommended reviewing crash data but emphasize that this only provides a snapshot of crash behavior, as one year is not sufficient for a true crash analysis.

MassDOT also has Safety Zones, where municipalities can change regulatory speed limits without approval from MassDOT; this applies to all roadways except state highways). These speed zones must be set at 20 mi/h and are intended for areas in which vulnerable road users are likely present (e.g., parks, playgrounds, senior citizen housing, hospitals, and schools).

2.1.12 Minnesota

Regarding the speed zone process, Minnesota follows the National Uniform Vehicle Code (established in 1929), which recommends that authority for all speed zones be the responsibility of the State Commissioner of Transportation. Minnesota law assigns the State Commissioner of Transportation this authority. The premise is to ensure uniformity in the implementation of speed zoning across Minnesota (Minnesota Department of Transportation, 2009).

The Minnesota Department of Transportation developed a report for speed limit recommendations on local roads and the process for which these recommendations are made (Minnesota Department of Transportation, 2009). Of particular focus were definitions of urban district, rural residential district, and residential roadway per the Minnesota Legislature. Minnesota Department of Transportation (2009) aimed to determine if 30 mi/h speed limits are appropriate in urban districts, and if not, are there locations where 25 mi/h is more appropriate. Minnesota revised statutes based on the answers to these questions.

Although no recommended changes arose regarding 30 mi/h speed limits in urban districts, several members of a task force favored a decrease to 25 mi/h, or a move to 25 mi/h in the future. A key factor was citizen-level support for such a change, as well as knowledge that pedestrian survival rates increase at lower speeds if a vehicle-pedestrian crash occurs. However, a crash data analysis in Minnesota, Wisconsin, and Iowa led to inconclusive results regarding the safety benefits of reducing speed limits to 25 mi/h. The focus of the analysis was on residential streets. A further review of survival rates indicated that to cause a significant change in pedestrian safety, speeds would need to change from 30 mi/h to 20 mi/h.

A key component of the evaluation process were law enforcement interviews. Law enforcement representatives indicated the following:

- Uniformity of speeds is a key principle to preserve.
- Reducing speed limits to 25 mi/h in urban districts would not reduce driving speeds.
- Pedestrian crashes tend to be in crosswalks of major streets.

- More effective speed reduction was observed through engineering solutions.
- Most speeding violations are observed on arterials and collectors.
- There are not enough resources to put a high priority on speed control.
- Violators need to be significantly over the speed limit for it to be worthwhile to write a ticket (definition of significantly over the speed limit was not provided).

In a more recent report, the Minnesota Department of Transportation (2015) describes two types of speed zones in Minnesota: (1) Statutory speed limits established by the Minnesota Legislature and (2) Speed zones established by the result of an engineering and traffic study. Minnesota Department of Transportation (2015), before detailing speed zones, state that access density has served as a better predictor of urban crash rate than the posted speed limit.

An engineering and traffic study supporting speed zones should include an analysis of existing vehicle speeds and roadway-specific information (e.g., roadway cross-section, access density, land use, etc.). Although various speed zones have been implemented, after studies have all indicated similar results: driver behavior did not change. Minnesota Department of Transportation (2015) states that most drivers pick a safe and comfortable speed based on their perception of the roadway environment and only changing the speed limit did not change their behavior. Table 2.5 summarizes the results of speed zone studies presented by the Minnesota Department of Transportation (2015). As a result, the Minnesota Department of Transportation (2015) suggests, based on national research, that automated speed enforcement be implemented as it has shown to be the most effective speed management strategy, both in lowering speeds and reducing crashes.

Table 2.5: Summary of Speed Zoning Studies in Minnesota

Location	Before	After	Change (mi/h)	85th Percentile (Before/After)	Change (mi/h)
TH 65			-10	34 34	0
TH 65			-10	44 45	+1
Anoka CSAH 1			-5	48 50	+2
Anoka CSAH 24			+15	49 50	+1
Anoka CSAH 51			+5	45 46	+1
Hennepin CSAH 4			-10	52 51	-1
Noble Ave			+5	37 37	0
62nd Ave N			-5	37 37	0
Miss St.			+5	39 40	+1

Source: Minnesota Department of Transportation (2015)

In 2019, the Minnesota Department of Transportation aimed to develop a consistent and unified vision related to speed limits that are supported by cities, counties, special interests, public safety, and enforcement (Minnesota Department of Transportation, 2019). The objectives included reviewing Minnesota speed limit history and laws, gathering input from technical and user groups, evaluating current approaches for setting speed limits, and ultimately defining a supported unified vision. By the end of 2020, the Minnesota Department of Transportation adopted the Minnesota Statewide Speed Limit Vision. Three core values related to speed limits were identified: (1) speed limits are affected by community context, land use, and road design, (2) speed limits are governed by voluntary compliance through education and accepted social norms, and (3) speed limits are established through consistent technical evaluation and applied equitably across all communities. The Minnesota Department of Transportation also noted the shift in conversation, where speed limits should be set based on consideration of context, function, and road users, including pedestrians and bicycles (Minnesota Department of Transportation, 2020).

2.1.13 Nevada

In Nevada, establishing a speed zone must comply with Section 2B.13 of the Manual on Uniform Traffic Control Devices (Nevada Department of Transportation, 2020). Nevada Department of

Transportation (2020) states that the objective of speed zoning is to reflect the 85th percentile speed, as to encourage uniform operating speeds to minimize high risk aggressive driving behavior (e.g., tailgating, excessive passing maneuvers, and others). Nevada requires a request for speed zones, where upon receipt of the request, a speed zone study is developed. The initial request is made to Nevada Traffic Operations, which then submits a request to the Traffic Information Division to collect and analyze speed data. The two divisions cooperatively determine the speed study parameters, such as:

- Limits of study section.
- Study segments.
- Data collection to account for seasonal variations in traffic flow.
- Stabilization of traffic trends following operational disruptions.
- Other temporal skewing anomalies.
- Data collection can include ball-bank testing of curves and determining no passing zones, as needed.

After data collection, the USLIMITS2 tool is used to analyze the data and develop a speed study report. If the report suggests that a speed zone is appropriate, the corresponding Traffic Operations Division prepares speed zone authorization documents for approval from the Director of the Nevada Department of Transportation. Upon Director approval, the District Traffic Engineer (or Engineering Services Manager) initiates work orders to post speed zone signs and implement other recommendations (e.g., no passing zones, curve warning signs, advisory speed plaques). Through the process, the Nevada Department of Transportation (2020) emphasizes that posting a regulatory speed limit lower than the recorded 85th percentile operating speed is not an effective treatment for speed-related safety issues and is discouraged.

2.1.14 North Carolina

North Carolina Executive Committee for Highway Safety (2012) presented draft recommendations for speed management initiatives in North Carolina. Stakeholders were identified, which included representatives from injury prevention and public health, transit, media and communications, engineering and planning, international experts, law enforcement and adjudication, research, and safety programs (both state and national). North Carolina Executive Committee for Highway Safety (2012) also identified key issues related to speed problems in North Carolina: treatment targets for speeding are too often diffuse, there are many miles of roadway but only a small percentage can be treated each year, designs and speed limits and environments often not in sync, law enforcement resources are scarce, minimal use of publicity to supplement enforcement, high enforcement tolerances, speed management and target treatment efforts have not been coordinated, and drivers do not get the message (from roadway design/operations, enforcement, adjudication, and media). In the end, North Carolina Executive Committee for Highway Safety (2012) proposed a comprehensive and cooperative public health approach to speed management that requires investment into the program and being persistent with it.

Thomas et al. (2013) conducted a study to provide recommendations that can be implemented to reduce the number of fatalities or serious injuries due to speeding. The study identified 15 potential strategies to be used by the North Carolina Department of Transportation and grouped them into six categories: (1) Management Strategies, (2) Engineering Strategies, (3) Enforcement Strategies, (4) Education and Public Information Strategies, (5) Information Technologies Strategies, and (6) Innovative (Unproven) Strategies. A summary of the strategies given by Thomas et al. (2013) and presented to the North Carolina Department of Transportation is shown in Table 2.6.

Thomas et al. (2013) also provide recommendations on network screening, where potential triggers for such screening can include changes in roadway functions or uses, significant changes in traffic volume, changes in development extent or type, and changes in roadway use. Thomas et al. (2013) emphasize that network screening should be conducted using Empirical Bayes methods, trends in crashes, or the proportion of crashes of specific types.

Table 2.6: Potential Speed Management Strategies for North Carolina

Management Strategies

• Reestablish an on-going speed monitoring program.
  − Track speeding and injury risk trends over time.
  − Measure progress of speed management program.
  − Adjust targets and program elements.
  − Use data for communicating risk to build support for effective strategies.
• Present the speeding safety problem in terms of injury prevention and develop coordinated internal/external communications on the issue.
  − Increase public and political input and support for effective speed management strategies.

Engineering Strategies

• Increase standardization of speed limit setting methodologies using an injury minimization approach to establish speed limits.
  − Increase safety, credibility, and consistency of established speed limits for different types of roadways.
• Prioritize use of design features that limit or manage speeds to the appropriate level.
  − Design improvements so that roads are self-enforcing to the extent feasible to prevent future speeding and speeding-related crashes.
• Implement methods for triggering and prioritizing roadways for review of speed limits and conducting safety assessments.
  − Develop effective methodologies to identify roadways that may benefit most from speed limit reviews, potential speed limit changes, potential roadway improvements, or enhanced enforcement.
• Determine desired operating speed and speed limit before designing new projects and upgrades, and design to support that speed limit. Conduct speed safety reviews of all new designs and at key stages throughout implementation.
  − Ensure new roadways are designed in accordance with best practices and keep with intended operating speed and speed limit to mitigate likelihood of future speeding and speed-related safety problems.

Enforcement Strategies

• Develop random allocation enforcement strategies through marking, parked patrol vehicles and overt or covert enforcement methods to cover a larger area of the transportation network (focus on where serious crashes occur).
  − Maximize deterrence through visible and sustainable levels of enforcement.
  − Increase perception that enforcement may be encountered at any time and at any place.
• Lower enforcement tolerances and publicize enforcement activities.
  − Reduce number of vehicles traveling over the speed limit by significant numbers but are less than typical enforcement tolerances.
• Use automated speed enforcement to supplement traditional enforcement.
  − Increase perceived and actual risk of being caught exceeding the speed limit.
  − Improve individual- and population-level deterrence of speeding.
• Shift speeding violations to a civil and uniform penalty system.

- Increase perceived and actual expectation of receiving consistent penalties when caught speeding.

Education and Public Information Strategies

- Utilize media (paid, social, etc.) campaigns to further the deterrence of all enforcement efforts. The utilized campaigns should emphasize the type of enforcement activities.
  - Enhance perceived risks of being caught speeding.
  - Educate drivers about enforcement programs.
  - Emphasize that detection efforts and sanctions are likely.
- Educate court officials on their importance in traffic safety.
  - Improve consistency and certainty of prosecution in regards to speeding violations.

Information Technologies Strategies

- Increase use of variable speed limits on roadways where there are conditions in which a single posted speed limit may often be inappropriate.
  - Safer and more credible indication of appropriate operating speeds for different conditions.
- Improve availability of complete, current, and accurate driver history data to enforcement officers and courts.
  - Knowledge of prior history for prosecution of speeding violations.

Innovative (Unproven) Strategies

- Improve the ability to recognize roads of the same type and speed limit through consistency.
  - Predictability and "functionality of roads."
- Implement a driver reward program to encourage safe speeds.
  - Rewards could work to increase speed limit compliance (National Highway Traffic Safety Administration, 2011).[1]
- Implement intelligent speed adaptation.
  - Warn when the speed limit is being exceeded using on-board systems.
  - Controls can be applied to slow the vehicle or limit the vehicle to no more than the posted speed limit.
- Create guidelines and conduct training/outreach to cities and local planning agencies to ensure that new developments and local roads follow the best design practices for speed management and safety.
  - Discussion and agreement on implementation of good design principles to manage speeds in new developments and connector roads.
- Maximize use of capacity by improving and increasing use of transit, HOV and managed lanes, flex-time work, and compact development patterns to minimize the need for increasing capacity.
  - Reduce exposure to driving and, therefore, speeding.
- Discourage the use of advertising that glamorizes speed.
  - Support the "Safe Systems" approach to speed management.

Source: Thomas et al. (2013)

[1] The most recent edition furthers this argument and provides some additional evidence regarding vehicles with intelligent speed adaptation capabilities, particularly with younger drivers (18 years to 24 years). The reader is referred to National Highway Traffic Safety Administration (2020) for additional information.

Findley et al. (2018) conducted a study to develop guidelines and documentation for engineering studies on establishing speed limits. For local municipalities, certificates for speed zone changes on non-controlled access facilities must be approved by the local governing body, certified under seal by the city clerk, and cannot be changed or altered in any way once certified and sealed. For interstates or controlled access facilities, or when appealing an existing 35 mi/h speed zone ordinance, such certificates are not required. Counties, however, do not have statutory authority to ordinance or enact speed limits. New ordinances with speed limits below 25 mi/h will generally not be approved, while replacement ordinances with speeds more than 10 mi/h below (or above) the current speed limit require additional justification. Findley et al. (2018) further suggest that speed limit changes only be made following an engineering and traffic study that is conducted or approved by the North Carolina Department of Transportation.

2.1.15 North Dakota

North Dakota Department of Transportation (2021) provides guidance on when to change posted speed limits and what speed to set as the posted speed limit. The guidance provided does not apply to major cities in North Dakota, as major cities are handled on a case-to-case basis. Similar to other states, North Dakota State Law requires an engineering and traffic study, in accordance with the Manual on Uniform Traffic Control Devices, to be the basis for implementing or revising speed zones. North Dakota emphasizes analysis of the current speed distribution of free-flowing vehicles and follows the procedure given in Figure 2.3.

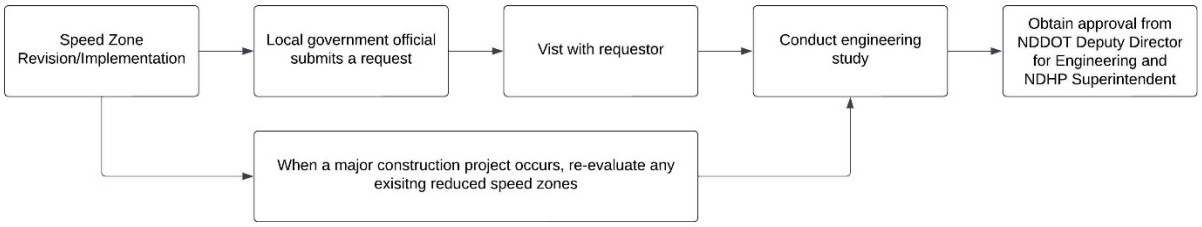


Figure 2.3: Speed Zone Implementation or Revision Process in North Dakota (Source: North Dakota Department of Transportation (2021))

North Dakota Department of Transportation (2021) cautions that setting speed limits lower than the 85th percentile speed can have adverse effects, such as:

- A need for increased enforcement to ensure driver compliance.
- Potential for an increase in crashes due to a larger variability in operating speeds.
- Mistrust in highway and enforcement officials and potential disregard for other speed limits. North Dakota Department of Transportation (2021) notes that motorists do not readily perceive the need for lower operating speeds.
- Research has repeatedly shown that changes in posted speed limits have little effect on operating speeds, as many drivers continue driving at the speed at which they are

comfortable, regardless of the posted speed limit (North Dakota Department of Transportation, 2021).

With the exception of work zones, the North Dakota Department of Transportation (2021) states that speed limits shall not be reduced by more than 20 mi/h at one time. North Dakota Department of Transportation (2021) concluded by recommending the following to reduce speeding:

- Increase the presence/visibility of law enforcement.
- Install dynamic speed display signs in accordance with the North Dakota Department of Transportation Guidelines for the Use of Dynamic Speed Display Signs.
- Implement traffic calming.
- Conduct a speed study and raise the posted speed limit if appropriate.

2.1.16 Ohio

When conducting speed zone studies, the Ohio Department of Transportation considers development of the area, roadway features, traffic volume, crashes, and the speed at which vehicles are traveling (Ohio Department of Transportation, 2021a). Both the 85th percentile speed and 10 mi/h pace are considered important factors.

To address speed zones and the process to establish them, the Ohio Department of Transportation started a Speed Zoning Committee, which was recently updated in 2021 (Ohio Department of Transportation, 2021b). The intent behind the Speed Zoning Committee is to revisit speed zoning processes, update guidance documents, and provide expanded training. Members of the committee include representatives from the Ohio Department of Transportation Central Office, MPOs and local municipalities, the Federal Highway Administration, and bicycle/pedestrian advocacy groups. The Ohio Department of Transportation updated their Traffic Engineering Manual in 2021, which prompted the Ohio Speed Zoning Committee to adopt policy/philosophical changes. Major changes include the consideration of vulnerable road users, where vulnerable road users now have a quantitative impact on the calculated speed limit. In place of 85th percentile speeds, 50th percentile speeds are used when there is a high presence of vulnerable road users, and the study is within an urban area. Lastly, the speed limit recommendation from USLIMITS2 is required as a check for every speed study conducted in Ohio.

2.1.17 Pennsylvania

With encouragement from the Federal Highway Administration for agencies to take a broad look at speeding-related policies, safety plans, and programs to identify opportunities for integrating speed management, Leidos (2016) developed a Speed Management Action Plan for the Pennsylvania Department of Transportation. The foundation of the plan was to integrate speed management within three main focus areas: (1) roadway departure crashes, (2) intersection crashes, and (3) pedestrian and bicycle crashes.

Leidos (2016) described the plan in the following parts:

- Describe the approach to develop the plan.
- Identify key data analysis.
- Present speed management strategies and countermeasures that can be integrated into Pennsylvania Department of Transportation roadway departure, intersection, and pedestrian and bicycle plans.
- Present broader themes related to speed management and potential strategies to address them.

Leidos (2016) note that the top strategies to combat speeding and aggressive driving behavior revolve around enforcement, education, and the use of technology. Specific strategies recommended include initiatives to target law enforcement in areas with a high rate of aggressive driving crashes (problem-specific policing and selective traffic enforcement programs), continue to fund aggressive driving enforcement trainings for law enforcement officers and the public, place speed timing devices and red light running cameras in appropriate locations (these were noted as legislative strategies recommended by highway safety partners), educate prosecutors and judges to ensure speed violations are treated seriously and justly, and continue to develop comprehensive traffic safety public information and education problems that are designed to motivate change in unsafe driver behavior.

Leidos (2016) recommended countermeasures for the three main focus areas: (1) roadway departure crashes, (2) intersection crashes, and (3) pedestrian and bicycle crashes. A summary of these countermeasure recommendations is given in Table 2.7.

Table 2.7: Potential Countermeasures for Pennsylvania Focus Areas

Speeding-Related Roadway Departure Crashes
• Enhance curve signing and delineation • Improve or delineate fixed-objects within curves • Improve roadway design and geometric enhancements • Use reflective and innovative signs, possible consider sequential dynamic curve warning systems • Transverse or optical speed bars • Curve inventory • Skid-resistant pavement or high-friction surface treatments and drainage improvements • Improve recovery area/clear zone • Systemic and systematic countermeasure implementation • Retroreflectivity
Speeding-Related Intersection Crashes
• Install roundabouts • Revise geometry of complex intersections • Reduction of lane width markings • Improve geometry of pedestrian and bicycle facilities • Congestion management • Skid-resistant applications in the intersection and on all approaches • Improve signing and delineation • Target law enforcement efforts, outreach efforts, and education efforts • Complete Streets concept to safely accommodate all types of road users • Consider signalized- and unsignalized-specific countermeasures
Pedestrian and Bicycle Crashes
• Reduce exposure to traffic • Improve signal hardware for pedestrians • Revise and improve roadway shoulders for bicycle traffic • Revise and improve intersection design for bicycle traffic • Accommodate bicycle use on roadways • Increase public awareness on pedestrian safety • Increase public awareness on bicycle traffic and bicycle safety • Internal bicycle education • Promote helmet use • Enforce pedestrian laws • Improve legislation on pedestrian and bicycle safety • Enforce bicycle safety laws • Dedicate funding for pedestrian and bicycle solutions • Further data collection and analysis for pedestrian and bicycle safety

Source: Leidos (2016)

On a broader scale, Leidos (2016) recommended strategies that include enhancing the speeding-related data collection process; specifically focusing on the specification of speeding-related

crashes based on the judge of the presiding officer. Leidos (2016) emphasizes the importance of law enforcement and engineers agreeing on a definition of a speeding-related crash to ensure accurate data collection and analysis. Also recommended is setting appropriate speed limits, as inconsistent procedures and policies pose a challenge to many agencies. Leidos (2016) note that design speeds or speed changes based on political pressure can result in posted speed limits ranging from 8 mi/h to 12 mi/h lower than observed operating speeds. This can result in reasonable speeds being considered a violation, resulting in a misallocation of law enforcement resources and efforts. Leidos (2016) further note that inadequately setting speed limits can impact the data collection process, which then impacts the analysis.

Also recommended are programmatic strategies to prevent the opportunity of speeding from occurring. Some specific recommendations include addressing geometric inconsistencies, using the Highway Safety Manual to evaluate geometric improvements through the Network Screening process, setting realistic speed limits, improving the checklist for local road projects, expanding safety considerations on all roadway projects, and targeting enforcement/outreach/education efforts. Leidos (2016) conclude by providing strategies to measure the performance of speed management efforts, such as identifying meaningful performance measures, ensure to consider all potential data sources (e.g., adjudication data, surveys, and common data such as safety and speed data), and continued engagement with partner agencies and stakeholders.

2.1.18 South Carolina

Although a dedicated speed zoning or speed management manual was not found for South Carolina, the South Carolina Department of Transportation (2019) presents related material in their Traffic Calming Guidelines Manual. Several requests are received from local governments and individuals to address speeding; therefore, the South Carolina Department of Transportation developed this manual to provide recommendations for traffic calming devices that can reduce speed to acceptable levels. South Carolina Department of Transportation (2019) notes the importance of partnerships with local governments, MPOs, and Councils of Governments to address this issue.

If a traffic calming device is to be implemented, it should be accompanied by an awareness and education campaign and should also be endorsed by local law enforcement agencies with a commitment to increase presence and enforcement in the area. If a request is made, it is referred to the corresponding local government to determine if such a device is eligible. Although the South Carolina Department of Transportation provides review, and will make changes as necessary, the traffic calming proposals are the full responsibility of the local government. The application should include detailed information about the site, existing speed limits, and the current mean and 85th percentile operating speeds. Upon completion, an evaluation should be conducted within one year of implementation to determine the effectiveness of the treatment.

2.1.19 South Dakota

In South Dakota, speed zoning begins with a request from the public or local government agencies; however, the South Dakota Department of Transportation can also decide to initiate the speed zoning process (South Dakota Department of Transportation, 2021). All speed zoning requests are directed to the Region Traffic Engineer to determine if a speed study is necessary. The Region

Traffic Engineer details the roadway environment, features, and traffic conditions/characteristics. Some of these details include the existing speed limit, the character of the surrounding environment, functional classification, roadside development, roadway characteristics, vehicle, pedestrian, and bicycle activity, and the presence of other items (e.g., sidewalks, lighting, bicycle lanes).

The speed study is conducted by Region Traffic engineers at one or more representative sites along the roadway in ideal weather and under free-flow conditions. The Region Traffic Engineer reviews the crash history of the location, as provided by the Highway Safety Engineer. Based on the crash history, adjustments can be made to lower the 85th percentile speed by as much as 7 mi/h. Adjustments can also be considered if a crash rate for a two-year period is much higher than the average for other roadways of similar characteristics. The Region Traffic Engineer conducts a review of other conditions that may not be apparent, then makes a recommendation for the appropriate speed limit. During the recommendation stage, the Region Traffic Engineer notifies the requesting agency or individual of approval or denial of the speed zone request. If approved, a speed limit administrative rule proposal must be submitted to the Transportation Commission to be considered at a regularly scheduled meeting for the Legislative Interim Rules Review Committee.

2.1.20 Texas

In 2015, the Texas Department of Transportation revised its guide for establishing speed zones to update information on the establishment of lower than 85th percentile speed zones on sections of roadways with crash rates greater than the statewide average for similar roadways (Texas Department of Transportation, 2015). In the appropriate section, the revised version focuses on specific criteria and procedures used to make this determination.

To make the determination, Texas Department of Transportation (2015) states that "*when establishing a speed within an existing zone on the highway system, the speed limit may be reduced up to 12 mi/h below the 85th percentile speed if the crash rate in the section of the roadway is greater that the statewide average crash rate for similar roadways*." Additionally, the most recent speed study conducted on the roadway should be evaluated to determine if the information is still valid based on traffic and roadway characteristics. If the information is still valid, this can be used to lower the speed limit, while if the information is not valid, there are three options:

- Conduct a full 85th percentile speed study.
- Conduct an 85th percentile speed study at one or more locations along the segment.
- Perform a trial run speed study along the segment.

After 85th percentile speed is determined, Texas Department of Transportation (2015) states that the following should also be considered to determine speed reduction (up to 12 mi/h):

- Narrow roadway pavement.
- Horizontal and vertical curvature.

- High driveway density.
- Lack of striped, improved shoulders.
- Crash history within the speed zone.

The final decision is based on the engineering judgement of the supervising engineer.

For the remainder of the manual, much remained unchanged. The manual is intended to provide information and procedures on the state highway system, where entities with authority to set speed zones are its target. It is required to be used by the Texas Department of Transportation and cities when establishing speed zones on the state highway system. The Traffic Operations Division prepares procedures for establishing speed zones and assists districts as required with speed zone studies and review/approval of district recommendations.

Texas Department of Transportation Districts are responsible for conducting the engineering and traffic study, submitting recommendations based on the results of the study, and requesting that cities pass ordinances establishing the speed zones. If the speed zone being considered is within a city's jurisdiction, the city must request that the district conduct the study or conduct the study themselves. If approved, cities prepare and pass city ordinances establishing the speed zone(s). Texas Department of Transportation (2015) states that counties and cities have the authority within their jurisdictions; however, any speed zone on highway routes in cities that were established by the Transportation Commission supersede any speed zone set by a city ordinance. All speed zone studies should cover the entire length of the proposed speed zone and include 85th percentile speeds, results from crash data analysis, strip maps, speed zone design, and re-checks of speed zones.

Texas Department of Transportation (2015) note that through before-after studies, speed limit signs have very little influence on drivers' choice of speed; however, it is emphasized that speed zoning is important, citing that it can be most notable through regulation of unreasonable driving behavior.

2.1.21 Utah

Although not a speed zoning or speed management manual, Zhang et al. (2019) conducted a study for the Utah Department of Transportation to assess speed limit designs in smaller cities and towns, where the speed limit designs were compared to results from USLIMITS2. Using a wide variety of case studies (46 locations), Zhang et al. (2019) found that USLIMITS2 recommended speeds lower than the posted speed limit, higher than the posted speed limit, and equal to the posted speed limit. A key takeaway was that USLIMITS2 recommended lower speed limits at entrances to small cities or towns that had high average annual daily traffic, locations in which 85th percentile speeds were low, and locations that experienced a high crash rate.

2.1.22 Vermont

Vermont Agency of Transportation (2016) recommends for practice that an engineering and traffic study be conducted to help determine a reasonable and safe speed. When conducting the study, the Vermont Agency of Transportation (2016) noted the following considerations:

- Roadway characteristics, shoulder condition, alignment and sight distance, the width of the roadway and shoulders, and the number of lanes.
    - Other characteristics considered are the presence of passing zones, maximum grade, and degree of critical curves (steep roadways and sharp curves usually warrant lower speeds).
    - Vermont Agency of Transportation (2016) further consider what motorists may do if the speed limit is lowered, such as increased passing to clear slower moving vehicles.
- Monitor the speed at which vehicles are traveling through a Spot Speed Study.
    - Other considerations should be made on low-volume roadways; for example, use several times runs to estimate speed. An additional recommendation is to determine pace and use pace to obtain the 85th percentile speed.
- Roadside development and culture.
    - Consider if the location is in a dense residential area, or a commercial area with a high access point density or a school zone.
    - Vermont Agency of Transportation (2016) states that considering the type and density of development can help determine a reasonable and safe speed.
- Determine safe speed for curves and other hazardous locations with the speed zone (including intersections).
- Record parking behavior and pedestrian and bicycle activity in the area.
    - Denote if parking is on-street or off-street, and how parking is controlled.
    - Higher pedestrian activity may warrant a lower speed limit.
- Record crash experience for the most recent 12-month period.
    - High crash experience may warrant moderating the speed limit. Vermont Agency of Transportation (2016) note that crashes are caused by a variety of other factors, such as turning movements, intersections, DUIs, inclement weather, etc. and should be considered.

Using the data collected under these considerations, a proper speed limit is determined for the roadway under consideration. Vermont Agency of Transportation (2016) states that cities or towns tend to set speed limits too low, which creates more speeders and to be mindful of this. Upon determining if a speed zone is appropriate, a traffic ordinance is adopted. The final step is enforcement, as a speed zone is only as effective as its enforcement (Vermont Agency of Transportation, 2016).

2.1.23 Washington

In Washington, the Secretary of Transportation has delegated approving authority for speed zones to the State Traffic Engineer (Washington State Department of Transportation, 2021). Regional Traffic Operations divisions are responsible for conducting the engineering and traffic analysis, context, and multi-modal user investigation to determine if a speed zone is warranted. Regional Traffic offices can receive requests from local agencies, tribal governments, citizen groups, developers, and law enforcement agencies. Washington State Department of Transportation (2021) states that requestors should consider roadway characteristics, user characteristics, and context characteristics before submitting a request. Washington State Department of Transportation (2021) further note that although speed zoning is often not the most effective speed management solution, requestors at-large often look at it as the easiest and least expensive solution.

The engineering and traffic study should consist of detailed information on roadway characteristics and roadway users, appropriate speed data analysis (85th percentile speed and 10 mi/h pace), crash history, and traffic conditions. Upon data collection and analysis, a preliminary review and consideration is conducted by the Headquarters Traffic Office. Regional Traffic offices will then submit a full package speed zone request to the State Traffic Engineer as a Calendar Agenda Item for approval or denial.

2.1.24 Wisconsin

In 2009, the Wisconsin Department of Transportation (2009) developed statewide speed management guidelines, which are also included and updated in the most recent version of the Traffic Engineering, Operations and Safety Manual (Wisconsin Department of Transportation, 2021). Although state statutes establish speed limits for roadways, Section 349.11 also gives state and local governments administrative authority to change the speed limit on a roadway. A summary of authority based on state statutes is given in Table 2.8.

Table 2.8: Speed Limits and Authority to Change in Wisconsin

Statutory Limits per Statute 346.54[a]	What Local Governments can do per Statute 349.11[b]
70 mi/h – Freeway/Expressway	Wisconsin Department of Transportation only.
65 mi/h – Freeway/Expressway	Wisconsin Department of Transportation only.
55 mi/h – State Trunk Highway	Wisconsin Department of Transportation only.
55 mi/h – County Truck Highway, Town Roads	Lower the statutory speed limit by 10 mi/h or less.
45 mi/h – Rustic Roads	Lower the statutory speed limit by 15 mi/h or less.
35 mi/h – Town Road (1,000 ft. minimum) with 150 ft. driveway spacing	Lower the statutory speed limit by 10 mi/h or less.
25 mi/h – Inside corporate limits of a city or village (other than outlying districts)	Raise speed limit to 55 mi/h or lower. Lower the statutory speed limit by 10 mi/h or less.
35 mi/h – Outlying district within city or village limits	Raise speed limit to 55 mi/h or lower. Lower the statutory speed limit by 10 mi/h or less.
35 mi/h – Semi-urban district outside corporate limits of a city or village	Raise speed limit to 55 mi/h or lower. Lower the statutory speed limit by 10 mi/h or less.
15 mi/h – School Zone, when conditions are met	Raise speed limit to that of the roadway. Lower the statutory speed limit by 10 mi/h or less.
15 mi/h – School Crossing, when conditions are met	Raise speed limit to that of the adjacent street. Lower the statutory speed limit by 10 mi/h or less.
15 mi/h – Pedestrian Safety Zone, with Public Transit Vehicle Stopped	No changes permitted.
15 mi/h – Alley	Lower by 10 mi/h or less.
15 mi/h – Street town road adjacent to a Public Park	Lower by 10 mi/h or less.
Construction or maintenance zones, as appropriate	State and Local authority to establish lower limit.

[a] Source: Wisconsin State Statutes

[b] All speed limit changes shall be based on a traffic engineering study, including modifications allowed under Statute. Local governments can implement speed limit changes on the local road system without Wisconsin Department of Transportation approval when proposals are within the constraints identified above.

Source: Wisconsin Department of Transportation (2009) and Wisconsin Department of Transportation (2021)

To assess the need for a speed zone, an engineering and traffic study must be conducted, where it is the same process for both state and local authorities. Table 2.9 provides a summary of the speed zoning and study process in Wisconsin.

Table 2.9: Speed Zoning and Study Process in Wisconsin

1. Identify and Inform Stakeholders	• Requests for speed studies, outside of DOT or local authorities, should come from a mayor or other elected executive, or a Traffic Safety Commission, and be submitted in writing. • If a study is warranted, primary stakeholders are notified before the study begins.
2. Collect Location-Specific Data	• Speed data • Crash data for the preceding three to five years • Roadway geometrics • Traffic control • Land uses, type of development, and access point density • Practice function of the roadway (analyst's perception of the actual function of the roadway) • Presence of conflicts with parked vehicles, pedestrians, and bicycles. • Proximity to schools • Current level of enforcement in the area • Data should be collected during the daytime while considering observer location/position, required sample size, and traffic conditions.
3. Analyze Data and Develop Study Conclusions	• 85th percentile speed • Pace speed • 50th percentile speed • Design speed • Speed distribution • Proportion of vehicles exceeding speed limit (can be used for an argument for or against a posted speed limit change) • Significance of secondary roadway attributes • Crash data analysis
4. Develop Speed Zone Recommendations	• To be effective, a speed zone should: – Reduce speed differential of vehicles – Be a reasonable speed so majority of drivers comply – Reflect consistent application of traffic engineering principles

	- All recommendations should be based on objective findings - Speed zones should be set within 5 mi/h of the observed 85th percentile speed

Source: Wisconsin Department of Transportation (2009) and Wisconsin Department of Transportation (2021)

2.2 SPEED ZONING AND SPEED MANAGEMENT IN OREGON

Oregon Revised Statutes now give road authorities the following statutory speed that can be posted at the discretion of the road authority if a street or highway meets the specific criteria (Oregon Department of Transportation, 2022):[2]

- 15 mi/h – alleys and narrow residential roadways
- 20 mi/h – business districts, school zones, and some residential
- 25 mi/h – residential districts, public parks, and ocean shores
- 55 mi/h – Most open rural highways and trucks on some interstate highways
- 60 mi/h – Trucks on some open rural highways (Oregon Administrative Rules designates trucks on most interstates)
- 65 mi/h – Passenger vehicles, light trucks, motorhomes, and light duty commercial vehicles on most interstate highways; some open rural highways; trucks on some interstate and rural highways
- 70 mi/h – passenger vehicles, light trucks, motorhomes, and light duty commercial vehicles on some interstates and open rural highways

Additionally, any road authority may establish an emergency or temporary speed zone (per ORS 810.180 - https://oregon.public.law/statutes/ors_810.180). These are most commonly used for work zones and major events (e.g., fire, flood, crash).

Oregon has experienced changes in the speed limit and speed zoning processes over the years, as shown in Table 2.10.

[2] ORS 801.100 - https://oregon.public.law/statutes/ors_801.100,
ORS 811.105- https://oregon.public.law/statutes/ors_811.105,|
ORS 811.111 - https://oregon.public.law/statutes/ors_811.111,
ORS 810.200 - https://oregon.public.law/statutes/ors_810.200

Table 2.10: Timeline of Speed Zoning and Speed Limit Changes in Oregon

Year	Change
1993	• Authority to set speeds given to the Oregon Department of Transportation. • Speed Zone Review Panel created.
2016	• Higher speeds allowed on some section of interstates and highways in Eastern Oregon (ORS 811.111).
2019	• Oregon Revised Statutes changed to make all streets, roadways, and highways in Oregon speed limits. • Change included allowing cities the option of lowering their statutory speed limits for residential districts, that are not arterials, by 5 mi/h.
2021	• Oregon Revised Statutes changed to allow delegation of speed zoning authority to local jurisdictions. • Local jurisdictions must adhere to criteria established in administrative rule. • Oregon Department of Transportation requires written notice before posting new speed limit signs.

All statutes require that speed zones be established based on an engineering and traffic study. Oregon Department of Transportation (2022) provide details on what needs to be included in the engineering and traffic study, where a summary of items is given in Table 2.11.[3]

[3] The reader is referred to Oregon Department of Transportation (2022) for additional details on each of these items.

Table 2.11: Summary of Considerations for Engineering and Traffic Study in Oregon

1. Context	• Roadside development, type, density of adjacent land use.
2. Federal functional classification	• Role the roadway plays in moving vehicles.
3. Speed characteristics	• Spot Speed Study is used to determine speed distributions. • 50th percentile and 85th percentile speeds determined. • Pace limits determined. • Percent of total vehicles exceeding the speed limit. • Maximum recorded speed.
4. Crash history	• Identify high crash characteristics and problem locations
5. Non-motorized users (pedestrians and bicycles)	• Should be considered when determining appropriate speed limit. • Facilities, such as sidewalks and separated cycling paths, should be considered.
6. Geometric features	• Vertical/horizontal alignments • Lane width and shoulder width • Available sight distance • Appropriate warning signs and speed advisory plaques should be used rather than lowering speed limits.
7. Enforcement	• Ensure conformity of drivers. • Speed limits set too low make enforcement difficult and expensive. • Deterrence effects of enforcement are temporary and must be reinforced often.
8. Public testimony	• May consider public testimony before establishing a speed zone.
9. Traffic volumes	• Key factor in drivers' choice of speed and determination of speed limit.
10. Access density	• A high number of access points (generally in urban areas) can increase vehicle conflicts. • Presence and spacing of access points is known to impact safety.

Source: Oregon Department of Transportation (2022)

Oregon Department of Transportation (2022) notes that speed zones are not intended for specific reasons, some of which include:

- Not to be a tool to warn motorists of risky locations.
- Not an appropriate countermeasure to address high crash locations. A separate field review should be conducted to identify possible causes and develop appropriate recommendations.
- Not to be a substitute for enforcement.
- Not to be a substitute for speed management countermeasures to slow traffic.

Oregon Department of Transportation (2022) distinctly describe different contexts and land uses for speed zoning, where the discussion on urban speed zones is directly relevant to the current study. Urban areas now involve multiple considerations, are susceptible to more conflicts, are targeted for a wider range of road user types, and are susceptible to significant distractions. There is also a higher demand from community planning objectives to consider the context in which the roadway passes and other roadway users. Urban roadways should be designed to provide for various transportation modes and users. As a result, current research, and implemented by other states, support 50th percentile speeds for urban areas and roadways with high number of vulnerable road users.

For speed zone requests in Oregon, if there is no delegated authority, the Oregon Department of Transportation must receive a request for investigation with a recommended speed. The request must come from the local jurisdiction, in which the request begins the investigation process to determine if a speed zone is appropriate. Requests to investigate a roadway within city limits must come from the city, while any individual who wants to make a request must work with the city to do so.

Unlike some of the states reviewed, Oregon has a Speed Zone Review Panel. The intent of the panel is to conduct hearings for contested speed zones and determine the speed to be designated. The Speed Zone Review Panel also serves as an advisory body to the Oregon Department of Transportation on speed zoning issues and practices. Oregon Department of Transportation (2022) states that the panel must consist of the following:

- The chair of the Governor's Transportation Safety Committee or a representative designated by the chair.
- The superintendent of the Oregon State Police or a representative designated by the superintendent.
- The Chief Engineer of the Oregon Department of Transportation or a representative designated by the Engineer.
- Two additional members, one representative of the interests of cities and one representative of the interests of counties. The League of Oregon Cities and the

Association of Oregon Counties must appoint a member representing the interest of cities and counties, respectively.

Oregon Department of Transportation (2022) details two study methods, of which the more comprehensive one will be the primary focus of this review. The Standard Engineering Study Method, as described by the Oregon Department of Transportation (2022), requires research and compilation of specific items before a field review. Table 2.12 provides a summary of these items.

Table 2.12: Summary of Items to Research and Compile Before Field Investigation

1. Existing Speed Zone Orders	• Obtain from https://ecmnet.odot.state.or.us/SpeedZone/Search/Index • Can also be obtained from Region or Headquarters Traffic Offices
2. Most recent investigation	• If there has been a previous investigation, obtain for reference.
3. Mileposts	• Use to describe the extents of the speed zone • State Highway Inventory Reports and Summary Reports (Recommended)(https://www.oregon.gov/odot/data/pages/road-assets-mileage.aspx). • TransGIS (https://gis.odot.state.or.us/transgis/)(corrected to scale). • Virtual Highway Corridor (3D mobile mapper data). • MicroStation maps with aerial photos. • Information obtained from difference sources can vary.
4. Current map(s) and aerial photo	• A PDF map is required with final report. • Aerial photos can be used to document context and determine relative density of land uses.
5. Crash data	• Crash data must include at least three full years of recorded crashes. • A partial year of data for the current year can be included. • Speed zone studies consider crash rates in the recommendation section. • Soliciting crash records from local road authorities or law enforcement can be beneficial.
6. Traffic volume (average daily traffic)	• Important piece for assessing the operations of the roadway. • Best source is the road authority for the roadway.
7. Google Street View or similar aids	• Can be used just prior to the field visit.
8. Federal functional classification	• Three main categories: arterials, collectors, and local. • Can use TransGIS (https://gis.odot.state.or.us/transgis/) to determine.
9. City and County boundaries	• Critical for determining applicable procedures. • Can use TransGIS (https://gis.odot.state.or.us/transgis/) to determine. • Can use Oregon Maps (https://www.oregon.gov/odot/Data/Pages/Maps.aspx) to determine. • Oregon Department of Transportation can determine whether a highway adjacent to a city limit boundary can be considered as being within the city for designating speeds.

Source: Oregon Department of Transportation (2022)

With roadway context being such an important component, Oregon Department of Transportation (2022) provides a table for assessing context. A summary of contexts and characteristics is given in Table 2.13.

Table 2.13: Summary for Assessing Roadway Context

Context	Building Setback	Building Access	Land Use	Building Density	Parking	Block Size
Urban Core	None or little setback	Front door from sidewalk	Mixed, but mostly Commercial; can be some Residential	High density and taller buildings	Primarily on-street, maybe some off-street	Small consistent blocks
Urban Mix	Little setback	Some front doors from sidewalk	Mixed Commercial with some Residential	Medium to high density and shorter buildings	Some on-street and some off-street	Small to medium block size
Suburban Residential	Little setback	Some access from sidewalk	Mostly Residential, Parks, or Recreational	Medium density, single- or multi-family	Varies	Small to medium block size
Suburban Fringe	Varies	Varies	Light Varied Suburban	Low density to sparse	On-street with some off-street	Larger size with not so well-defined blocks
Rural Community (Outside City Limits)	Little setback from sidewalk	Some front doors from sidewalk	Mixed, mostly Commercial (some Residential or Parks)	Medium density, maybe mix of residential and commercial buildings	Mix of on-street and off-street parking, or open front	Small to medium
Rural (Outside City Limits)	NA	NA	Mostly Agriculture or Undeveloped	Sparse buildings	None to little	Widely spaced intersections and driveways

Source: Oregon Department of Transportation (2022)

Oregon Department of Transportation (2022) notes the importance of using precise descriptions to describe the relative use of the roadway segment by pedestrians and bicycles. Descriptions should be relative to the surrounding area. Factors that can lead to pedestrian and bicycle use are given, such as on-street parking that is utilized, bus stops, regular crossing opportunities, wide sidewalks and furniture for pedestrians, separated or buffered bicycle lanes, and high employment density. Factors that may lead to low pedestrian and bicycle use are also given, such as high vehicle speeds, multiple lanes in each direction, the perception that the street may not be safe for non-motorized users, and discontinuity of route or facilities.

Oregon Department of Transportation (2022) states that the following are required when conducting spot speed studies:

- 85th percentile speed.
- 50th percentile speed.
- 10 mi/h pace limits.
- Percent of traffic in 10 mi/h pace.
- Percent of traffic exceeding posted speed limit.
- Maximum recorded speed, per direction and combined.
- Line or data point chart that includes:
    - Speed in 1 mi/h increments on the x-axis.
    - Cumulative percentage of total vehicles counted on the y-axis.
    - Chart must be scaled large enough to read percentile accurately for any speed.
    - A vertical line indicating 85th percentile speed, 50th percentile speed, and the posted speed limit.

Speed zones should not be changed at an intersection, but on one side or the other. Speed zones should not be changed within school zones. Transition speed zones can be a minimum of 1,000 ft long. Changes in speed zoning should fit with a definite change in context, development, or if the road characteristics change. Recommended speed limits in city limits are generally selected from a range of allowable speeds, as shown in Table 2.14.[4]

Table 2.14: Allowable Speed by Functional Class and Context

Context	Arterial	Collector	Local
Urban Core	20 mi/h to 25 mi/h	20 mi/h to 25 mi/h	20 mi/h to 25 mi/h
Urban Mix	25 mi/h to 30 mi/h	25 mi/h to 30 mi/h	20 mi/h to 25 mi/h
Suburban Commercial or Residential	30 mi/h to 35 mi/h	25 mi/h to 30 mi/h	25 mi/h to 35 mi/h
Suburban Fringe	35 mi/h to 45 mi/h	30 mi/h to 40 mi/h	25 mi/h to 35 mi/h

Source: Oregon Department of Transportation (2022)

[4] There are various scenarios that allow for a recommended speed outside of the ranges in the table, as detailed in OAR 734-020-0015 (https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=286803).

As discussed previously, the Oregon Department of Transportation (2022) permits an Alternate Investigation Method that can be used on any city street or county road that is functionally a collector or local. The differences between this investigation and the Standard Engineering Study Method are minor. The report for the Alternate Investigation Method is abbreviated and some data is not necessary to include. Oregon Department of Transportation (2022) also comment on Minor Adjustment Studies that can be used to determine a need for a transition speed zone or to reduce or extend an existing speed zone. The Minor Adjustment Studies do not require a spot speed study. The data considered relevant include crash data, posted speed limits of adjacent speed zones, and any changes to the roadway or development. The study documents the Engineer's considerations and recommendations and provides the necessary information to issue a new speed zone order.

The Oregon Department of Transportation performs a periodic review of speed zoning by road authorities (i.e., local agencies with delegated authority), which typically occur every five years; however, the Oregon Department of Transportation can perform the review at their discretion. The review is to ensure that the agency with delegated authority is complying with ORS, OARs, and the Oregon Speed Zoning Manual. For the review, up to 10 speed zones can be selected, where the reports are then assessed, and notes of any concerns or suggestions are documented. From the reviews, the Oregon Department of Transportation can take the following actions:

- Monitor the speed zone again in five years.
- Choose to analyze additional speed zones and/or recommend more frequent reviews based on noted concerns.

If a road authority repeatedly fails to comply with rules, the Oregon Department of Transportation can withdraw the delegation of authority.

2.3 SUMMARY

A review of speed zoning or speed management manuals was conducted for states where a speed zoning manual, speed management manual, or closely related study was found. Overall, the speed zoning process is fairly consistent across each state. An engineering and traffic study (accompanied by details of how the study should be conducted, data to be used, etc.), 85th percentile speed, 50th percentile speed, and various roadway characteristics were factors considered in each state reviewed. Also common was the manner in which speed zoning requests can be made, where each state permits agencies and citizens to submit requests; albeit, there are caveats for some states. For example, Oregon permits citizens to submit requests, but it must be in conjunction with a city and formally requested by the city. Another common theme was the use of crash data in the speed zoning process. The use of USLIMITS2 for speed limit determination or comparing results was also a common theme across most states, as was referring to procedures outlined in the Manual on Uniform Traffic Control Devices. The use of USLIMITS2 ranged from using it to follow speed study requirements, to using it as a tool to check speed limit recommendations, to being a requirement to analyze data and develop a speed study report. For some states, such as Ohio, the use of USLIMITS2 is required for validation. In other states, if the speed recommendation differs from the results of USLIMITS2, the speed limit recommendation should be reconsidered. Many of the states reviewed discouraged setting speed limits below the 85th percentile speed, which included input from law enforcement.

A less common theme across states was related to the authority in the speed zoning process. While some states delegate authority (at differing levels of autonomy), several states still require that the final decision be made by top levels at the State Department of Transportation. There were some states that delegated authority, but it remained within the State Department of Transportation (e.g., State Traffic Engineer instead of the Secretary or Director of the Department of Transportation). Oregon appears unique in this regard, as authority can be delegated to local jurisdictions.

Another less common theme across states was the role vulnerable road users play in the speed zoning process. Although about half the states reviewed mention vulnerable road users, only a few provide specific details on how they should be considered in the speed zoning process. The states that provide these details state that pedestrian and bicycle activity, the number of pedestrian and bicycle crashes, if pedestrians and bicycles use the roadway segment, and the number of pedestrian and bicycle conflicts with motor vehicles should be considered when defining a speed zone. In Illinois, infrastructure is also considered, such as the presence of sidewalks or if there are sidewalks immediately behind a curve.

While some states provided a "how to" in regards to speed zoning, others provided additional details on specific speeding-related problems and plans to address these problems through speed management and speed zoning. Included were countermeasure recommendations, strategy recommendations, and systemic solutions to address speed. Recommendations were related to management, engineering, enforcement, and education.

3.0 ANALYSIS LOCATIONS AND CONTEXT

In consultation with the Oregon Department of Transportation and the Technical Advisory Committee, a list of potential locations was identified for analysis. The primary criteria considered included: (1) a speed zone was implemented based on the new speed zoning method, (2) the speed zone was on a roadway in an urban area, and (3) speed data before the speed zone was implemented must be obtainable. Despite efforts, no spot speed data before speed zone implementation was available outside of the Portland Metropolitan area. As a result, all locations for this analysis were located in the Portland Metropolitan area.

The speed zones considered for analysis are shown in Table 3.1. In total, 10 speed zones were considered and a total of 35 spot speed locations. The spot speed locations were selected based on there being both before and after speed data. Further note that some speed zones experienced multiple speed limit reductions across the speed zone considered (e.g., one section of the speed zone was reduced from 40 mi/h to 30 mi/h and another section was reduced from 35 mi/h to 30 mi/h). The length of the speed zones varied from less than 0.5 miles to more than 8 miles.

Table 3.1: Speed Zones Considered for Analysis

Speed Zone	Number of Spot Speed Locations	Change (mi/h)	Length (mi)
N Lombard St (N St Louis Ave to N Bruce Ave)	1	30 to 25, 35 to 25	0.3, 0.4
NE 102nd Ave (NE Mason St to NE Weidler St)	1	35 to 30	1.3
NE/SE 122nd Ave (NE Sandy Blvd Undercrossing to SE Foster Rd)	6	35 to 30	5.6
NE/SE 82nd Ave (US-30 Bypass to SE Clatsop St)	9	35 to 30	7
NE Glisan St (NE 82nd Ave to NE 162nd Ave)	5	35 to 30, 40 to 30	2, 2
NE Killingsworth St (NE Cleveland Ave to US-30 Bypass)	2	30 to 25, 35 to 30	2.2, 1.4
NW Front Ave/NW Naito Pwky (NW 21st Ave to Broadway Bridge Undercrossing)	2	35 to 30	1.1
SE 52nd Ave (SE Powell Blvd to SE Harney Dr)	3	30 to 25	2.4
SE Powell Blvd (SE 7th Ave to SW Junction Pl)	4	35 to 30	8.7
SW Capitol Hwy/SW 49th Ave (SW Taylors Ferry Rd to SW Stephenson St)	2	35 to 30	1.1

For each speed zone, and the spot speed locations, roadway context was summarized based on the following:

- The presence of a bicycle route, or if a bicycle route is planned or recommended.

- This data was obtained from PBOT's Bicycle Network GIS data.[5]

- The number of pedestrian crossings.
  - This data was obtained from PBOT's PedPDX Crossing GIS data.[6]

- The number of transit stops.
  - This data was obtained from PBOT's Transit Stop Peak Arrival GIS data.[7]

- If the speed zone contains pedestrian districts.
  - This data was obtained from PBOT's Transportation System Plan Pedestrian Districts GIS data.[8]

- Equity information, including the total population, proportion of population that is not White, the number of households, median household income, a race index, an income index, and a total index. The equity information is based on census data and is for census tracts adjacent to the speed measurement locations. The race and income indices are on a scale of 1 to 5, where values closer to 5 indicate a more diverse census tract or a lower median household income.
  - This data was obtained from PBOT's Equity Index GIS data.[9] The provided link provides additional information on the PBOT Equity Matrix and how it is used to create the equity indices.

- Land use information, including current designated zoning descriptions and comprehensive plan descriptions (zoning based on the vision for the future of Portland and based on Portland's Comprehensive Plan).[10,11]

- If available, traffic volume counts and active transportation counts.

---

[5] PBOT Bicycle Network GIS Metadata (https://www.portlandmaps.com/metadata/index.cfm?&action=DisplayLayer&LayerID=53123)
[6] PBOT PedPDX Crossing GIS Data (https://gis-pdx.opendata.arcgis.com/datasets/PDX::pedpdx-crossing/about)
[7] PBOT Transit Stop Peak Arrival Metadata (https://www.portlandmaps.com/metadata/index.cfm?&action=DisplayLayer&LayerID=54628)
[8] PBOT Transportation System Plan Pedestrian Districts GIS Metadata (https://www.portlandmaps.com/metadata/index.cfm?&action=DisplayLayer&LayerID=52499)
[9] PBOT Equity Index GIS Metadata (https://www.portlandmaps.com/metadata/index.cfm?&action=DisplayLayer&LayerID=59857)
[10] For information on Portland's Comprehensive Plan, the reader is referred to Comprehensive Plan: Portland's Vision for Growth and Progress (https://www.portland.gov/bps/planning/comp-plan-2035/about-comprehensive-plan).
[11] For descriptions of Portland's Current Zoning and Comprehensive Plan Land Use Designations, the reader is referred to Current Zoning Designations (https://www.portland.gov/code/33) and Comprehensive Plan Land Use Designations (https://www.portland.gov/bps/planning/comp-plan-2035/vision-growth-and-progress/comprehensive-plan-land-use-designations).

- All short-term traffic volume counts were obtained from PBOT's Traffic Counts GIS data.[12]

3.1 N LOMBARD ST

The speed zone on N Lombard St is shown in Figure 3.1. The speed zone has two sections: (1) a speed reduction of 35 mi/h to 25 mi/h with a length of 0.40 miles and (2) a speed reduction of 30 mi/h to 25 mi/h with a length 0.30 miles. Across the two sections, a length of 0.70 miles, there are eight pedestrian crossings, six transit stops, an active protected bike lane, a recommended separated in roadway bike lane, and is located in a pedestrian district (southern part of speed zone in the 30 mi/h to 25 mi/h section).

In this speed zone, only one location contained spot speed measurements for before and after the speed zone was implemented (new speed limit sign installed on June 11, 2021): N Lombard St North of N Weyerhaeuser Ave. At this location, there is a population of 7,609 with 43.1% not being White. There are 2,881 households with a median household income of $59,356. Based on this information, PBOT has designated a race index of 4 and an income index of 4, giving the area adjacent to N Lombard St North of N Weyerhaeuser Ave a total equity index of 8. Current zoning designations adjacent to the spot speed location are General Industrial 2, Commercial Mixed Use 1, and Residential Multi-Dwelling 2, while Comprehensive Plan designations are Industrial Sanctuary, Mixed Use – Dispersed, and Multi-Dwelling – Corridor. The roadway at the spot speed location is two-way with one lane in each direction.

Exposure at N Lombard St North of N Weyerhaeuser Ave, based on short-term counts in 2022, consists of average daily traffic of 3,745 in the northbound direction and 3,973 in the southbound direction. In the northbound direction, the split between cars and trucks is 69% (cars) to 31% (trucks). In the southbound direction, the split is similar at 71.6% (cars) to 28.4% (trucks). No active transportation counts were found at this location.

[12] PBOT Traffic Counts (https://pdx.maps.arcgis.com/apps/webappviewer/index.html?id=7ce8d1f5053141f1bc0f5bd7905351e6)

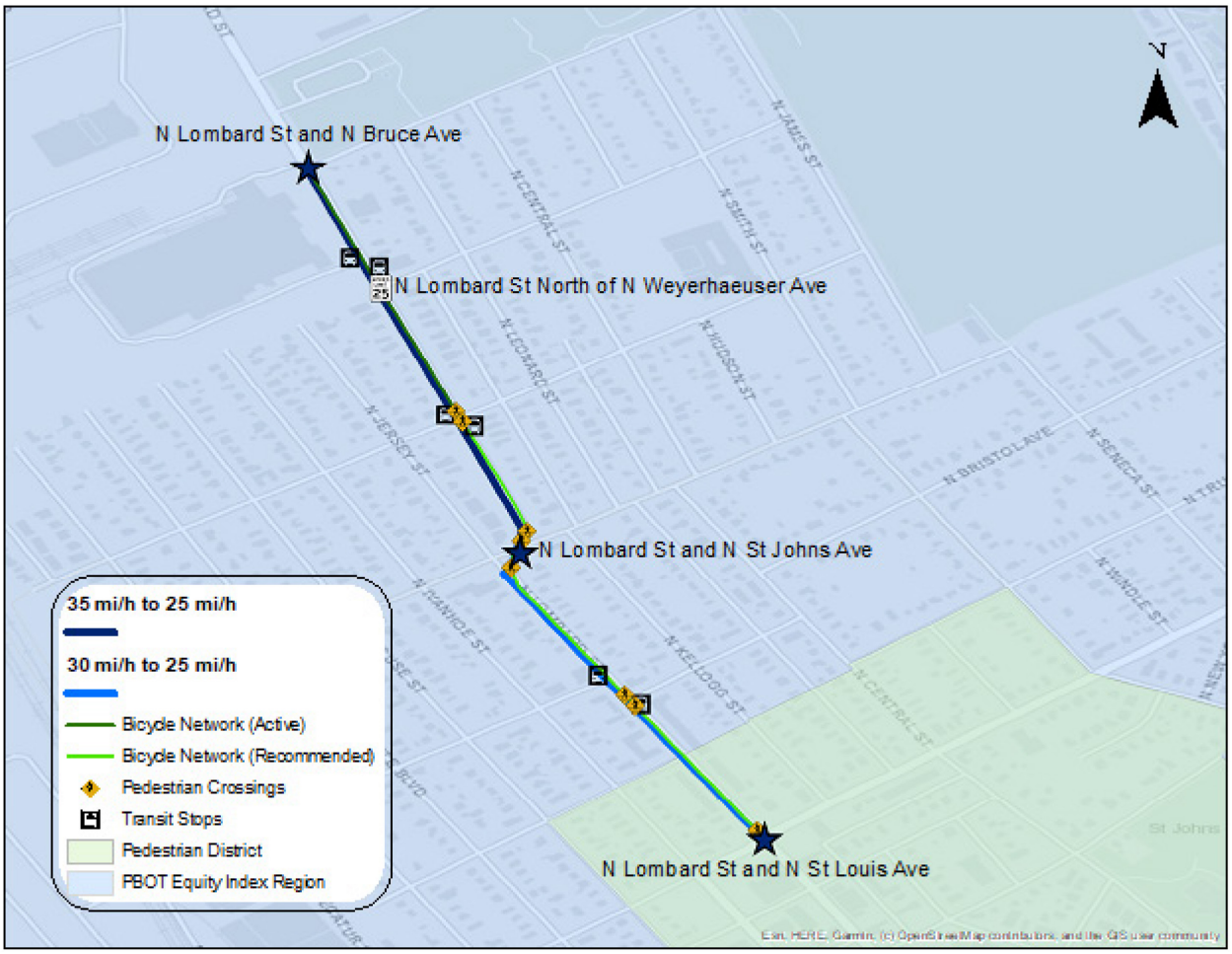


Figure 3.1: Speed Zone on N Lombard St

3.2 NE 102ND AVE

The speed zone on NE 102nd Ave is shown in Figure 3.2. The speed zone is not divided into sections and the reduction is consistent from beginning to end at 35 mi/h to 30 mi/h. Across the speed zone, a length of 1.30 miles, there are 10 pedestrian crossings, 17 transit stops, active buffered bike lanes and active protected bike lanes, and is located in a pedestrian district (southern part of speed zone near NE Weidler St).

In this speed zone, only one location contained spot speed measurements for before and after the speed zone was implemented (new speed limit sign installed on November 5, 2020): NE 102nd Ave North of NE Shaver St. At this location, different census tracts are adjacent on the east and west sides. On the east side, there is a population of 4,498 with 41% not being White. There are 1,817 households with a median household income of $50,777. Based on this information, PBOT has designated a race index of 4 and an income index of 5, giving the area adjacent to NE 102nd Ave North of NE Shaver St on the east side a total equity index of 9. On the west side, there is a population of 2,234 with 36.3% not being White. There are 785 households with a median household income of $64,698. Based on this information, PBOT has designated a race index of 4

and an income index of 4, giving the area adjacent to NE 102nd Ave North of NE Shaver St on the west side a total equity index of 8.

The current zoning designation adjacent to the spot speed location is Residential 7,000, while the Comprehensive Plan designation is Single – Dwelling 7,000. The roadway at the spot speed location is two-way with one lane in each direction and a center turn lane that both directions of travel are permitted to use.

Exposure at NE 102nd Ave North of NE Shaver St, based on short-term counts in 2023, consists of average daily traffic of 8,076 in the northbound direction and 8,238 in the southbound direction. In the northbound direction, the split between cars and trucks is 91.6% (cars) to 8.4% (trucks). In the southbound direction, the split is similar at 91.1% (cars) to 8.9% (trucks). No active transportation counts were found at this location.

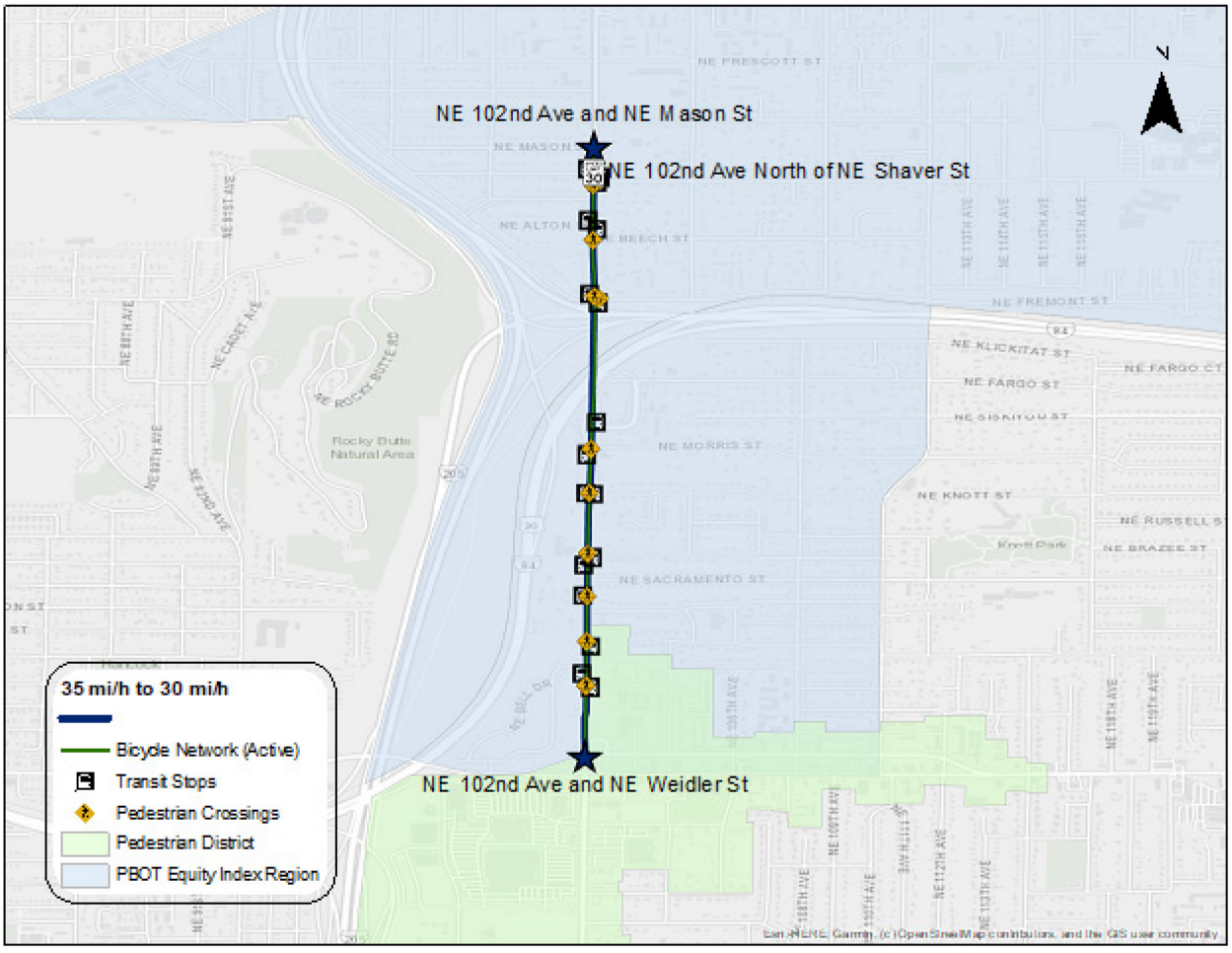


Figure 3.2: Speed Zone on NE 102nd Ave

3.3 NE/SE 122ND AVE

The speed zone on NE/SE 122nd Ave is shown in Figure 3.3. The speed zone is not divided into sections and the reduction is consistent from beginning to end at 35 mi/h to 30 mi/h. Across the

speed zone, a length of 5.60 miles, there are 47 pedestrian crossings, 53 transit stops, active bike lanes and active buffered bike lanes, retired bike lanes that were converted to buffered bike lanes in 2017, and two pedestrian districts. The spot speed location South of NE Holladay St falls within one pedestrian district, while the other pedestrian district surrounds SE Division St (no spot speed measurements could be obtained for the area around SE Division St).

In this speed zone, there are six spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.2. The largest population is adjacent to the South of SE Raymond St location and is located to the east. The east side of the speed zone is less diverse with higher median household income according to PBOT's Equity Index data. The South of NE Halsey St location is adjacent to two census tracts; hence, there is information on both census tracts provided in Table 3.2.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the six spot speed locations are given in Table 3.3. The majority of spot speed locations have adjacent zoning that is residential, while some locations have adjacent commercial mixed-use designations and commercial employment designations. Regarding Comprehensive Plan zoning, the majority of spot speed locations have single- or multi-dwelling designations. At each spot speed location, the roadway is two-way with two lanes in each direction and has a center turn lane that both directions of travel are permitted to use. Average daily traffic volume is consistent across locations with the exception of South of SE Raymond St, where average daily traffic is approximately one-half compared to the other locations. The split between cars and trucks is also fairly consistent across spot speed locations.

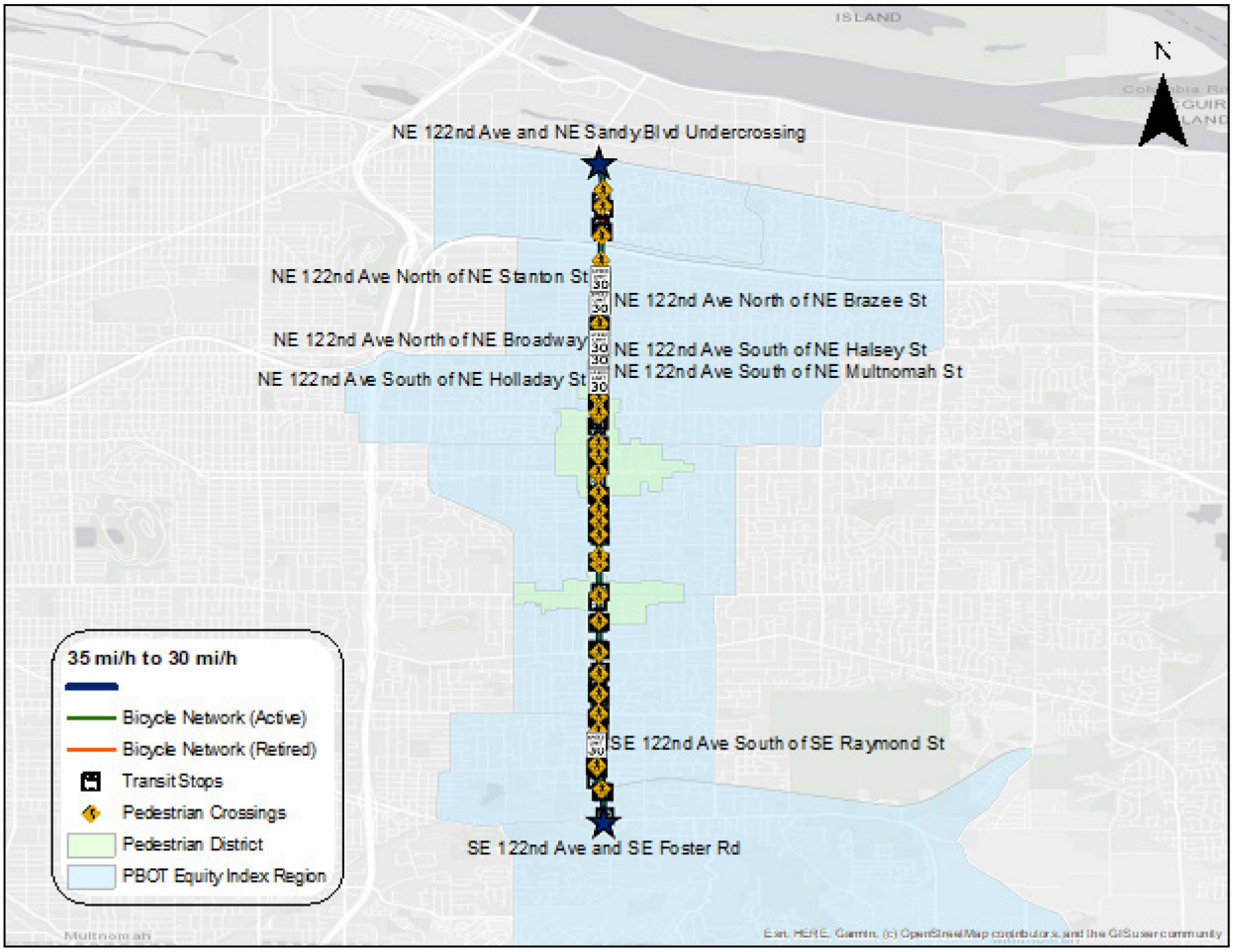


Figure 3.3: Speed Zone on NE/SE 122nd Ave

Table 3.2: Spot Speed Locations and Equity Characteristics in NE/SE 122nd Ave Speed Zone

East Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of NE Stanton St	North of NE Brazee St[1]	6,862	28.8%	2,744	$57,352	3	4	7
North of NE Broadway	North of NE Broadway	6,862	28.8%	2,744	$57,352	3	4	7
South of NE Holladay St	South of NE Holladay St	4,914	42.1%	1,752	$52,986	4	4	8
	South of NE Halsey St[2]	6,862	28.8%	2,744	$57,352	3	4	7
	South of NE Halsey St[2]	4,914	42.1%	1,752	$52,986	4	4	8
	South of NE Multnomah St[3]	4,914	42.1%	1,752	$52,986	4	4	8
South of SE Raymond St	South of SE Raymond St	11,457	48.3%	3,405	$44,028	5	5	10
West Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of NE Stanton St	North of NE Brazee St[1]	3,178	40.7%	1,136	$61,458	4	4	8
North of NE Broadway	North of NE Broadway	3,178	40.7%	1,136	$61,458	4	4	8
South of NE Holladay St	South of NE Holladay St	8,171	46.5%	3,116	$40,913	5	5	10
	South of NE Halsey St[2]	3,178	40.7%	1,136	$61,458	4	4	8
	South of NE Halsey St[2]	8,171	46.5%	3,116	$40,913	5	5	10
	South of NE Multnomah St[3]	8,171	46.5%	3,116	$40,913	5	5	10
South of SE Raymond St	South of SE Raymond St	4,893	41.9%	1,576	$64,929	4	4	8

[1] NE Brazee St is 0.20 miles south of NE Stanton St

[2] NE Halsey St is 0.20 miles north of NE Holladay St

[3] NE Multnomah St is 347 feet north of NE Holladay St

Table 3.3: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in NE/SE 122nd Ave Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
North of NE Stanton St	North of NE Brazee St[1]	• Residential 7,000 • Residential 5,000	• Single – Dwelling 7,000 • Single – Dwelling 5,000	• Two-way • Two lanes in each direction • Center turn lane	• 11,915 (NB)[4] • 13,174 (SB) • 91.7% cars, 8.3% trucks (NB) • 90.5% cars, 9.5% trucks (SB)
North of NE Broadway	North of NE Broadway	• Residential 7,000 • Commercial Employment • Commercial Mixed Use 1	• Single – Dwelling 7,000 • Mixed Use – Civic Corridor	• Two-way • Two lanes in each direction • Center turn lane	• 11,622 (NB)[5] • 11,695 (SB) • 92.8% cars, 7.2% trucks (NB) • 90.6% cars, 9.4% trucks (SB)
South of NE Holladay St	South of NE Holladay St	• Residential Multi-Dwelling 1 • Residential 7,000	• Multi-Dwelling – Neighborhood • Single – Dwelling 7,000	• Two-way • Two lanes in each direction • Center turn lane	• 11,271 (NB)[6] • 12.475 (SB) • 89.8% cars, 10.2% trucks (NB) • 93.4% cars, 6.6% trucks (SB)
	South of NE Halsey St[2]	• Commercial Mixed Use 1 • Commercial Employment •	• Mixed Use – Civic Corridor	• Two-way • Two lanes in each direction • Center turn lane	• 11,723 (NB)[7] • 13,512 (SB) • 93.2% cars, 6.8% trucks (NB) • 94.1% cars, 5.9% trucks (SB)
	South of NE Multnomah St[3]	• Commercial Employment • Residential Multi-Dwelling 1 • Residential 7,000	• Mixed Use – Civic Corridor • Multi-Dwelling – Neighborhood • Single – Dwelling 7,000	• Two-way • Two lanes in each direction • Center turn lane	• 11,368 (NB)[8] • 12.214 (SB) • 91.4% cars, 8.6% trucks (NB) • 90.6% cars, 9.4% trucks (SB)
South of SE Raymond St	South of SE Raymond St	• Residential Multi-Dwelling 2	• Multi-Dwelling – Corridor	• Two-way • Two lanes in each direction	• 5,698 (NB)[9] • 5,628 (SB)

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
		• Commercial Mixed Use 1 • Commercial Mixed Use 2	• Mixed Use – Civic Corridor	• Center turn lane	• 91.4% cars, 8.6% trucks (NB) • 90.8% cars, 9.2% trucks (SB)

[1] NE Brazee St is 0.20 miles south of NE Stanton St

[2] NE Halsey St is 0.20 miles north of NE Holladay St

[3] NE Multnomah St is 347 feet north of NE Holladay St

[4] Short-term counts are from north of Brazee (newer counts) and done in 2022

[5] Short-term counts are from 2022

[6] Short-term counts are from 2023

[7] Short-term counts are from 2023

[8] Short-term counts are from 2022

[9] Short-term counts are from 2023

3.4 NE/SE 82ND AVE

The speed zone on NE/SE 82nd Ave is shown in Figure 3.4. The speed zone is not divided into sections and the reduction is consistent from beginning to end at 35 mi/h to 30 mi/h. Across the speed zone, a length of 7 miles, there are 57 pedestrian crossings, 99 transit stops, planned protected bike lanes, recommended separated in-roadway bike lanes, sections with no bike lanes, and five pedestrian districts. The spot speed location of South of NE Beech St and North of NE Klickitat St fall within one pedestrian district, South of NE Eugene St, South of NE Davis St, and South of SE Mill St are just north of a pedestrian district, North of SE Brooklyn St falls within a pedestrian district, and North of SE Rhone St, South of SE Knapp St, and North/South of SE Lambert St are just south of a pedestrian district.

In this speed zone, there are eight spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.4. Population adjacent to the spot speed locations remains fairly consistent, with exceptions to South of SE Knapp St and North/South of SE Lambert St (to the east), South of NE Davis St (to the west), and South of SE Mill St (to the west), all of which have adjacent populations of 6,000 or greater. Overall, the east side of the speed zone is more diverse with lower median household income according to PBOT's Equity Index data.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the six spot speed locations are given in Table 3.5. The majority of spot speed locations have adjacent zoning that is residential, while some locations have adjacent commercial and employment designations. Regarding Comprehensive Plan zoning, the majority of spot speed locations have single- or multi-dwelling designations and mixed-use designations. At each spot speed location, the roadway is two-way with two lanes in each direction and has a center turn lane that both directions of travel are permitted to use. Average daily traffic is consistent across locations with the exception of the spot speed locations in the north and south ends of the speed zone, both of which have similar average daily traffic volumes and are about 2,000 less than other spot speed locations. The split between cars and trucks is also fairly consistent across spot speed locations. No traffic count data was available in the southbound direction at the South of SE Knapp St location.

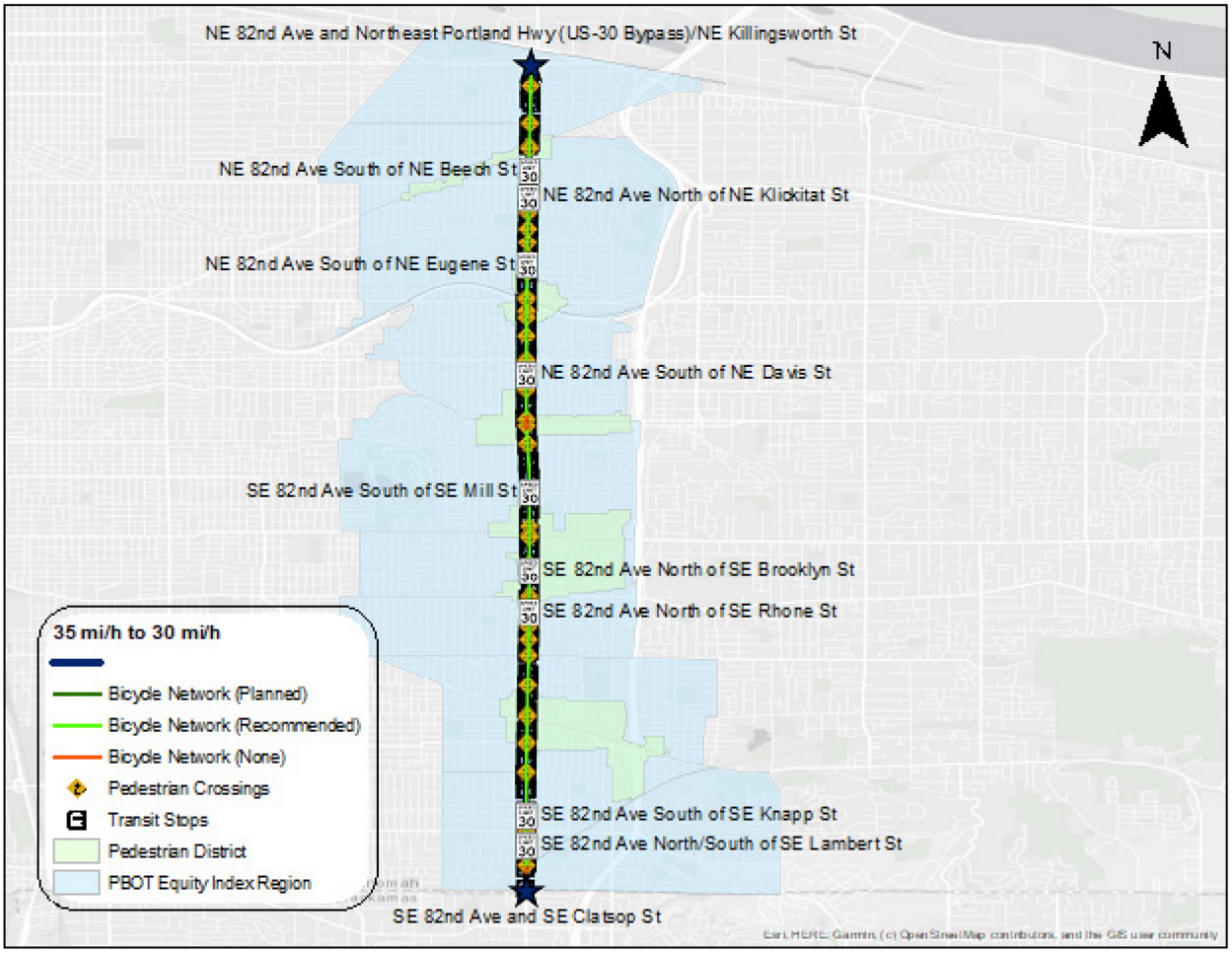


Figure 3.4: Speed Zone on NE/SE 82nd Ave

Table 3.4: Spot Speed Locations and Equity Characteristics in NE/SE 82nd Ave Speed Zone

East Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
South of NE Beech St	South of NE Beech St	5,623	32.4%	2,069	$56,134	3	4	7
	North of NE Klickitat St[1]	5,623	32.4%	2,069	$56,134	3	4	7
South of NE Eugene St	South of NE Eugene St	5,623	32.4%	2,069	$56,134	3	4	7
South of NE Davis St	South of NE Davis St	4,239	37.8%	1,559	$60,729	4	4	8
South of SE Mill St	South of SE Mill St	4,525	35.5%	1,779	$45,380	4	5	9
North of SE Brooklyn St	North of SE Rhone St[2]	4,374	57.4%	1,657	$33,209	5	5	10
South of SE Knapp St	South of SE Knapp St	6,305	53.8%	2,073	$52,686	5	4	9
	North/South of SE Lambert St[3]	6,305	53.8%	2,073	$52,686	5	4	9
West Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
South of NE Beech St	South of NE Beech St	5,740	20.7%	2,475	$62,754	2	4	6
	North of NE Klickitat St[1]	5,740	20.7%	2,475	$62,754	2	4	6
South of NE Eugene St	South of NE Eugene St	5,740	20.7%	2,475	$62,754	2	4	6
South of NE Davis St	South of NE Davis St	7,266	29.6%	2,981	$63,793	3	4	7
South of SE Mill St	South of SE Mill St	6,149	18.5%	2,503	$76,891	2	3	5
North of SE Brooklyn St		4,749	28.9%	2,003	$69,088	3	4	7
	North of SE Rhone St[2]	5,209	28.9%	2,009	$61,436	3	4	7
South of SE Knapp St	South of SE Knapp St	4,200	43.5%	1,562	$54,423	4	4	8
	North/South of SE Lambert St3	4,200	43.5%	1,562	$54,423	4	4	8

[1] NE Klickitat St is 0.20 miles south of NE Beech St

[2] SE Rhone St is 0.30 miles south of SE Brooklyn St

[3] SE Lambert St is 0.20 miles south of SE Knapp St

Table 3.5: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in NE/SE 82nd Ave Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
South of NE Beech St	South of NE Beech St	• Commercial Mixed Use 2 • Residential Multi-Dwelling 1 • Residential 2,500	• Mixed Use – Civic Corridor • Single – Dwelling 5,000	• Two-way • Two lanes in each direction • Center turn lane	• 9.398 (NB)[4] • 8,410 (SB) • 93.5% cars, 6.5% trucks (NB) • 93% cars, 7% trucks (SB)
	North of NE Klickitat St[1]	• Commercial Mixed Use 2 • Residential 5,000 • Residential 2,500	• Mixed Use – Civic Corridor	• Two-way • Two lanes in each direction • Center turn lane	• 11,536 (NB) [5] • 10,736 (SB) • 91.8% cars, 8.2% trucks (NB) • 92.6% cars, 7.4% trucks (SB)
South of NE Eugene St	South of NE Eugene St	• Commercial Employment • Residential 2,500 • Residential 5,000 • General Employment 1	• Mixed Use – Civic Corridor • Mixed Employment	• Two-way • Two lanes in each direction • Center turn lane	• 11,985 (NB) [6] • 10,792 (SB) • 93.3% cars, 6.7% trucks (NB) • 93.3% cars, 6.7% trucks (SB)
South of NE Davis St	South of NE Davis St	• Commercial Employment • Residential Multi-Dwelling 2 • Residential 2,500	• Mixed Use – Civil Corridor • Multi-Dwelling – Corridor • Single – Dwelling 2,500	• Two-way • Two lanes in each direction • Center turn lane	• 11,614 (NB) [7] • 11,169 (SB) • 91.1% cars, 8.9% trucks (NB) • 94.7% cars, 5.3% trucks (SB)
South of SE Mill St	South of SE Mill St	• General Employment • Commercial Employment • Residential Multi-Dwelling 1 • Residential Multi-Dwelling 2	• Mixed Employment • Mixed Use – Civic Corridor • Multi-Dwelling – Neighborhood • Multi-Dwelling – Corridor	• Two-way • Two lanes in each direction • Center turn lane	• 11,554 (NB) [8] • 11,107 (SB) • 93% cars, 7% trucks (NB) • 92.7% cars, 7.3% trucks (SB)
North of SE Brooklyn St	North of SE Rhone St[2]	• Commercial Mixed Use 2 • Residential Multi-Dwelling 1 • Residential 2,500	• Mixed Use – Civic Corridor • Multi-Dwelling – Corridor	• Two-way • Two lanes in each direction • Center turn lane	• 12,336 (NB) [9] • 11,700 (SB) • 95.1% cars, 4.9% trucks (NB)

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
		• Commercial Employment	• Single – Dwelling 2,500 • Multi-Dwelling - Neighborhood		• 94.5% cars, 5.5% trucks (SB)
South of SE Knapp St	South of SE Knapp St	• General Employment 1 • Residential Manufactured Dwelling Park • Residential 2,500	• Mixed Employment • Manufactured Dwelling Park • Single – Dwelling 2,500	• Two-way • Two lanes in each direction • Center turn lane	• 9,898 (NB) [10] • NA (SB) • 90.4% cars, 9.6% trucks (NB) • NA (SB)
	North/South of SE Lambert St[3]	• General Employment 1 • General Employment 2 • Residential Multi-Dwelling 1 • Residential Manufactured Dwelling Park • Residential 2,500	• Mixed Employment • Multi-Dwelling – Neighborhood • Manufactured Dwelling Park • Single – Dwelling 2,500	• Two-way • Two lanes in each direction • Center turn lane	• 9,716 (NB) [11] • 9,177 (SB) • 93.9% cars, 6.1% trucks (NB) • 92.8% cars, 7.2% trucks (SB)

[1] NE Klickitat St is 0.20 miles south of NE Beech St

[2] SE Rhone St is 0.30 miles south of SE Brooklyn St

[3] SE Lambert St is 0.20 miles south of SE Knapp St

[4] Short-term counts are from 2023

[5] Short-term counts are from 2023

[6] Short-term counts are from 2022

[7] Short-term counts are from 2022

[8] Short-term counts are from 2022

[9] Short-term counts are from north of Rhone (newer counts) and done in 2022

[10] Short-term counts are from 2023 (no southbound data available)

[11] Short-term counts are from 2022

3.5 NE GLISAN ST

The speed zone on NE Glisan St is shown in Figure 3.5. The speed zone is divided into two sections: (1) a 35 mi/h to 30 mi/h reduction from NE Glisan St and NE 82nd Ave to NE Glisan St and NE 122nd Ave, and (2) a 40 mi/h to 30 mi/h reduction from NE Glisan St and NE 122nd Ave to NE Glisan St and NE 162nd Ave. The length of the first section of the speed zone is 2 miles, as is the second section, for a total speed zone length of 4 miles. In this speed zone, there are 18 pedestrian crossings (11 in the 35 mi/h to 30 mi/h reduction section and seven in the 40 mi/h to 30 mi/h reduction section), 47 transit stops (20 in the 35 mi/h to 30 mi/h reduction section and 27 in the 40 mi/h to 30 mi/h reduction section), active buffered bike lanes (in both sections), active protected bike lanes (in the 40 mi/h to 30 mi/h reduction section), recommended separated in-roadway bike lanes (in the 35 mi/h to 30 mi/h reduction section), and three pedestrian districts (one in each section and one that includes both sections).

In this speed zone, there are five spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.6. The largest population is adjacent to the West of NE 113th Ave location. All spot speed locations are in census tracts that are diverse and have low median household income based on PBOT's Equity Index data; specifically, three of the five locations have a total index of 10, while the other two have a total index of 8.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the six spot speed locations are given in Table 3.3. The majority of spot speed locations have adjacent zoning that is residential, with open space, campus institutional, and commercial designations being unique. Regarding Comprehensive Plan zoning, the majority of spot speed locations have single- or multi-dwelling designations. The roadway characteristics differ among the spot speed locations. At the East of NE 85th Ave location, the roadway is two-way, two lanes in each direction, and has a center turn lane that both directions of travel are permitted to use; this is the only location in this speed zone in which there are two lanes in each direction. At the West of NE 113th Ave location, the roadway is two-way with two lanes in the eastbound direction and one lane in the westbound direction (the center turn lane is still present). The remaining three locations are all two-way with one lane in each direction and on-street parking (the center turn lane is still present). At the East of NE 143rd Ave location, on-street parking is present in the eastbound direction. At the East of NE 157th Ave location, on-street parking is present in both directions. The final location, East of NE 155th Ave, has on-street parking in the westbound direction. Average daily traffic is consistent across locations with the exception of West of NE 113th Ave, where average daily traffic is much greater relative to the other locations. The split between cars and trucks is also fairly consistent across the spot speed locations, where the West of NE 113th Ave location has the highest proportion of trucks at 10.2%.

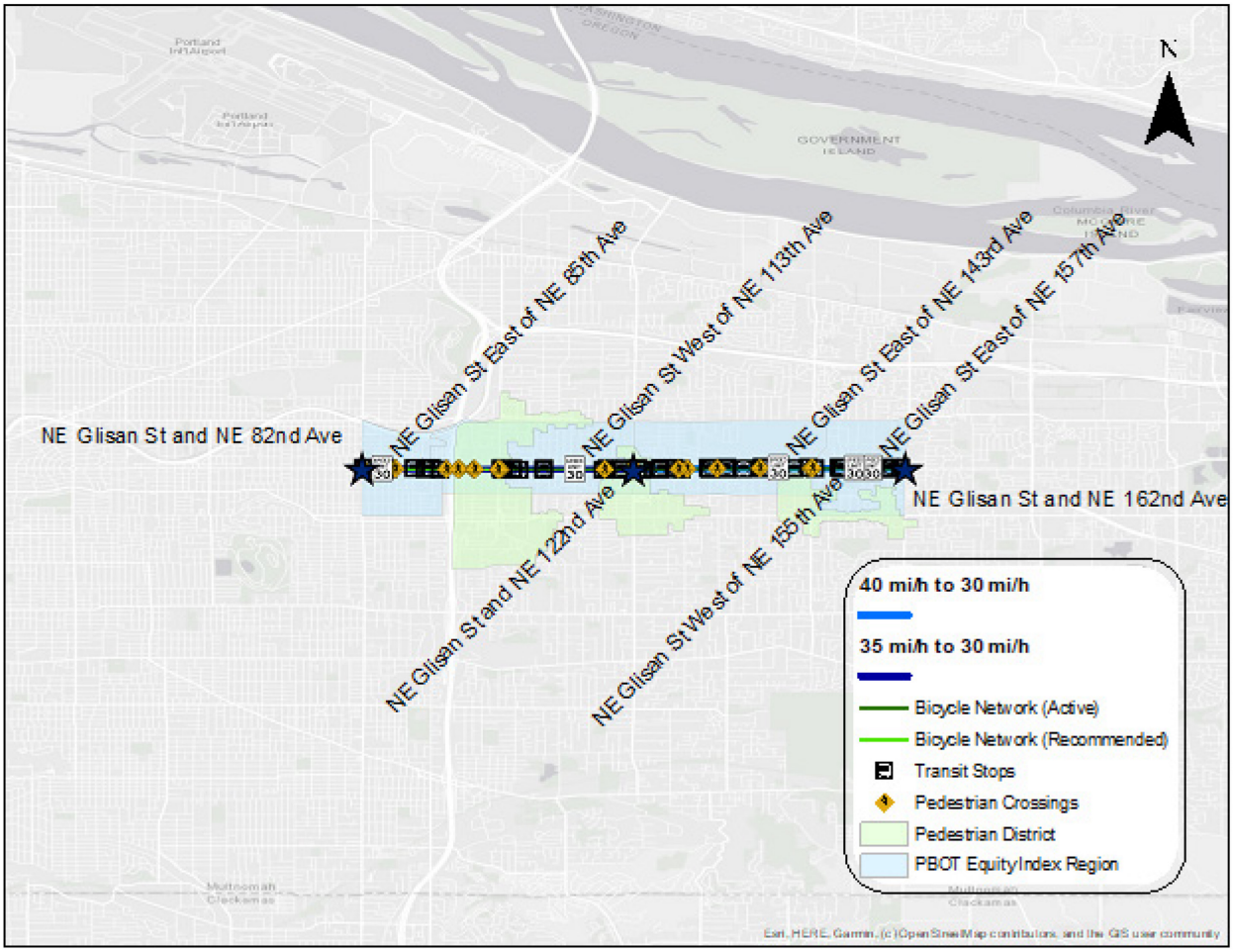


Figure 3.5: Speed Zone on NE Glisan St

Table 3.6: Spot Speed Locations and Equity Characteristics in NE Glisan St Speed Zone

North and South Sides of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
East of NE 85th Ave	East of NE 85th Ave	4,239	37.8%	1,559	$60,729	4	4	8
West of NE 113th Ave	West of NE 113th Ave	8,171	46.5%	3,116	$40,913	5	5	10
East of NE 143rd Ave	East of NE 143rd Ave	4,914	42.1%	1,752	$52,986	4	4	8
East of NE 157th Ave	East of NE 157th Ave	6,835	51%	2,286	$45,775	5	5	10
West of NE 155th Ave[1]		6,835	51%	2,286	$45,775	5	5	10

[1] NE 155th Ave is 0.10 miles west of NE 157th Ave

Table 3.7: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in NE Glisan St Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
East of NE 85th Ave	East of NE 85th Ave	• Residential 5,000 • Residential 2,500 • Campus Institutional 1	• Single – Dwelling 5,000 • Single – Dwelling 2,500 • Institutional Campus	• Two-way • Two lanes in each direction • Center turn lane	• 8,666 (EB)[2] • NA (WB) • 92.3% cars, 7.7% trucks (EB) • NA (EB)
West of NE 113th Ave	West of NE 113th Ave	• Residential 5,000 • Residential 2,500	• Single – Dwelling 5,000 • Single – Dwelling 2,500	• Two-way • Two lanes (EB), one lane (WB) • Center turn lane	• 11,784 (EB)[3] • 13,214 (WB) • 89.8% cars, 10.2% trucks (EB) • 93.3% cars, 6.7% trucks (WB)
East of NE 143rd Ave	East of NE 143rd Ave	• Open Space • Residential Multi-Dwelling 1 • Residential Multi-Dwelling 2 • Residential 5,000	• Open Space • Multi-Dwelling – Neighborhood • Multi-Dwelling - Corridor • Single – Dwelling 5,000	• Two-way • One lane each direction • On-street parking (EB) • Center turn lane	• 9,017 (EB)[4] • 9,470 (WB) • 95.7% cars, 4.3% trucks (EB) • 92.9% cars, 7.1% trucks (WB)
East of NE 157th Ave	East of NE 157th Ave	• Residential Multi-Dwelling 1 • Residential Multi-Dwelling 2 • Residential 10,000 • Commercial Mixed Use 1	• Multi-Dwelling – Neighborhood • Multi-Dwelling - Corridor • Single – Dwelling 10,000 • Mixed Use - Dispersed	• Two-way • One lane each direction • On-street parking each direction • Center turn lane	• 7,354 (EB)[5] • 8,008 (WB) • 93.8% cars, 6.2% trucks (EB) • 94.2% cars, 5.8% trucks (WB)
West of NE 155th Ave[1]		• Residential Multi-Dwelling 1 • Residential 5,000 • Residential 7,000	• Multi-Dwelling – Neighborhood • Single – Dwelling 5,000	• Two-way • One lane each direction • On-street parking (WB)	• 7,577 (EB)[6] • 8,300 (WB) • 94.2% cars, 5.8% trucks (EB)

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
			• Single – Dwelling 7,000	• Center turn lane	• 94.6% cars, 5.4% trucks (WB)

[1] NE 155th Ave is 0.10 miles west of NE 157th Ave

[2] Short-term counts are from 2023

[3] Short-term counts are from 2023

[4] Short-term counts are from 2023

[5] Short-term counts are from 2023

[6] Short-term counts are from 2020 (February)

3.6 NE KILLINGSWORTH ST

The speed zone on NE Killingsworth St is shown in Figure 3.6. The speed zone is divided into two sections: (1) a 30 mi/h to 25 mi/h reduction from NE Killingsworth St and NE Cleveland Ave to NE Killingsworth St and NE 42nd Ave, and (2) a 35 mi/h to 30 mi/h reduction from NE Killingsworth St and NE 42nd Ave to NE Killingsworth St and NE Portland Hwy (US-30 Bypass). The length of the first section of the speed zone is 2.2 miles, the length of the second section of the speed zone is 1.4 miles, and the total speed zone length is 3.6 miles. In this speed zone, there are 32 pedestrian crossings (23 in the 30 mi/h to 25 mi/h reduction section and nine in the 35 mi/h to 30 mi/h reduction section), 35 transit stops (17 in the 30 mi/h to 25 mi/h reduction section and 18 in the 35 mi/h to 30 mi/h reduction section), active bike lanes, buffered bike lanes, and protected bike lanes (in the 35 mi/h to 30 mi/h reduction section), planned protected bike lanes (in the 35 mi/h to 30 mi/h reduction section), recommended separated in-roadway and neighborhood greenway bike lanes (in the 30 mi/h to 25 mi/h reduction section), no bike lanes (in the 30 mi/h to 25 mi/h reduction section), and three pedestrian districts. The East of NE 20th Ave location is located in a pedestrian district on the west side of the speed zone, while the East of NE 64th Ave and East of NE Cully Blvd locations are located in a pedestrian district on the far east of the speed zone.

In this speed zone, there are four spot speed locations (the before and after locations are different and separated by the distance given in Table 3.8). Population and equity characteristics at the spot speed locations are given in Table 3.8. The largest population is adjacent to the West of NE 22nd Ave and East of NE 20th Ave locations on the north side of NE Killingsworth St. According to PBOT's Equity Index data, there is a noticeable difference in diversity and median incomes between the two sets of spot speed locations, where the locations on the far east side of the speed zone are more diverse and have lower median household income (this is true for both the north and south sides of NE Killingsworth St).

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the six spot speed locations are given in Table 3.9. The majority of spot speed locations have adjacent zoning that is residential, with open space, commercial use, and general employment also being present. Regarding Comprehensive Plan zoning, the majority of spot speed locations have single- or multi-dwelling designations. The roadway characteristics differ among the spot speed locations. At the West of NE 22nd Ave and East of NE 20th Ave locations, the roadway is two-way and has one lane in each direction. At the East of NE 64th Ave and East of NE Cully Blvd locations, the roadway is two-way with one lane in each direction and a center turn lane. Also present as these locations is on-street parking, where on-street parking is present in both directions at the East of NE 64th Ave and present in only the eastbound direction at the East of NE Cully Blvd location. Average daily traffic volume remains fairly consistent across locations, as do the splits between cars and trucks.

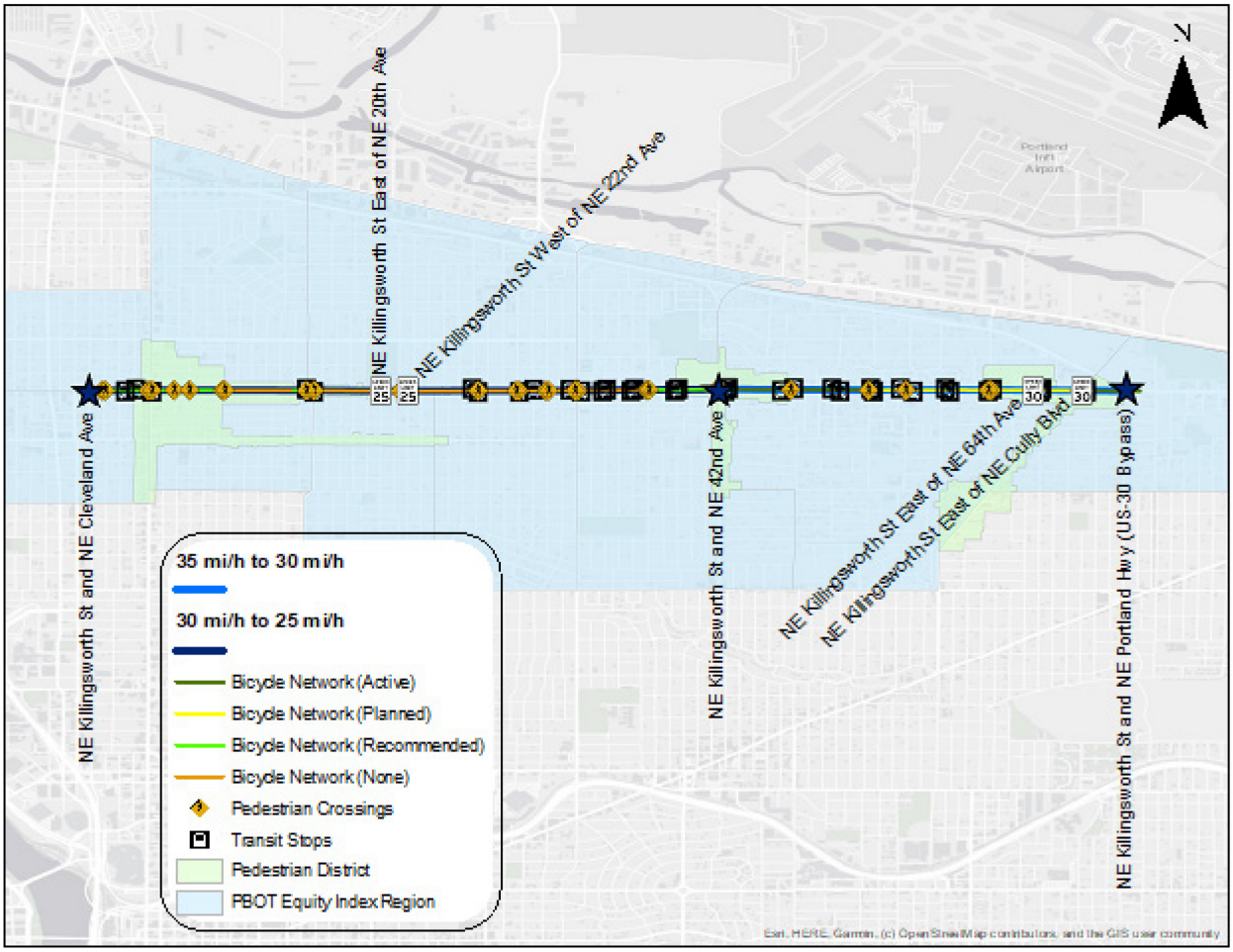


Figure 3.6: Speed Zone on NE Killingsworth St

Table 3.8: Spot Speed Locations and Equity Characteristics in NE Killingsworth St Speed Zone

North Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
West of NE 22nd Ave	East of NE 20th Ave[1]	7,007	31.3%	2,472	$110,172	3	2	5
East of NE 64th Ave	East of NE Cully Blvd[2]	4,236	59.2%	1,396	$40,288	5	5	10
	East of NE Cully Blvd[2]	3,291	49%	1,328	$45,976	5	5	10
South Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
West of NE 22nd Ave	East of NE 20th Ave[1]	4,368	16.8%	1,758	$105,556	2	2	4
East of NE 64th Ave	East of NE Cully Blvd[2]	5,500	38.7%	1,782	$74,884	4	3	7
		3,291	49%	1,328	$45,976	5	5	10

[1] NE 20th Ave is 472 feet east of NE 22nd Ave

[2] NE Cully Blvd is 0.20 miles east of NE 64th Ave

Table 3.9: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in NE Killingsworth St Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
West of NE 22nd Ave	East of NE 20th Ave[1]	• Open Space • Residential Multi-Dwelling 2 • Residential 2,500 • Residential Multi-Dwelling 1	• Open Space • Multi-Dwelling – Corridor • Single – Dwelling 2,500 • Multi-Dwelling - Neighborhood	• Two-way • One lane each direction	• 5,252 (EB)[3] • 5,000 (WB) • 95.4% cars, 4.6% trucks (EB) • 92.3% cars, 7.7% trucks (WB)
East of NE 64th Ave	East of NE Cully Blvd[2]	• Residential Manufactured Dwelling Park • Residential Multi-Dwelling 1 • General Employment 2 • Commercial Mixed Use 2 • Residential Multi-Dwelling 2	• Manufactured Dwelling Park • Multi-Dwelling – Neighborhood • Mixed Employment • Mixed Use – Neighborhood • Multi-Dwelling - Corridor	• Two-way • One lane each direction • On-street parking (NE Cully Blvd, EB) • On-street parking in both directions (NE 64th Ave) • Center turn lane	• 6,233 (EB)[4] • 5,398 (WB) • 92.5% cars, 7.5% trucks (EB) • 90.8% cars, 9.2% trucks (WB)

[1] NE 20th Ave is 472 feet east of NE 22nd Ave

[2] NE Cully Blvd is 0.20 miles east of NE 64th Ave

[3] Short-term counts are from east of NE 22nd Ave (newer counts) and done in 2024

[4] Short-term counts are from east of NE Cully Blvd (newer counts) and done in 2023

3.7 NW FRONT AVE/NW NAITO PKWY

The speed zone on NW Front Ave/NW Naito Pkwy is shown in Figure 3.7. The speed zone is 1.10 miles long and consists of only one section with a 35 mi/h to 30 mi/h reduction. In this speed zone, there are seven pedestrian crossings, seven transit stops, active protected bike lanes, planned protected bike lanes, recommended separated in-roadway bike lanes, and one pedestrian district. Both spot speed locations are within the pedestrian district.

In this speed zone, there are two spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.10. Compared to other speed zones, this speed zone has much lower adjacent population (the census tract the West of NW 9th Ave location falls in extends well beyond the spot speed location and speed zone; hence, the larger population indicated). According to PBOT's Equity Index data, there is a noticeable difference in diversity and median incomes between the two sets of spot speed locations, where the location on the west of the speed zone (West of NW 19th Ave) is more diverse and has a lower median household income.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the two spot speed locations are given in Table 3.11. Unlike the other speed zones, no residential designations are present adjacent to this speed zone; rather, designations are only employment and commercial. Regarding Comprehensive Plan zoning, designations are also only employment and commercial. The roadway characteristics differ among the spot speed locations. At the West of NW 19th Ave location, the roadway is two-way with two lanes in each direction. At the West of NW 9th Ave location, there was a recent reconfiguration, which consists of a two-way roadway with one lane in each direction. At this location, there is also a center turn lane and on-street parking in the westbound direction. Average daily traffic is higher at the West of NW 9th Ave location, while the West of NW 19th Ave location has the highest percentage of trucks across all speed zones considered.

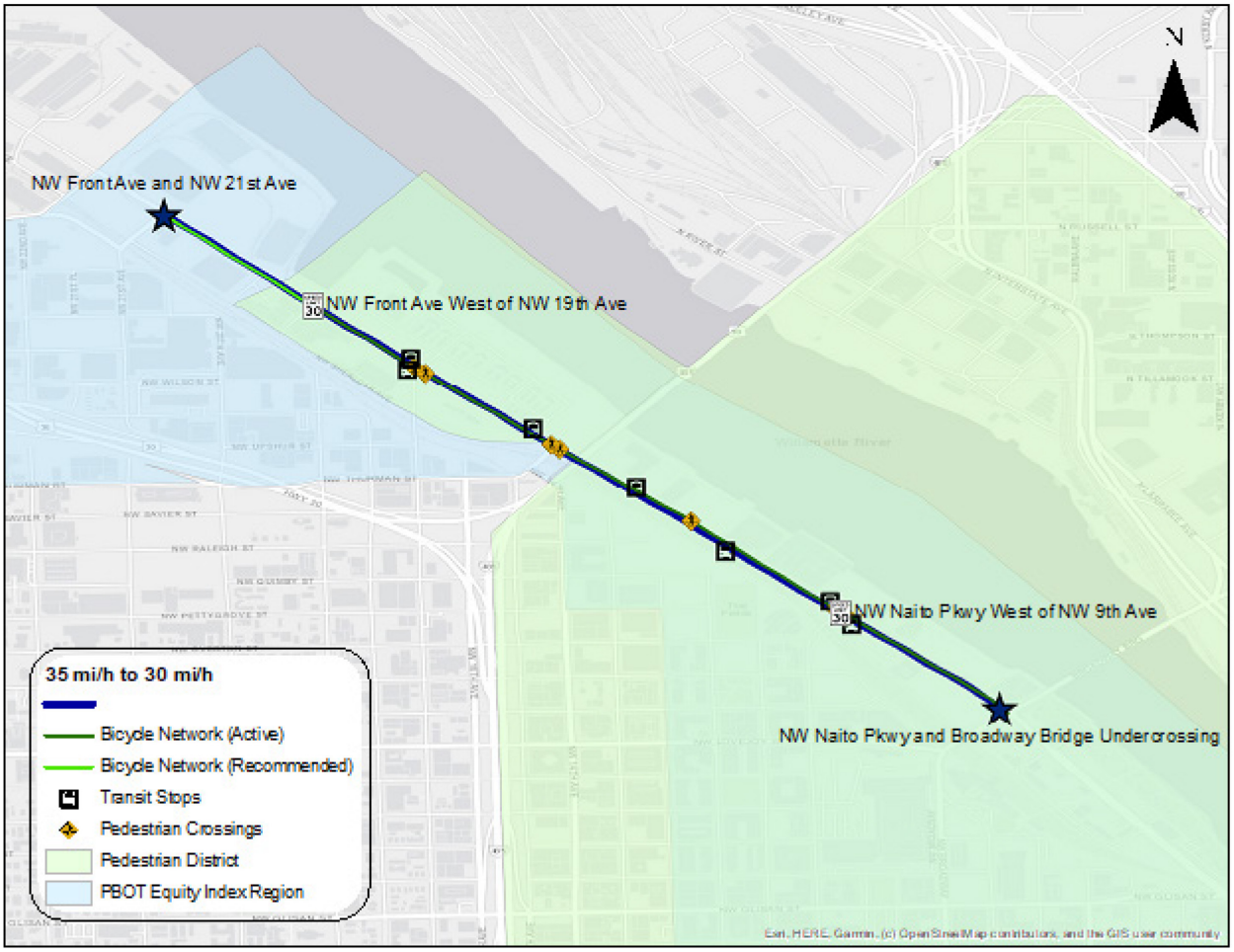


Figure 3.7: Speed Zone on NW Front Ave/NW Naito Pkwy

Table 3.10: Spot Speed Locations and Equity Characteristics in NW Front Ave/NW Naito Pwky Speed Zone

North and South Sides of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
West of NW 19th Ave	West of NW 19th Ave	2,814	18.6%	1,353	$90,594	2	3	5
West of NW 9th Ave	West of NW 9th Ave	8,148	25.3%	5,570	$45,625	3	5	8

Table 3.11: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in NW Front Ave/NW Naito Pkwy Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
West of NW 19th Ave	West of NW 19th Ave	• Central Employment • Central Commercial	• Central Employment • Central Commercial	• Two-way • Two lanes in each direction	• 2,692 (EB)[1] • 2,634 • 87.5% cars, 12.5% trucks • 89.7% cars, 10.3% trucks
West of NW 9th Ave	West of NW 9th Ave	• Central Employment	• Central Employment	• Two-way • One in each direction • Center turn lane • On-street parking (WB)	• 3,958 (EB)[2] • 3,306 (WB) • 92.8% cars, 7.2% trucks (EB) • 92.4% cars, 7.6% trucks (WB)

[1] Short-term counts from 2023

[2] Short-term counts from 2023

3.8 SE 52ND AVE

The speed zone on SE 52nd Ave is shown in Figure 3.8. The speed zone is 2.40 miles long and consists of only one section with a 30 mi/h to 25 mi/h reduction. In this speed zone, there are 16 pedestrian crossings, 24 transit stops, active bike lanes, and two pedestrian districts. No spot speed locations fall within a pedestrian district, but the North of SE Tolman St location is just outside of a pedestrian district to the south.

In this speed zone, there are three spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.12. The population adjacent to the speed zone is consistent among spot speed locations, with a low of 3,520 on the east side of the North of SE Tolman St location. According to PBOT's Equity Index data, diversity and median household income are also consistent among the spot speed locations. The exception is the west side of North of SE Tolman St, which is the least diverse location among all speed zone spot speed locations (percentage of population that is not White is 12.6%, which results in a Race Index of 1). This location also has the highest median household income.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the three spot speed locations are given in Table 3.13. The primary zoning designations adjacent to all spot speed locations are residential, with each location also having a commercial designation. Regarding Comprehensive Plan zoning, designations are residential and mixed-use (neighborhood and dispersed). The roadway characteristics differ among the spot speed locations. At the North of SE Tolman St location, the roadway is two-way with one lane in each direction and on-street parking in the northbound direction. At the North of SE Knapp St location, the roadway is two-way with one lane in each direction and on-street parking in both directions. For the other two spot speed locations, which are separated by 0.20 miles, both are two-way roadways with one lane in each direction. Differences for these locations are observed with on-street parking, where the North of SE Malden St location has on-street parking in both directions and the North of SE Malden Dr has on-street parking in the northbound direction. Average daily traffic is highest at the North of SE Tolman St location and lowest at the North of SE Malden Dr location.

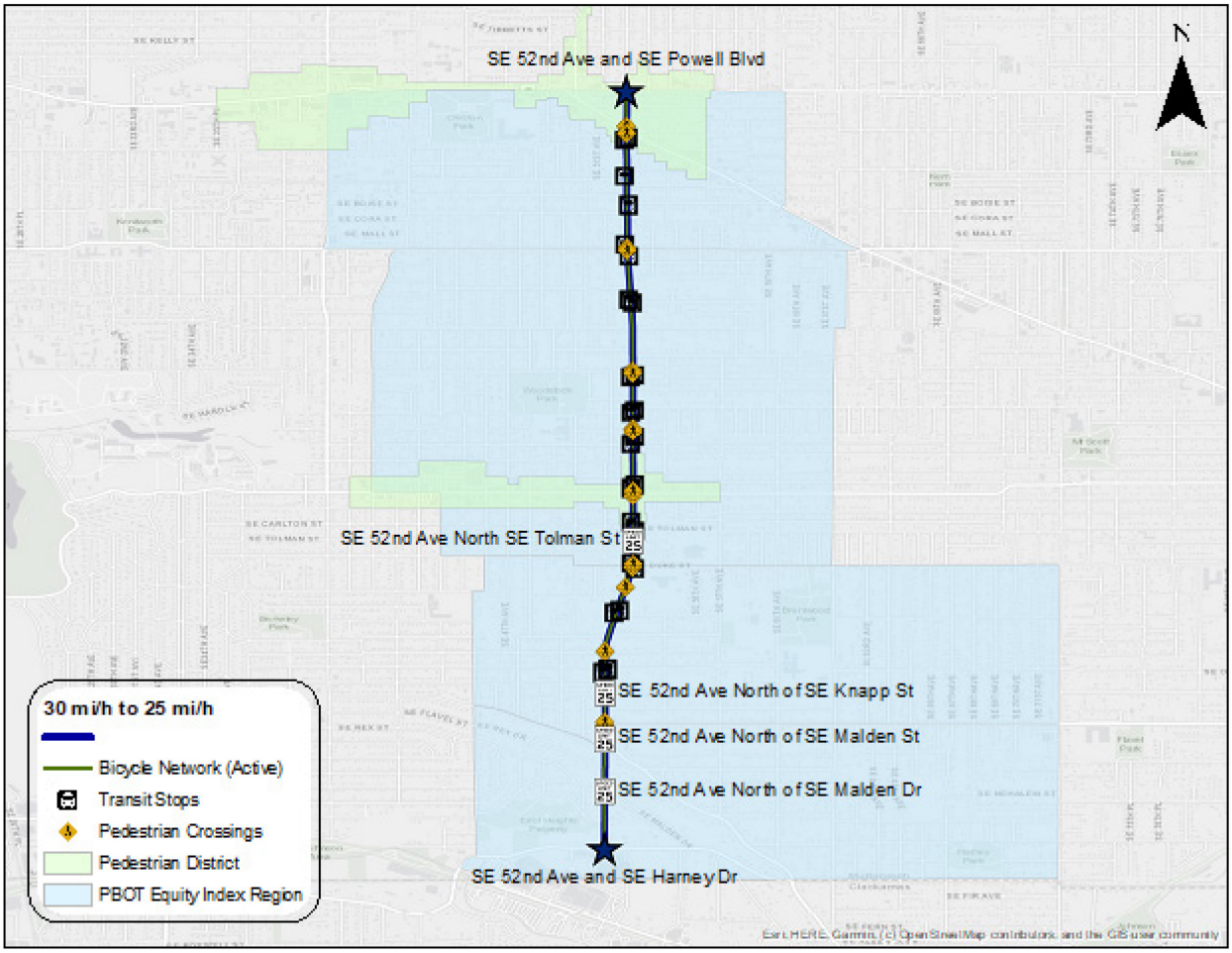


Figure 3.8: Speed Zone on SE 52nd Ave

Table 3.12: Spot Speed Locations and Equity Characteristics in SE 52nd Ave Speed Zone

East Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of SE Tolman St	North of SE Tolman St	3,520	20.9%	1,425	$66,518	2	4	6
North of SE Knapp St	North of SE Knapp St	5,042	30.4%	1,793	$56,875	3	4	7
North of SE Malden St	North of SE Malden Dr[1]	4,149	28.6%	1,620	$61,957	3	4	7
West Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of SE Tolman St	North of SE Tolman St	3,884	12.6%	1,496	$85,265	1	3	4
North of SE Knapp St	North of SE Knapp St	5,042	30.4%	1,793	$56,875	3	4	7
North of SE Malden St		5,042	30.4%	1,793	$56,875	3	4	7
	North of SE Malden Dr[1]	4,149	28.6%	1,620	$61,957	3	4	7

[1] SE Malden Dr is 0.20 miles south of SE Malden St

Table 3.13: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in SE 52nd Ave Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
North of SE Tolman St	North of SE Tolman St	• Residential Multi-Dwelling 1 • Residential 2,500 • Residential 5,000 • Commercial Mixed Use 1	• Multi-Dwelling – Neighborhood • Single – Dwelling 2,500 • Single – Dwelling 5,000 • Mixed Use – Neighborhood • Mixed Use - Dispersed	• Two-way • One lane each direction • On-street parking (NB)	• 6,503 (NB)[2] • 5,860 (SB) • 95% cars, 5% trucks (NB) • 95.2% cars, 4.8% trucks (SB)
North of SE Knapp St	North of SE Knapp St	• Residential 2,500 • Commercial Mixed Use 1	• Single – Dwelling 2,500 • Mixed Use - Dispersed	• Two-way • One lane each direction • On-street parking in both directions	• 4,834 (NB)[3] • 4,615 (SB) • 93.7% cars, 6.3% trucks (NB) • 90.1% cars, 9.9% trucks (SB)
North of SE Malden St	North of SE Malden Dr[1]	• Residential 2,500 • Commercial Mixed Use 1 • Residential Multi-Dwelling 1 • Residential 7,000 • Residential 5,000	• Single – Dwelling 2,500 • Mixed Use – Dispersed • Multi-Dwelling – Neighborhood • Single – Dwelling 7,000 • Single – Dwelling 5,000	• Two-way • One lane each direction • On-street parking in both directions (North of SE Malden St) • On-street parking in northbound direction (North SE Malden Dr)	• 4,236 (NB)[4] • 4,310 (SB)[4] • 93.7% cars, 6.3% trucks (NB)[4] • 92.6% cars, 7.4% trucks (SB)[4] • 2,598 (NB)[5] • 3,092 (SB)[5] • 92% cars, 8% trucks (NB)[5] • 90.2% cars, 9.8% trucks (SB)[5]

[1] SE Malden Dr is 0.20 miles south of SE Malden St
[2] Short-term counts from 2021
[3] Short-term counts from 2023
[4] Short-term counts from 2023 for North of SE Malden St
[5] Short-term counts from 2024 for North of SE Malden Dr

3.9 SE POWELL BLVD

The speed zone on SE Powell Blvd is shown in Figure 3.9. This speed zone is the longest speed zone considered for analysis at 8.70 miles long and consists of only one section with a 35 mi/h to 30 mi/h reduction. In this speed zone, there are 52 pedestrian crossings, 106 transit stops, active bike lanes, active buffered bike lanes, active neighborhood greenways, planned buffered bike lanes and protected bike lanes, recommended separated in-roadway bike lanes, and five adjacent or nearby pedestrian districts. No spot speed locations fall within a pedestrian district, but the East of SE 78th Ave and East of 79th Ave locations are just outside of a pedestrian district to the west.

In this speed zone, there are four spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.14. The population adjacent to the speed zone is consistent among spot speed locations. According to PBOT's Equity Index data, the north and south sides of the speed zone are comparable regarding diversity and median household income.

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the four spot speed locations are given in Table 3.15. The primary zoning designations adjacent to all spot speed locations are residential, where there are single commercial, employment, and open space designations. Regarding Comprehensive Plan zoning, designations are residential, mixed-use, mixed employment, and open space. The roadway characteristics differ among the spot speed locations. At the East of SE 78th Ave and East of SE 79th Ave locations, the roadway is two-way with two lanes in each direction, a raised median, and dedicated left-turn lanes. At the West of SE 108th Ave location, the roadway is two-way with one lane in each direction and on-street parking in both directions. At the West of SE 130th Ave location, the roadway is two-way with one lane in each direction and a center turn lane that both directions of travel are permitted to use. Average daily traffic is lowest at the West of SE 108th Ave location and highest at the East of SE 78th Ave and East of SE 79th Ave locations.

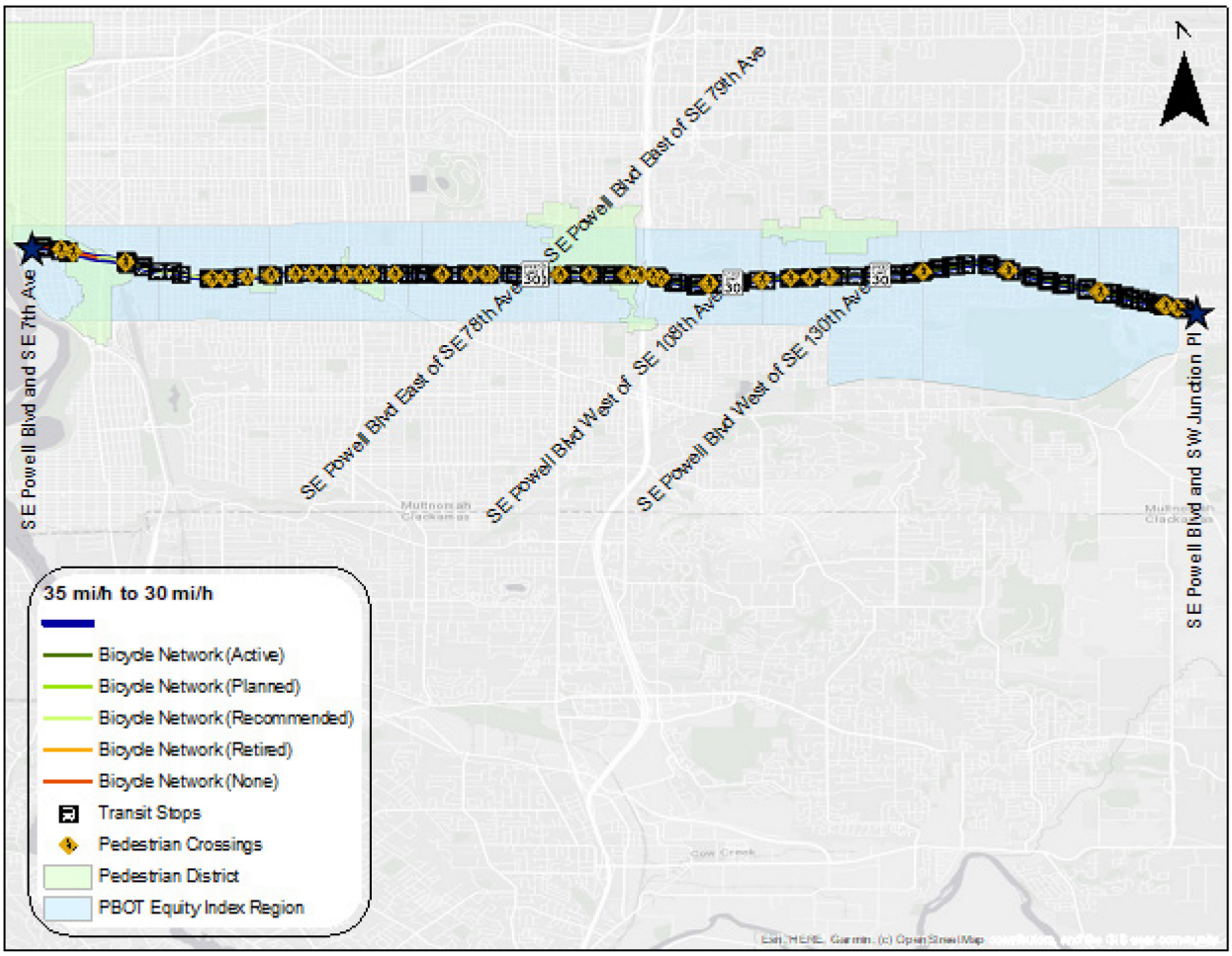


Figure 3.9: Speed Zone on SE Powell Blvd

Table 3.14: Spot Speed Locations and Equity Characteristics in SE Powell Blvd Speed Zone

North Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
East of SE 78th Ave	East of SE 78th Ave	4,749	28.9%	2,003	$69,088	3	4	7
East of SE 79th Ave[1]		4,749	28.9%	2,003	$69,088	3	4	7
West of SE 108th Ave	West of SE 108th Ave	4,515	53.9%	1,497	$40,820	5	5	10
West of SE 130th Ave	West of SE 130th Ave	5,539	48.3%	3,405	$44,028	5	5	10
South Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
East of SE 78th Ave	East of SE 78th Ave	5,209	28.9%	2,009	$61,436	3	4	7
East of SE 79th Ave[1]		5,209	28.9%	2,009	$61,436	3	4	7
West of SE 108th Ave	West of SE 108th Ave	4,515	53.9%	1,497	$40,820	5	5	10
West of SE 130th Ave	West of SE 130th Ave	5,539	48.3%	3,405	$44,028	5	5	10

[1] SE 79th Ave is 249 feet east of SE 78th Ave

Table 3.15: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in SE Powell Blvd Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
East of SE 78th Ave	East of SE 78th Ave	• Residential Multi-Dwelling 1 • Residential 5,000 • Residential 2,500	• Multi-Dwelling – Neighborhood • Single – Dwelling 5,000 • Single – Dwelling 2,500	• Two-way • Two lanes in each direction • Raised median	• 12,465 (EB)[2] • 13,033 (WB) • 92% cars, 8% trucks (EB) • 91.1% cars, 8.9% trucks (WB)
East of SE 79th Ave[1]		• Commercial Mixed Use 2 • Open Space	• Mixed Use – Civic Corridor • Open Space	• Dedicated left-turn lanes	
West of SE 108th Ave	West of SE 108th Ave	• Residential Multi-Dwelling 1 • Residential 5,000 • Residential Manufactured Dwelling Park • General Employment 2	• Multi-Dwelling – Neighborhood • Manufactured Dwelling Park • Mixed Employment	• Two-way • One lane each direction • On-street parking in both directions	• 8,842 (EB)[3] • 10,772 (WB)[4] • 91.5% cars, 8.5% trucks (EB)[3] • 93.2% cars, 6.8% trucks (WB)[4]
West of SE 130th Ave	West of SE 130th Ave	• Residential 5,000 • Residential Multi-Dwelling 1 • Residential Manufactured Dwelling Park • Residential 7,000	• Single – Dwelling 5,000 • Multi-Dwelling – Neighborhood • Manufactured Dwelling Park • Single – Dwelling 7,000	• Two-way • One lane in each direction • Center turn lane	• 10,418 (EB)[5] • 10,166 (WB) • 91.4% cars, 8.6% trucks (EB) • 91.7% cars, 8.3% trucks (WB)

[1] SE 79th Ave is 249 feet east of SE 78th Ave

[2] Short-term counts from 2023 for East of 78th Ave

[3] Short-term counts from 2023 for West of SE 108th Ave

[4] Short-term counts from 2023 for East of SE 108th Ave

[5] Short-term counts from 2023

3.10 SW CAPITOL HWY/SW 49TH AVE

The speed zone on SW Capitol Hwy/SW 49th Ave is shown in Figure 3.10. The speed zone is 1.10 miles long and consists of only one section with a 35 mi/h to 30 mi/h reduction. In this speed zone, there are 10 pedestrian crossings, 10 transit stops, active bike lanes and protected bike lanes, recommended bike lanes and protected bike lanes, no bike lanes, and one pedestrian district. No spot speed locations fall within a pedestrian district, but the North of SW Dickinson St location is on the southern border of the one pedestrian district.

In this speed zone, there are two spot speed locations. Population and equity characteristics at the spot speed locations are given in Table 3.16. The population adjacent to the speed zone is consistent among spot speed locations. According to PBOT's Equity Index data, the level of diversity and median household income is also consistent among the spot speed locations, where the west side of the North of SW Vacuna St location is the least diverse and has the highest median household income (this region also includes a large area that does not contain the speed zone).

Current zoning, Comprehensive Plan zoning, roadway, and exposure characteristics at the two spot speed locations are given in Table 3.17. The primary zoning designations adjacent to all spot speed locations are residential, where there are single commercial and open space designations. Regarding Comprehensive Plan zoning, designations are residential, mixed-use, and open space. The roadway characteristics are the same for each spot speed location. Each location is a two-way roadway with one lane in each direction and has a center turn lane that both directions of travel are permitted to use. Average daily traffic is consistent among the two spot speed locations, as is the split between cars and trucks.

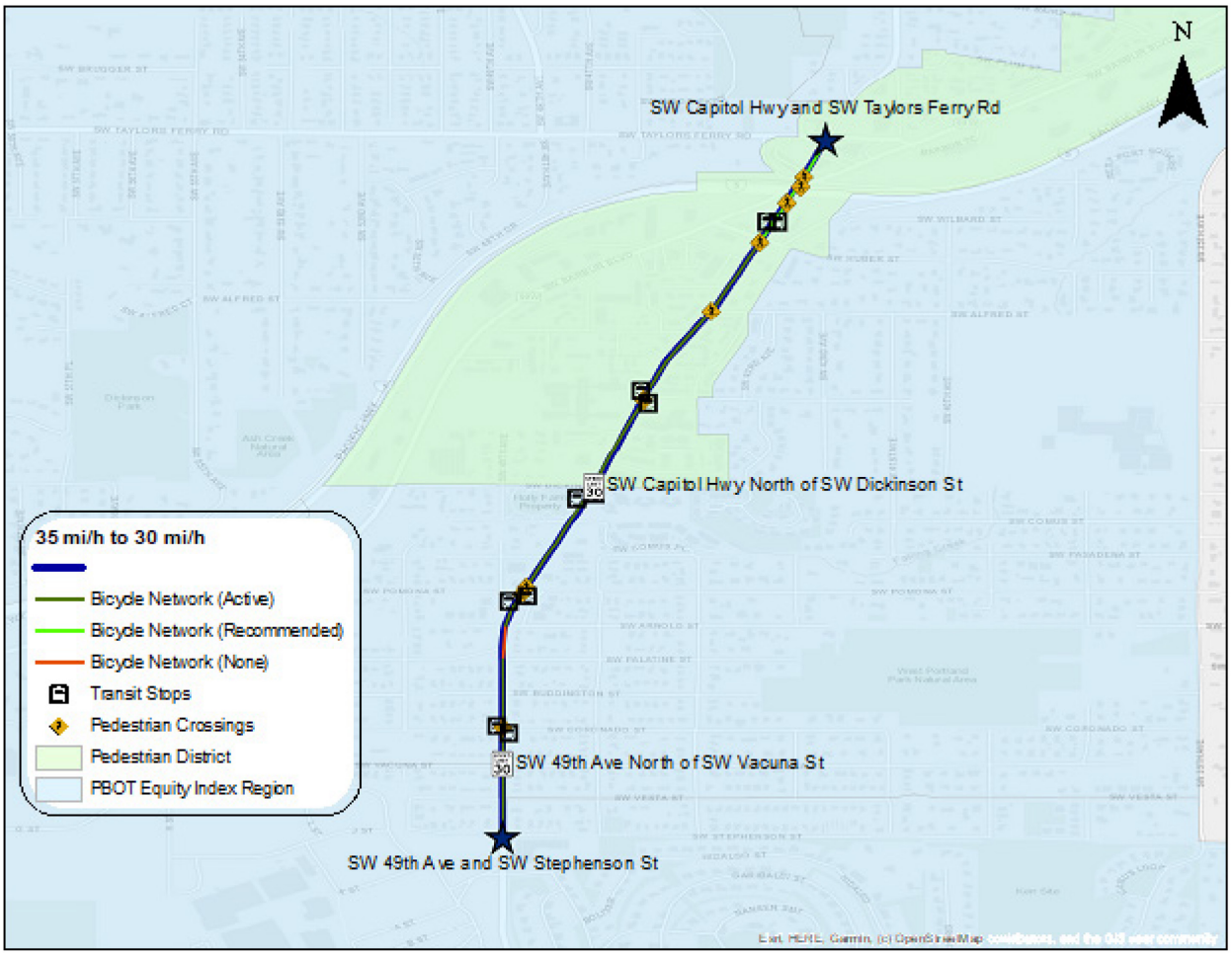


Figure 3.10: Speed Zone on SW Capitol Hwy/SW 49th Ave

Table 3.16: Spot Speed Locations and Equity Characteristics in SW Capitol Hwy/SW 49th Ave Speed Zone

East Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of SW Dickinson St	North of SW Dickinson St	4,185	32.2%	1,171	$63,264	3	4	7
North of SW Vacuna St	North of SW Vacuna St	4,185	32.2%	1,171	$63,264	3	4	7
West Side of Spot Speed Location								
Before Site	**After Site**	**Population**	**Percent Non-White Population**	**Households**	**Median Household Income ($)**	**Race Index**	**Income Index**	**Total Index**
North of SW Dickinson St	North of SW Dickinson St	4,185	32.2%	1,171	$63,264	3	4	7
North of SW Vacuna St	North of SW Vacuna St	3,811	19.5%	1,720	$89,286	2	3	5

[1] SE 79th Ave is 249 feet east of SE 78th Ave

Table 3.17: Spot Speed Locations and Zoning, Roadway, and Exposure Characteristics in SW Capitol Hwy/SW 49th Ave Speed Zone

Before Site	After Site	Zoning (Current)	Zoning (CP)	Roadway	Exposure
North of SW Dickinson St	North of SW Dickinson St	• Commercial Mixed Use 1 • Residential Multi-Dwelling 1 • Open Space	• Mixed Use – Dispersed • Multi-Dwelling – Neighborhood • Open Space	• Two-way • One lane in each direction • Center turn lane	• 5,810 (NB)[1] • 5,702 (SB) • 93.7% cars, 6.3% trucks (NB) • 94% cars, 6% trucks (SB)
North of SW Vacuna St	North of SW Vacuna St	• Residential 2,500 • Residential 5,000	• Single – Dwelling 2,500 • Single – Dwelling 5,000	• Two-way • One lane in each direction • Center turn lane	• 5,147 (NB)[2] • 4,948 (SB) • 96.3% cars, 3.7% trucks (NB) • 95.8% cars, 4.2% trucks (SB)

[1] Short-term counts from 2023
[2] Short-term counts from 2023

4.0 METHODS

To assess speed compliance and safety, three separate methodologies were used to conduct three separate analyses. Therefore, this chapter will present the speed compliance methods and the safety methods separately.

4.1 SPEED COMPLIANCE

To assess speed compliance after implementation of a speed zone (after the new speed limit sign was installed), two analyses were conducted: (1) a descriptive analysis and (2) statistical tests to determine if there were significant differences in mean observed vehicle speed.

The descriptive analysis consisted of both visual and quantitative measures. Before analysis was conducted, erroneous speed observations were removed. This process was based on previous research, where any speed observation of 0 mi/h and any speed observation of greater than 100 mi/h were removed (Anderson et al., 2022). Upn removing erroneous speed observations, the visual component of the descriptive analysis consisted of generating speed distribution plots for before and after the implementation of the speed zone, in addition to visuals to accompany the quantitative measures. The quantitative measures for the descriptive analysis included the following metrics:

- Mean vehicle speed.
- Median vehicle speed.
- 85th percentile vehicle speed.
- Maximum vehicle speed.
- Percentage of vehicles exceeding the posted speed limit.
- Percentage of vehicles exceeding 5 mi/h over the posted speed limit.
- Percentage of vehicles exceeding 10 mi/h over the posted speed limit.
- Percentage of vehicles exceeding 15 mi/h over the posted speed limit.

To determine if there were significant differences in mean speed before and after speed zone implementation, independent and paired t-tests were conducted. For the paired t-tests, various random samples of various sample sizes were used, where the results were consistent across all tested. For two-samples with equal variances, the test statistic is determined by:

$$t = \frac{\mu_1 - \mu_2}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad \textbf{(4-1)}$$

where μ_1 is the mean speed in the first sample, μ_2 is the mean speed in the second sample, n_1 is the sample size for the first sample, n_2 is the sample size for the second sample, and S_p is the pooled standard deviation such that:

$$\boldsymbol{S_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}} \quad \textbf{(4-2)}$$

where s_1^2 is the sample standard deviation for the first sample, s_2^2 is the sample standard deviation of the second sample, and all other terms were defined previously.

If variances among the two samples is significantly different, the following applies:

$$\boldsymbol{t = \frac{\mu_1 - \mu_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}} \quad \textbf{(4-3)}$$

with degrees of freedom:

$$\boldsymbol{DF = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)^2}} \quad \textbf{(4.4)}$$

For each set of samples, a variance test was conducted to determine if the variances should be considered significantly different or the same.

Lastly, due to the sample sizes used in this study, the smallest of differences can be deemed statistically significant, but may not be practically significant. To address this, an effect size was computed for each test based on Cohen's d. Cohen's d represents a standardized effect based on the variability in the data (standard deviation) and is computed as:

$$\boldsymbol{d = \frac{\mu_1 - \mu_2}{S_p}} \quad \textbf{(4-5)}$$

Cohen's d values can be positive or negative, where a positive value indicates some number of standard deviations greater in the first sample compared to the second sample (e.g., mean speed in the before condition is 1 standard deviation greater than mean speed in the after condition) and a negative value indicates some number of standard deviations less in the first sample compared to

the second sample (e.g., mean speed in the before condition is 1 standard deviation less than mean speed in the after condition).

The thresholds used in this study for Cohen's d are those proposed by Cohen (1988):

$[0.00, 0.20)$	Negligible Effect
$[0.20, 0.50)$	Small Effect
$[0.50, 0.80)$	Moderate Effect
$[0.80, \infty)$	Large Effect

4.2 SAFETY OUTCOMES

Due to limited availability of crash data for the after period, to evaluate safety outcomes, this study applies Hauer's Simple (Naïve) Before-After Method (Hauer, 1997). In this approach, the number of before years and number of after years is used in conjunction with the ratio of the after duration and before duration. The approach allows for a computation of the effectiveness of the speed zone on safety, the variance, and a 95% confidence interval for effectiveness. The drawback of this approach is its inability to account for regression-to-the-mean bias but is a good alternative when limited after data is available.

Hauer (1997) and Monsere et al. (2017) further note that there are issues that can arise when the simple before-after approach is applied, which can be categorized by the following:

- Changes in factors other than the treatment (e.g., traffic volume, environmental conditions, user behavior, land use).
- Other programs and/or treatments.
- Changes in reporting thresholds.
- Regression-to-the-mean bias is not accounted for.
- Assumes that crash counts follow a Poisson process (equal mean and variance).

Due to this, the simple before-after results provide an estimate of the effect due to the mix of these factors (i.e., the effect due to the treatment alone cannot be determined).

4.3 SPEED MODELING

To identify significant associations between the after period and observed vehicle speeds, as well as site-level effects, several models were developed. It is important to note that the intent of the models is not to make causal inference; rather, determine the explanatory effects of specific variables on observed vehicle speeds and thresholds.

The first set of models consist of traditional linear regression models, such that:

$$\boldsymbol{y_i = \beta_o + x_{i1}\beta_1 + x_{i2}\beta_2 + \cdots + x_{iK}\beta_K + \varepsilon_i}$$

(4-6)

where β_o is a constant term, x_{iK} is an explanatory variable, β_K is an estimable parameter for explanatory variable x_{iK}, and ε_i and is a normally distributed disturbance term. For this study, the dependent variable is the natural logarithm of observed speed, which allows for the parameters to be interpreted as partial elasticities; specifically, a one-unit increase in explanatory variable x results in a percent increase/decrease in y that is equal to $\beta \times 100$. For explanatory variables, time-related characteristics (time-of-day, day of the week), site indicators, and an indicator for after sign installation on the speed zone are used. Model specifications provide an association between the used explanatory variables and observed speed, not a causal relationship.

The second set of models are binary logit models that are used to model the probability that the dependent variables take on the value 1.0, where the following scenarios are considered:

- 1 if speed is over posted speed limit, 0 otherwise
- 1 if speed exceeds 5 mi/h over posted speed limit, 0 otherwise.
- 1 if speed exceeds 10 mi/h over posted speed limit, 0 otherwise.
- 1 if speed exceeds 15 mi/h over posted speed limit, 0 otherwise.

The logit probability is defined as (McFadden, 1981):

$$\boldsymbol{P_n(i) = \frac{e^{(\beta_i X_{in})}}{\sum_{\forall i} e^{(\beta_i X_{in})}}}$$

(4-7)

where $P_n(i)$ is the probability of speed observation n having outcome i (speeding, exceeding 5 mi/h over posted speed limit, exceeding 10 mi/h over posted speed limit, or exceeding 10 mi/h over posted speed limit), $\boldsymbol{\beta_i}$ is a vector of parameters to be estimated, and $\boldsymbol{X_{in}}$ is a vector of explanatory variables. Upon normalizing one of the outcomes to zero (alternative-specific-constant rule), the binary logit model can be represented by:

$$\boldsymbol{P_n(i) = \frac{e^{(\dot{\beta})}}{1 + e^{(\dot{\beta})}}}$$

(4-8)

and:

$$\boldsymbol{\dot{\beta} = \beta_o + \beta_1 x_{1n} + \cdots + \beta_i x_{in} + \varepsilon_{in}}$$

(4-9)

where ε_{in} is a Type I Extreme Value distributed error term and all other terms were defined previously.

To interpret estimates from a binary logit model, this study will report both odds ratios and marginal effects. The discussion, however, will be based on marginal effects. Odds ratios are computed by simply exponentiating the parameter estimate β, where a value greater than 1.0 indicates an increase in the odds of a given outcome and a value less than 1.0 indicates a decrease in the odds of a given outcome. Marginal effects are used more often and provide effects on a probability scale by giving a change in probability due an indicator variable changing from zero to one, such that:

$$\boldsymbol{ME_{Xk} = Pr[P_n(i) = 1 \mid X, X_k = 1] - Pr[P_n(i) = 1 \mid X, X_k = 0]} \quad \textbf{(4-10)}$$

where X is the mean of all other variables (held constant) while X_k changes from zero to one.

5.0 RESULTS

The following chapter summarizes the analysis results. First, the results from the speed compliance descriptive analysis will be presented, followed by the statistical tests, the results from the safety analysis, and the results from the speed models.

5.1 SPEED COMPLIANCE DESCRIPTIVE ANALYSIS

As part of the speed compliance descriptive analysis, each speed zone and each spot location within each speed zone were considered independently. In addition to tabulated results, visuals are provided that illustrate the metrics discussed in Chapter 4.1. In cases where there were multiple data collection periods, all data together was considered, and all data collection periods separately were considered to determine if there was any change based on when the data was collected.

5.1.1 N Lombard St

Spot speed data at one location was obtained for the speed zone on N Lombard St: North of Weyerhaeuser Ave. This location is located in the section of the speed zone that had a reduction of 35 mi/h to 25 mi/h. Data collection and sign installation dates are shown in Table 5.1 and Figure 5.1. Descriptive statistics and statistical test results are shown in and Table 5.3. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.2 and Figure 5.3.

Mean speed after the reduction reduced from 38.39 mi/h to 31.10 mi/h, one of the largest reductions observed across all speed zones. Also decreasing was the median speed and the 85th percentile speed. However, with the mean speed in the after condition still being above the new posted speed limit, proportions in vehicles exceeding the speed limit, proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit all increased in the after condition.

The difference in mean speeds between conditions was highly significant and the estimated effect size indicated a large effect. Specifically, according to Cohen's d, mean speed in the before condition is 1.147 (1.154 for paired test) standard deviations greater than mean speed in the after condition.

Table 5.1: Data Collection Periods on N Lombard St Speed Zone

Location	Before Data	Sign Installed	After Data
North of N Weyerhaeuser Ave	Jul. 27, 2017 to Jul. 28, 2017	Jun. 11, 2021	Oct. 10, 2022 to Oct. 13, 2022

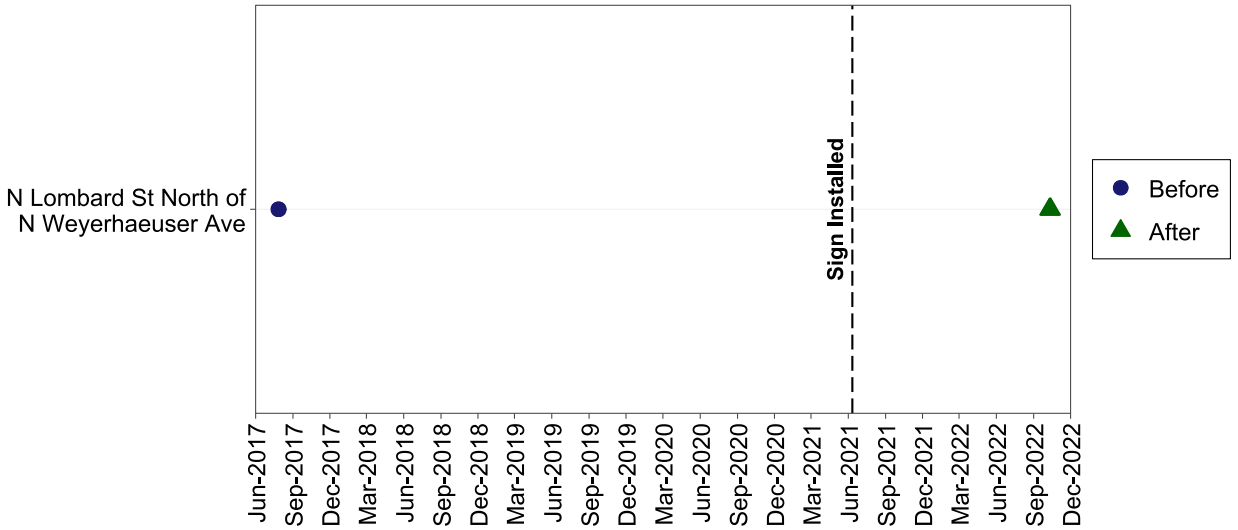


Figure 5.1: Data Collection and Sign Installation Timeline for N Lombard St Speed Zone

Table 5.2: N Lombard St Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
North of N Weyerhaeuser Ave	Before	7,953	38.39	38	44	93	70.16%	32.98%	11.25%	3.61%
	After	24,295	31.10	31	36	75	86.90%	56.05%	19.46%	4.32%

Table 5.3: *t*-test Results at Spot Speed Locations on the N Lombard St Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
North of N Weyerhaeuser Ave	0.000	1.147	Large	0.000	1.154	Large

[a] Independent two-sample t-test

[b] Paired two-sample t-test

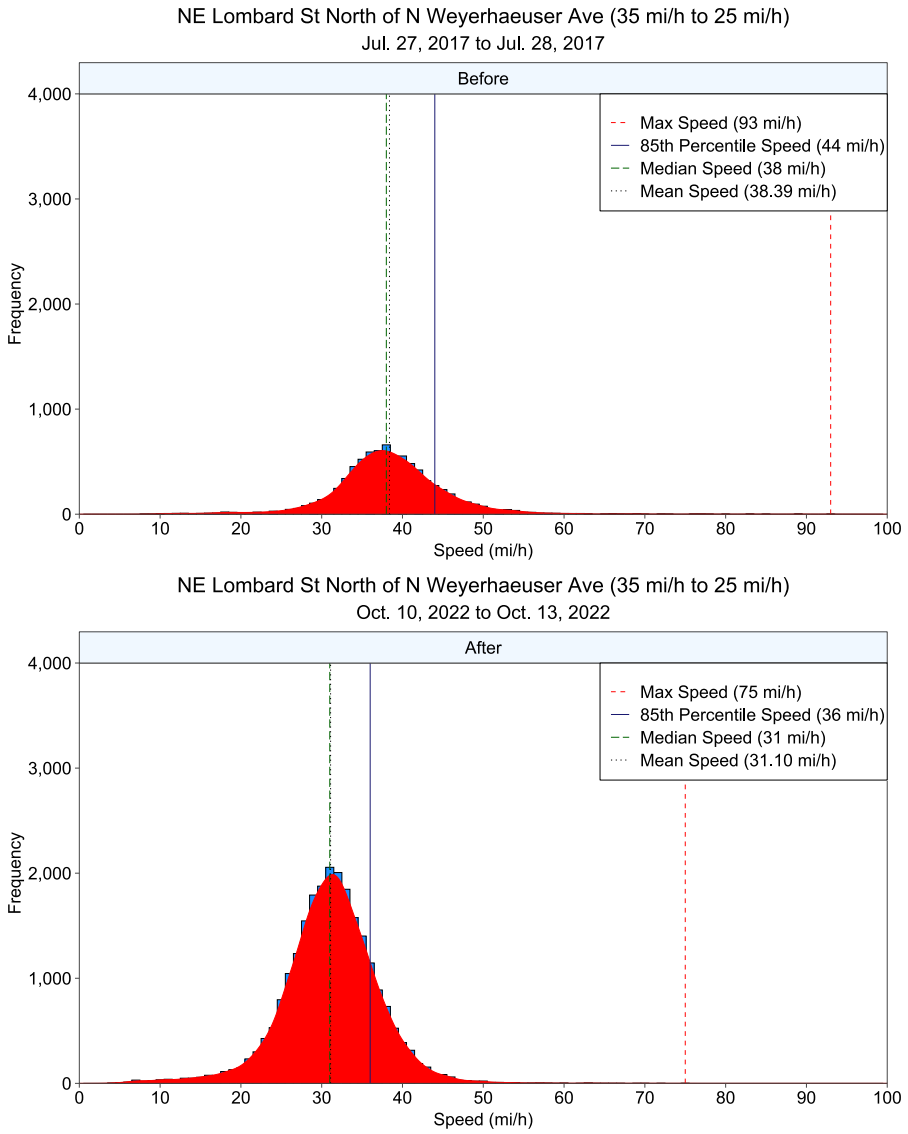


Figure 5.2: Speed Distribution North of N Weyerhaeuser Ave on the N Lombard St Speed Zone

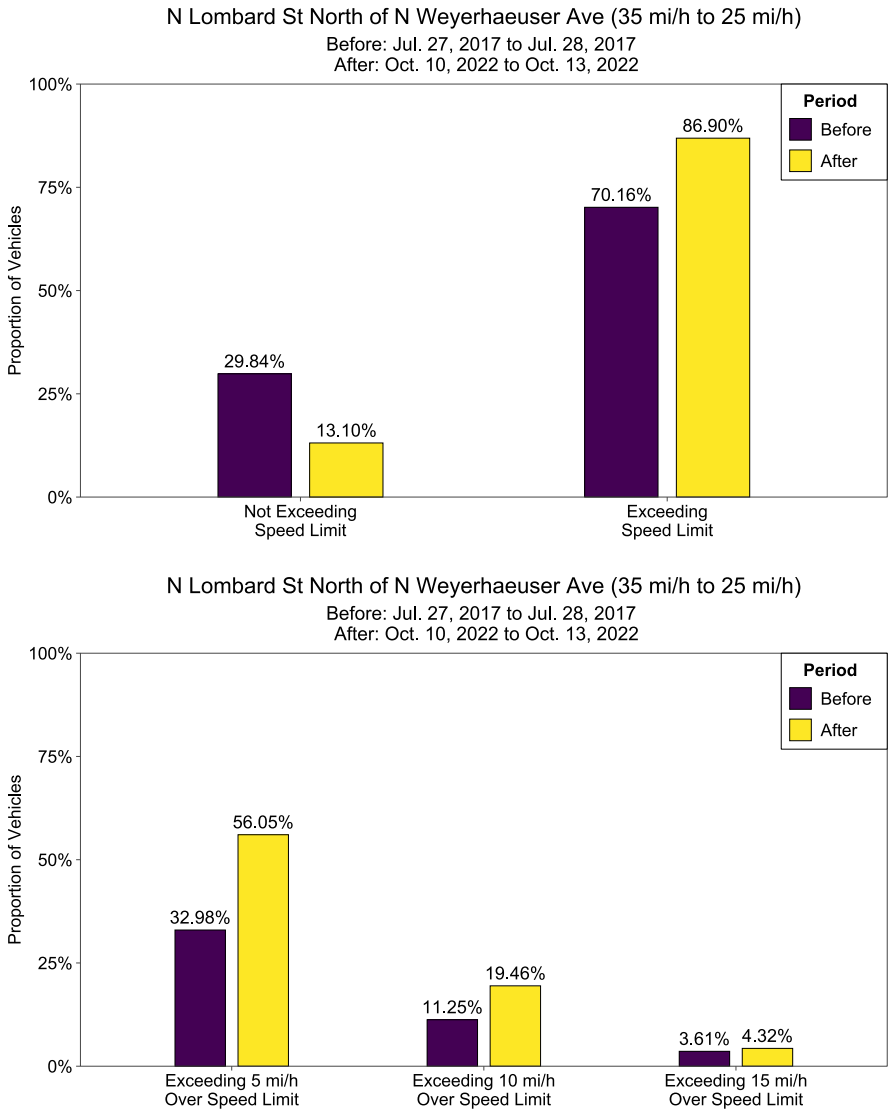


Figure 5.3: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at N Weyerhaeuser Ave on the N Lombard St Speed Zone

5.1.2 NE 102nd Ave

Spot speed data at one location was obtained for the speed zone on NE 102nd Ave: North of NE Shaver St. This location is located in the section of the speed zone that had a reduction of 35 mi/h to 30 mi/h. At this location, there were multiple dates with before data, where all before data is compared to the after data and each set of dates are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.4 and Figure 5.4. Descriptive statistics and statistical test results are shown in Table 5.5 and Table 5.6. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.5 and Figure 5.6. For disaggregated speed distribution plots and figures of proportion of vehicles exceeding speed thresholds (comparison among different before dates), refer to Figure A.1 to Figure A.4 in Appendix A.

Considering all before dates together, mean speed after the reduction had a slight decrease (35.94 mi/h to 35.51 mi/h). The median speed decreased by 1 mi/h, as did the 85th percentile speed. Despite the slight decrease in mean speed, the mean speed was still greater than the new posted speed limit of 30 mi/h, which resulted in increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit.

Disaggregating by before collection dates showed that mean speed slightly decreased when compared to before data from Oct. 2017 (decrease of 0.36 mi/h), decreased by 1.69 mi/h when compared to before data from Nov. 2017, and increased by 1.72 mi/h when compared to before data from Oct. 2019. Median speed decreased when compared to the Oct. 2017 and Nov. 2017 before periods yet increased when compared to the Oct. 2019 before period. These same trends were also observed for 85th percentile speed. Still, due to mean speed being greater than the new posted speed limit, regardless of when the before data was collected increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit were observed.

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes ranged from negligible to small.

Table 5.4: Data Collection Periods on NE 102nd Ave Speed Zone

Location	Before Data	Sign Installed	After Data
North of NE Shaver St	Oct. 12, 2017 to Oct. 13, 2017 Nov. 15, 2017 to Nov. 17, 2017 Oct. 30, 2019 to Oct. 31, 2019	Nov. 5, 2020	Oct. 4, 2023 to Oct. 6, 2023

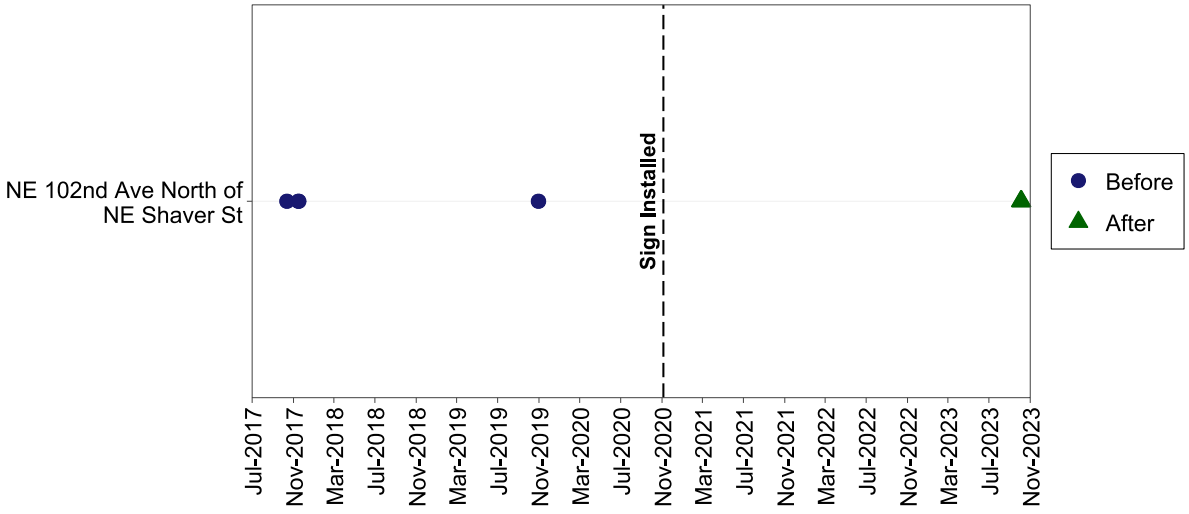


Figure 5.4: Data Collection and Sign Installation Timeline for NE 102nd Ave Speed Zone

Table 5.5: NE 102nd Ave Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
North of NE Shaver St	Before	74,060	35.94	36	41	99	54.20%	16.72%	3.35%	0.68%
	After	29,813	35.51	35	40	89	88.45%	49.46%	12.01%	2.17%
North of NE Shaver St (Oct. 2017 Before Data)	Before	16,320	35.87	36	41	99	57.43%	17.44%	3.26%	0.77%
	After	29,813	35.51	35	40	89	88.45%	49.46%	12.01%	2.17%
North of NE Shaver St (Nov. 2017 Before Data)	Before	36,739	37.20	37	42	76	64.98%	23.01%	4.89%	0.96%
	After	29,813	35.51	35	40	89	88.45%	49.46%	12.01%	2.17%
North of NE Shaver St (Oct. 2019 Before Data)	Before	21,001	33.79	34	38	64	32.81%	5.14%	0.74%	0.10%
	After	29,813	35.51	35	40	89	88.45%	49.46%	12.01%	2.17%

Table 5.6: *t*-test Results at Spot Speed Locations on the NE 102nd Ave Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
North of NE Shaver St	0.000	0.085	Negligible	0.000	0.089	Negligible
North of NE Shaver St (Oct. 2017 Before Data)	0.000	0.066	Negligible	0.000	0.067	Negligible
North of NE Shaver St (Nov. 2017 Before Data)	0.000	0.340	Small	0.000	0.338	Small
North of NE Shaver St (Oct. 2019 Before Data)	0.000	-0.376	Small	0.000	-0.378	Small

[a] Independent two-sample t-test

[b] Paired two-sample t-test

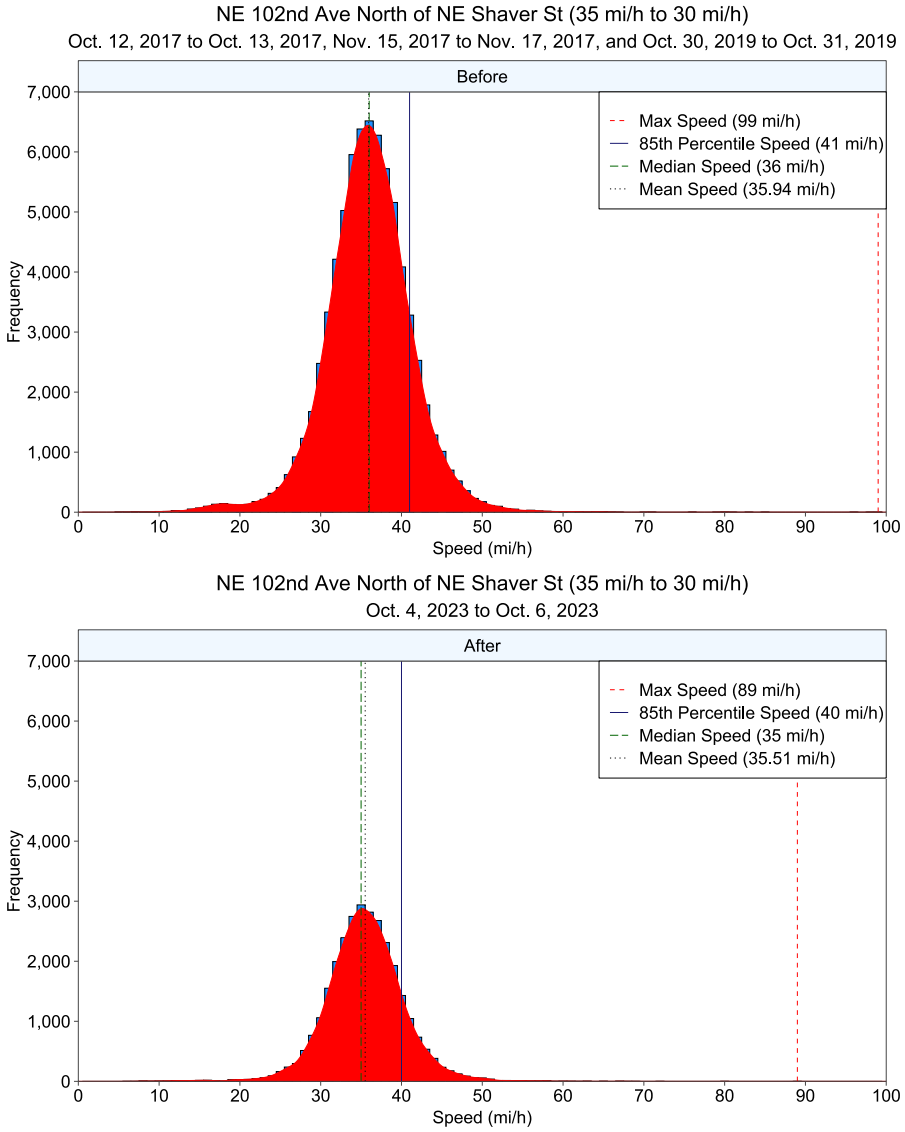


Figure 5.5: Speed Distribution North of NE Shaver St on the NE 102nd Ave Speed Zone

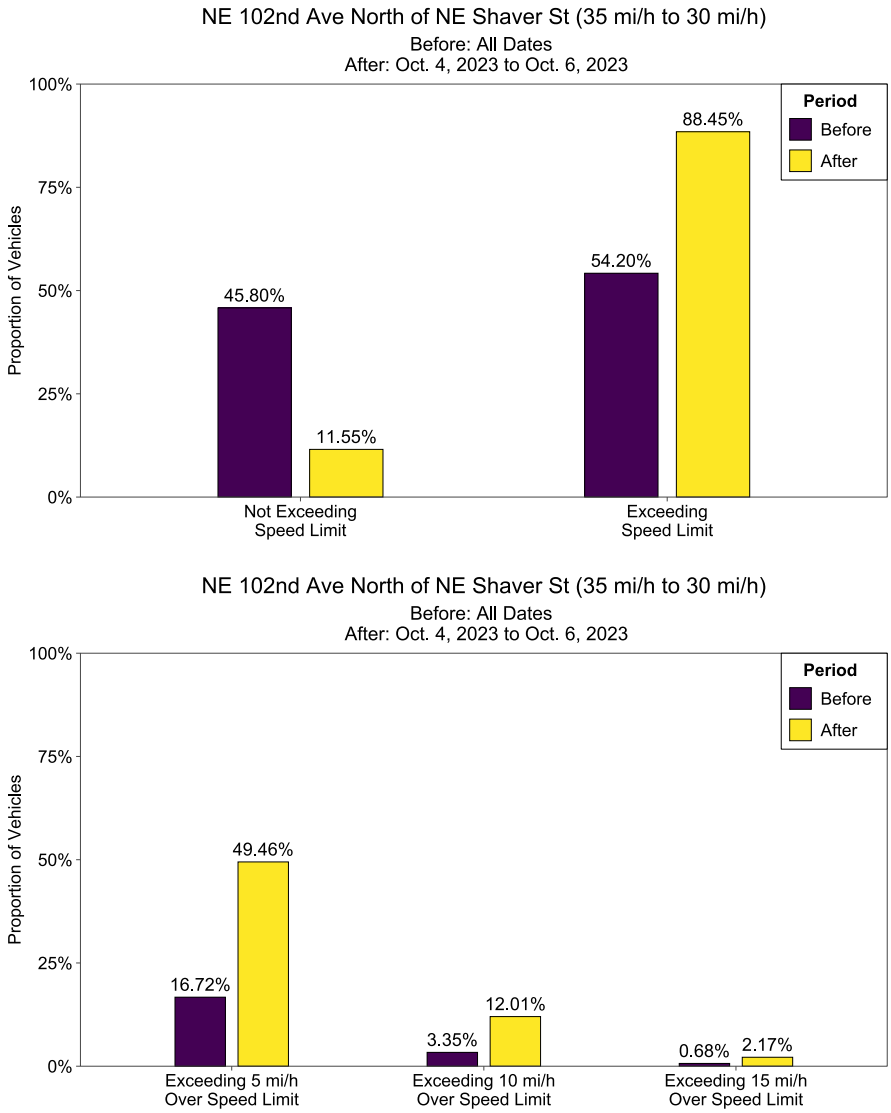


Figure 5.6: Changes in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at North of NE Shaver St on the NE 102nd Ave Speed Zone

5.1.3 NE/SE 122nd Ave

Spot speed data was obtained to make for six comparisons on the NE/SE 122nd Ave speed zone. This speed zone has a single reduction of 35 mi/h to 30 mi/h. In this speed zone, there were spot speed locations that were compared to nearby spot speed measurements (as discussed in Chapter 3.0) and one location that had multiple before collection periods. For the location with multiple before collection periods, all before data is compared to the after data and each set of before data are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.7 and Figure 5.7. Descriptive statistics and statistical test results are shown in Table 5.8 and Table 5.9Table 5.6. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.8 to Figure 5.13. For disaggregated speed distribution plots and

figures of proportion of vehicles exceeding speed thresholds, refer to Figure A.5 to Figure A.8 in Appendix A.

On this speed zone, results varied by spot speed location. Decreases were observed at the South of NE Holladay St (decrease in mean speed of 4.59 mi/h), South of NE Holladay St and South of NE Halsey St (decrease in mean speed of 11.37 mi/h, but also separated by 0.20 miles), and South of NE Holladay St and South of NE Multnomah St (decrease in mean speed of 3.88 mi/h and separated by 347 ft) spot speed locations. At South of SE Raymond St, which had multiple before data collection periods, there was a decrease in both the aggregated comparison (decrease of 3.48 mi/h) and disaggregated comparisons. Despite the different before data collection periods, decreases in mean speed were consistent, ranging from 3.10 mi/h to 3.77 mi/h.

The proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit increased at most locations, despite locations having a decrease in mean speed (mean speed in the after condition was about equal to the new posted speed limit or greater than the new posted speed limit). Two sites experienced increases in proportion of vehicles speeding, but experienced decreases in proportion of vehicles exceeding higher thresholds (South of NE Holladay St, South of NE Holladay St and South of NE Multnomah St).

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes ranged from small to large. The largest effect size was observed at the South of NE Holladay St and South of NE Halsey St (separated by 0.20 miles), where mean speed in the before condition was 1.578 (1.585 for paired test) standard deviations greater than mean speed in the after condition. Also with large effects were the disaggregated trends for South of SE Raymond St, where mean speed in the before condition with Apr. 2018 data was 0.816 (0.808 for paired test) standard deviations greater than mean speed in the after condition and mean speed in the before condition with Apr. 2019 data was 0.844 (0.843 for paired test) standard deviations greater than mean speed in the after condition.

Table 5.7: Data Collection Periods on NE/SE 122nd Ave Speed Zone

Location	Before Data	Sign Installed	After Data
North of NE Stanton St	Sep. 12, 2017 to Sep. 18, 2017	Apr. 21, 2021	NA
North of NE Brazee St	NA	Apr. 21, 2021	May 31, 2022 to Jun. 2, 2022
North of NE Broadway	Nov. 8, 2017 to Nov. 9, 2017	Apr. 21, 2021	May 31, 2022 to Jun. 2, 2022
South of NE Holladay St	Nov. 8, 2017 to Nov. 9, 2017	Apr. 21, 2021	NA
South of NE Halsey St	NA	Apr. 21, 2021	Apr. 25, 2023 to Apr. 28, 2023
South of NE Multnomah St	NA	Apr. 21, 2021	May 24, 2022 to May 27, 2022
South of SE Raymond St	Mar. 22, 2017 to Mar. 23, 2017 Apr. 10, 2018 to Apr. 13, 2018 Apr. 16, 2019 to Apr. 18, 2019	Apr. 21, 2021	Nov. 1, 2023 to Nov. 3, 2023

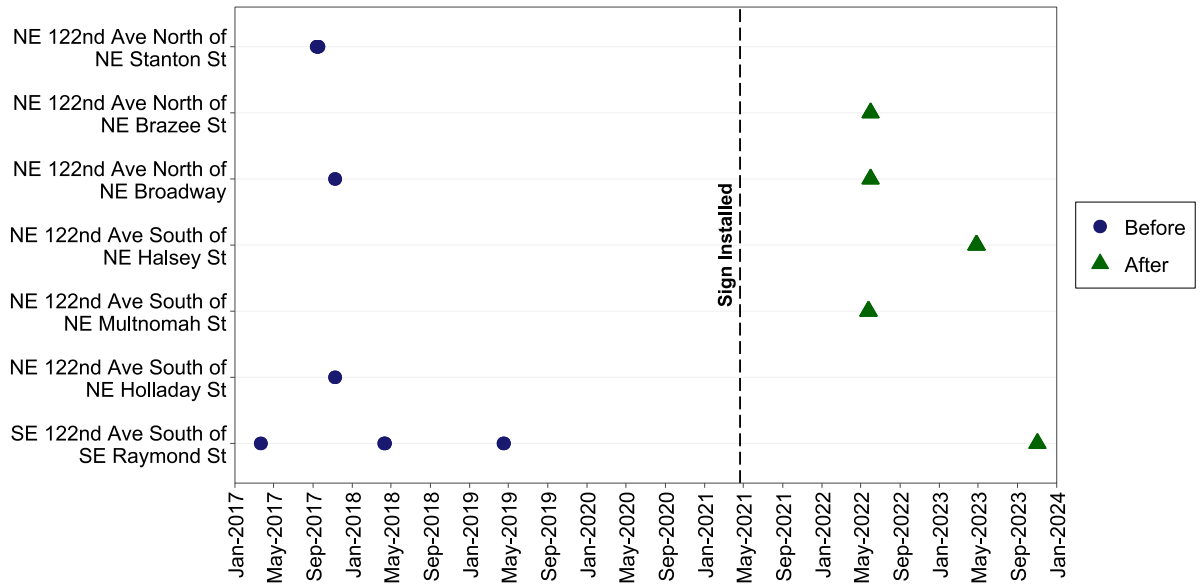


Figure 5.7: Data Collection and Sign Installation Timeline for NE/SE 122nd Ave Speed Zone

Table 5.8: NE/SE 122nd Ave Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
North of NE Stanton St and North of NE Brazee St[1]	Before	124,916	32.82	34	39	88	36.81%	9.83%	1.77%	0.35%
	After	47,659	36.55	36	42	81	88.90%	58.17%	20.49%	5.21%
North of NE Broadway	Before	25,489	30.69	31	37	62	21.59%	5.21%	0.93%	0.19%
	After	45,419	32.10	32	38	80	61.72%	25.24%	6.42%	1.47%
South of NE Holladay St	Before	26,471	38.54	38	46	99	66.19%	36.17%	16.33%	5.89%
	After	50,084	33.95	34	39	80	77.08%	37.19%	10.18%	2.43%
South of NE Holladay St and South of NE Halsey St[2]	Before	26,471	38.54	38	46	99	66.19%	36.17%	16.33%	5.89%
	After	69,166	27.17	28	33	73	30.79%	6.67%	1.35%	0.26%
South of NE Holladay St and South of NE Multnomah St[3]	Before	26,471	38.54	38	46	99	66.19%	36.17%	16.33%	5.89%
	After	67,369	34.66	34	40	80	81.61%	41.48%	11.90%	2.99%
South of SE Raymond St	Before	69,920	33.40	33	38	79	29.38%	4.92%	0.67%	0.14%
	After	21,663	29.92	30	34	78	41.09%	8.99%	1.75%	0.40%
South of SE Raymond St (Mar. 2017 Before Data)	Before	7,908	32.02	32	36	57	17.60%	2.59%	0.25%	0.05%
	After	21,663	29.92	30	34	78	41.09%	8.99%	1.75%	0.40%
South of SE Raymond St (Apr. 2018 Before Data)	Before	37,223	33.50	34	38	79	29.84%	4.97%	0.71%	0.12%
	After	21,663	29.92	30	34	78	41.09%	8.99%	1.75%	0.40%
South of SE Raymond St (Apr. 2019 Before Data)	Before	24,789	33.69	34	38	75	32.43%	5.60%	0.76%	0.21%
	After	21,663	29.92	30	34	78	41.09%	8.99%	1.75%	0.40%

[1] NE Brazee St is 0.20 miles south of NE Stanton St

[2] NE Halsey St is 0.20 miles north of NE Holladay St

[3] NE Multnomah St is 347 feet north of NE Holladay St

Table 5.9: *t*-test Results at Spot Speed Locations on the NE/SE 122nd Ave Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
North of NE Stanton St and North of NE Brazee St	0.000	-0.592	Moderate	0.000	-0.595	Moderate
North of NE Broadway	0.000	-0.233	Small	0.000	-0.238	Small
South of NE Holladay St	0.000	0.672	Moderate	0.000	0.671	Moderate
South of NE Holladay St and South of NE Halsey St	0.000	1.578	Large	0.000	1.585	Large
South of NE Holladay St and South of NE Multnomah St	0.000	0.577	Moderate	0.000	0.584	Moderate
South of SE Raymond St	0.000	0.787	Moderate	0.000	0.785	Moderate
South of SE Raymond St (Mar. 2017 Before Data)	0.000	0.490	Small	0.000	0.491	Small
South of SE Raymond St (Apr. 2018 Before Data)	0.000	0.816	Large	0.000	0.808	Large
South of SE Raymond St (Apr. 2019 Before Data)	0.000	0.844	Large	0.000	0.843	Large

[a] Independent two-sample t-test

[b] Paired two-sample t-test

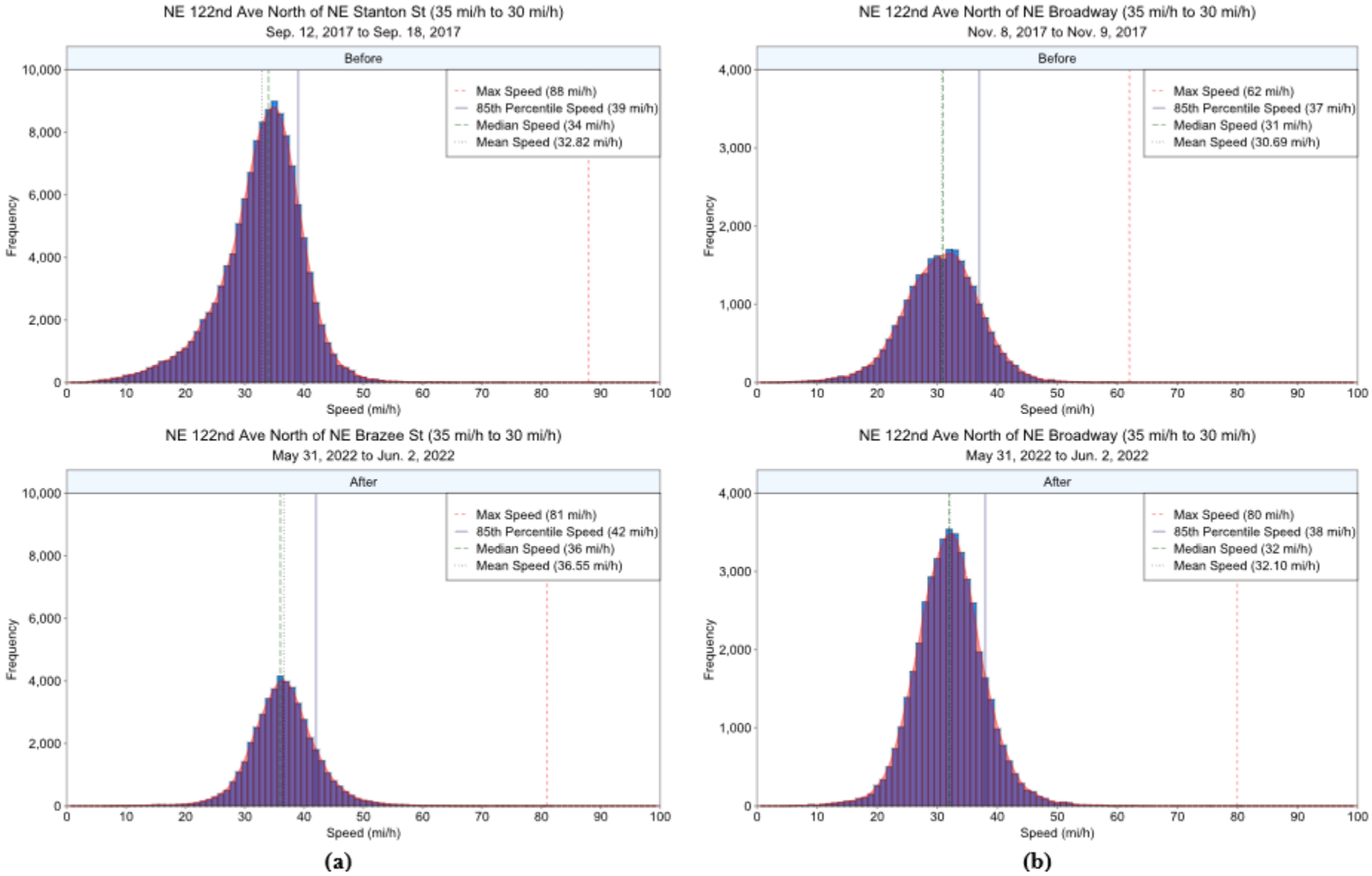


Figure 5.8: Speed Distribution (a) North of NE Stanton St and North of NE Brazee St, and (b) North of NE Broadway on the NE/SE 122nd Ave Speed Zone

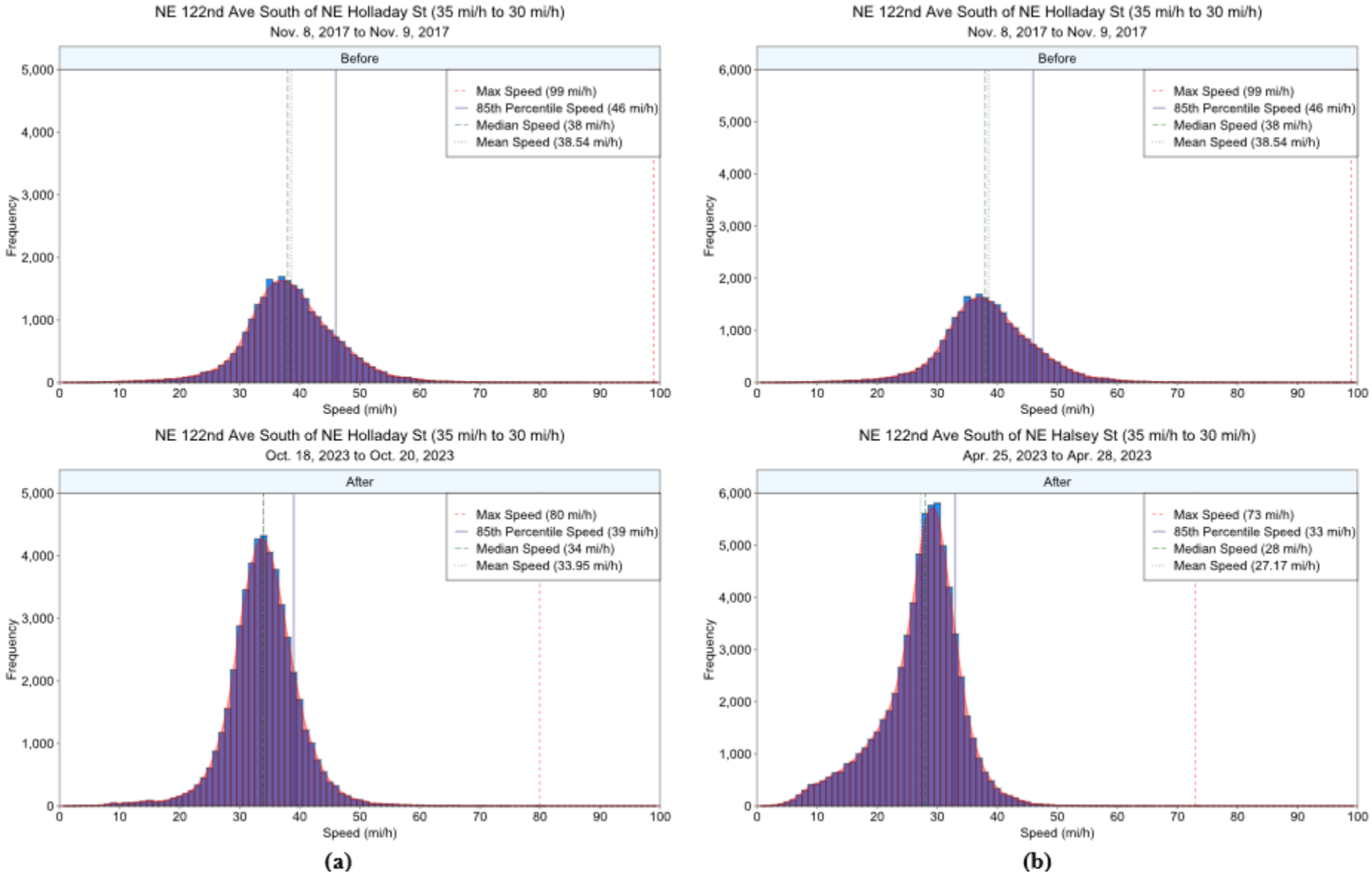


Figure 5.9: Speed Distribution (a) South of NE Holladay St and (b) South of NE Holladay St and South of NE Halsey St on the NE/SE 122nd Ave Speed Zone

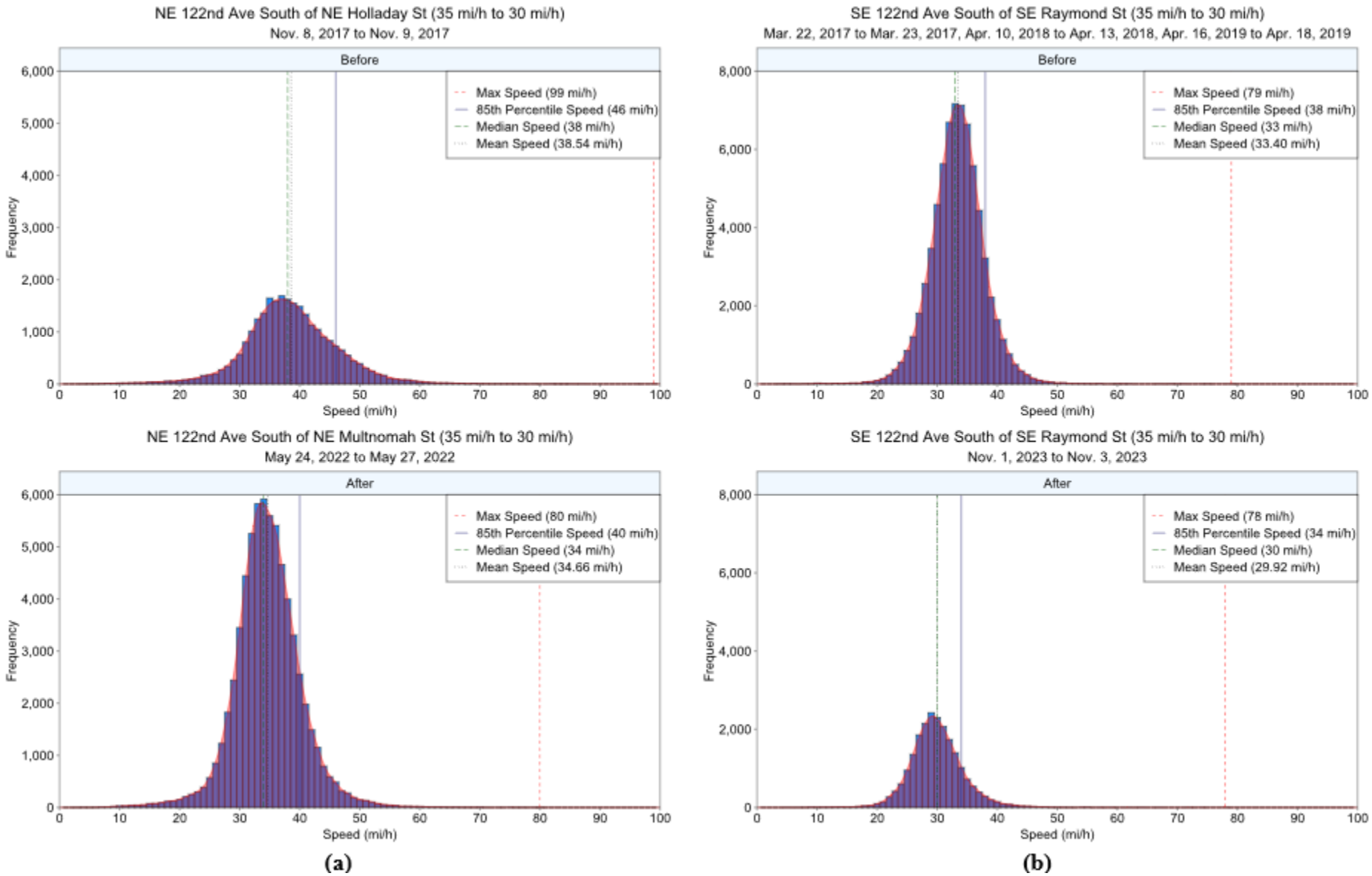


Figure 5.10: Speed Distribution (a) South of NE Holladay St and South of NE Multnomah St, and (b) South of SE Raymond St on the NE/SE 122nd Ave Speed Zone

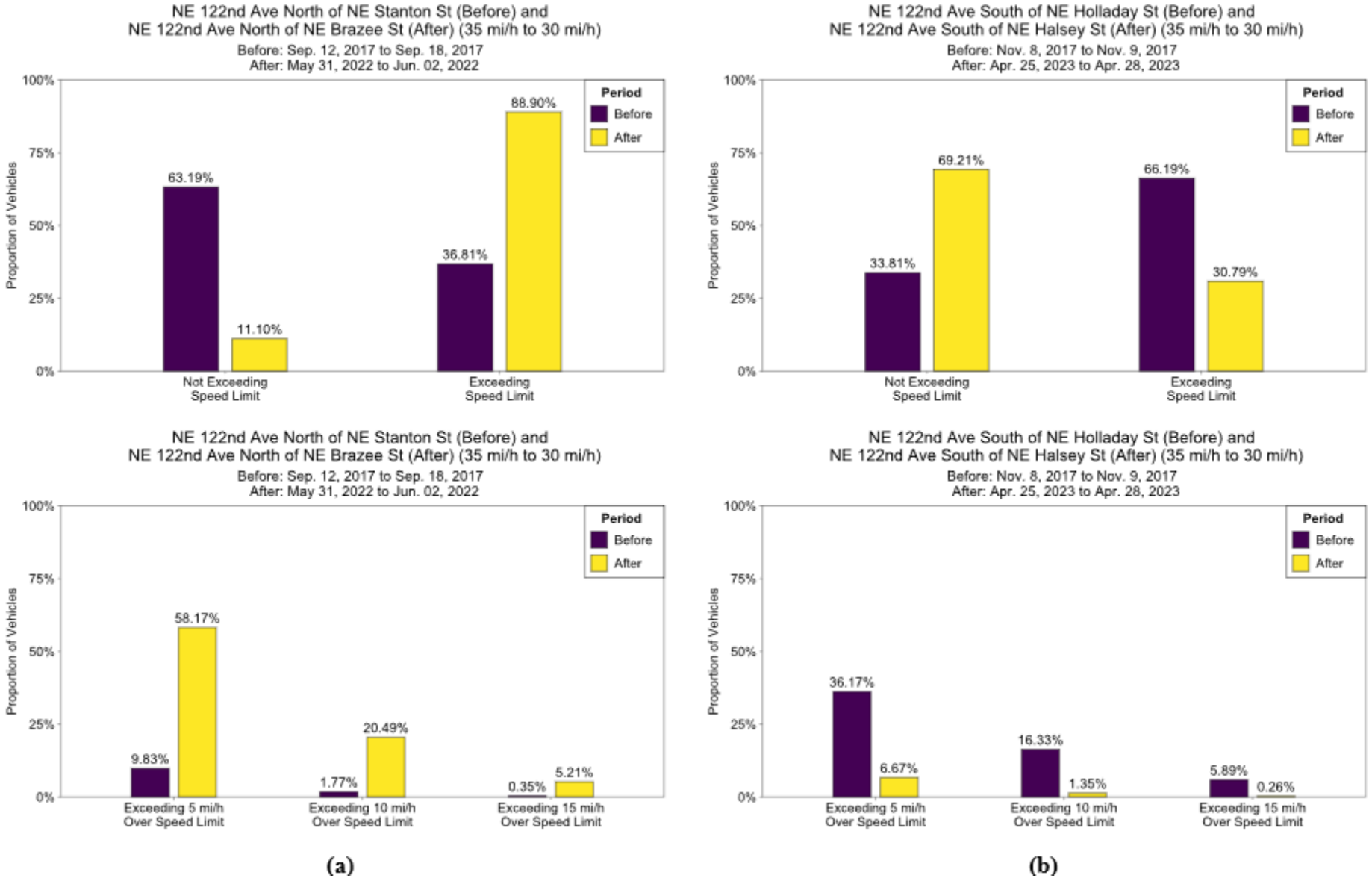


Figure 5.11: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) North of NE Stanton St and North of NE Brazee St, and (b) South of NE Holladay St and South of NE Halsey St on the NE/SE 122nd Ave Speed Zone

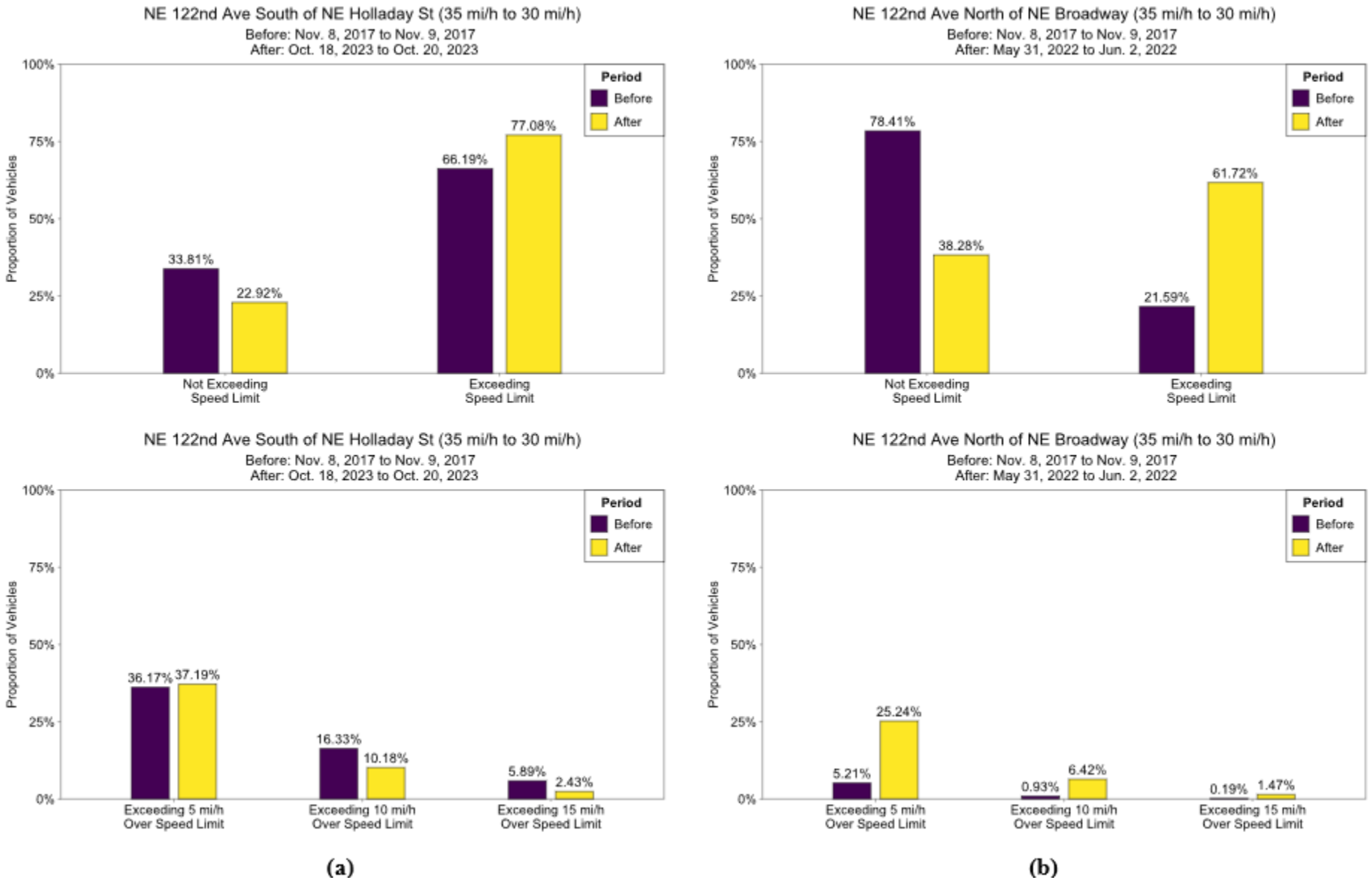


Figure 5.12: Changes in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) South of NE Holladay St and (b) North of NE Broadway on the NE/SE 122nd Ave Speed Zone

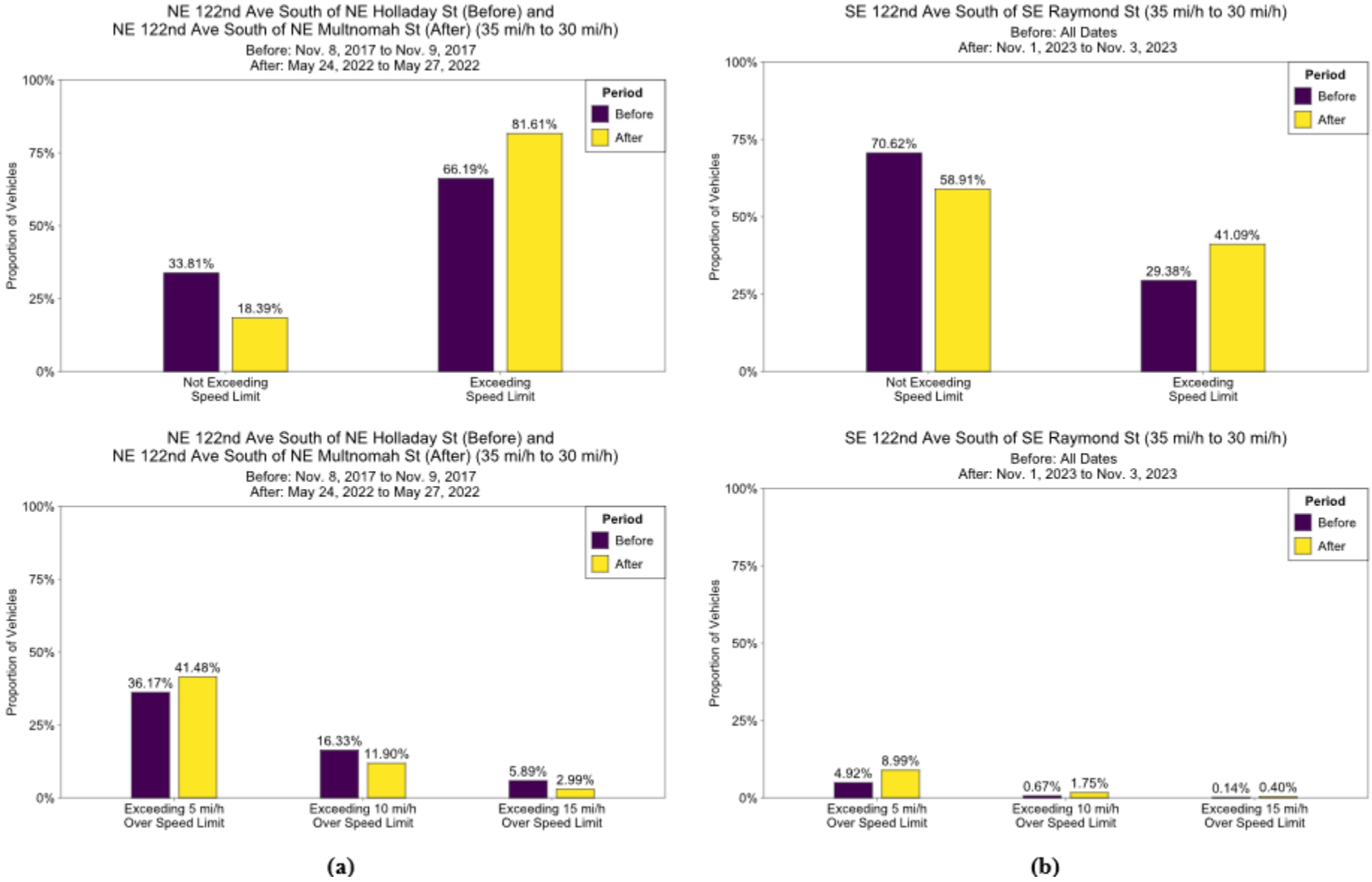


Figure 5.13: Changes in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) South of NE Holladay St and South of NE Multnomah St, and (b) South of SE Raymond St on the NE/SE 122nd Ave Speed Zone

5.1.4 NE/SE 82nd Ave

Spot speed data was obtained to make for seven comparisons on the NE/SE 82nd Ave speed zone. This speed zone has a single reduction of 35 mi/h to 30 mi/h. In this speed zone, there were spot speed locations that were compared to nearby spot speed measurements (as discussed in Chapter 3.0) and one location (South of SE Mill St) that had multiple before collection periods. For the location with multiple before collection periods, all before data is compared to the after data and each set of before data are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.10 and Figure 5.14. Descriptive statistics and statistical test results are shown in Table 5.11 and Table 5.12Table 5.6. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.15 to Figure 5.24. For disaggregated speed distribution plots and figures of proportion of vehicles exceeding speed thresholds, refer to Figure A.9 and Figure A.10 in Appendix A.

On this speed zone, most locations experienced a decrease in mean speed after the speed limit reduction (including the disaggregate comparison at South of SE Mill St). The exceptions were South of NE Beech St and North of NE Klickitat St, and South of SE Knapp St and South of SE Lambert St, both of which experienced increases in mean speed. This trend was also observed for median speed and 85th percentile speed. Despite a majority of locations experiencing a decrease in mean speed, all locations experienced increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit. For locations that experienced a decrease in mean speed, mean speed was either approximately equal to the new speed limit or greater than the new speed limit.

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes ranged from negligible to small.

Table 5.10: Data Collection Periods on NE 82nd Ave Speed Zone

Location	Before Data	Sign Installed	After Data
South of NE Beech St	Apr. 11, 2017 to Apr. 14, 2017	May 19, 2021	Nov. 1, 2023 to Nov. 3, 2023
North of NE Klickitat St	NA	May 19, 2021	Apr. 25, 2023 to Apr. 28, 2023
South of NE Eugene St	Apr. 24, 2017 to Apr. 27, 2017	May 19, 2021	May 23, 2022 to May 25, 2022
South of NE Davis St	Mar. 29, 2021 to Apr. 1, 2021	May 19, 2021	May 23, 2022 to May 25, 2022
South of SE Mill St	Jul. 24, 2018 to Jul. 26, 2018 Aug. 9, 2018 to Aug. 10, 2018	May 19, 2021	May 23, 2022 to May 25, 2022
North of SE Brooklyn St	May 12, 2021 to May 14, 2021	May 19, 2021	NA
North of SE Rhone St	NA	May 19, 2021	May 23, 2022 to May 25, 2022
South of SE Knapp St	Feb. 25, 2020 to Feb. 26, 2020	May 19, 2021	Nov. 1, 2023 to Nov. 3, 2023
North of SE Lambert St	NA	May 19, 2021	Jan. 19, 2022 to Jan. 21, 2022
South of SE Lambert St	NA	May 19, 2021	Jan. 19, 2022 to Jan. 21, 2022

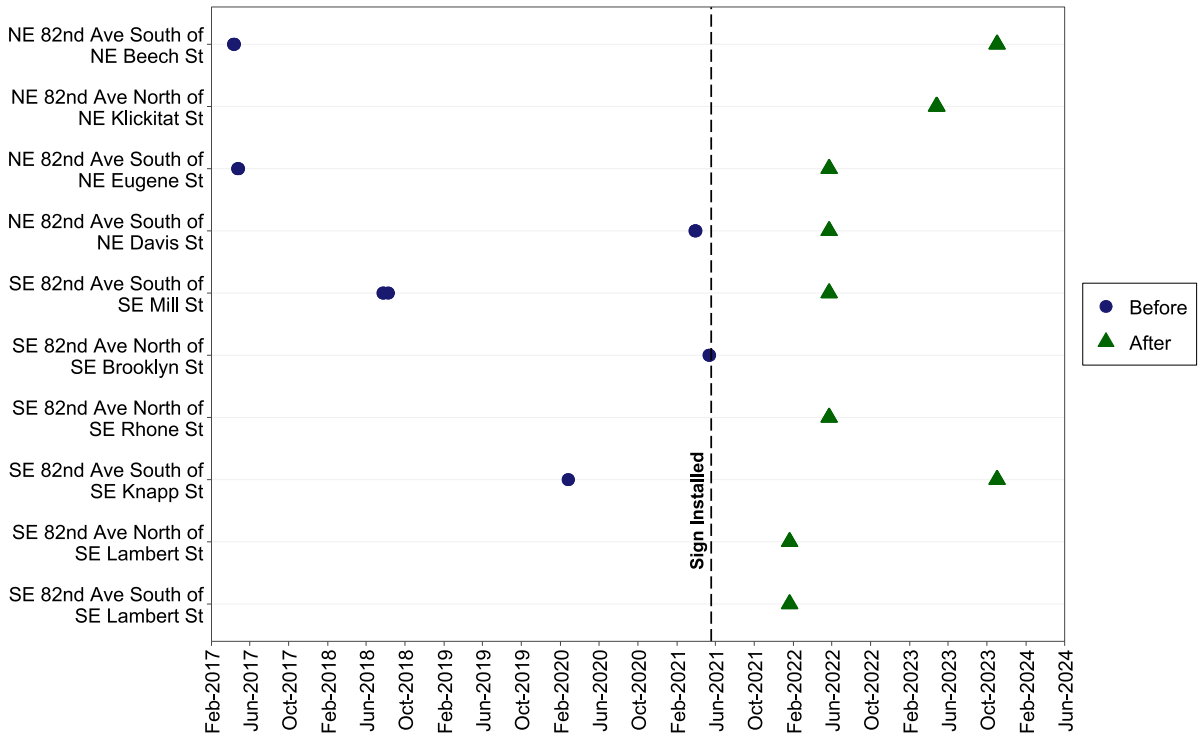


Figure 5.14: Data Collection and Sign Installation Timeline for NE/SE 82nd Ave Speed Zone

Table 5.11: NE/SE 82nd Ave Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
South of NE Beech St	Before	58,779	28.80	29	34	69	10.98%	1.94%	0.29%	0.05%
	After	30,276	28.14	29	33	60	34.04%	6.94%	1.07%	0.19%
South of NE Beech St and North of NE Klickitat St[1]	Before	58,779	28.80	29	34	69	10.98%	1.94%	0.29%	0.05%
	After	62,036	29.99	30	35	74	47.52%	13.26%	2.49%	0.54%
South of NE Eugene St	Before	70,516	31.42	32	37	74	26.61%	5.37%	0.90%	0.17%
	After	46,586	30.45	31	36	68	54.93%	18.20%	3.89%	0.94%
South of NE Davis St	Before	58,097	31.35	32	37	70	22.07%	4.79%	0.94%	0.22%
	After	46,606	29.54	30	35	73	46.02%	13.44%	2.60%	0.53%
South of SE Mill St	Before	41,334	33.81	34	39	72	35.74%	7.97%	1.45%	0.27%
	After	45,030	32.01	32	37	72	65.19%	23.66%	4.88%	1.04%
South of SE Mill St (Jul. 2018 Before Data)	Before	26,100	33.48	34	38	63	30.29%	5.39%	0.80%	0.13%
	After	45,030	32.01	32	37	72	65.19%	23.66%	4.88%	1.04%
South of SE Mill St (Aug. 2018 Before Data)	Before	15,234	34.38	35	40	72	45.08%	12.38%	2.57%	0.49%
	After	45,030	32.01	32	37	72	65.19%	23.66%	4.88%	1.04%
North of SE Brooklyn St and North of SE Rhone St[2]	Before	38,933	30.27	31	37	95	20.10%	4.59%	0.99%	0.22%
	After	45,544	29.30	30	35	71	42.60%	10.67%	1.88%	0.38%
South of SE Knapp St	Before	20,574	31.63	32	36	86	19.77%	3.11%	0.39%	0.05%
	After	18,364	30.95	31	35	79	55.60%	13.97%	2.23%	0.35%
South of SE Knapp St and North of SE Lambert St[3]	Before	20,574	31.63	32	36	86	19.77%	3.11%	0.39%	0.05%
	After	16,679	30.70	31	35	69	53.61%	12.69%	2.04%	0.41%
South of SE Knapp St and South of SE Lambert St[3]	Before	20,574	31.63	32	36	86	19.77%	3.11%	0.39%	0.05%
	After	18,453	32.49	33	37	62	69.20%	26.11%	4.75%	0.80%

[1] NE Klickitat St is 0.20 miles south of NE Beech St

[2] SE Rhone St is 0.30 miles south of SE Brooklyn St

[3] SE Lambert St is 0.20 miles south of SE Knapp St

Table 5.12: *t*-test Results at Spot Speed Locations on the NE/SE 82nd Ave Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
South of NE Beech St	0.000	0.110	Negligible	0.000	0.104	Negligible
South of NE Beech St and North of NE Klickitat St	0.000	-0.203	Small	0.000	-0.204	Small
South of NE Eugene St	0.000	0.147	Negligible	0.000	0.145	Negligible
South of NE Davis St	0.000	0.304	Small	0.000	0.305	Small
South of SE Mill St	0.000	0.328	Small	0.000	0.326	Small
South of SE Mill St (Jul. 2018 Before Data)	0.000	0.286	Small	0.000	0.288	Small
South of SE Mill St (Aug. 2018 Before Data)	0.000	0.392	Small	0.000	0.397	Small
North of SE Brooklyn St and North of SE Rhone St	0.000	0.156	Negligible	0.000	0.155	Negligible
South of SE Knapp St	0.000	0.136	Negligible	0.000	0.135	Negligible
South of SE Knapp St and North of SE Lambert St	0.000	0.184	Negligible	0.000	0.180	Negligible
South of SE Knapp St and South of SE Lambert St	0.000	-0.166	Negligible	0.000	-0.166	Negligible

[a] Independent two-sample t-test

[b] Paired two-sample t-test

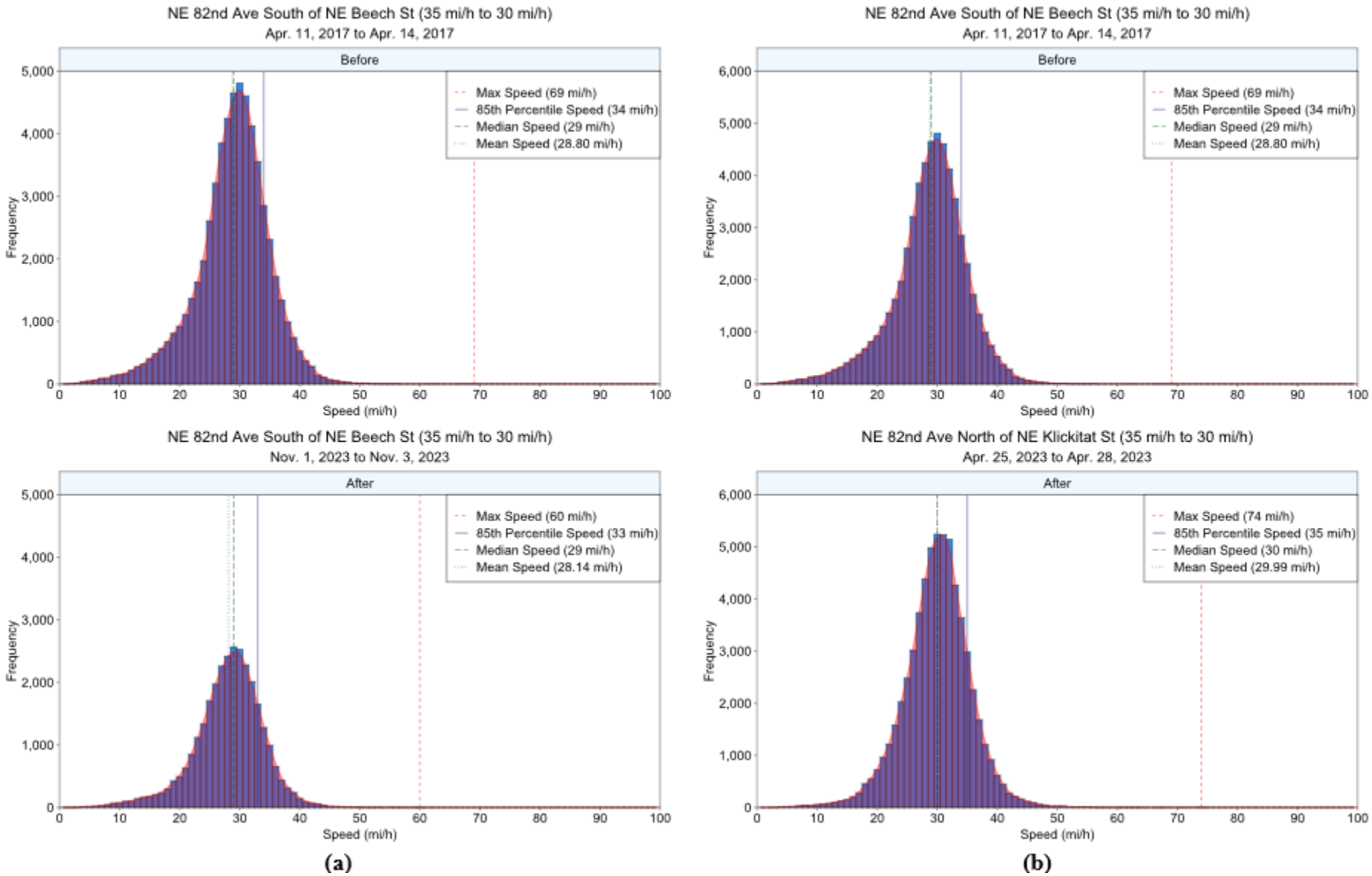


Figure 5.15: Speed Distribution at (a) South of NE Beech St and (b) South of NE Beech St and North of NE Klickitat St on the NE/SE 82nd Ave Speed Zone

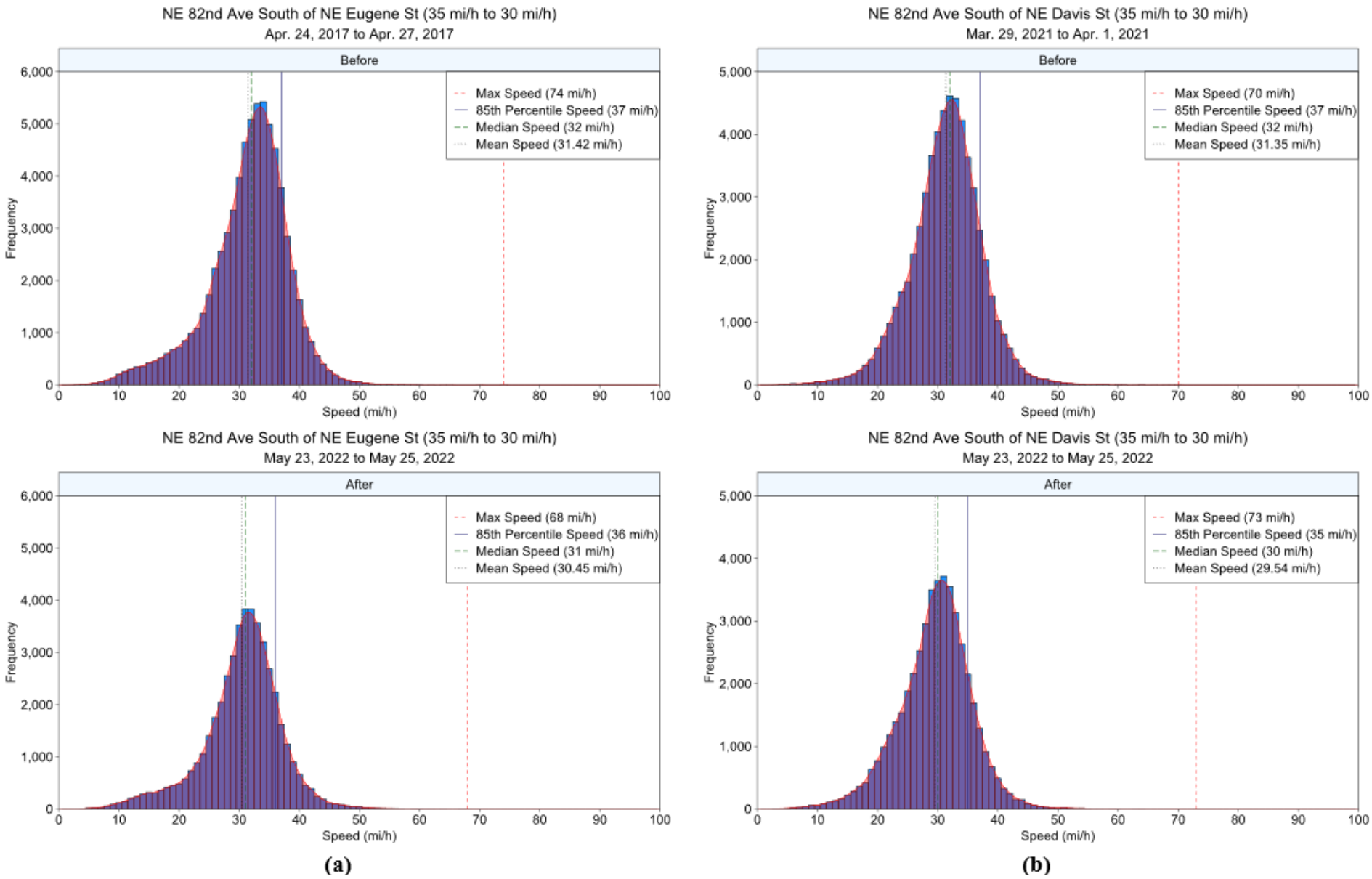


Figure 5.16: Speed Distribution at (a) South of NE Eugene St and (b) South of NE Davis St on the NE/SE 82nd Ave Speed Zone

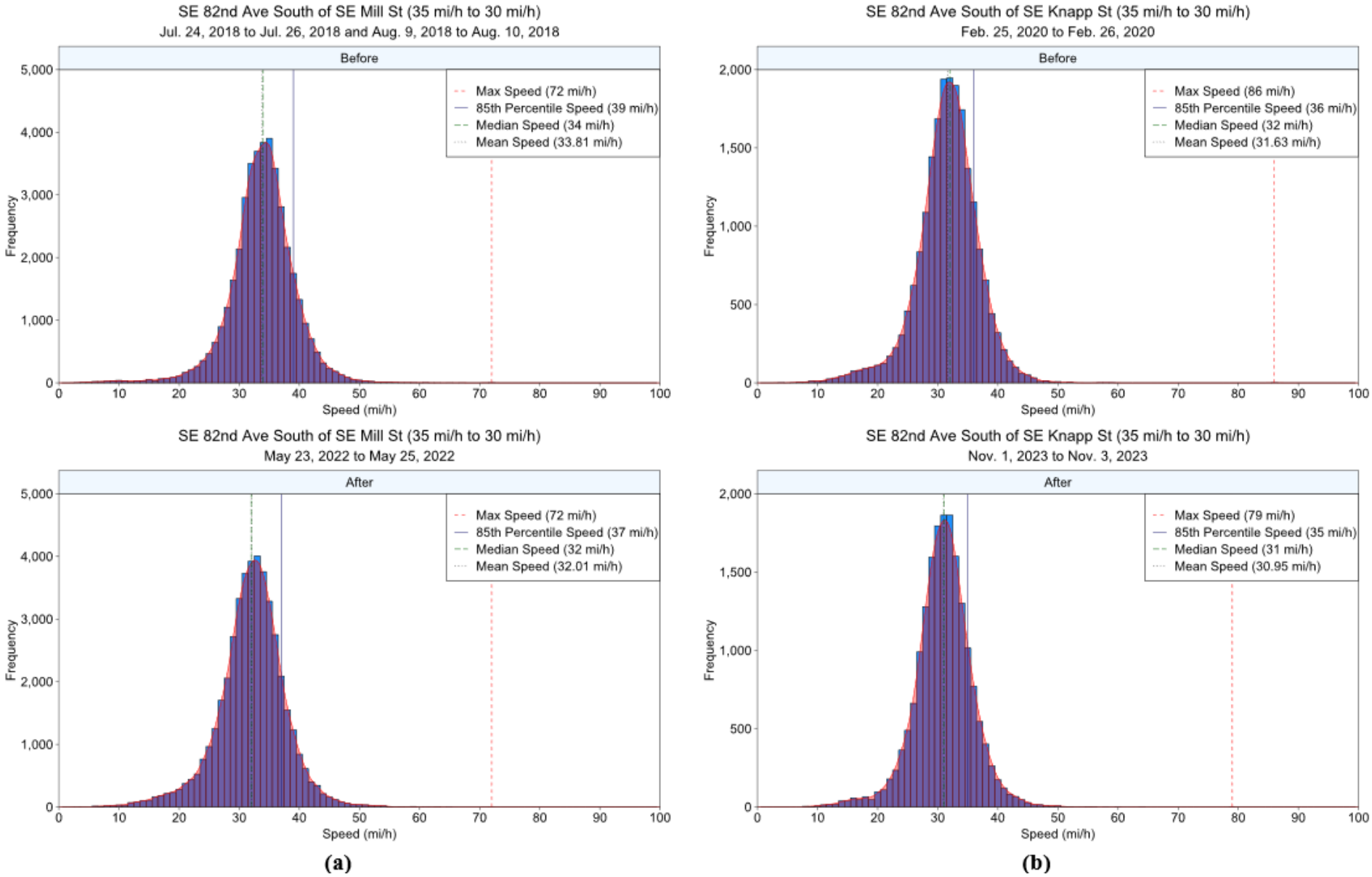


Figure 5.17: Speed Distribution at (a) South of SE Mill St and (b) South of SE Knapp St on the NE/SE 82nd Ave Speed Zone

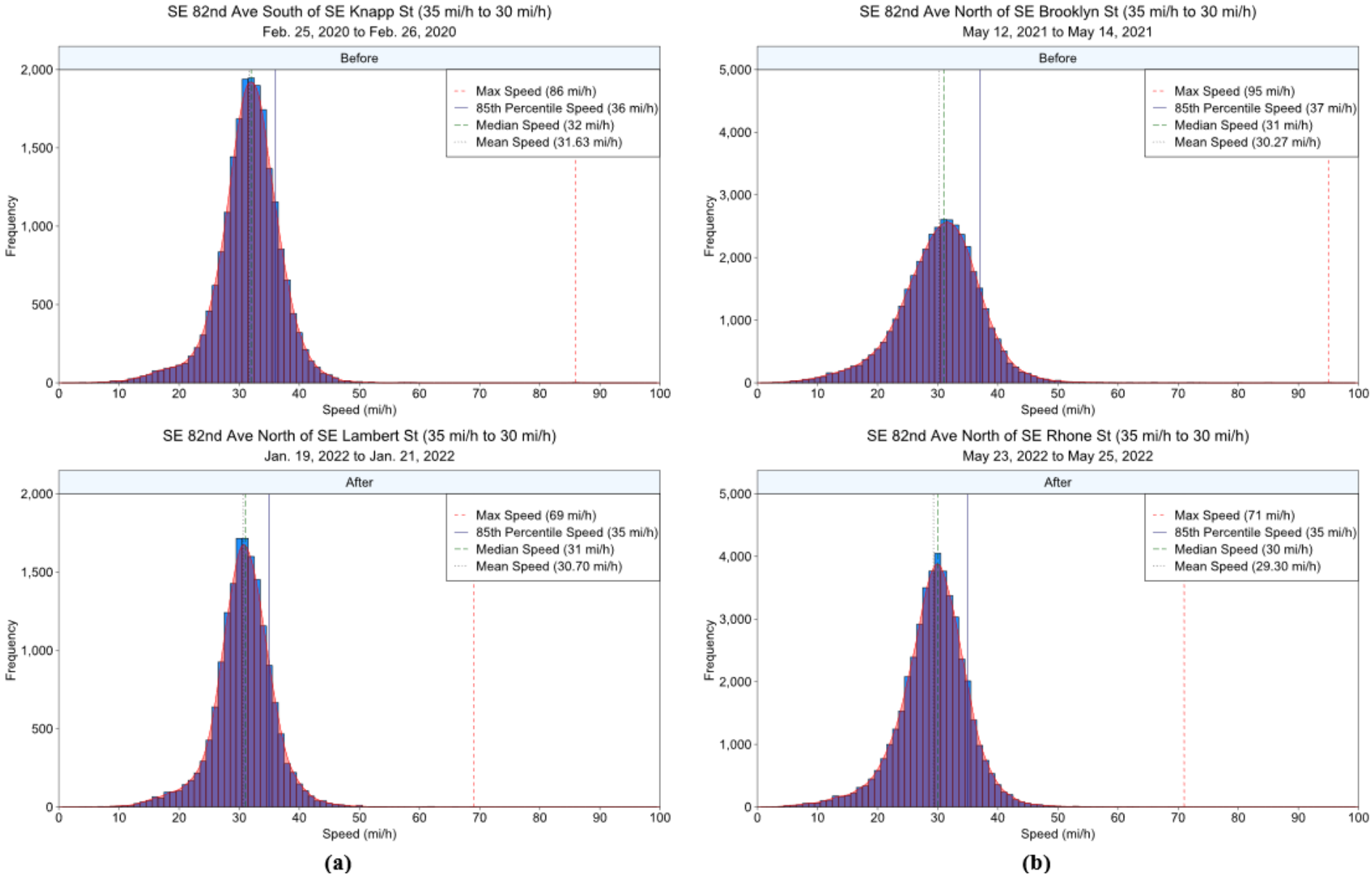


Figure 5.18: Speed Distribution at (a) South of SE Knapp St and North of SE Lambert St, and (b) South of SE Brooklyn St and North of SE Rhone St on the NE/SE 82nd Speed Zone

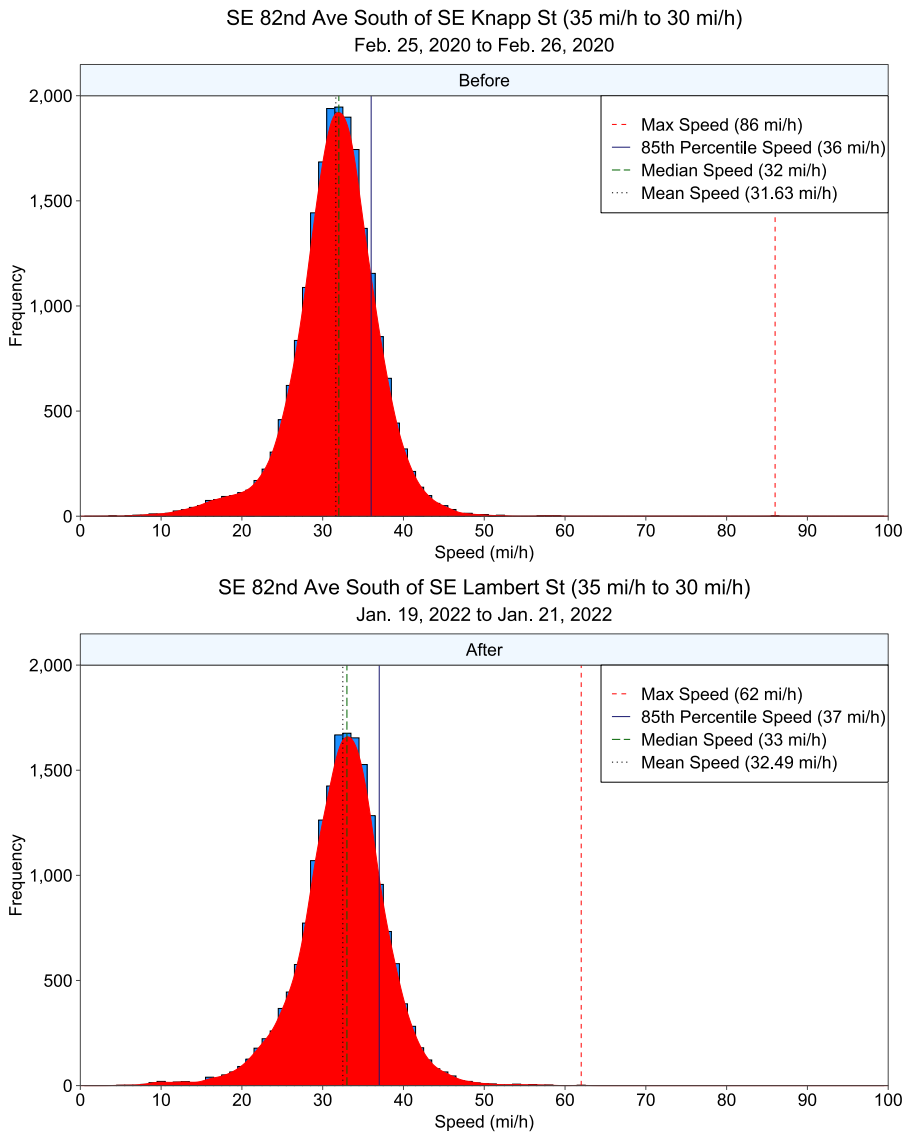


Figure 5.19: Speed Distribution at South of SE Knapp St and South of SE Lambert St on the NE/SE 82nd Ave Speed Zone

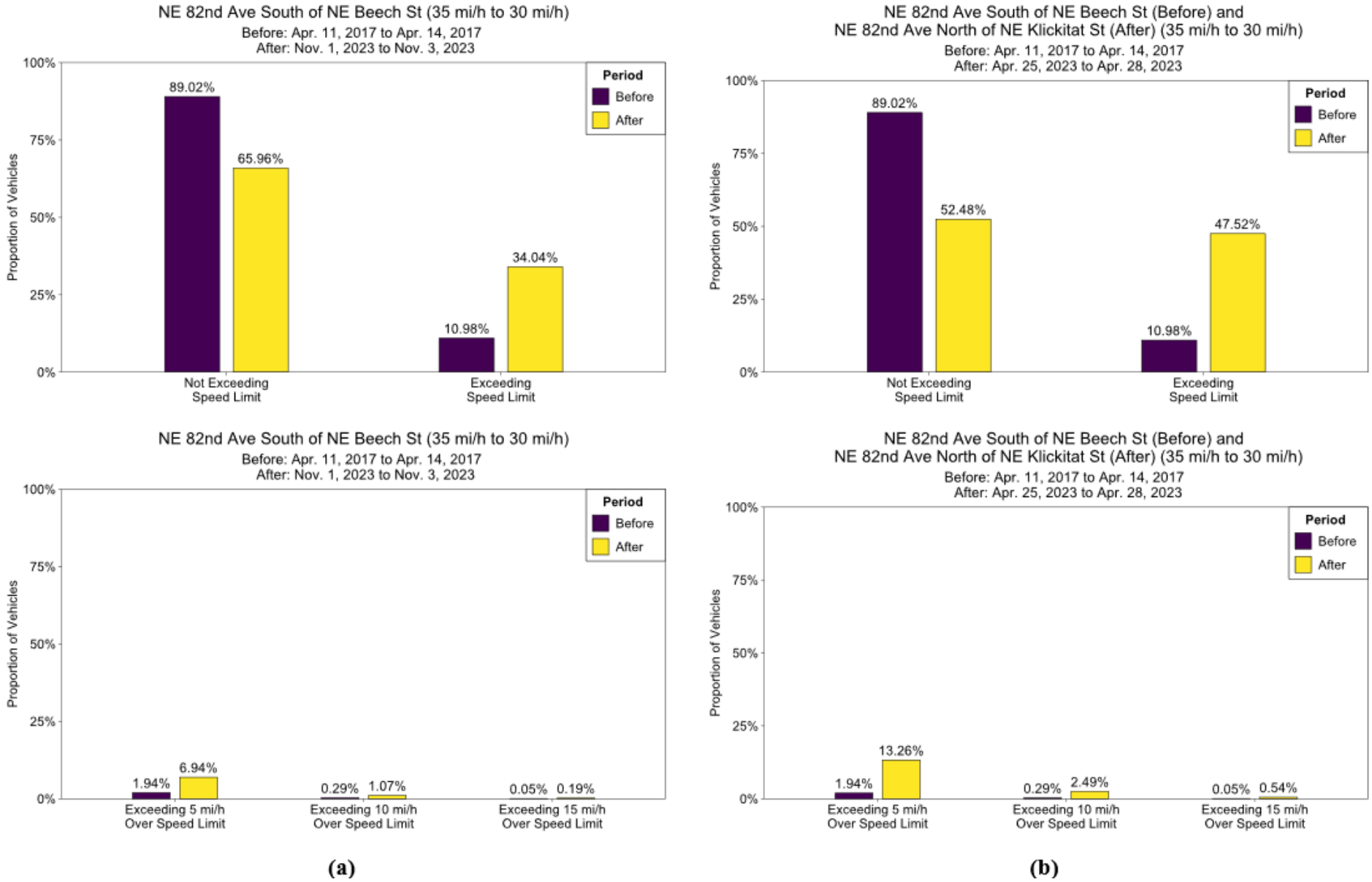


Figure 5.20: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) South of NE Beech St and (b) South of NE Beech St and North of NE Klickitat St on the NE/SE 82nd Ave Speed Zone

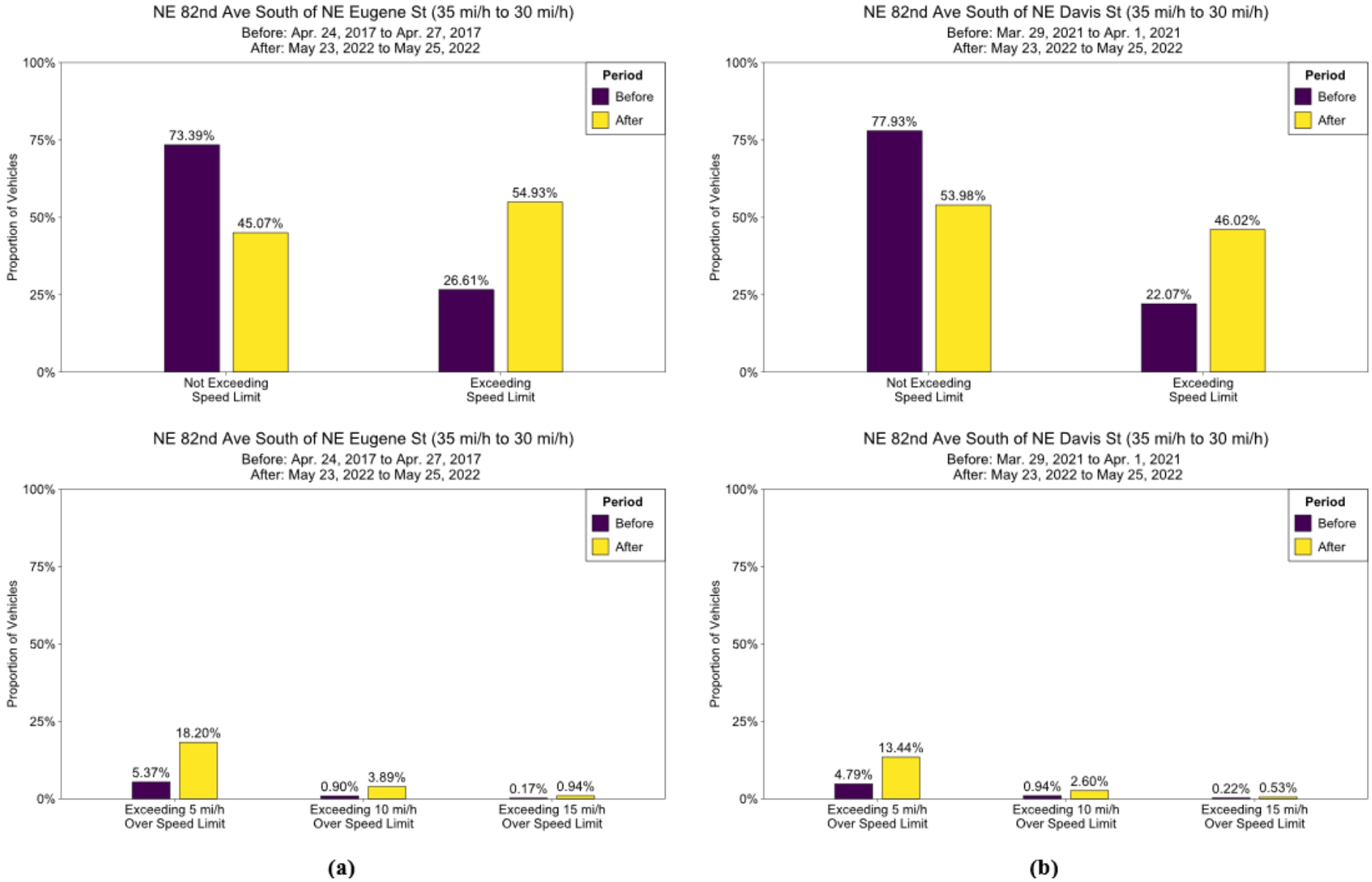


Figure 5.21: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) South of NE Eugene St and (b) South of NE Davis St on the NE/SE 82nd Ave Speed Zone

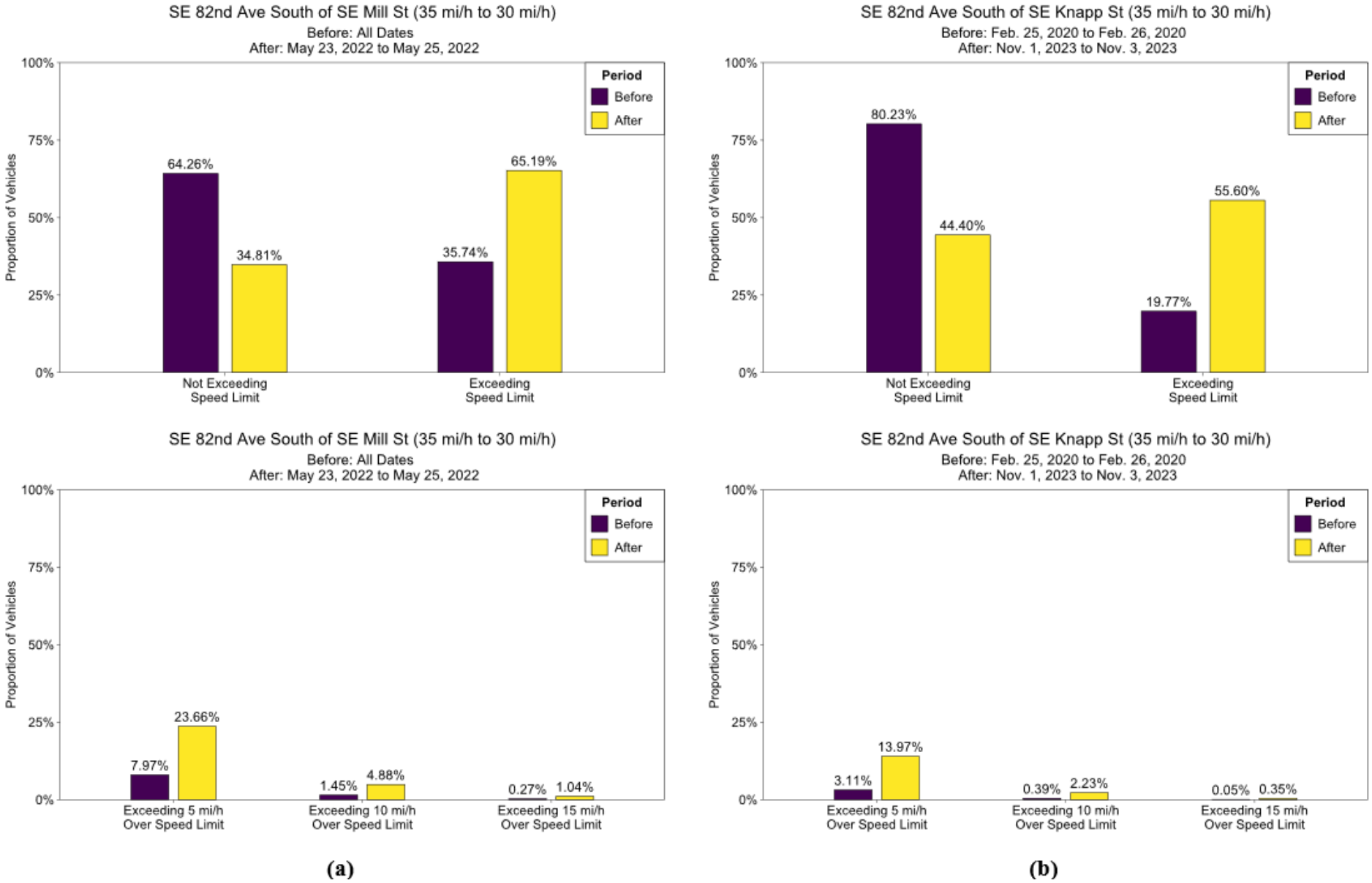
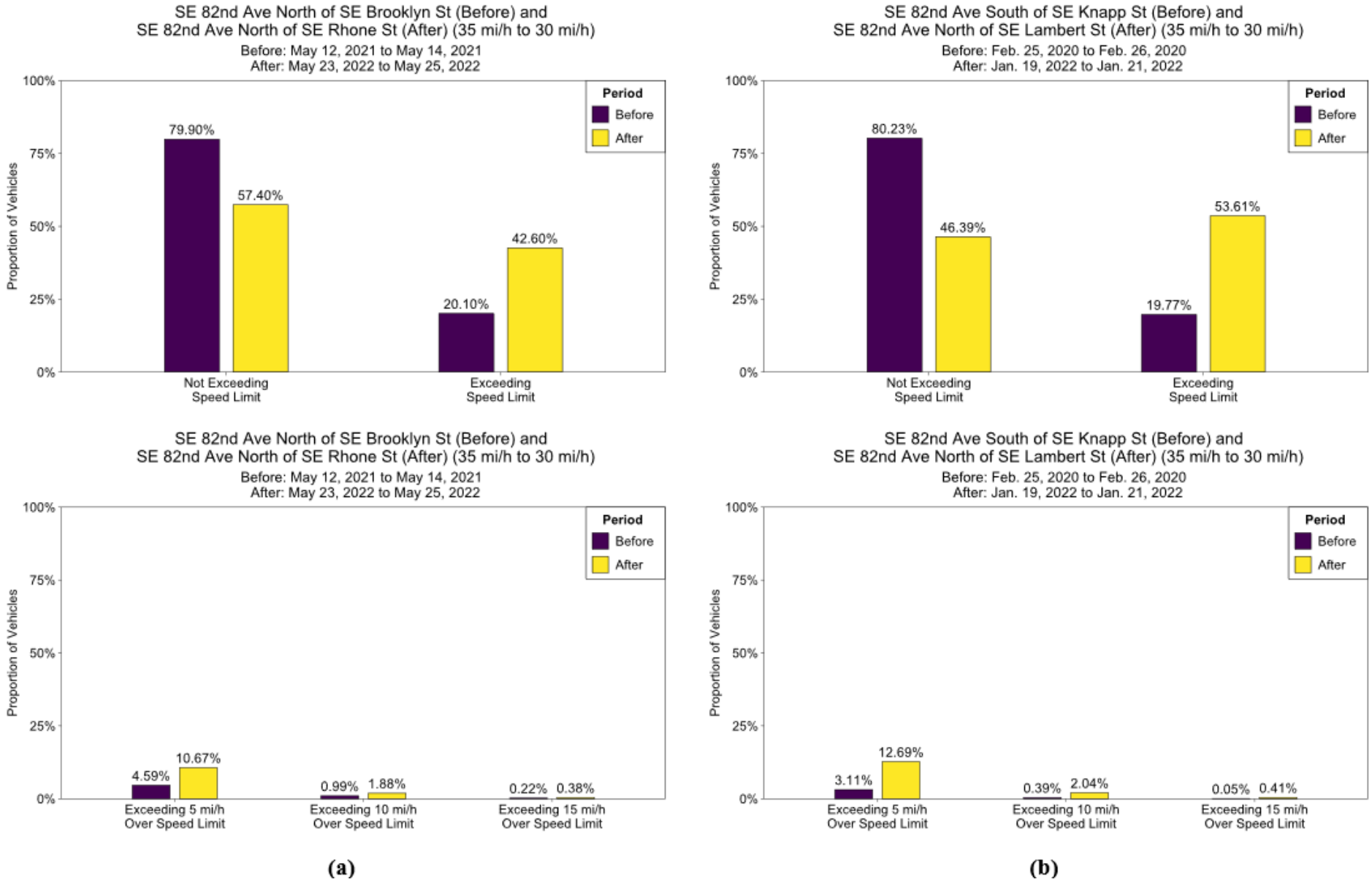


Figure 5.22: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) South of SE Mill St and (b) South of SE Knapp St on the NE/SE 82nd Ave Speed Zone



(a) **(b)**

Figure 5.23: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at (a) North of SE Brooklyn St and North of SE Rhone St, and (b) South of SE Knapp St and North of SE Lambert St on the NE/SE 82nd Ave Speed Zone

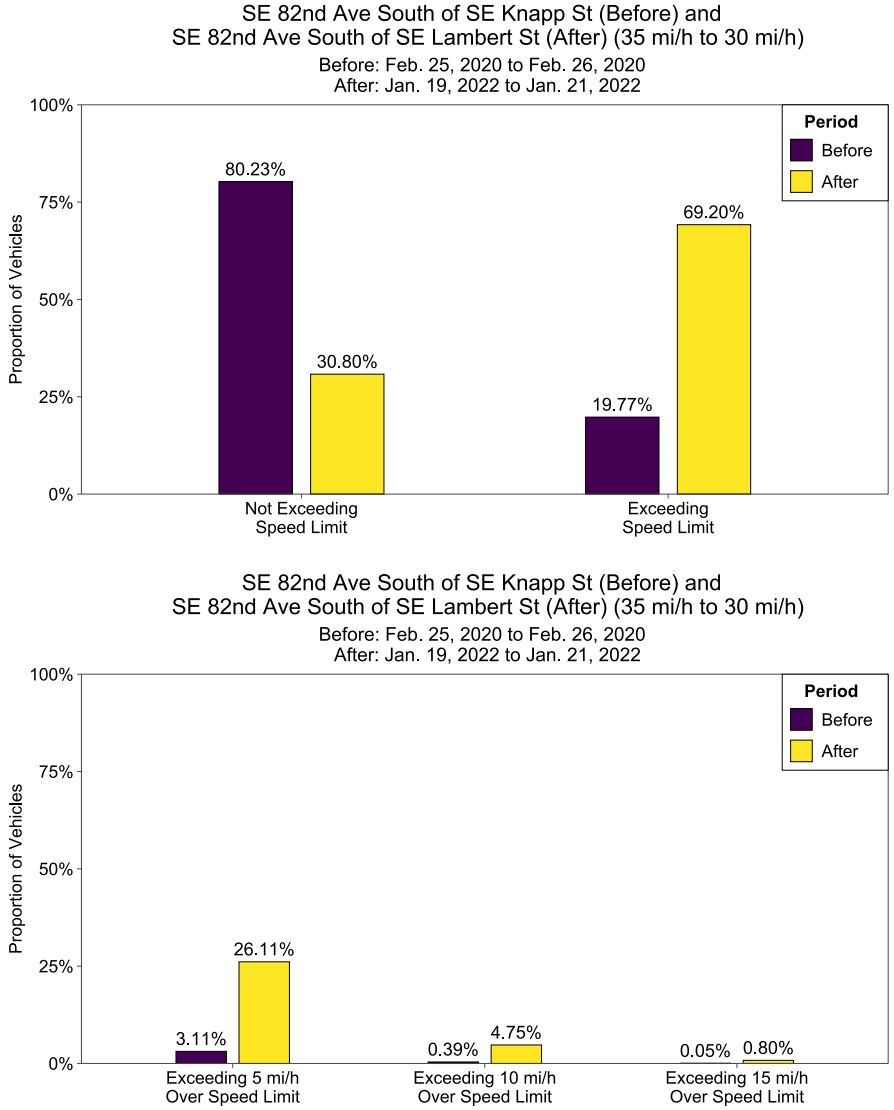


Figure 5.24: Change in Proportion of Vehicles Speeding and Exceeding Speed Thresholds at South of SE Knapp St and South of SE Lambert St on the NE/SE 82nd Ave Speed Zone

5.1.5 NE Glisan St

Spot speed data was obtained to make for five comparisons on the NE Glisan St speed zone. This speed zone has two reduction segments: (1) 35 mi/h to 30 mi/h and (2) 40 mi/h to 30 mi/h. In this speed zone, there were spot speed locations that were compared to nearby spot speed measurements (as discussed in Chapter 3.0) and two locations with multiple before collection periods (East of NE 143rd Ave and East of NE 157th Ave). For locations with multiple before collection periods, all before data is compared to the after data and each set of before data are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.13 and Figure 5.25. Descriptive statistics and statistical test results are shown in Table 5.14 and t-test results in Table 5.15. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.26 to Figure 5.31. For disaggregated speed distribution plots and figures of proportion of vehicles exceeding speed thresholds, refer to Figure A.11 to Figure A.18 in Appendix A.

In the 35 mi/h to 30 mi/h reduction segment, there were two spot speed locations: (1) East of NE 85th Ave and (2) West of NE 113th Ave. The East of NE 85th Ave location experienced an increase in mean speed (1 mi/h) and median speed (1 mi/h). At this location, there were increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit, where the proportion of vehicles speeding in the after condition was greater than 90%. More than 60% were exceeding 5 mi/h over the speed limit, nearly 20% exceeding 10 mi/h over the speed limit, and more than 4% exceeding 15 mi/h over the speed limit. Opposite trends were observed at West of NE 113th Ave, where there was a decrease in mean speed (5.66 mi/h), median speed (6 mi/h), and 85th percentile speed (6 mi/h). Despite these decreases, only slight decreases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit were observed. The proportions in the after condition were similar to East of NE 85th Ave, with the exception of the proportion of vehicles exceeding 15 mi/h over the speed limit, which was nearly 6% in the after condition (down from over 8%).

In the 40 mi/h to 30 mi/h reduction segment, all locations experienced a decrease in mean speed (or a very slight increase of less than 1 mi/h), all locations experienced a decrease in median speed (or no change), and all locations experienced a decrease in 85th percentile speed. This was true for both the aggregate and disaggregate comparisons. Despite these decreases, each location experienced substantial increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit. Once more, despite decreases in mean and median speeds, they were still higher than the new posted speed limit.

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes ranged negligible to large. The large effect sizes were observed at West of NE 113th Ave and the disaggregate comparison of East of NE 143rd Ave with Feb. 2018 before data (the effect size was negligible when compared to Feb. 2020 before data and small for the aggregate comparison). At the West of NE 113th Ave location, mean speed in the before condition was 0.975 standard deviations greater than mean speed in the after condition. At the East of NE 143rd Ave location with Feb. 2018 before data, mean speed in the before condition was 1.169 standard deviations greater than mean speed in the after condition.

Table 5.13: Data Collection Periods on NE Glisan St Speed Zone

Location	Before Data	Sign Installed	After Data
East of NE 85th Ave	Mar. 7, 2018 to Mar. 9, 2018	Nov. 11, 2021	Sep. 26, 2023 to Sep. 29, 2023
West of NE 113th Ave	Jun. 20, 2018 to Jun. 22, 2018	Nov. 11, 2021	Oct. 18, 2023 to Oct. 20, 2023
East of NE 143rd Ave	Feb. 13, 2018 to Feb. 16, 2018	Nov. 11, 2021	Oct. 18, 2023 to Oct. 20, 2023
	Feb. 3, 2020 to Feb. 7, 2020		
West of NE 155th Ave	Jan. 22, 2018 to Jan. 29, 2018	Nov. 11, 2021	NA
	Feb. 3, 2020 to Feb. 6, 2020		
East of NE 157th Ave	Feb. 11, 2020 to Feb. 14, 2020	Nov. 11, 2021	Oct. 2, 2023 to Oct. 5, 2023
	Feb. 26, 2018 to Mar. 2, 2018		
	Feb. 6, 2020 to Feb. 7, 2020		
	May 23, 2018 to May 25, 2018		

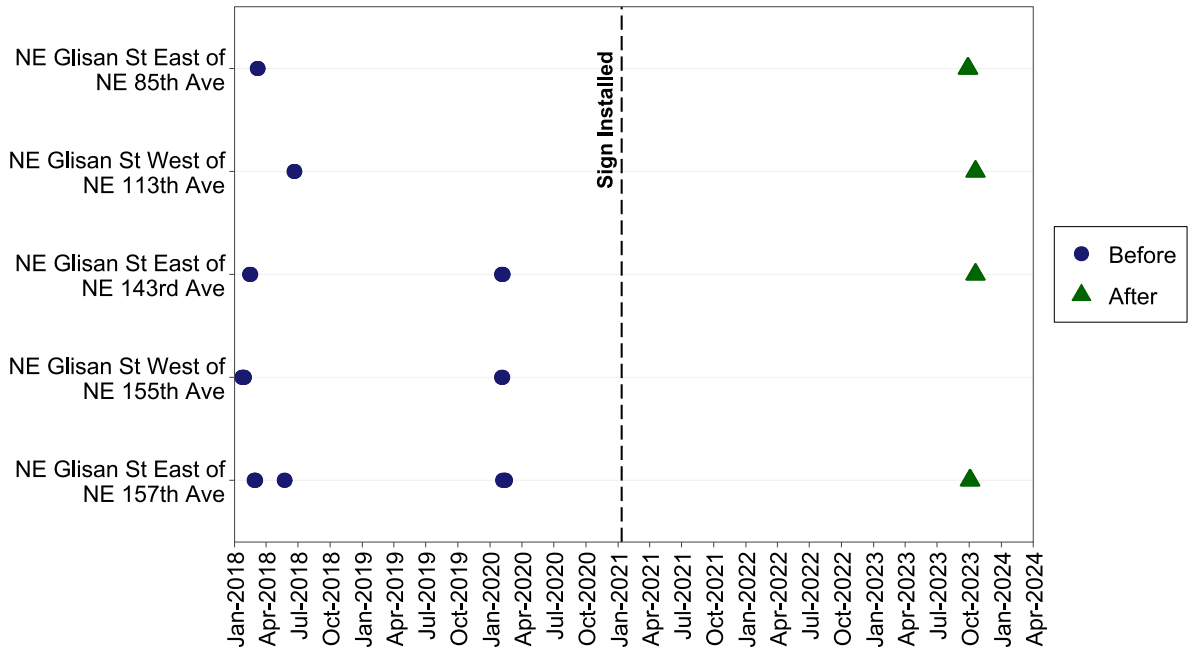


Figure 5.25: Data Collection and Sign Installation Timeline for NE Glisan St Speed Zone

Table 5.14: NE Glisan St Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
East of NE 85th Ave	Before	41,985	35.83	36	41	79	56.16%	17.47%	3.26%	0.61%
	After	30,094	36.82	37	41	94	92.62%	60.22%	19.68%	4.31%
West of NE 113th Ave	Before	51,690	42.42	42	48	98	90.81%	62.36%	26.54%	8.15%
	After	50,281	36.76	36	42	97	90.43%	58.02%	21.77%	5.64%
East of NE 143rd Ave	Before	92,111	37.32	37	43	89	26.85%	6.86%	1.35%	0.34%
	After	38,180	35.10	35	40	82	86.13%	44.37%	11.67%	2.39%
East of NE 143rd Ave (Feb. 2018 Before Data)	Before	27,606	40.92	41	46	83	53.64%	15.23%	2.90%	0.67%
	After	38,180	35.10	35	40	82	86.13%	44.37%	11.67%	2.39%
East of NE 143rd Ave (Feb. 2020 Before Data)	Before	64,505	35.78	36	41	89	15.38%	3.28%	0.68%	0.20%
	After	38,180	35.10	35	40	82	86.13%	44.37%	11.67%	2.39%
East of NE 157th Ave	Before	108,379	35.56	36	41	96	19.11%	3.80%	0.74%	0.19%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
East of NE 157th Ave (Feb. 2018 Before Data)	Before	8,315	38.04	39	44	96	34.85%	9.33%	2.48%	0.85%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
East of NE 157th Ave (May 2018 Before Data)	Before	33,544	37.71	38	43	76	28.41%	5.69%	0.90%	0.23%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
East of NE 157th Ave (Feb. 2020 Before Data)	Before	66,520	34.17	35	40	86	12.45%	2.16%	0.43%	0.10%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
West of NE 155th Ave and East of NE 157th Ave[1]	Before	151,874	34.85	36	41	85	19.75%	3.58%	0.60%	0.14%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
West of NE 155th Ave and East of NE 157th Ave (Jan. 2018 Before Data)	Before	106,758	35.57	37	42	85	22.53%	4.00%	0.65%	0.16%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%
West of NE 155th Ave and East of NE 157th Ave (Feb. 2020 Before Data)	Before	45,116	33.15	34	40	80	13.16%	2.60%	0.49%	0.11%
	After	34,008	33.63	34	39	93	74.35%	36.37%	10.01%	2.18%

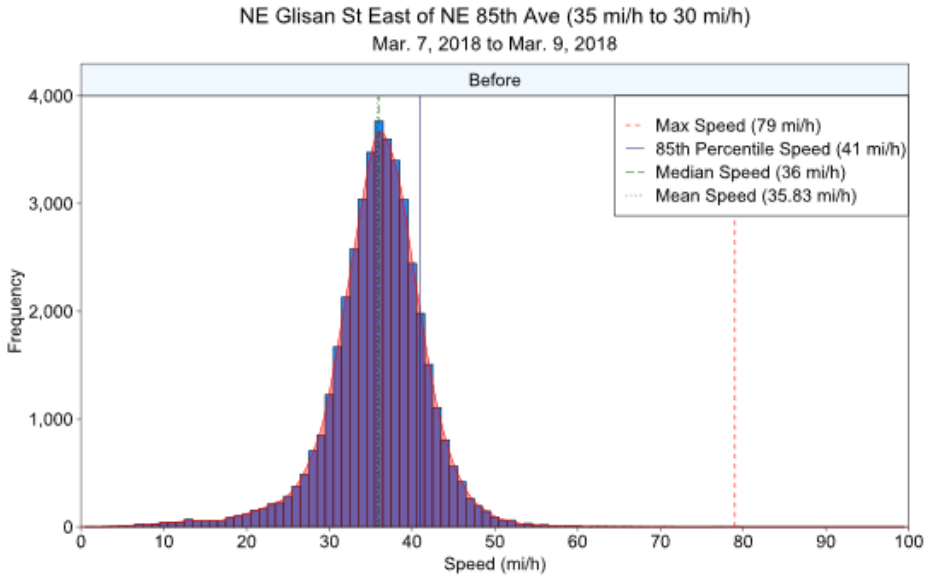
[1] NE 155th Ave is 0.10 miles west of NE 157th Ave

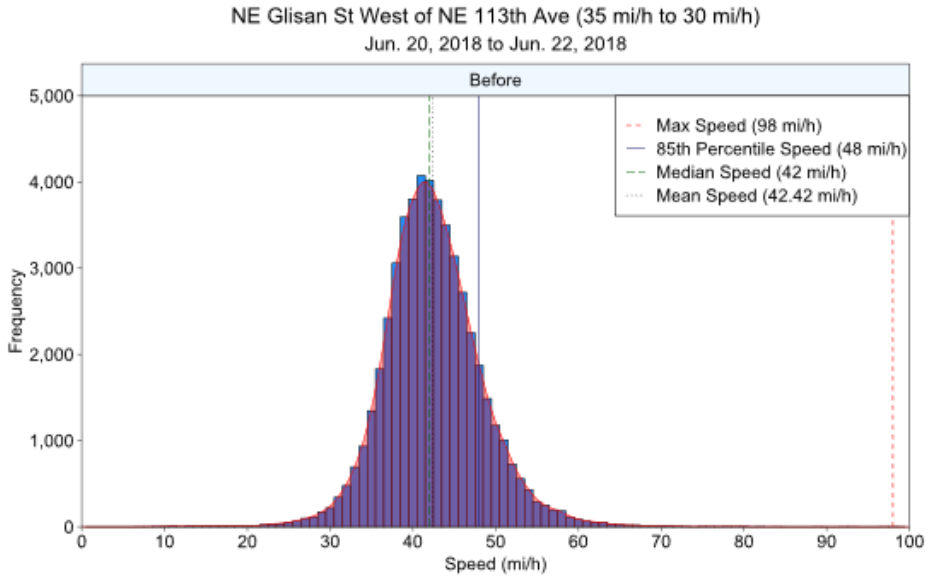
Table 5.15: *t*-test Results at Spot Speed Locations on NE Glisan St Speed Zone

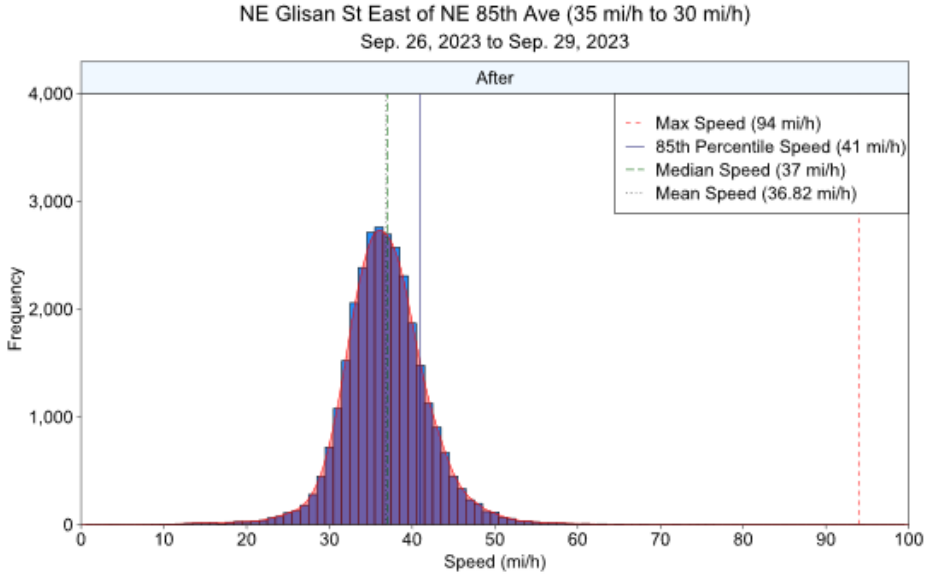
Location	*p*-value[a]	Cohen's	Magnitude[a]	*p*-	Cohen's	Magnitude[b]
East of NE 85th Ave	0.000	-0.180	Negligible	0.000	-0.179	Negligible
West of NE 113th Ave	0.000	0.975	Large	0.000	0.975	Large
East of NE 143rd Ave	0.000	0.424	Small	0.000	0.428	Small
East of NE 143rd Ave (Feb. 2018	0.000	1.169	Large	0.000	1.169	Large
East of NE 143rd Ave (Feb. 2020	0.000	0.138	Negligible	0.000	0.142	Negligible
East of NE 157th Ave	0.000	0.316	Small	0.000	0.318	Small
East of NE 157th Ave (Feb. 2018	0.000	0.645	Moderate	0.000	0.658	Moderate
East of NE 157th Ave (May 2018	0.000	0.717	Moderate	0.000	0.718	Moderate
East of NE 157th Ave (Feb. 2020	0.000	0.090	Negligible	0.000	0.087	Negligible
West of NE 155th Ave and East of NE	0.000	0.182	Negligible	0.000	0.183	Negligible
West of NE 155th Ave and East of NE 157th Ave	0.000	0.291	Small	0.000	0.304	Small
West of NE 155th Ave and East of NE 157th Ave	0.000	-0.073	Negligible	0.000	-0.066	Negligible

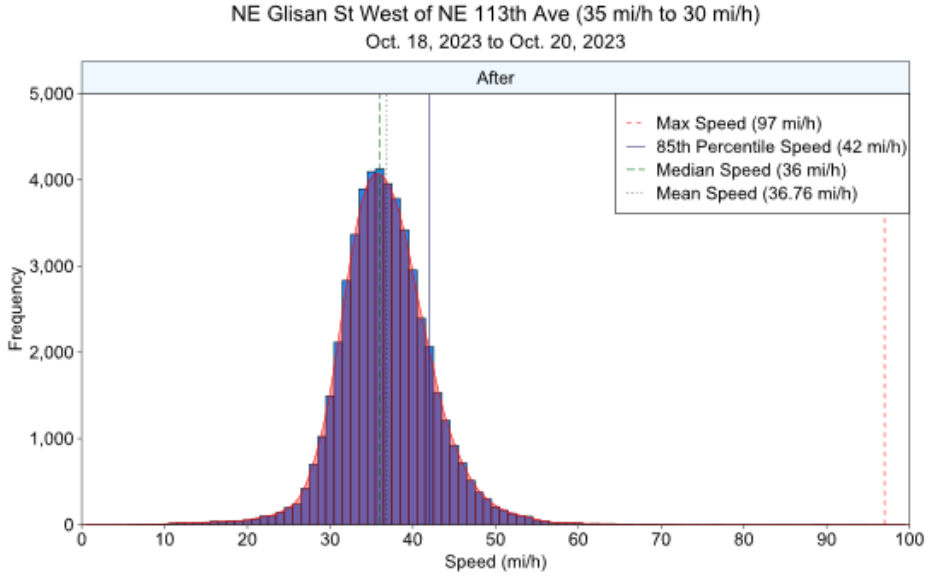
[a] Independent two-sample t-test

[b] Paired two-sample t-test



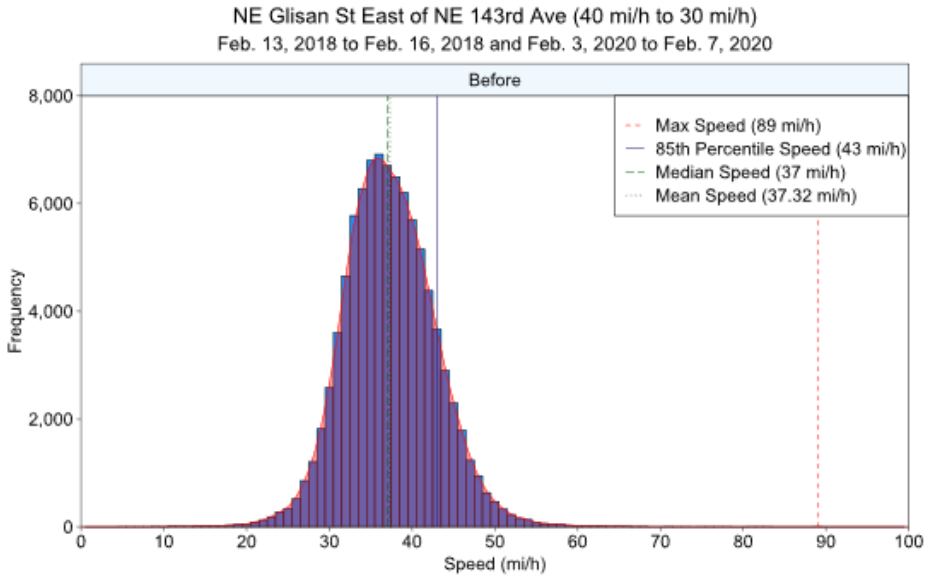


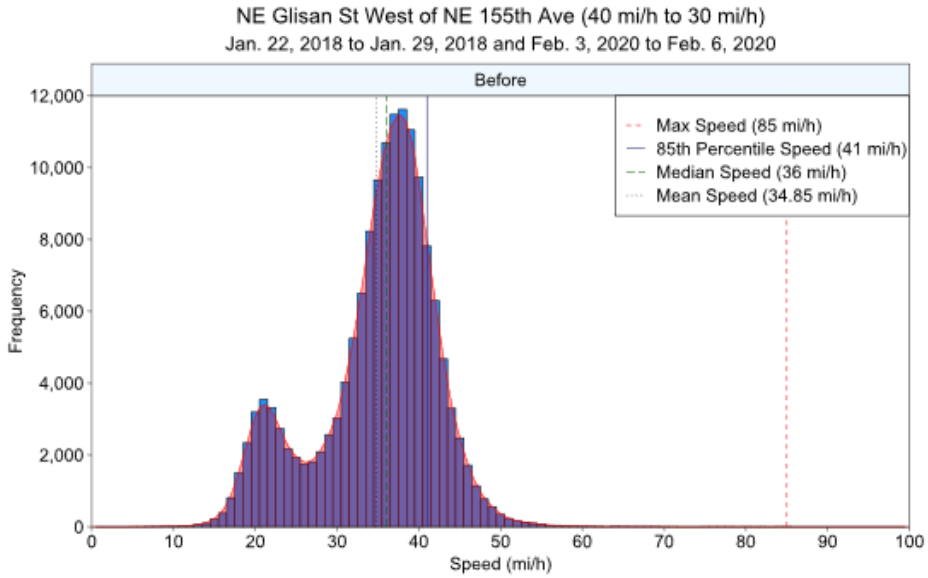


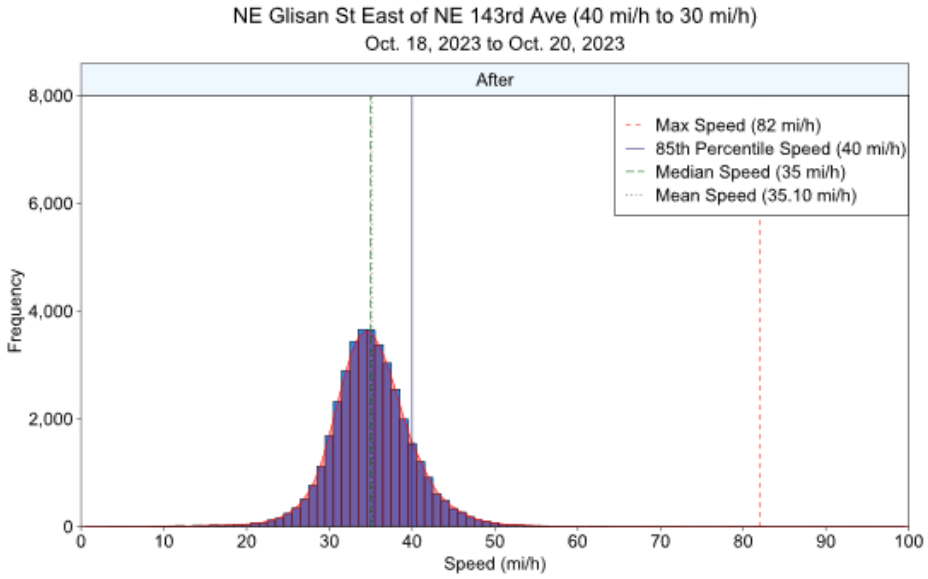


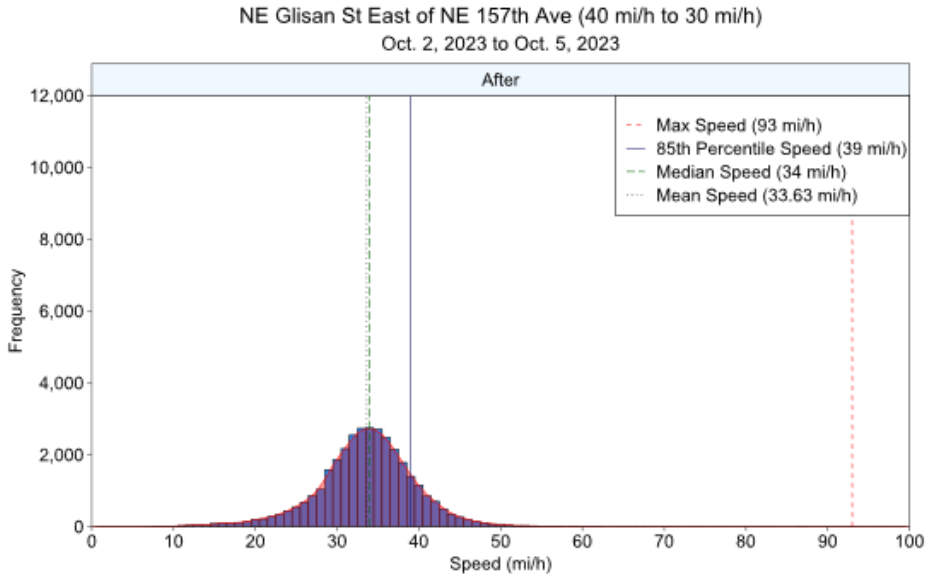
(a) **(b)**

Figure 5.26: Speed Distribution at (a) East of NE 85th Ave and (b) West of NE 113th Ave on NE Glisan St Speed Zone









(a) **(b)**

Figure 5.27: Speed Distribution at (a) East of NE 143rd Ave and (b) West of NE 155th Ave and East of NE 157th Ave on NE Glisan St Speed Zone

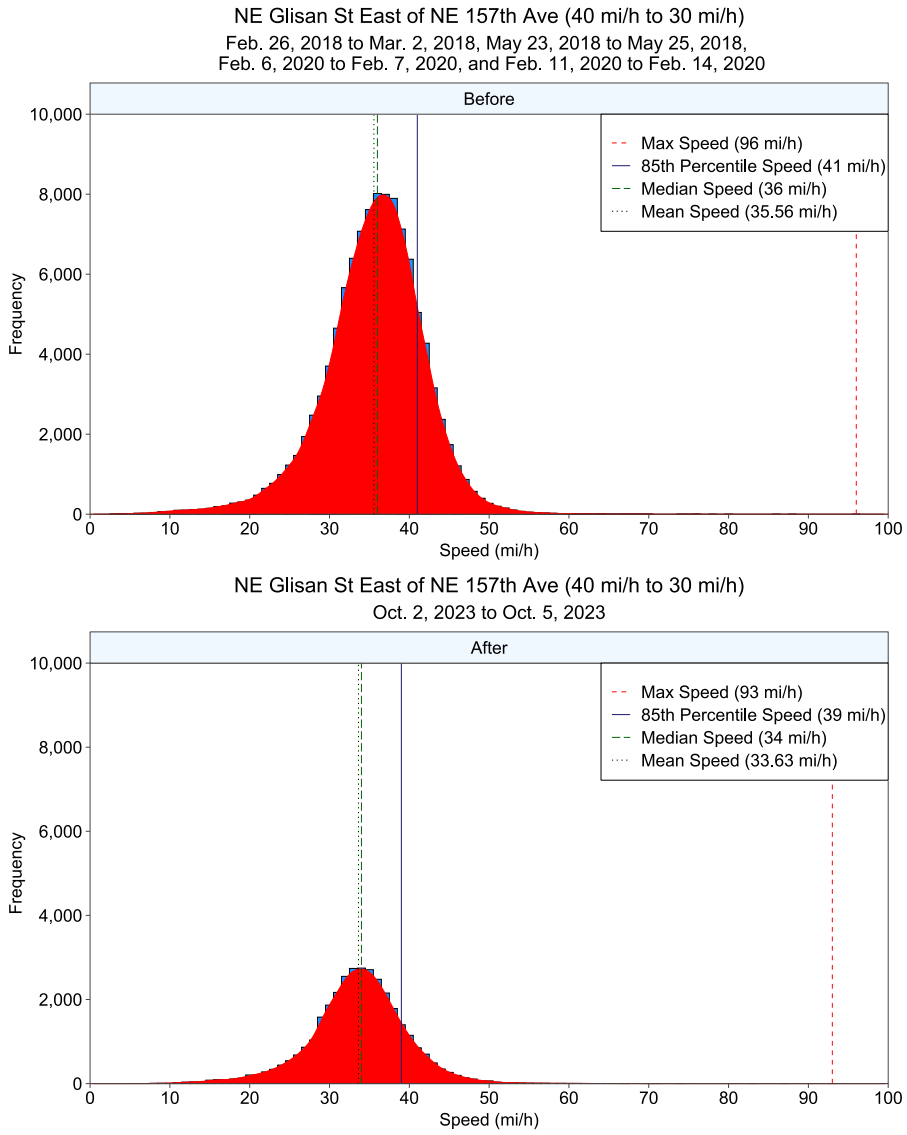
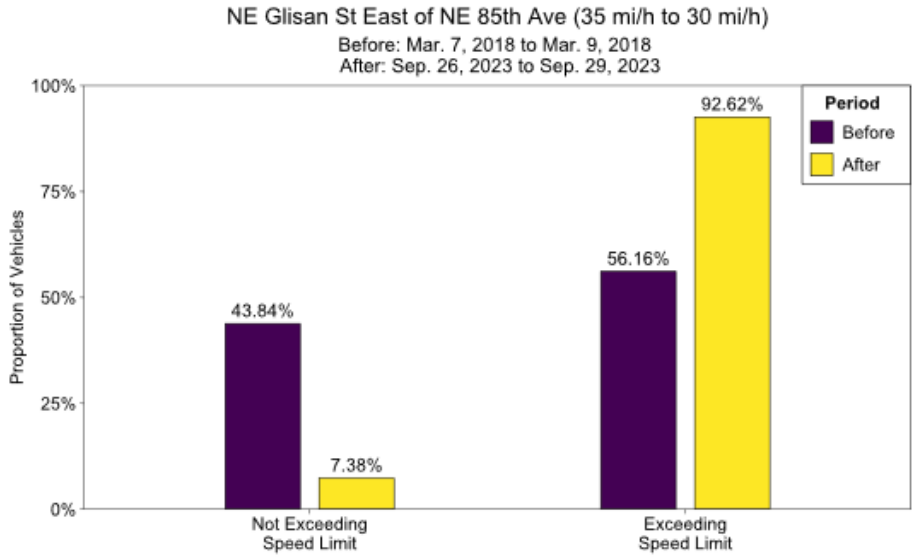
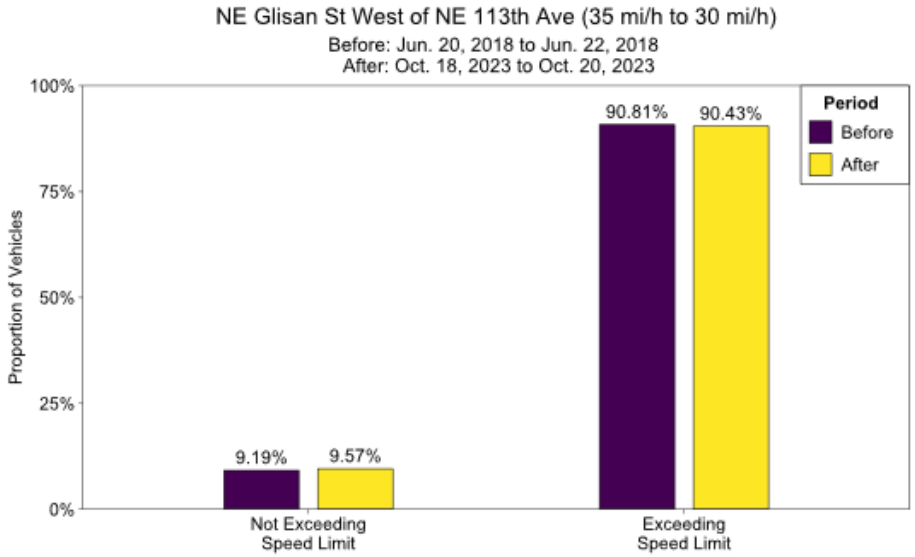
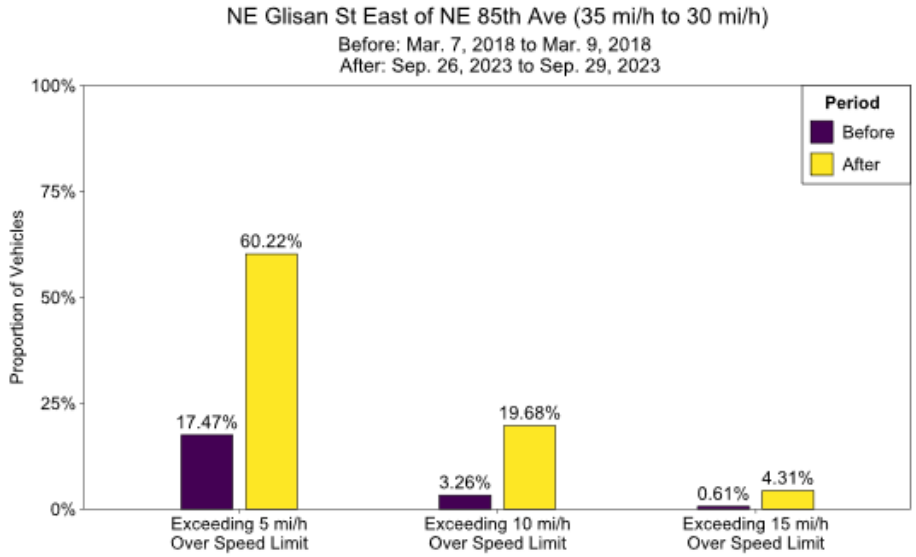
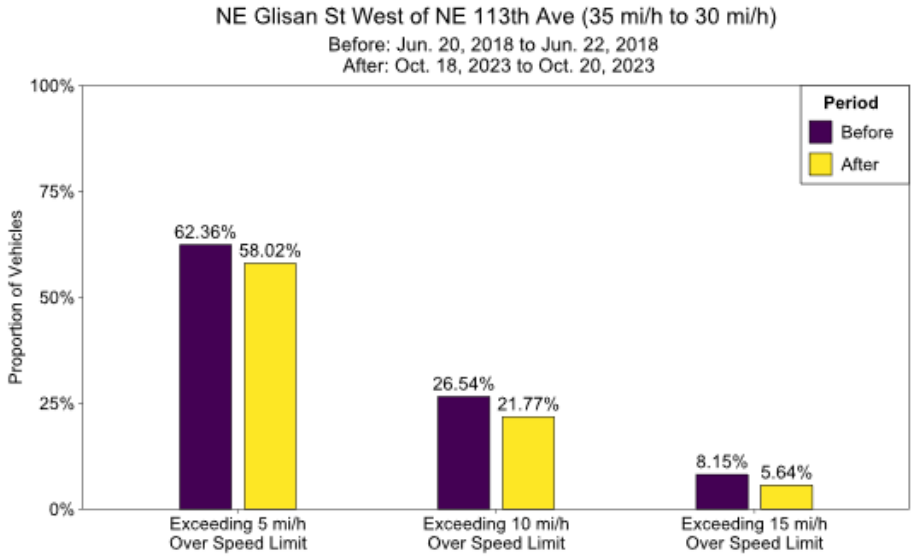


Figure 5.28: Speed Distribution at East of NE 157th Ave on NE Glisan St Speed Zone









(a) **(b)**

Figure 5.29: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) East of NE 85th Ave and (b) West of NE 113th Ave on NE Glisan St Speed Zone

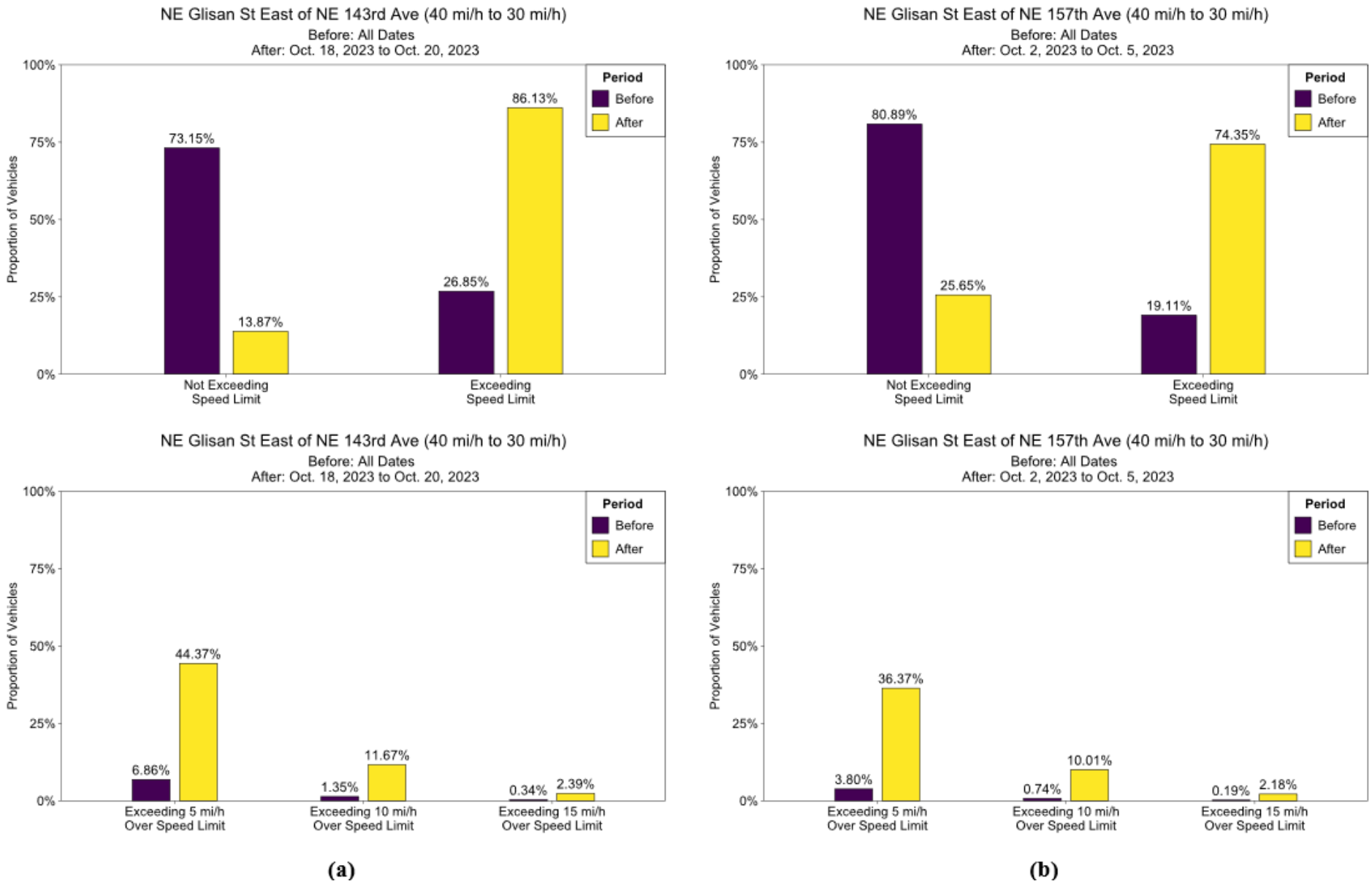


Figure 5.30: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) East of NE 143rd Ave and (b) East of NE 157th Ave on NE Glisan St Speed Zone

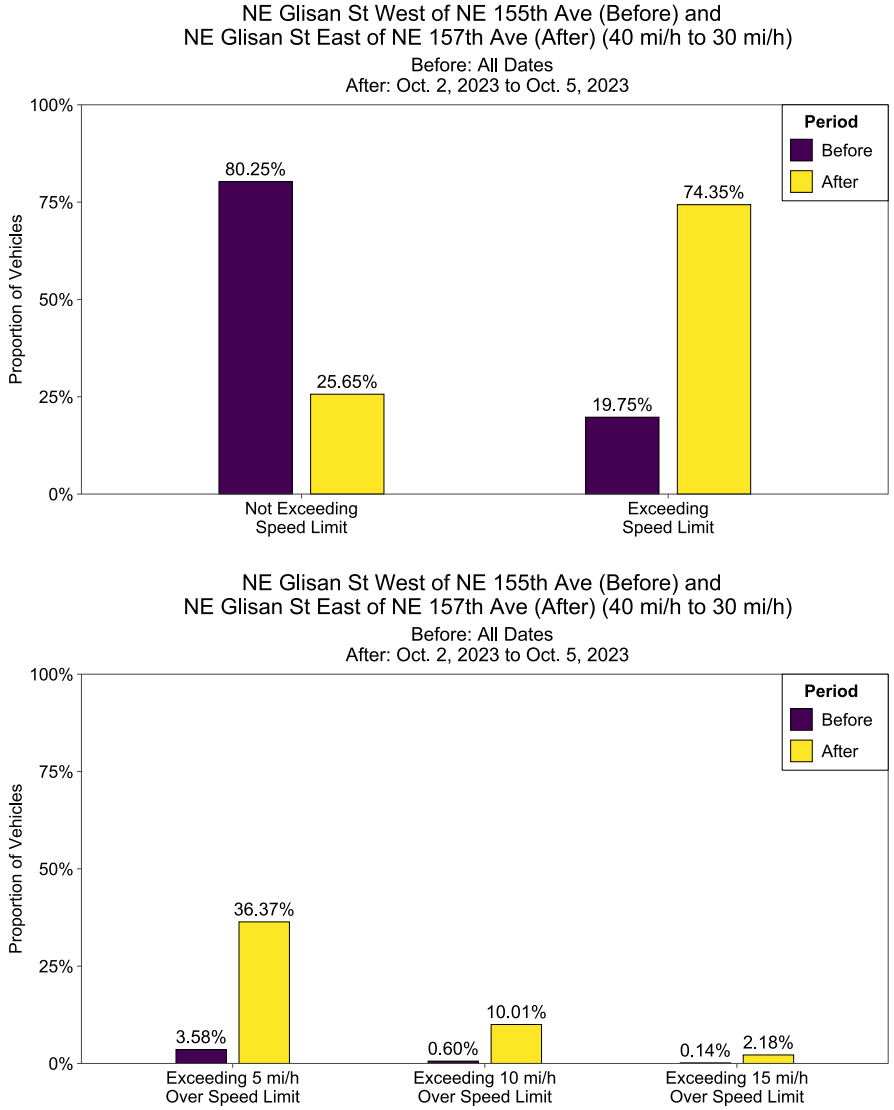


Figure 5.31: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at West of NE 155th Ave and East of NE 157th Ave

5.1.6 NE Killingsworth St

Spot speed data was obtained to make for two comparisons on the NE Killingsworth St speed zone. This speed zone has two reduction segments: (1) 30 mi/h to 25 mi/h and (2) 35 mi/h to 30 mi/h. In this speed zone, there were spot speed locations that were compared to nearby spot speed measurements (as discussed in Chapter 3.0). Data collection and sign installation dates are shown in Table 5.16 and Figure 5.32. Descriptive statistics and statistical test results are shown in and Table 5.18.

In the 30 mi/h to 25 mi/h reduction segment, there was one spot speed location: West of NE 22nd Ave and East of NE 20th Ave. This location experienced a decrease in mean speed (1.05 mi/h), a 1 mi/h decrease in median speed, and a 1 mi/h decrease in 85th percentile speed. Despite decreases in these measures, the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15 mi/h over the speed limit all increased in the after condition. Although decreases in mean and median speeds were observed, they were greater than the new posted speed limit.

For the one comparison in the 35 mi/h to 30 mi/h reduction segment, mean speed decreased by 11.24 mi/h, median speed by 11 mi/h and 85th percentile speed by 10 mi/h. It should be noted that these two locations are separated by 0.20 miles. Decreases were also observed in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15 mi/h over the speed limit (the decrease in proportion of vehicles exceeding 15 mi/h over the speed limit was 0.01%).

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes being negligible and large. The large effect size was observed at East of NE 64th Ave and East of NE Cully Blvd, which indicated that mean speed in the before condition was 1.831 (1.833 for paired) standard deviations greater than mean speed in the after condition.

Table 5.16: Data Collection Periods on NE Killingsworth St Speed Zone

Location	Before Data	Sign Installed	After Data
East of NE 20th Ave	NA	Feb. 1, 2021	Feb. 28, 2022 to Mar. 4, 2022
West of NE 22nd Ave	Jul. 24, 2019 to Jul. 26, 2019	Feb. 1, 2021	NA
East of NE 64th Ave	Feb. 5, 2013 to Feb. 6, 2013	Feb. 1, 2021	NA
East of NE Cully Blvd	NA	Feb. 1, 2021	May 3, 2023 to May 5, 2023

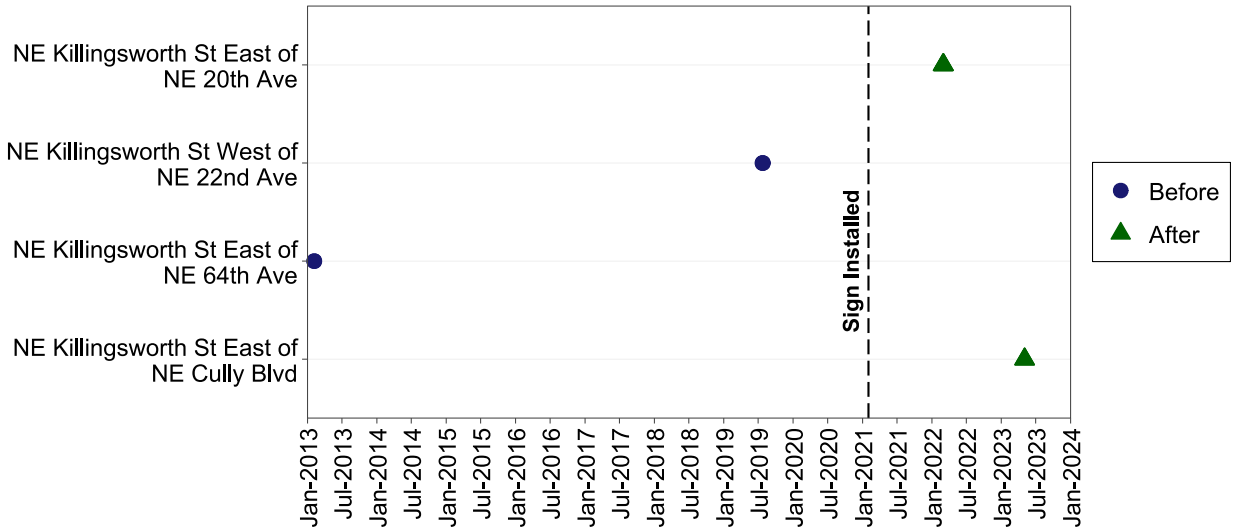


Figure 5.32: Data Collection and Sign Installation Timeline for NE Killingsworth St Speed Zone

Table 5.17: NE Killingsworth St Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
West of NE 22nd Ave and East of NE 20th Ave[1]	Before	25,883	29.20	30	34	70	43.39%	7.76%	1.00%	0.21%
	After	38,515	28.15	29	33	78	73.16%	33.67%	6.99%	1.27%
East of NE 64th Ave and East of NE Cully Blvd[2]	Before	9,196	33.56	34	39	65	37.09%	7.21%	1.02%	0.17%
	After	22,921	22.32	23	29	79	8.10%	1.35%	0.34%	0.16%

[1] NE 20th Ave is 472 feet east of NE 22nd Ave

[2] NE Cully Blvd is 0.20 miles east of NE 64th Ave

Table 5.18: *t*-test Results at Spot Speed Locations on NE Killingsworth St Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
West of NE 22nd Ave and East of NE 20th Ave	0.000	0.191	Negligible	0.000	0.191	Negligible
East of NE 64th Ave and East of NE Cully Blvd	0.000	1.831	Large	0.000	1.833	Large

[a] Independent two-sample t-test

[b] Paired two-sample t-test

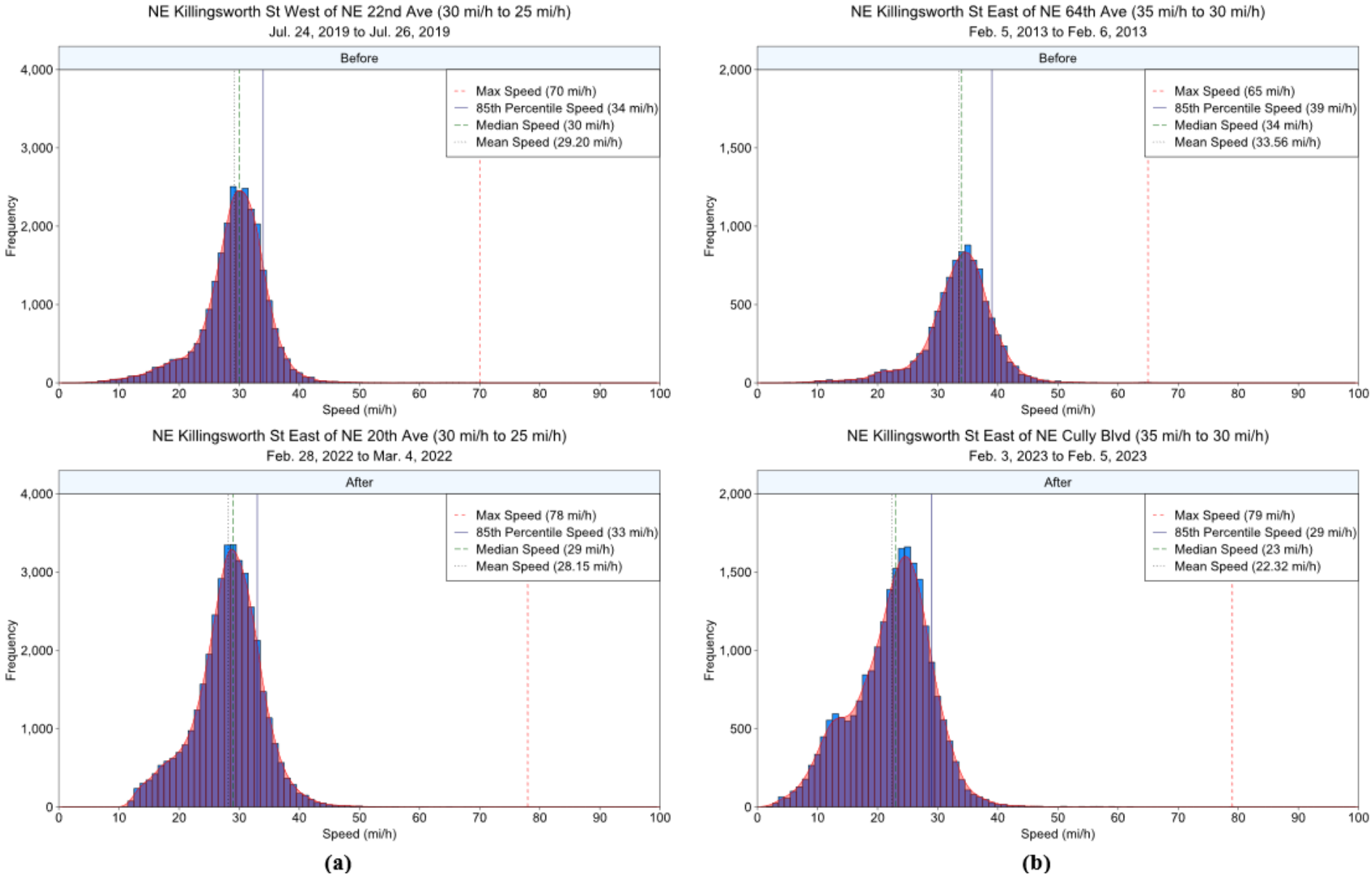


Figure 5.33: Speed Distribution at (a) West of NE 22nd Ave and East of NE 20th Ave, and (b) East of NE 64th Ave and East of NE Cully Blvd on NE Killingsworth St Speed Zone

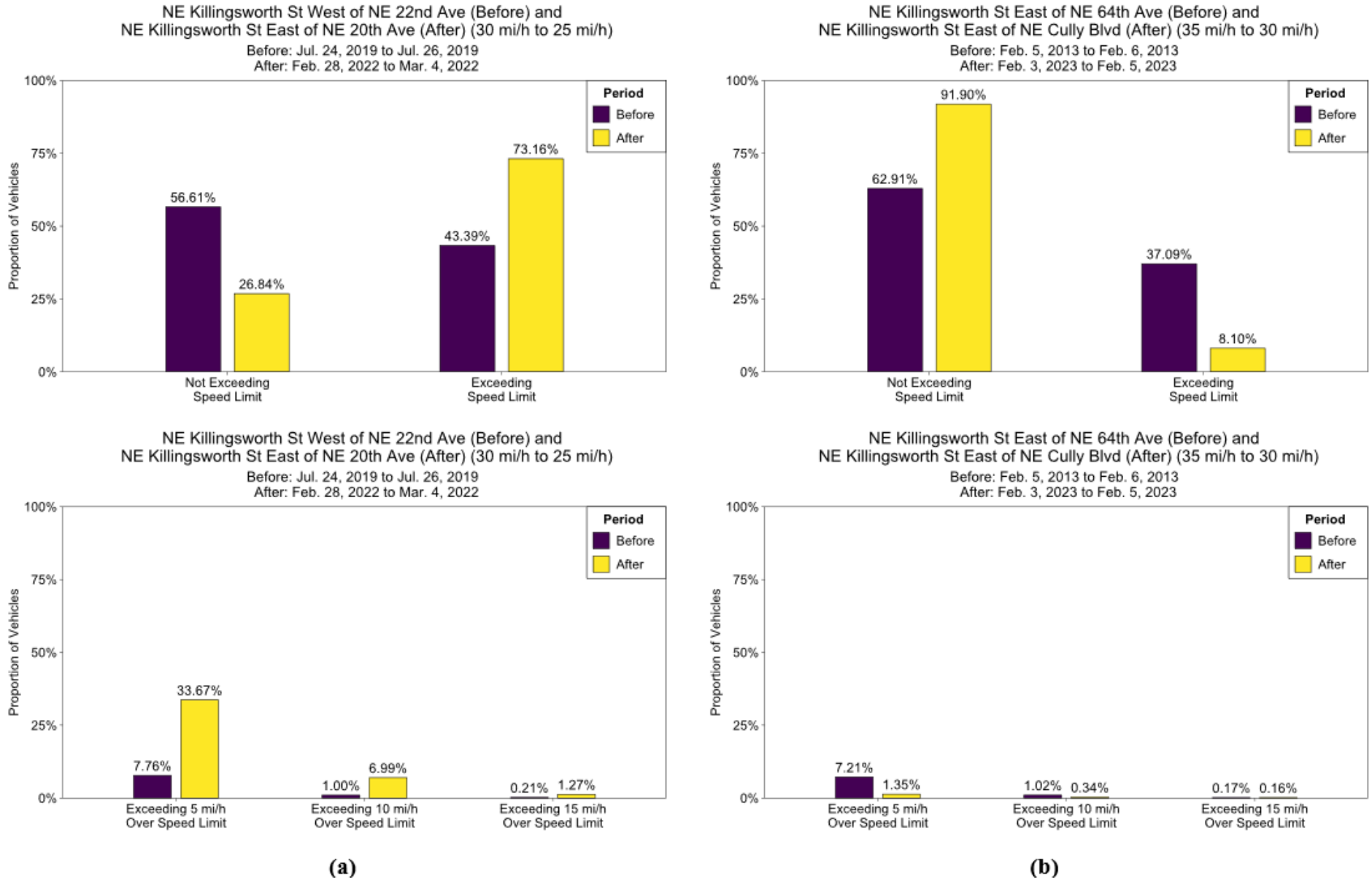


Figure 5.34: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) West of NE 22nd Ave and East of NE 20th Ave, and (b) East of NE 64th Ave and East of NE Cully Blvd on NE Killingsworth St Speed Zone

5.1.7 NW Front Ave/NW Naito Pkwy

Spot speed data was obtained to make for two comparisons on the NW Front Ave/NW Naito Pwky speed zone. This speed zone has a single reduction of 35 mi/h to 30 mi/h. In this speed zone, there was one location with multiple before collection periods (West of NW 9th Ave). For locations with multiple before collection periods, all before data is compared to the after data and each set of before data are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.19 and Figure 5.35. Descriptive statistics and statistical test results are shown in Table 5.20 and Table 5.21Table 5.6. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.36 to Figure 5.37. For disaggregated speed distribution plots and figures of proportion of vehicles exceeding speed thresholds, refer to Figure A.19 to Figure A.24 in Appendix A.

At the West of 19th Ave location, mean speed remained essentially the same, as did median speed and 85th percentile speed. With mean speed in the after condition being near the previous posted speed limit, there were substantial increases in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit.

At the West of NW 9th Ave location, decreases in mean, median, and 85th percentile speed were observed for both the aggregate and disaggregate comparisons. At this location, mean speed in the after condition is closer to the new posted speed limit, which results in smaller proportions of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit; however, the proportions are still greater in the after condition.

This speed zone had the only comparison between mean speeds that was insignificant, where this occurred at the West of NW 19th Ave location. All other differences were highly significant with effect sizes ranging from negligible to moderate. All moderate effect sizes were based on the disaggregate comparison, while the aggregate comparison had a small effect size.

Table 5.19: Data Collection Periods on NW Front Ave/NW Naito Pkwy Speed Zone

Location	Before Data	Sign Installed	After Data
West of NW 19th Ave	Mar. 7, 2017 to Mar. 9, 2017	Sep. 8, 2020	Sep. 27, 2023 to Sep. 29, 2023
West of NW 9th Ave	Dec. 1, 2016 to Dec. 2, 2016	Sep. 8, 2020	
	Mar. 15, 2017 to Mar. 17, 2017		Sep. 27, 2023 to Sep. 29, 2023
	Mar. 7, 2017 to Mar. 9, 2017		Oct. 4, 2023 to Oct. 6, 2023
	Apr. 12, 2017 to Apr. 14, 2017		

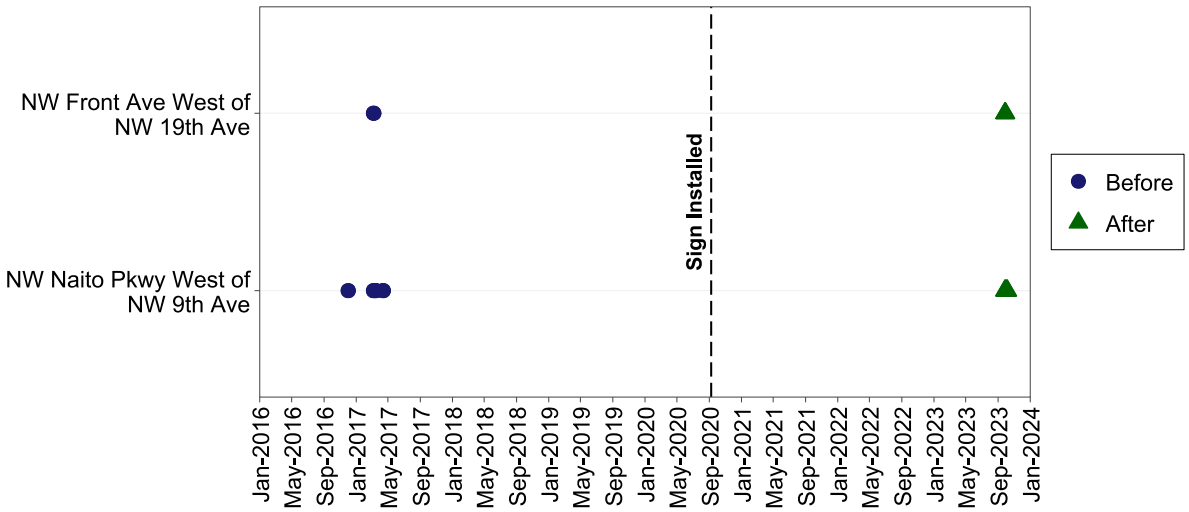


Figure 5.35: Data Collection and Sign Installation Timeline for NW Front Ave/NW Naito Pkwy Speed Zone

Table 5.20: NW Front Ave/NW Naito Pkwy Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
West of NW 19th Ave	Before	14,096	36.12	36	42	80	55.55%	20.92%	4.40%	0.81%
	After	9,712	36.15	36	42	78	84.41%	54.68%	22.60%	6.48%
West of NW 9th Ave	Before	46,654	33.35	34	39	88	36.38%	9.33%	1.69%	0.32%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%
West of NW 9th Ave (Dec. 2016 Before Data)	Before	18,213	33.75	34	39	74	38.02%	9.30%	1.65%	0.25%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%
West of NW 9th Ave (Mar. 2017 Before Data)[1]	Before	7,185	35.27	35	41	69	49.05%	16.81%	3.37%	0.64%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%
West of NW 9th Ave (Mar. 2017 Before Data)[2]	Before	10,832	30.73	32	37	88	23.97%	5.75%	1.02%	0.22%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%
West of NW 9th Ave (All Mar. 2017 Before Data)[3]	Before	18,017	32.54	33	39	88	33.97%	10.16%	1.96%	0.39%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%
West of NW 9th Ave (Apr. 2017 Before Data)	Before	10,424	34.05	34	39	63	37.68%	7.95%	1.31%	0.32%
	After	20,041	30.55	31	36	80	56.95%	18.42%	3.54%	0.76%

[1] Mar. 7, 2017 to Mar. 9, 2017

[2] Mar. 15, 2017 to Mar. 17, 2017

[3] Mar. 7, 2017 to Mar. 9, 2017 and Mar. 15, 2017 to Mar. 17, 2017 (all Mar. 2017 before data)

Table 5.21: t-test Results at Spot Speed Locations on NW Front Ave/NW Naito Pkwy Speed Zone

Location	p-value[a]	Cohen's d[a]	Magnitude[a]	p-value[b]	Cohen's d[b]	Magnitude[b]
West of NW 19th Ave	0.678	-0.006	Negligible	0.733	-0.005	Negligible
West of NW 9th Ave	0.000	0.435	Small	0.000	0.436	Small
West of NW 9th Ave (Dec. 2016 Before Data)	0.000	0.511	Moderate	0.000	0.509	Moderate
West of NW 9th Ave (Mar. 2017 Before Data)	0.000	0.761	Moderate	0.000	0.760	Moderate
West of NW 9th Ave (Mar. 2017 Before Data)	0.039	0.025	Negligible	0.104	0.022	Negligible
West of NW 9th Ave (All Mar. 2017 Before Data)	0.000	0.290	Small	0.000	0.290	Small
West of NW 9th Ave (Apr. 2017 Before Data)	0.000	0.595	Moderate	0.000	0.599	Moderate

[a] Independent two-sample t-test

[b] Paired two-sample t-test

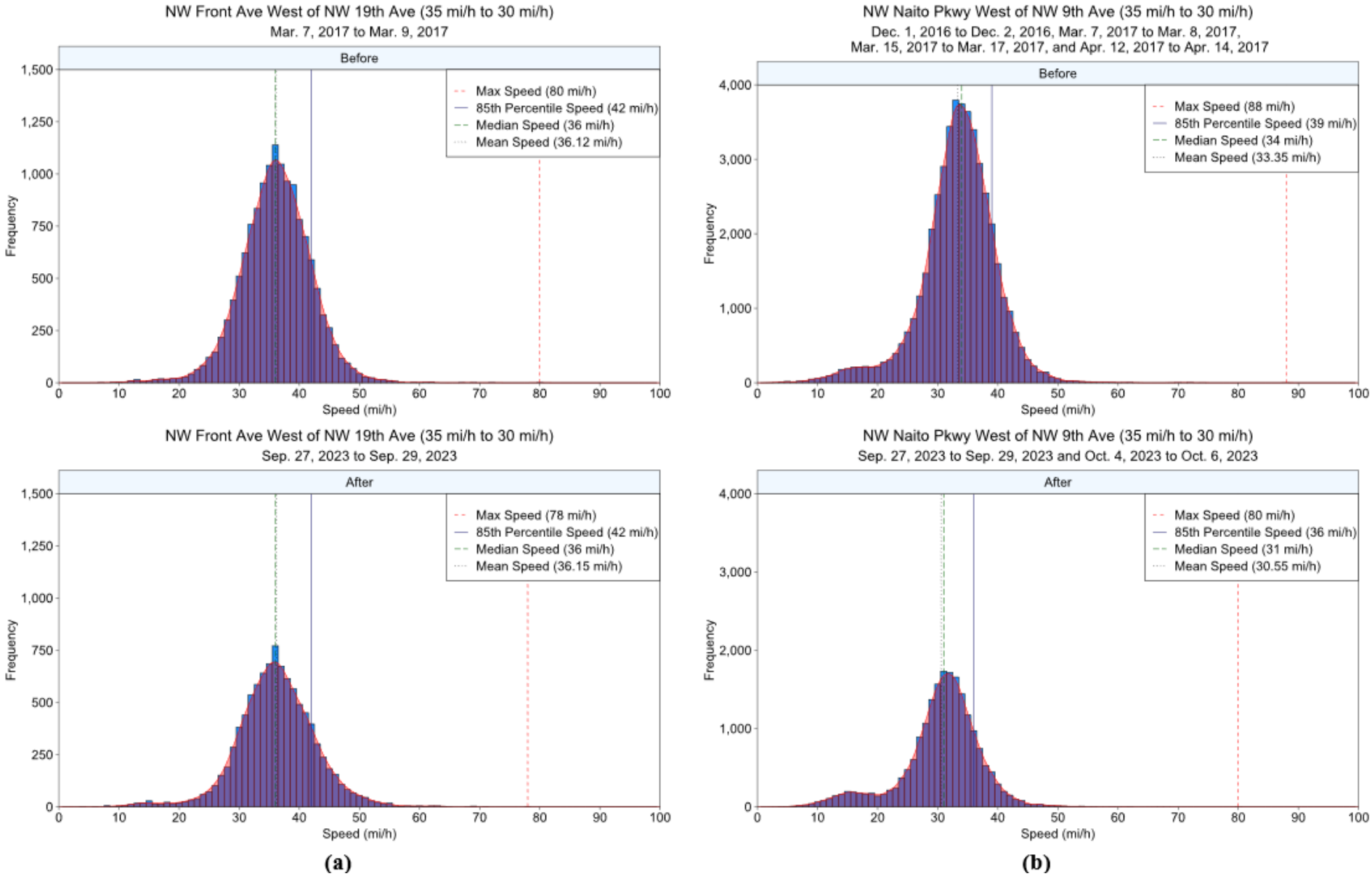


Figure 5.36: Speed Distribution at (a) West of NW 19th Ave and (b) West of NW 9th Ave on NW Front Ave/NW Naito Pwky Speed Zone

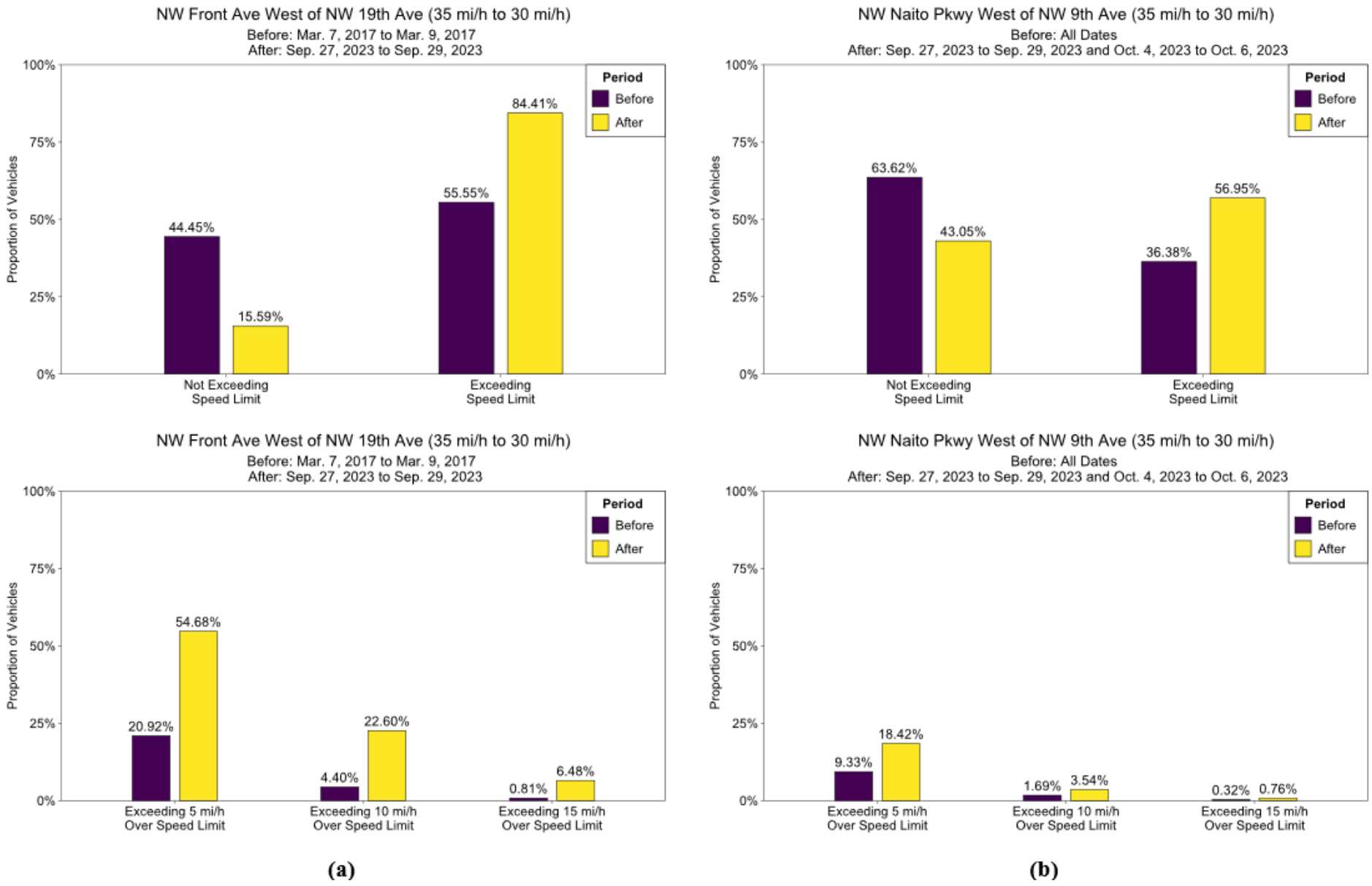


Figure 5.37: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) West of NW 19th Ave and (b) West of NW 9th Ave on NW Front Ave/NW Naito Pwky Speed Zone

5.1.8 SE 52nd Ave

Spot speed data was obtained to make for three comparisons on the SE 52nd Ave speed zone. This speed zone has a single reduction of 30 mi/h to 25 mi/h. In this speed zone, there was one spot speed location that was compared to nearby spot speed measurement (as discussed in Chapter 3.0). Data collection and sign installation dates are shown in Table 5.22 and Figure 5.38. Descriptive statistics and statistical test results are shown in and Table 5.24. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.39 to Figure 5.42.

All locations experienced a decrease in mean speed, median speed, and 85th percentile speed. The largest differences were observed at the North of SE Malden Dr/SE Malden St locations, which are separated by 0.20 miles. Despite decreases in mean, median, and 85th percentile speed at the North of SE Tolman St and North of SE Knapp St locations, there were increases in the proportion of vehicles speeding and the proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit. The North of SE Knapp St experienced higher proportions exceeding these thresholds in the after condition, with over 80% exceeding the speed limit, over 40% exceeding 5 mi/h over the speed limit, over 9% exceeding 10 mi/h over the speed limit, and approximately 1.5% exceeding 15 mi/h over the speed limit. The North of SE Malden Dr/SE Malden St comparisons resulted in decreases in the proportion of vehicles speeding and the proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit.

All differences in mean speed were highly significant, where the largest effect size was at the North of SE Malden Dr/SE Malden St, which indicated the mean speed in the before condition was 1.794 (1.797 for paired) standard deviations greater than mean speed in the after condition. Effect sizes for the other two locations were moderate and small.

Table 5.22: Data Collection Periods on SE 52nd Ave Speed Zone

Location	Before Data	Sign Installed	After Data
North of SE Tolman St	Nov. 27, 2012 to Nov. 28, 2012	Sep. 2, 2020	Dec. 6, 2021 to Dec. 7, 2021
North of SE Knapp St	Dec. 2, 2019 to Dec. 4, 2019	Sep. 2, 2020	Sep. 19, 2023 to Sep. 22, 2023
North of SE Malden St	NA	Sep. 2, 2020	Oct. 17, 2023 to Oct. 20, 2023
North of SE Malden Dr	Apr. 2, 2019 to Apr. 4, 2019	Sep. 2, 2020	NA

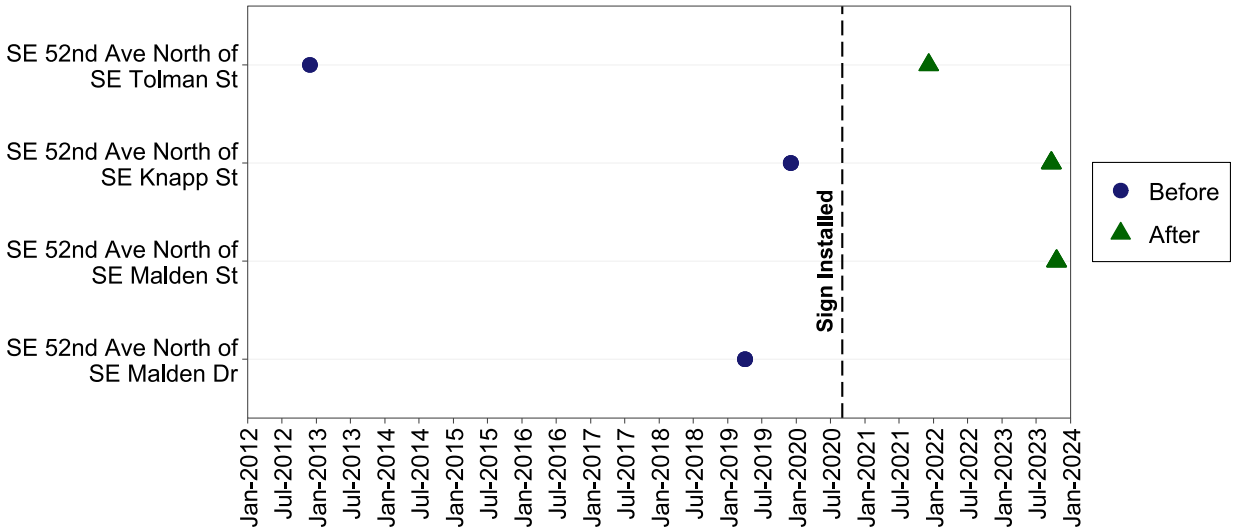


Figure 5.38: Data Collection and Sign Installation Timeline for SE 52nd Ave Speed Zone

Table 5.23: SE 52nd Ave Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
North of SE Tolman St	Before	13,504	29.61	30	34	54	43.15%	8.22%	1.10%	0.13%
	After	12,458	26.65	27	31	50	62.45%	15.98%	2.16%	0.32%
North of SE Knapp St	Before	20,724	31.58	32	36	76	60.50%	19.37%	3.31%	0.54%
	After	29,090	29.49	30	34	65	82.45%	44.10%	9.24%	1.53%
North of SE Malden Dr/Malden St[1]	Before	11,528	34.99	35	41	92	77.66%	45.90%	18.61%	4.99%
	After	23,711	23.34	24	30	60	37.38%	12.89%	2.05%	0.32%

[1] SE Malden Dr is 0.20 miles south of SE Malden St

Table 5.24: *t*-test Results at Spot Speed Locations on SE 52nd Ave Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
North of SE Tolman St	0.000	0.651	Moderate	0.000	0.653	Moderate
North of SE Knapp St	0.000	0.405	Small	0.000	0.407	Small
North of SE Malden Dr/Malden St	0.000	1.794	Large	0.000	1.797	Large

[a] Independent two-sample t-test

[b] Paired two-sample t-test

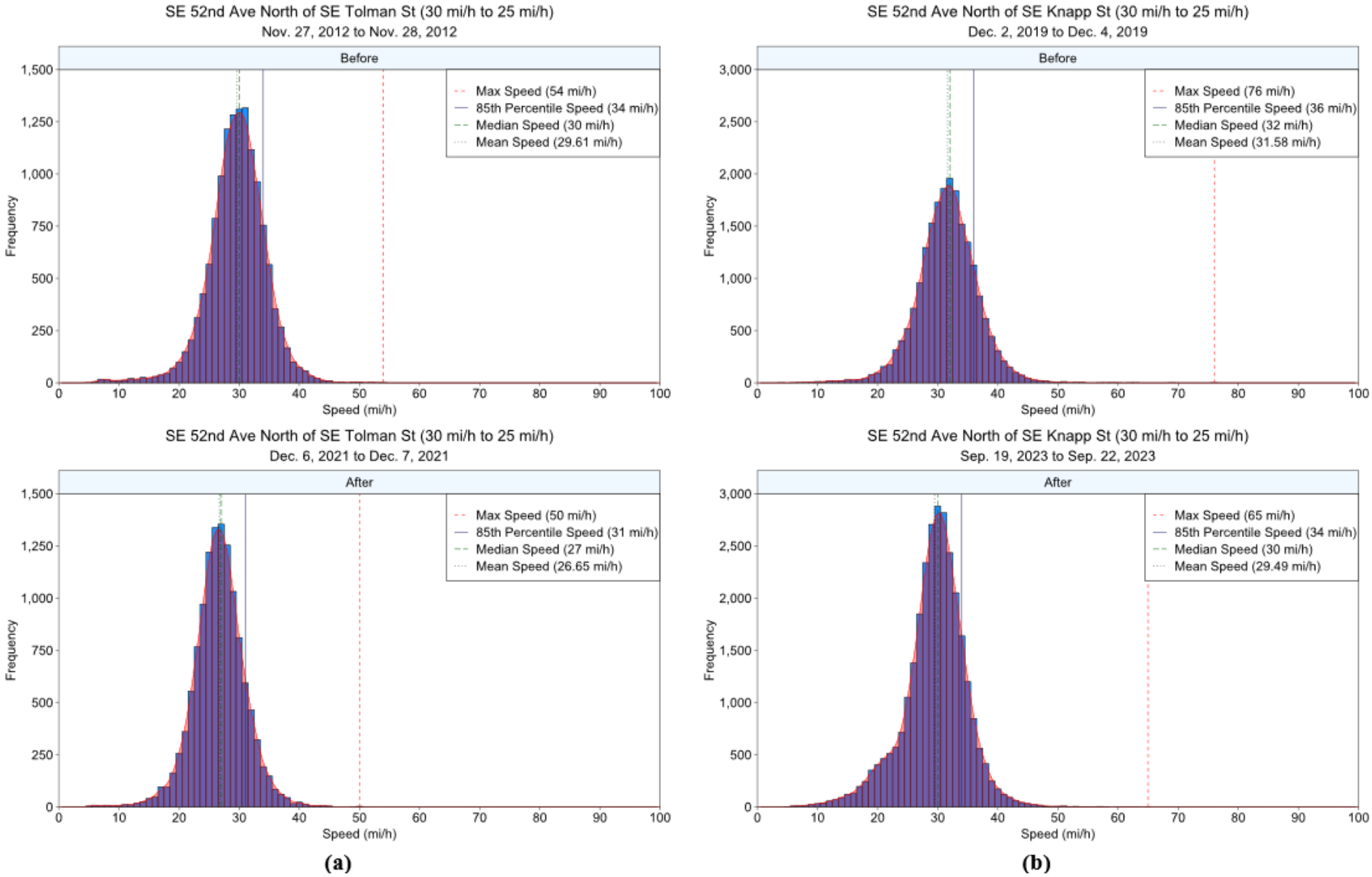


Figure 5.39: Speed Distribution at (a) North of SE Tolman St and (b) North of SE Knapp St on SE 52nd Ave Speed Zone

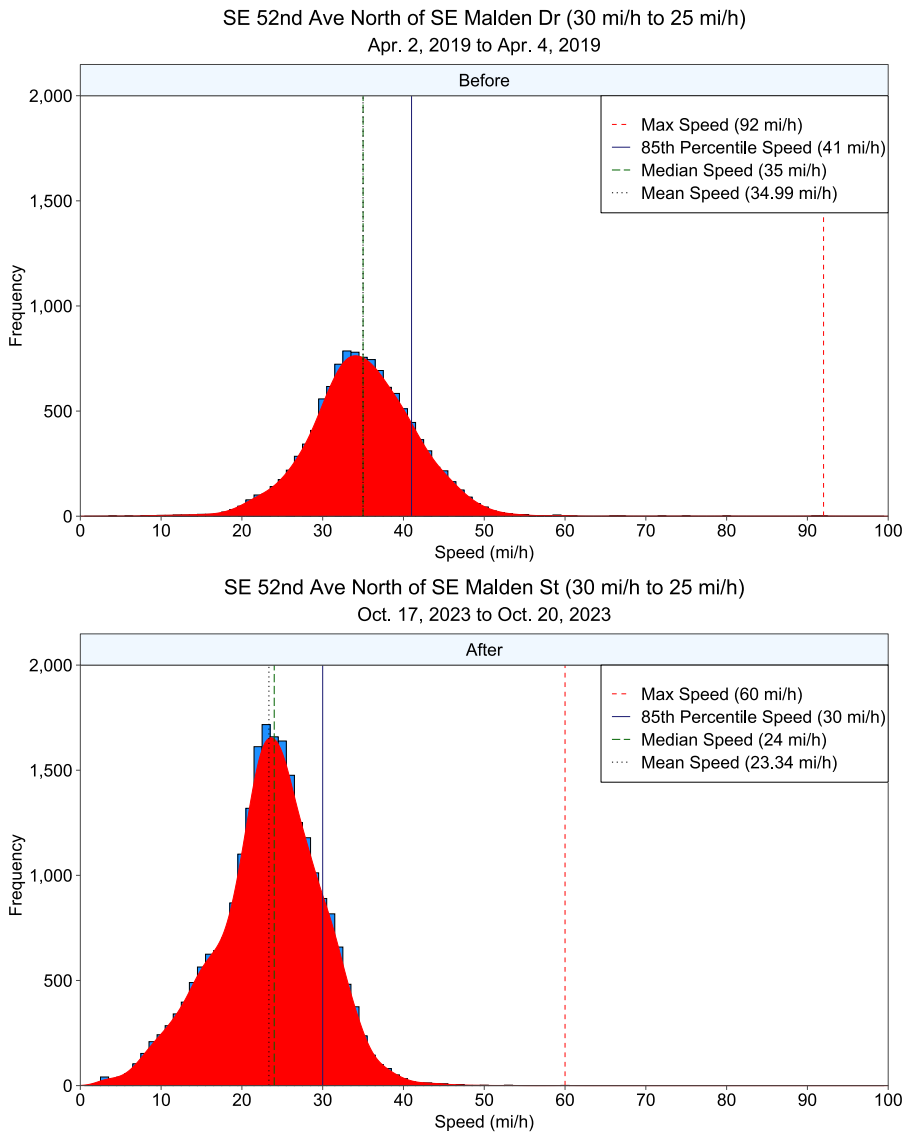


Figure 5.40: Speed Distribution at North of SE Malden Dr and North of SE Malden St on SE 52nd Ave Speed Zone

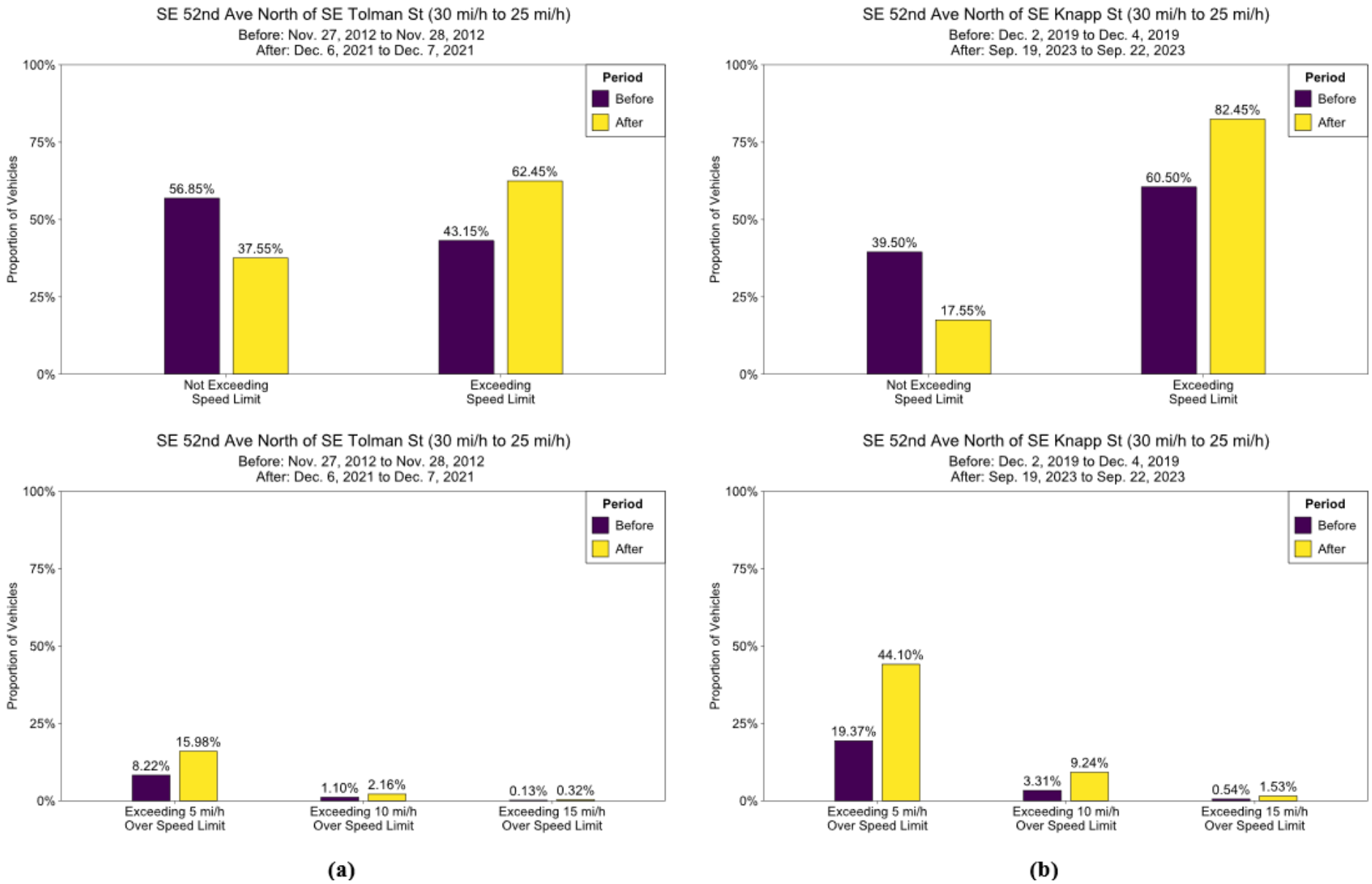


Figure 5.41: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) North of SE Tolman St and (b) North of SE Knapp St on SE 52nd Ave Speed Zone

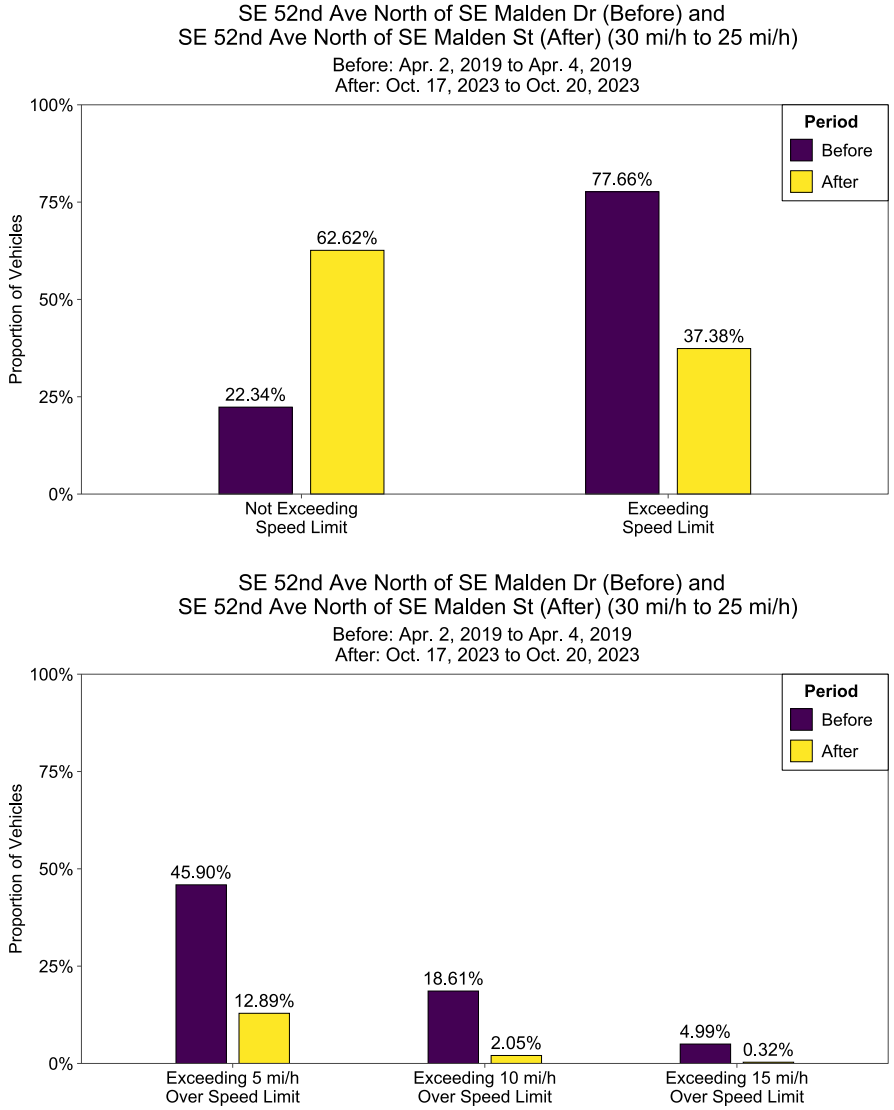


Figure 5.42: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at North of SE Malden Dr and North of SE Malden St on SE 52nd Ave Speed Zone

5.1.9 SE Powell Blvd

Spot speed data was obtained to make for four comparisons on the SE Powell Blvd speed zone. This speed zone has a single reduction of 35 mi/h to 30 mi/h. In this speed zone, there were spot speed locations that were compared to nearby spot speed measurements (as discussed in Chapter 3.0). Data collection and sign installation dates are shown in Table 5.25 and Figure 5.43. Descriptive statistics and statistical test results are shown in and Table 5.27. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.44 to Figure 5.47.

On this speed zone, two locations experienced a decrease in mean, mean, and 85th percentile speed, while two locations experienced an increase in mean, median, and 85th percentile speed. The two locations with decreases were West of SE 108th Ave and West of SE 130th Ave, but despite decreases in these speed measures, both locations had an increase in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit. The two locations with increases were East of SE 78th Ave, and East of SE 79th Ave and East of SE 79th Ave (separated by 249 ft), where both locations also had an increase in the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit. For three locations, the proportion of vehicles speeding in the after condition was approximately 75%, with the fourth having a proportion of vehicles speeding at over 65%.

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes were negligible or small.

Table 5.25: Data Collection Periods on SE Powell Blvd Speed Zone

Location	Before Data	Sign Installed	After Data
East of SE 78th Ave	Apr. 22, 2019 to Apr. 25, 2019	Nov. 30, 2021	Sep. 25, 2023 to Sep. 27, 2023
East of SE 79th Ave	Oct. 11, 2018 to Oct. 12, 2018	Nov. 30, 2021	NA
West of SE 108th Ave	Feb. 6, 2017 to Feb. 8, 2017	Nov. 30, 2021	Oct. 2, 2023 to Oct. 6, 2023
West of SE 130th Ave	Oct. 3, 2013 to Oct. 4, 2013	Nov. 30, 2021	Oct. 31, 2023 to Nov. 3, 2023

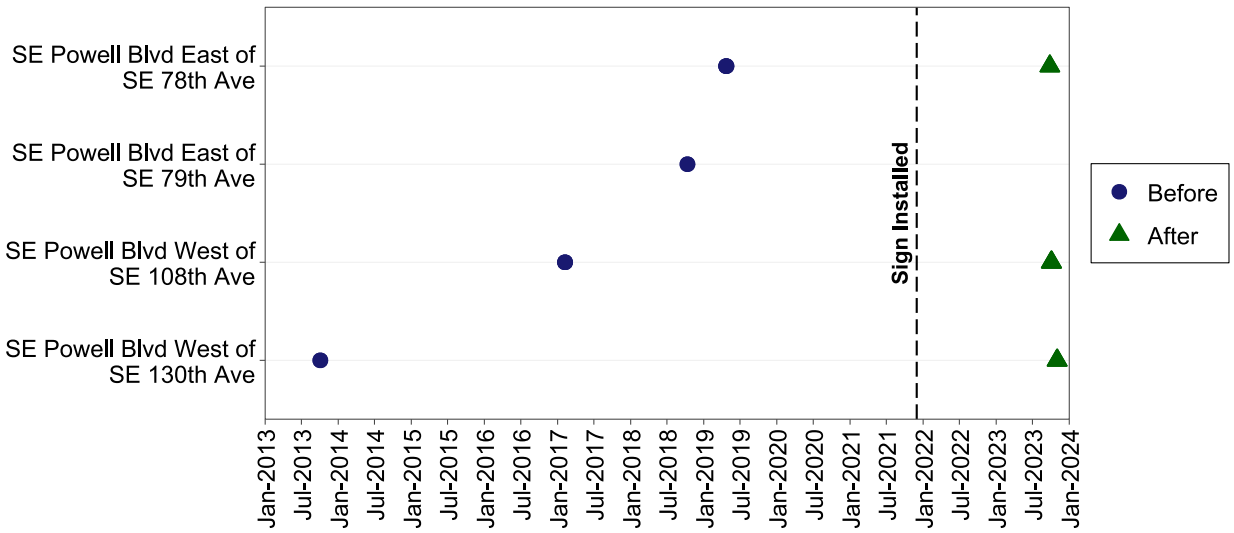


Figure 5.43: Data Collection and Sign Installation Timeline for SE Powell Blvd Speed Zone

Table 5.26: SE Powell Blvd Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
East of SE 78th Ave	Before	83,793	32.78	33	38	82	31.77%	6.84%	1.21%	0.23%
	After	63,029	33.55	34	39	81	74.08%	33.59%	9.01%	2.08%
East of SE 79th Ave and East of SE 78th Ave[1]	Before	27,433	32.16	33	38	65	27.68%	5.20%	0.75%	0.15%
	After	63,029	33.55	34	39	81	74.08%	33.59%	9.01%	2.08%
West of SE 108th Ave	Before	36,009	34.61	35	40	67	44.04%	11.48%	1.79%	0.27%
	After	76,784	33.33	33	38	96	75.35%	31.70%	6.37%	0.98%
West of SE 130th Ave	Before	18,652	33.96	34	40	66	41.86%	11.32%	1.70%	0.25%
	After	56,857	31.64	32	37	76	65.13%	23.78%	4.55%	0.89%

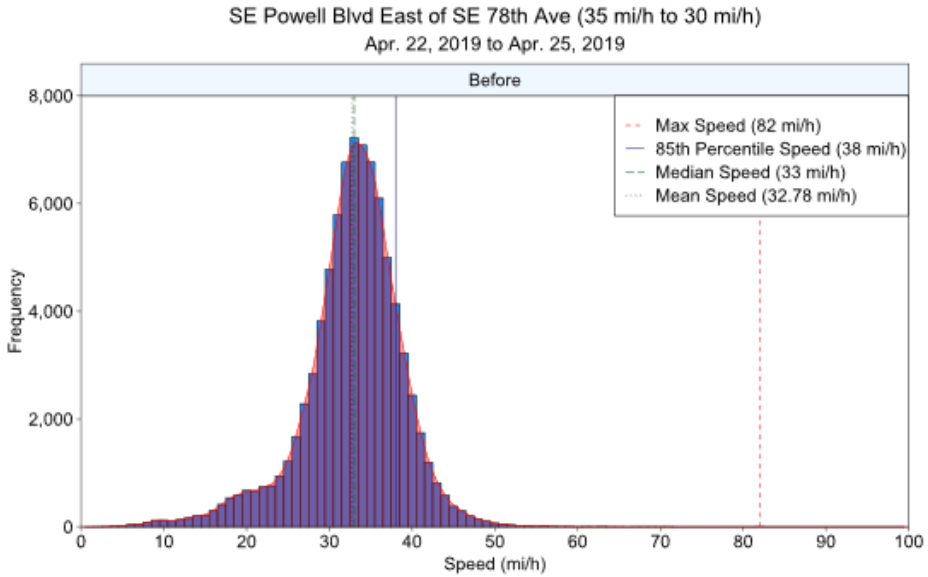
[1] SE 79th Ave is 249 feet east of SE 78th Ave

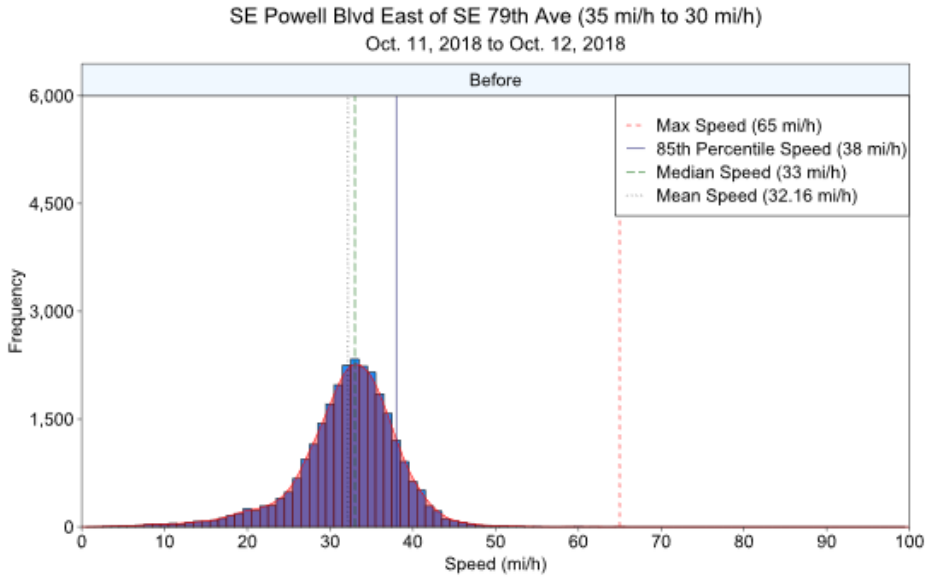
Table 5.27: *t*-test Results at Spot Speed Locations on SE Powell Blvd Speed Zone

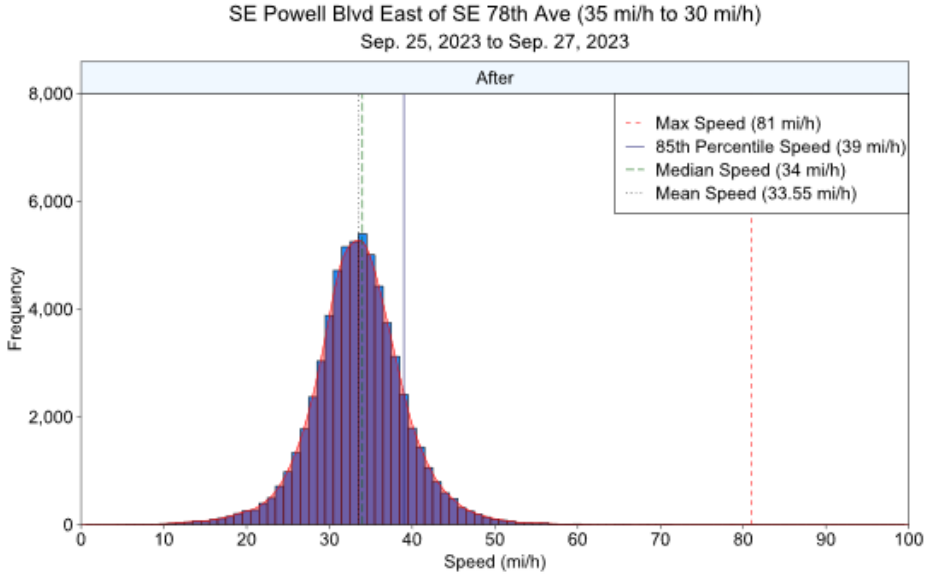
Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
East of SE 78th Ave	0.000	-0.132	Negligible	0.000	-0.134	Negligible
East of SE 79th Ave and East of SE 78th Ave	0.000	-0.239	Small	0.000	-0.244	Small
West of SE 108th Ave	0.000	0.243	Small	0.000	0.242	Small
West of SE 130th Ave	0.000	0.377	Small	0.000	0.373	Small

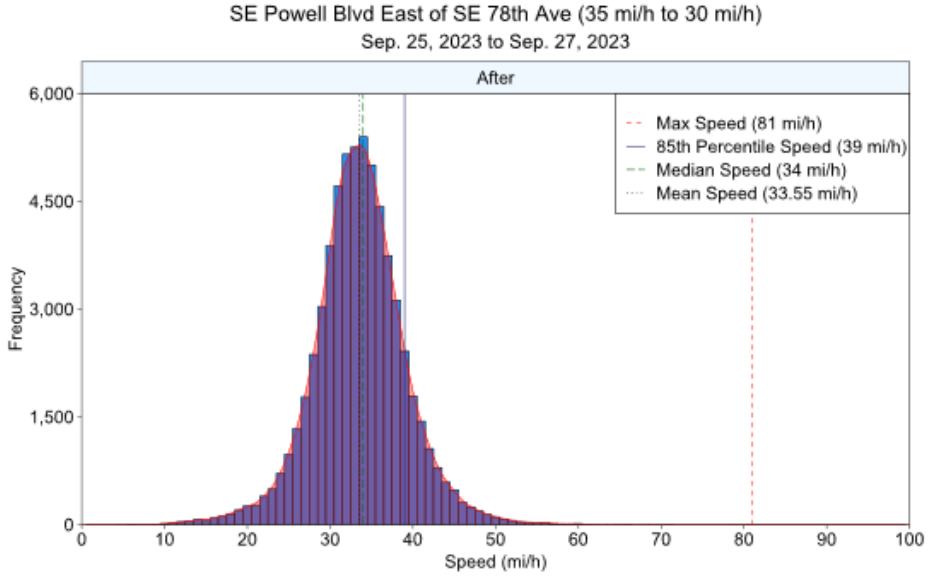
[a] Independent two-sample t-test

[b] Paired two-sample t-test









(a) **(b)**

Figure 5.44: Speed Distribution at (a) East of SE 78th Ave and (b) East of SE 79th Ave and East of SE 78th Ave on SE Powell Blvd Speed Zone

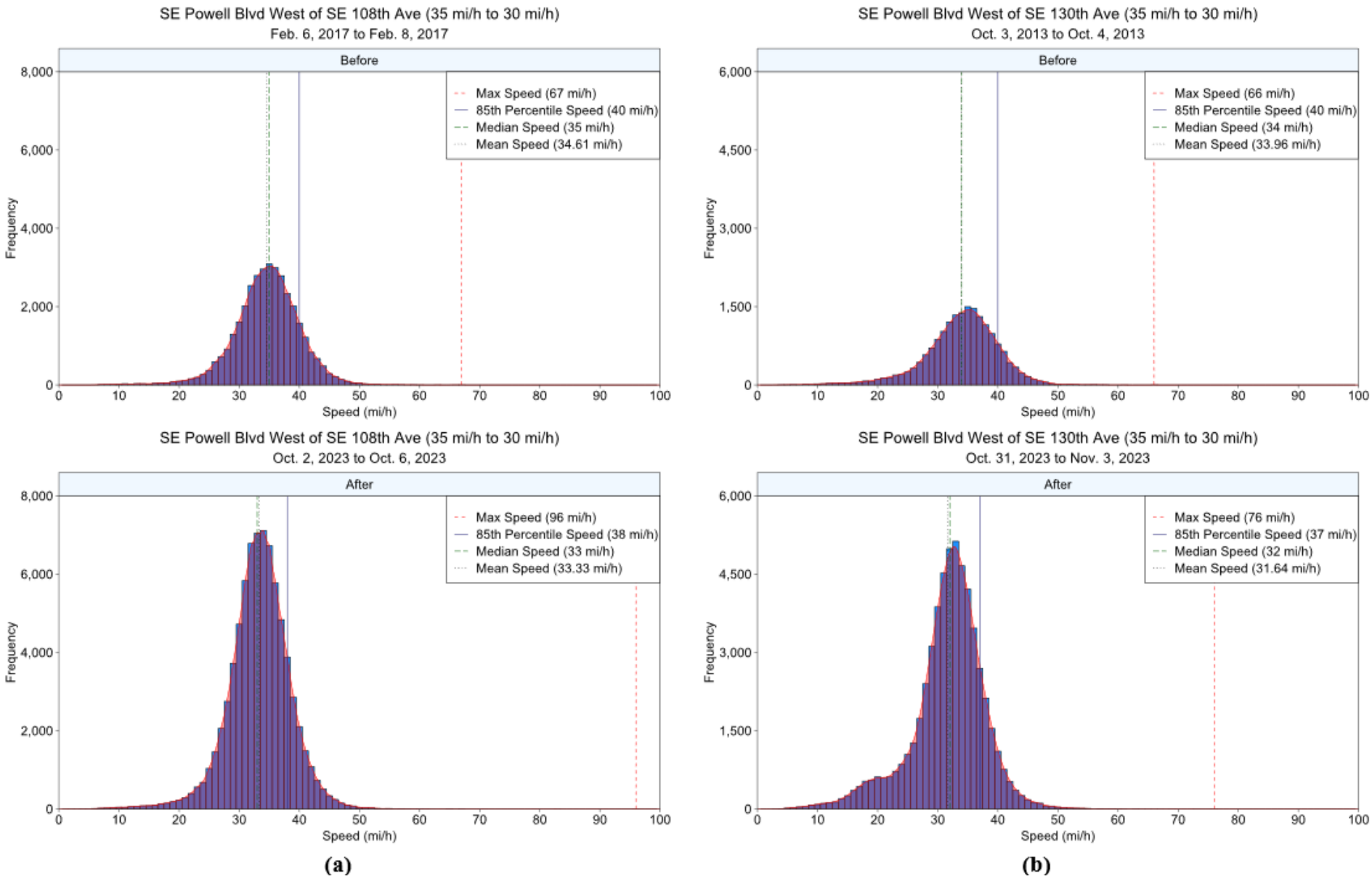


Figure 5.45: Speed Distribution at (a) West of SE 108th Ave and (b) West of SE 130th Ave on SE Powell Blvd Speed Zone

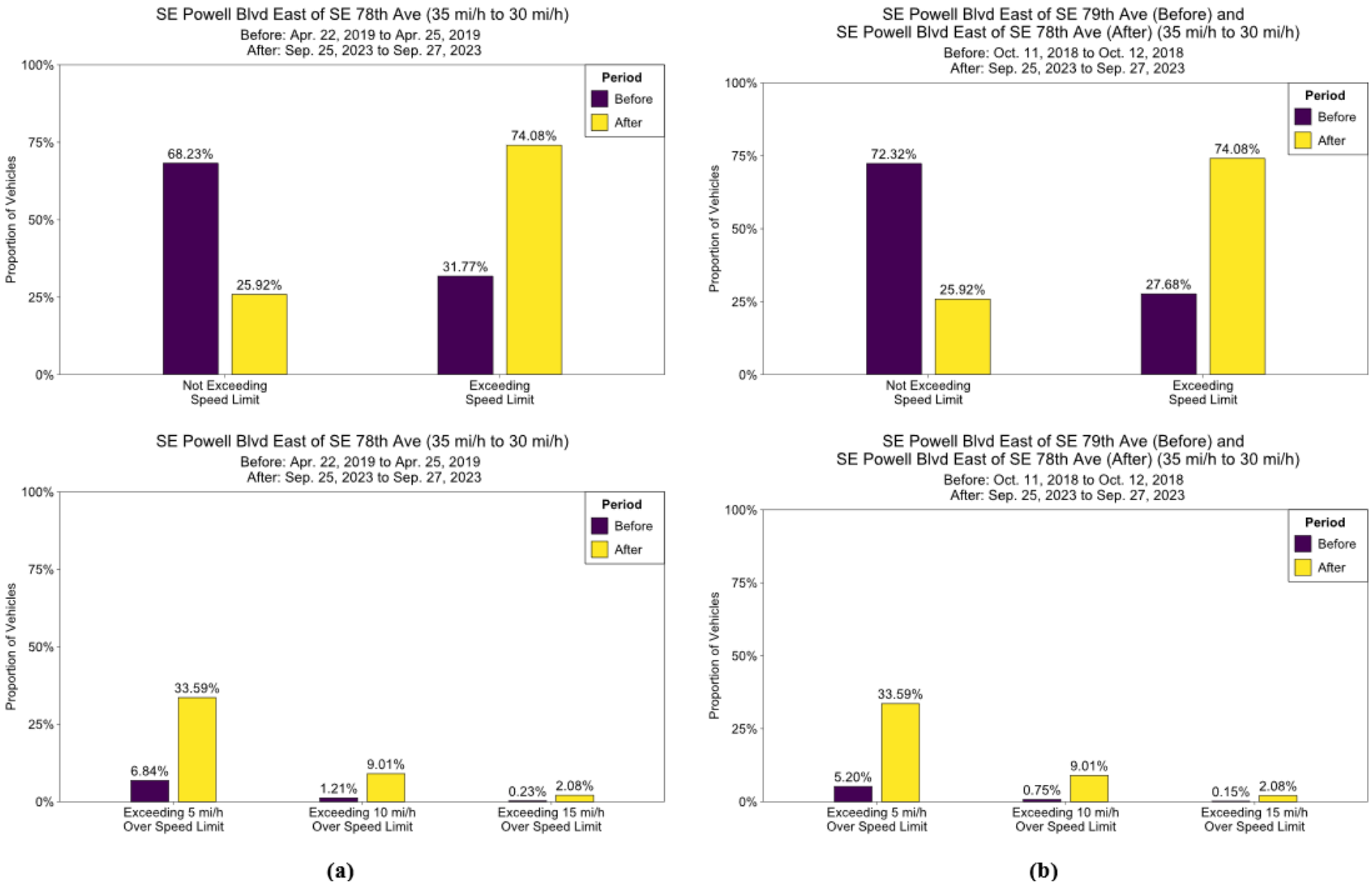


Figure 5.46: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) East of SE 78th Ave and (b) East of SE 79th Ave and East of SE 78th Ave on SE Powell Blvd Speed Zone

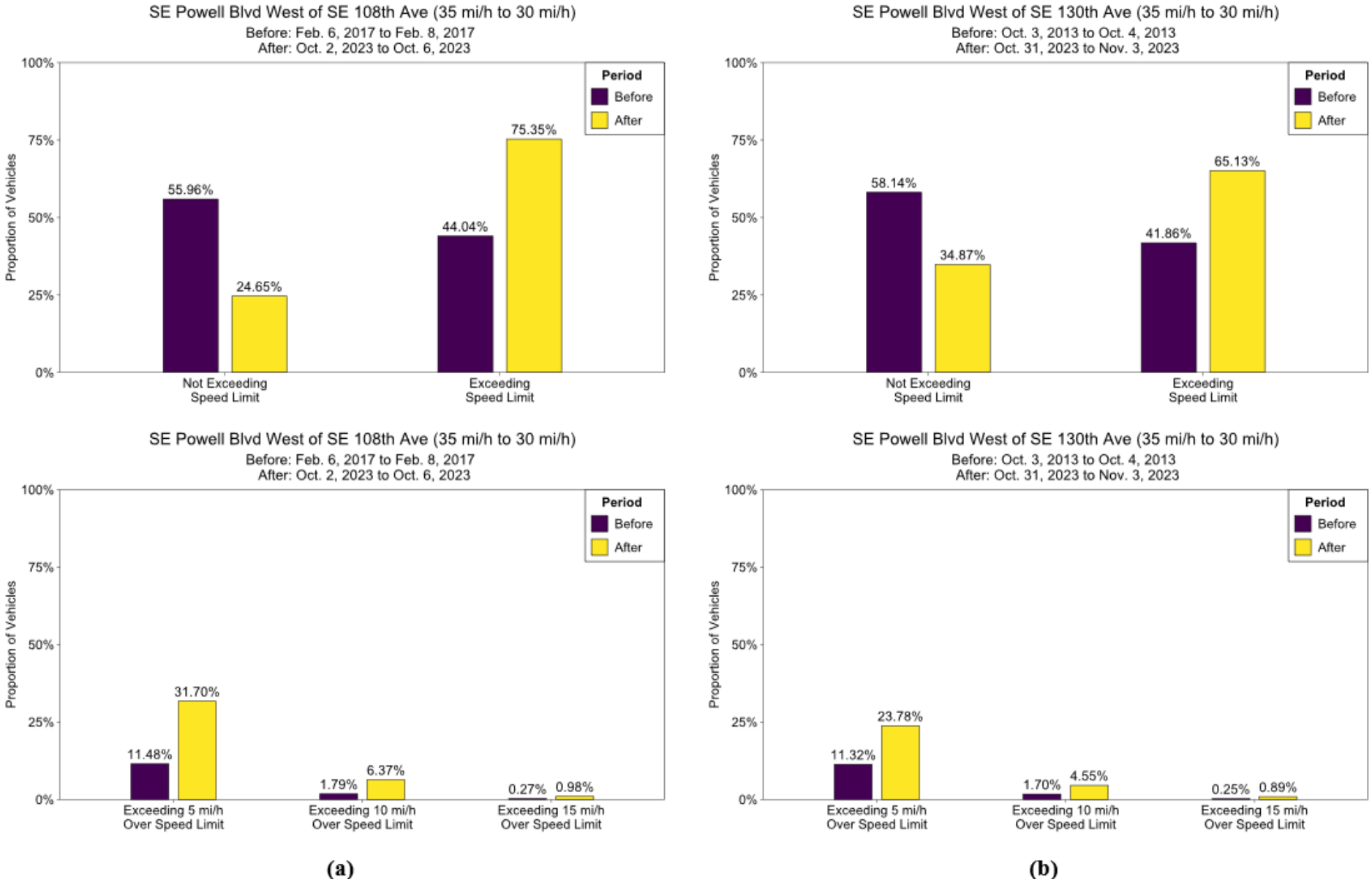


Figure 5.47: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) West of SE 108th Ave and (b) West of SE 130th Ave on SE Powell Blvd Speed Zone

5.1.10 SW Capitol Hwy/SW 49th Ave

Spot speed data was obtained to make for two comparisons on the SW Capitol Hwy/SW 49th Ave speed zone. This speed zone has one reduction segment of 35 mi/h to 30 mi/h. In this speed zone, both locations had multiple before collection periods. For locations with multiple before collection periods, all before data is compared to the after data and each set of before data are compared independently with the after data. Data collection and sign installation dates are shown in Table 5.28 and Figure 5.48. Descriptive statistics and statistical test results are shown in Table 5.29 and Table 5.30. Speed distribution and proportion of vehicles exceeding speed thresholds are shown in Figure 5.49 and Figure 5.50. For disaggregated speed distribution plots and figures of proportion of vehicles exceeding speed thresholds, refer to Figure A.25 to Figure A.30 in Appendix A.

Both locations experienced a decrease or no change in mean, median, and 85th percentile speed for both the aggregate and disaggregate comparisons. Once more, despite the decreases in these speed measures, the proportion of vehicles speeding and proportion of vehicles greater than 5 mi/h, 10 mi/h, and 15mi/h over the speed limit increased. Similar to most speed zones assessed in this study, despite mean, median, and 85th percentile speed decreases, all these measures are still above the new posted speed limit.

The difference in mean speeds for each comparison were highly significant and the estimated effect sizes ranged from negligible to moderate.

Table 5.28: Data Collection Periods on SW Capitol Hwy/SW 49th Ave Speed Zone

Location	Before Data	Sign Installed	After Data
North of SW Dickinson St	Jan. 23, 2020 to Jan. 24, 2020	Apr. 13, 2021	Oct. 25, 2023 to Oct. 27, 2023
	Apr. 4, 2018 to Apr. 10, 2018		
North of SW Vacuna St	Jan., 21, 2020 to Jan. 22, 2020	Apr. 13, 2021	Oct. 25, 2023 to Oct. 27, 2023
	Apr. 23, 2018 to Apr. 25, 2018		
	Apr. 4, 2018 to Apr. 8, 2018		
	May 2, 2018 to May 4, 2018		

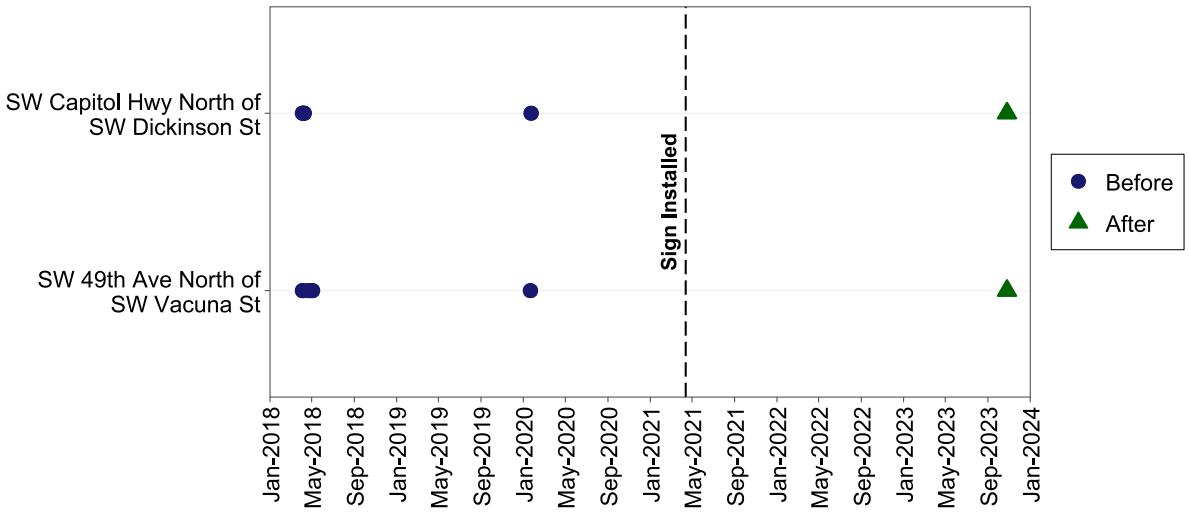


Figure 5.48: Data Collection and Sign Installation Timeline for SW Capitol Hwy/SW 49th Ave Speed Zone

Table 5.29: SW Capitol Hwy/SW 49th Ave Speed Zone Spot Speed (mi/h) Descriptive Statistics

Location	Period	Observations	Mean	Median	85th Percentile	Max	Percent Speeding	Proportion Greater than 5 mi/h	Proportion Greater than 10 mi/h	Proportion Greater than 15 mi/h
North of SW Dickinson St	Before	88,709	35.89	37	42	94	58.35%	21.25%	4.29%	0.70%
	After	24,336	33.40	34	39	65	74.71%	37.63%	8.45%	1.30%
North of SW Dickinson St (Apr. 2018 Before Data)	Before	75,416	36.38	37	42	94	62.22%	23.66%	4.85%	0.80%
	After	24,336	33.40	34	39	65	74.71%	37.63%	8.45%	1.30%
North of SW Dickinson St (Jan. 2020 Before Data)	Before	13,293	33.09	34	39	74	36.41%	7.63%	1.08%	0.18%
	After	24,336	33.40	34	39	65	74.71%	37.63%	8.45%	1.30%
North of SW Vacuna St	Before	56,425	36.78	37	43	99	59.55%	25.74%	7.95%	2.43%
	After	21,539	33.62	34	38	77	76.70%	35.56%	7.14%	1.07%
North of SW Vacuna St (Apr. 2018 Before Data)[1]	Before	19,729	37.48	37	44	99	64.03%	29.06%	10.25%	3.52%
	After	21,539	33.62	34	38	77	76.70%	35.56%	7.14%	1.07%
North of SW Vacuna St (Apr. 2018 Before Data)[2]	Before	11,835	37.14	37	43	75	66.38%	27.01%	6.68%	1.52%
	After	21,539	33.62	34	38	77	76.70%	35.56%	7.14%	1.07%
North of SW Vacuna St (May 2018 Before Data)	Before	11,014	38.60	39	45	96	71.61%	37.21%	12.87%	4.18%
	After	21,539	33.62	34	38	77	76.70%	35.56%	7.14%	1.07%
North of SW Vacuna St (Jan. 2020 Before Data)	Before	13,846	34.02	34	39	63	37.76%	10.81%	1.86%	0.27%
	After	21,539	33.62	34	38	77	76.70%	35.56%	7.14%	1.07%

[1] Apr. 4, 2018 to Apr. 6, 2018

[2] Apr. 23, 2018 to Apr. 25, 2018

Table 5.30: *t*-test Results at Spot Speed Locations on SW Capitol Hwy/SW 49th Ave Speed Zone

Location	*p*-value[a]	Cohen's *d*[a]	Magnitude[a]	*p*-value[b]	Cohen's *d*[b]	Magnitude[b]
North of SW Dickinson St	0.000	0.402	Small	0.000	0.400	Small
North of SW Dickinson St (Apr. 2018 Before Data)	0.000	0.486	Small	0.000	0.476	Small
North of SW Dickinson St (Jan. 2020 Before Data)	0.000	-0.052	Negligible	0.000	-0.054	Negligible
North of SW Vacuna St	0.000	0.524	Moderate	0.000	0.525	Moderate
North of SW Vacuna St (Apr. 2018 Before Data)	0.000	0.627	Moderate	0.000	0.626	Moderate
North of SW Vacuna St (Apr. 2018 Before Data)	0.000	0.611	Moderate	0.000	0.619	Moderate
North of SW Vacuna St (May 2018 Before Data)	0.000	0.793	Moderate	0.000	0.791	Moderate
North of SW Vacuna St (Jan. 2020 Before Data)	0.000	0.075	Negligible	0.000	0.077	Negligible

[a] Independent two-sample t-test

[b] Paired two-sample t-test

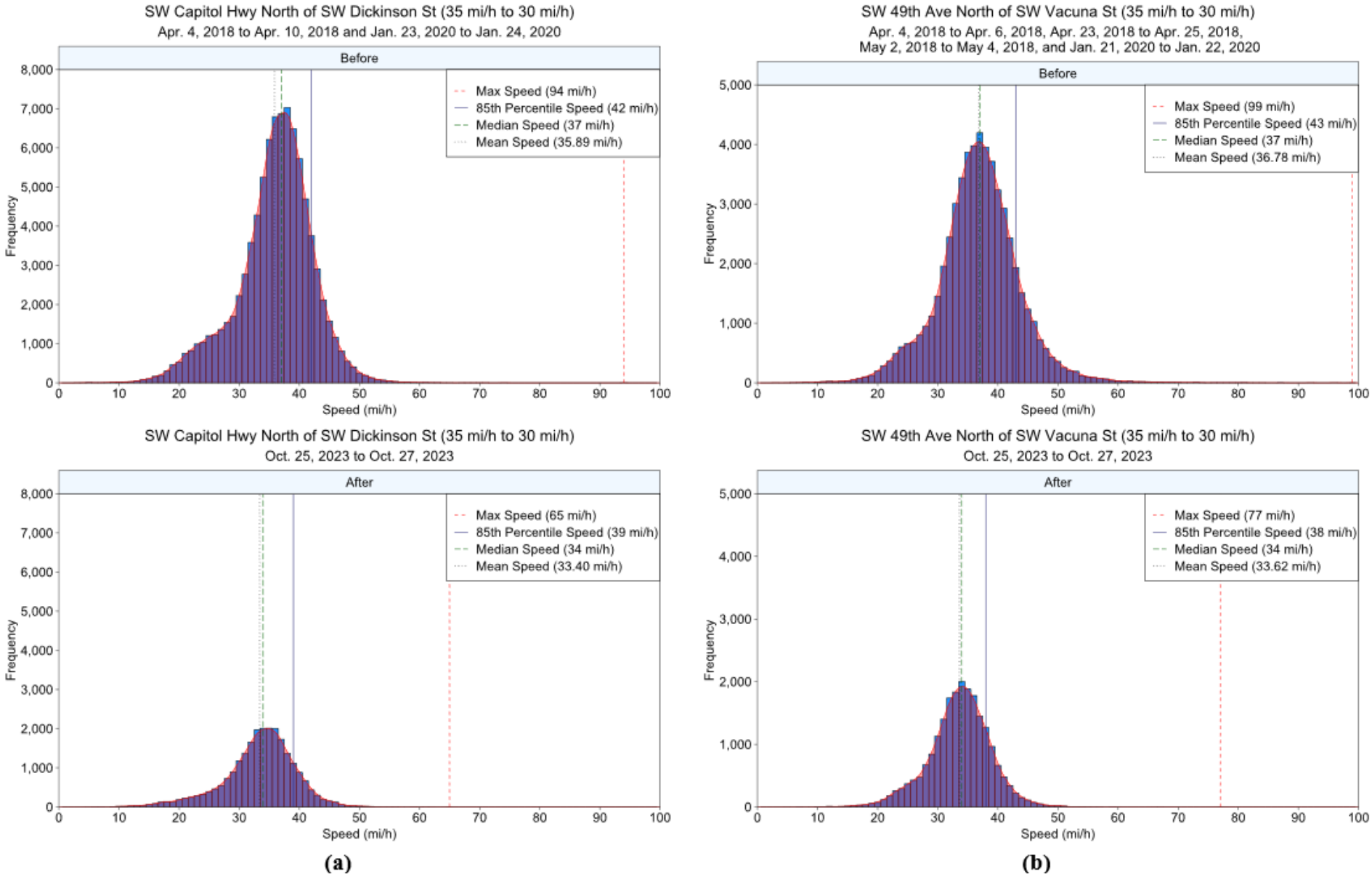
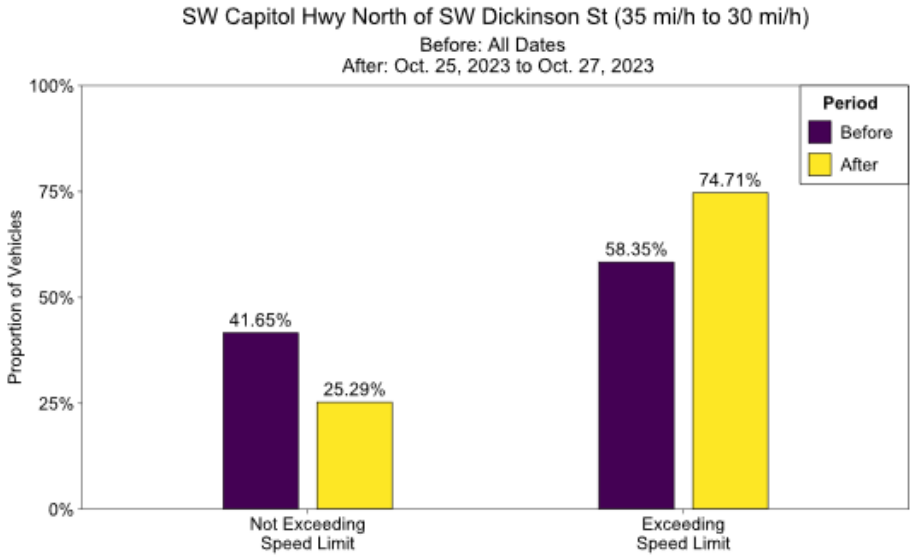
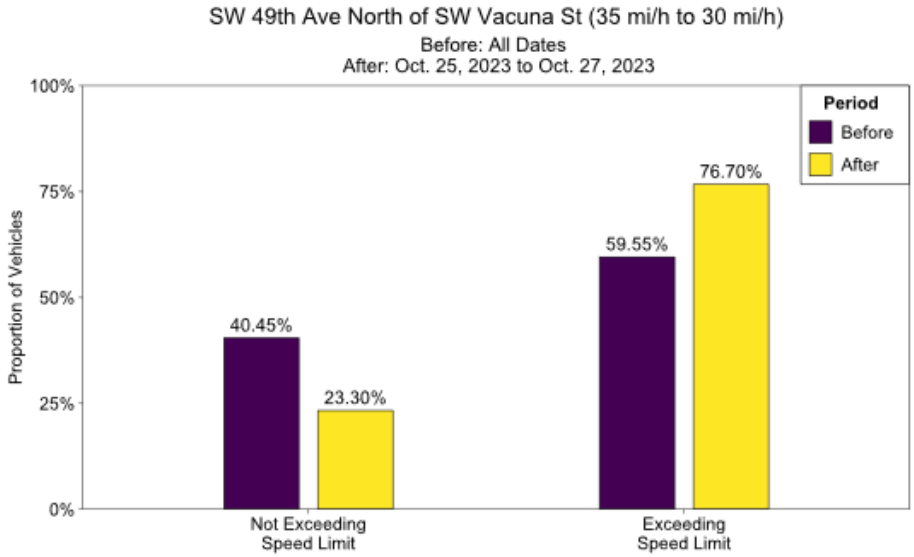
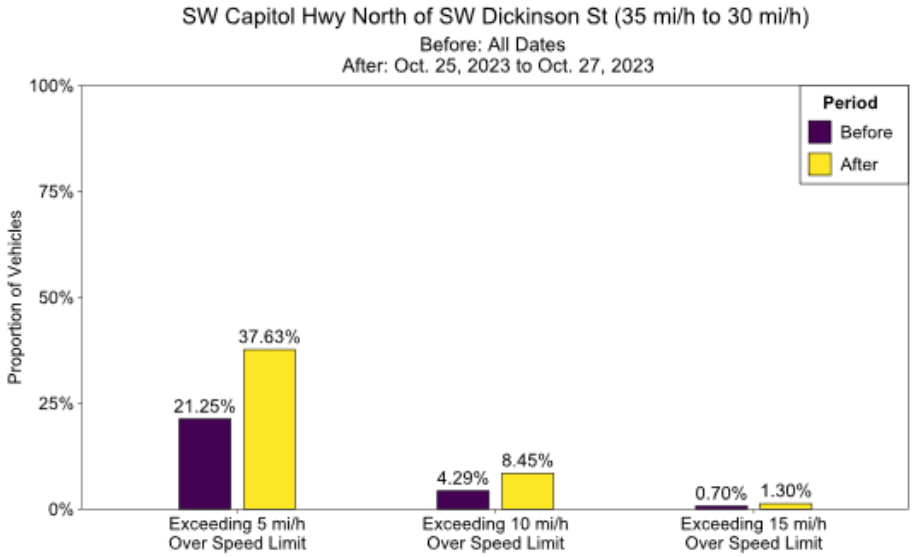
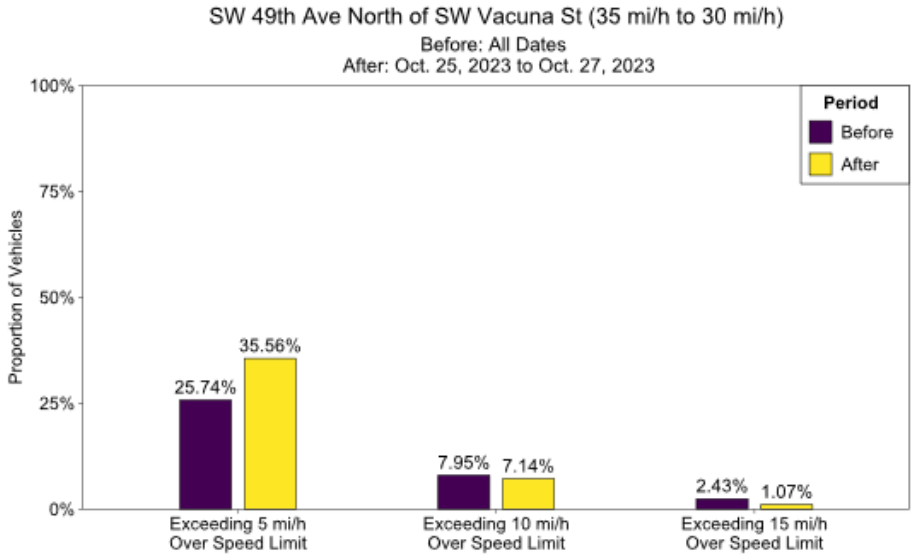


Figure 5.49: Speed Distribution at (a) North of SW Dickinson St and (b) North of SW Vacuna St on SW Capitol Hwy/SW 49th Ave Speed Zone









(a) **(b)**

Figure 5.50: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) North of SW Dickinson St and (b) North of SW Vacuna St on SW Capitol Hwy/SW 49th Ave Speed Zone

5.2 SAFETY OUTCOMES

For the simple before-after analysis, all 10 speed zones were considered, and the sign installation date was obtained. A summary of the speed zone, sign installation date, and the available before and after years of crash data is given in Table 5.31. Note that the speed zone on SE Powell Blvd has just one month of available after data. Due to this, the simple before-after method was applied once with the inclusion of SE Powell Blvd and once while excluding SE Powell Blvd.

Table 5.31: Speed Zones, Sign Installation Date, and Available Before and After Crash Data

Zone	Sign Installed	Before Years	After Years (or Months)
NE 82nd Ave	May 19, 2021	3	7 months
NE 102nd Ave	November 5, 2020	3	1 year, 1 month
NE 122nd Ave	April 21, 2021	3	8 months
SE Powell Blvd	November 30, 2021	3	1 month
NW Front Ave	September 8, 2020	3	1 year, 3 months
NE Glisan St	January 11, 2021	3	11 months
SE 52nd Ave	September 2, 2020	3	1 year, 3 months
NE Killingsworth St	February 1, 2021	3	10 months
SW Capitol Hwy	April 13, 2021	3	8 months
N Lombard St	June 11, 2021	3	6 months

The simple before-after analysis was conducted considering the following:

- Speed zone segments with a reduction of 35 mi/h to 30 mi/h.
    - One analysis including SE Powell Blvd and one analysis excluding SE Powell Blvd.
- Speed zone segments with a reduction of 30 mi/h to 25 mi/h.
- All speed zone segments regardless of speed limit reduction.
    - One analysis including SE Powell Blvd and one analysis excluding SE Powell Blvd.

There were two speed zone segments that had the only reduction of its magnitude: (1) NE Glisan St from NE 122nd Ave to NE 162nd Ave (40 mi/h to 30 mi/h) and (2) N Lombard St from N St Johns Ave to N Bruce Ave (35 mi/h to 25 mi/h). Due to there being only one segment for each of these reductions, there were not enough segments to produce reliable results from the simple before-after analysis; therefore, these segments were only included in the analysis that considered all speed zone segments regardless of speed limit reduction.

5.2.1 Speed Zone Segments with 35 mi/h to 30 mi/h Reduction

Table 5.32 shows the results of the simple before-after analysis considering speed zone segments with a 35 mi/h to 30 mi/h reduction (for results that include SE Powell Blvd, refer to Table B.1 in

Appendix B). As shown, a CMF of 0.728 was estimated with a standard deviation of 0.066. Additionally, the estimate of the 95% confidence interval does not include the value 1.0.

Although the results indicate that the speed reduction for these speed zone segments results in a decrease in the expected number of crashes, the sample is limited by the low number of speed zones (seven). All seven locations did experience a decrease in crashes after the sign was installed on the speed zone, but the number of after years was also limited, where just two sites had more than one year of after data. Further, due to the simple before-after approach not accounting for regression-to-the-mean bias, some bias is likely present.

Table 5.32: Simple-Before After Analysis for Speed Zones with a 35 mi/h to 30 mi/h Reduction

Parameter	Value
Number of Speed Zones	7
Total Number of Crashes in the After Period (λ)	145
Total Number of Crashes in the Before Period (π)	198.97
Estimated Change in the Total Number of Crashes (δ)	53.97
CMF (Index of Effectiveness) (θ)	0.728
Standard Deviation of δ	14.14
Standard Deviation of θ	0.066
CMF +/1 1 Std. Dev.	0.662 to 0.794
CMF 95% Confidence Interval	0.598 to 0.857

5.2.2 Speed Zone Segments with 30 mi/h to 25 mi/h Reduction

Table 5.33 shows the results of the simple before-after analysis considering speed zone segments with a 30 mi/h to 25 mi/h reduction. As shown, a CMF of 1.076 was estimated with a standard deviation of 0.220. Additionally, the estimate of the 95% confidence interval does include the value 1.0.

Although the results indicate that the speed reduction for these speed zone segments results in an increase in the expected number of crashes, the sample is limited by the low number of speed zones (three). In addition, crash counts in the after period were low and the after durations for two of the three sites were less than one year. Due to the low number of speed zones and low crash counts for two of the segments, the estimated CMF for these segments may be unreliable. In such a scenario, CMF estimates can be very sensitive to small changes in counts. Nonetheless, all three locations did experience a decrease in crashes after the sign was installed on the speed zone. Further, due to the simple before-after approach not accounting for regression-to-the-mean bias, some bias is likely present.

Table 5.33: Simple-Before After Analysis for Speed Zones with a 30 mi/h to 25 mi/h Reduction

Parameter	Value
Number of Speed Zones	3
Total Number of Crashes in the After Period (λ)	31
Total Number of Crashes in the Before Period (π)	28.50
Estimated Change in the Total Number of Crashes (δ)	2.50
CMF (Index of Effectiveness) (θ)	1.076
Standard Deviation of δ	6.290
Standard Deviation of θ	0.220
CMF +/1 1 Std. Dev.	0.856 to 1.297
CMF 95% Confidence Interval	0.644 to 1.508

5.2.3 All Speed Zone Segments

Table 5.34 shows the results of the simple before-after analysis considering all speed zone segments regardless of speed limit reduction (for results that include SE Powell Blvd, refer to Table B.2 in Appendix B). As shown, a CMF of 0.815 was estimated with a standard deviation of 0.062. Additionally, the estimate of the 95% confidence interval does not include the value 1.0.

Although the results indicate that the speed reduction across all speed zones indicate a decrease in the expected number of crashes, the sample is still limited by a low number of speed zones (nine). All nine locations experienced a decrease in crashes after the sign was installed on the speed zone, but the number of after years was also limited, where just two sites had more than one year of after data. Four of the sites have lower crash counts, which the estimated CMF can be sensitive to using this approach. Further, due to the simple before-after approach not accounting for regression-to-the-mean bias, some bias is likely present.

Table 5.34: Simple-Before After Analysis for all Speed Zones

Parameter	Value
Number of Speed Zones	9
Total Number of Crashes in the After Period (λ)	210
Total Number of Crashes in the Before Period (π)	257.28
Estimated Change in the Total Number of Crashes (δ)	47.28
CMF (Index of Effectiveness) (θ)	0.815
Standard Deviation of δ	16.820
Standard Deviation of θ	0.062
CMF +/1 1 Std. Dev.	0.753 to 0.878
CMF 95% Confidence Interval	0.693 to 0.938

5.3 SPEED MODELING

For the speed modeling, speed zone spot speed locations were grouped by speed reduction. Within each speed reduction group, five models were developed: (1) observed speed, (2) 1 if speed exceeds speed limit, 0 otherwise, (3) 1 if speed exceeds 5 mi/h over posted speed limit, 0 otherwise,

(4) 1 if speed exceeds 10 mi/h over posted speed limit, 0 otherwise, and (5) 1 if speed exceeds 15 mi/h over posted speed limit, 0 otherwise. For each speed reduction group, model specifications for observed speed are presented in the body of the report, while model specifications for the binary logit models can be viewed in Appendix C. It should be noted once more that the intent of these models is to be explanatory in nature, not to make causal inference.

5.3.1 Speed Models for 35 mi/h to 30 mi/h Reduction

Table 5.35 shows the regression specifications for the 35 mi/h to 30 mi/h reduction group (additional model specifications can be viewed in Table C.1 to Table C.4 in Appendix C). Model specifications show that observed speed after the new speed limit signed was installed is expected to decrease by 4.4%, on average. This is consistent with the descriptive analysis, where most sites experienced a decrease in mean speed (despite mean speed still being greater than the new posted speed limit). The temporal variables are to control for time periods and days of the week, and the reference site for the site-level indicators is the N Lombard St spot speed location.

Noteworthy site-level effects include the sites in which speed is expected to increase. At the North of NE Shaver St spot speed location on the NE 102nd Ave speed zone, observed speed is expected to increase by nearly 8%. Based on PBOT's Equity Index data, this spot speed location is near a diverse population with lower median income. Additionally, the adjacent land use is primarily residential and the road is two-way with one lane in each direction (a center turn lane is also present).

Also with a significant increase is the South of NE Holladay St spot speed location on the NE/SE 122nd Ave speed zone, where speed is expected to increase by 13.2%, on average. The population near this location is more diverse with lower median income. This location is also adjacent to residential-type land use designations, where the roadway is two-lane with one lane in each direction and a center turn lane.

Both spot speed locations on the NE Glisan St speed zone are expected to have increases in observed speed. Both sites are adjacent to a diverse population with lower median income and the primary land use designation is residential.

The West of NW 19th Ave spot speed location on the NW Front Ave/NW Naito Pwky speed zone is expected to have a 9.4% increase in observed speed, on average. Unlike previous sites with increases in speed, this site is adjacent to less diverse population with a higher median income. The adjacent land use is also different, where the primary designations are employment and commercial. The roadway configuration is also different, as there are two lanes in each direction.

Lastly, both locations on the SW Capitol Hwy/SW 49th Ave speed zone are expected to have increases in observed speed. These locations are adjacent to a moderately diverse population with lower median income. The land use designation varies from commercial to residential to open space. Both locations also have one lane in each direction with a center turn lane and a small proportion of truck volume.

There does not appear to be a common theme among the sites that are expected to have increases in observed speeds, as a collection of sites share some attributes, while others do not.

In regards to speeding and exceeding speed thresholds, model specifications suggest a higher probability of observing each in the after period (refer to Table C.1 to Table C.4 in Appendix C). Specifically, after sign installation there is:

- A 0.262 higher probability of observing speeds that exceed the speed limit.
- A 0.164 higher probability of observing speeds that exceed 5 mi/h over the posted speed limit.
- A 0.042 higher probability of observing speeds that exceed 10 mi/h over the posted speed limit.
- A 0.008 higher probability of observing speeds that exceed 15 mi/h over the posted speed limit.

Odds ratios also indicate an increase in odds of observing speeds exceeding these thresholds (odds ratios ranging from 3.6 to 1.7). These results follow the trends observed in the descriptive analysis, where despite decreases in mean speed, speeding increased and the proportion of vehicles exceeding speed thresholds also increased.

The majority of spot speed locations result in a lower probability of observing speeds exceeding these thresholds, with the exception of South of NE Holladay St (NE/SE 122nd Ave speed zone) and West of NE 113th Ave (NE Glisan St speed zone). Both of these sites result in a higher probability of observing speeds that exceed all thresholds considered.

Table 5.35: Regression Specifications for 35 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Effect on Speed
Constant	3.553	0.001	2,669.37	
After Sign Installation				
1 if after speed zone sign installed	-0.044	0.000	-125.44	-4.4%
Time-of-Day				
1 if 6:00 a.m. to 10:00 a.m.	-0.045	0.001	-78.45	-4.5%
1 if 10:00 a.m. to 4:00 p.m.	-0.064	0.000	-128.86	-6.4%
1 if 4:00 p.m. to 8:00 p.m.	-0.075	0.001	-143.53	-7.5%
Time-of-Week				
1 if Tuesday	-0.008	0.001	-12.45	-0.8%
1 if Wednesday	-0.005	0.001	-7.20	-0.5%
1 if Thursday	0.002	0.001	3.16	0.2%
1 if Friday	0.025	0.001	30.77	2.5%
Spot Speed Location				
NE 102nd Ave Speed Zone				
1 if NE 102nd Ave North of NE Shaver St	0.078	0.001	59.29	7.8%
NE/SE 122nd Ave Speed Zone				
1 if NE 122nd Ave North of NE Broadway	-0.035	0.001	-25.56	-3.5%
1 if NE 122nd Ave South of NE Holladay St	0.132	0.002	77.07	13.2%
1 if SE 122nd Ave South of SE Raymond St	-0.016	0.001	-12.12	-1.6%
NE/SE 82nd Ave Speed Zone				
1 if NE 82nd Ave South of NE Beech St	-0.164	0.001	-122.92	-16.4%
1 if NE 82nd Ave South of NE Davis St	-0.079	0.001	-60.88	-7.9%
1 if NE 82nd Ave South of NE Eugene St	-0.073	0.001	-56.57	-7.3%
1 if SE 82nd Ave South of SE Knapp St	-0.046	0.002	-30.01	-4.6%
1 if SE 82nd Ave South of SE Mill St	0.000	0.001	0.33	0.0%
NE Glisan St Speed Zone				
1 if NE Glisan St East of NE 85th Ave	0.091	0.001	66.53	9.1%
1 if NE Glisan St West of NE 113th Ave	0.180	0.001	137.14	18.0%
NW Front Ave/NW Naito Pwky Speed Zone				
1 if NW Front Ave West of NW 19th Ave	0.094	0.002	53.97	9.4%
1 if NW Naito Pkwy West of NW 9th Ave	-0.031	0.001	-22.01	-3.1%
SE Powell Blvd Speed Zone				
1 if SE Powell Blvd East of SE 78th Ave	0.003	0.001	2.49	0.3%
1 if SE Powell Blvd West of SE 108th Ave	0.032	0.001	24.66	3.2%
1 if SE Powell Blvd West of SE 130th Ave	-0.026	0.001	-19.52	-2.6%
SW Capitol Hwy/SW 49th Ave Speed Zone				
1 if SW 49th Ave North of SW Vacuna St	0.077	0.001	57.00	7.7%
1 if SW Capitol Hwy North of SW Dickinson St	0.052	0.001	40.01	5.2%
Model Summary				
Number of Observations	1,551,931			
R-squared	0.163			
Adjusted R-squared	0.163			

5.3.2 Speed Models for 30 mi/h to 25 mi/h Reduction

Table 5.36 shows the regression specifications for the 30 mi/h to 25 mi/h reduction group (additional model specifications can be viewed in Table C.5 to Table C.8 in Appendix C). Model specifications show that observed speed after the new speed limit signed was installed is expected to decrease by 8.6%, on average. This is consistent with the descriptive analysis, where most sites experienced a decrease in mean speed (despite mean speed still being greater than the new posted speed limit). The temporal variables are to control for time periods and days of the week. Only two sites were available for model estimation in this speed reduction group, where one is the reference scenario. The one site that does have an estimated effect is the North of SE Tolman St on the SE 52nd Ave speed zone, which is expected to decrease observed speed by 7.8%, on average. This location is adjacent to a population that is not diverse with a moderate median household income. The primary land use designation is residential, while the roadway is one lane in each direction with on-street parking in the northbound direction. This site also has a fairly low percentage of truck traffic.

In regards to speeding and exceeding speed thresholds, model specifications suggest a higher probability of observing each in the after period (refer to Table C.5 to Table C.8 in Appendix C). Specifically, after sign installation there is:

- A 0.208 higher probability of observing speeds that exceed the speed limit.
- A 0.181 higher probability of observing speeds that exceed 5 mi/h over the posted speed limit.
- A 0.039 higher probability of observing speeds that exceed 10 mi/h over the posted speed limit.
- A 0.007 higher probability of observing speeds that exceed 15 mi/h over the posted speed limit.

Odds ratios also indicate an increase in odds of observing speeds exceeding these thresholds (odds ratios ranging from 2.9 to 2.6). These results follow the trends observed in the descriptive analysis, where despite decreases in mean speed, speeding increased and the proportion of vehicles exceeding speed thresholds also increased.

Table 5.36: Regression Specifications for 30 mi/h to 25 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Effect on Speed
Constant	3.498	0.003	1,318.36	
After Sign Installation				
1 if after speed zone sign installed	-0.086	0.002	-56.61	-8.6%
Time-of-Day				
1 if 6:00 a.m. to 10:00 a.m.	-0.073	0.003	-28.93	-7.3%
1 if 10:00 a.m. to 4:00 p.m.	-0.074	0.002	-33.05	-7.4%
1 if 4:00 p.m. to 8:00 p.m.	-0.092	0.002	-39.33	-9.2%
Time-of-Week				
1 if Tuesday	0.018	0.002	9.17	1.8%
1 if Wednesday	0.023	0.002	10.45	2.3%
1 if Thursday	0.026	0.003	9.24	2.6%
1 if Friday	0.026	0.004	6.71	2.6%
Spot Speed Location				
SE 52nd Ave Speed Zone				
1 if SE 52nd Ave North of SE Tolman St	-0.078	0.002	-51.09	-7.8%
Model Summary				
Number of Observations	75,776			
R-squared	0.098			
Adjusted R-squared	0.098			

5.3.3 Speed Models for 40 mi/h to 30 mi/h Reduction

Table 5.37 shows the regression specifications for the 40 mi/h to 30 mi/h reduction group (additional model specifications can be viewed in Table C.9 to Table C.12 in Appendix C). Model specifications show that observed speed after the new speed limit signed was installed is expected to decrease by 5.6%, on average. This is consistent with the descriptive analysis, where most sites experienced a decrease in mean speed (despite mean speed still being greater than the new posted speed limit). The temporal variables are to control for time periods and days of the week. Only two sites were available for model estimation in this speed reduction group, where one is the reference scenario. The site that does have an estimated effect is the East of NE 157th Ave location on the NE Glisan St speed zone, which is expected to decrease observed speed by 5.5%, on average. This location is adjacent to a population that is diverse with a low median income. The primary land use designation is residential, while the roadway is one lane in each direction with on-street parking in both directions.

In regards to speeding and exceeding speed thresholds, model specifications suggest a higher probability of observing each in the after period (refer to Table C.9 to Table C.12 in Appendix C). Specifically, after sign installation there is:

- A 0.581 higher probability of observing speeds that exceed the speed limit.

- A 0.350 higher probability of observing speeds that exceed 5 mi/h over the posted speed limit.
- A 0.098 higher probability of observing speeds that exceed 10 mi/h over the posted speed limit.
- A 0.020 higher probability of observing speeds that exceed 15 mi/h over the posted speed limit.

Odds ratios also indicate an increase in odds of observing speeds exceeding these thresholds. These results follow the trends observed in the descriptive analysis, where despite decreases in mean speed, speeding increased and the proportion of vehicles exceeding speed thresholds also increased.

Table 5.37: Regression Specifications for 40 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Effect on Speed
Constant	3.652	0.001	2472.13	
After Sign Installation				
1 if after speed zone sign installed	-0.056	0.001	-72.78	-5.6%
Time-of-Day				
1 if 6:00 a.m. to 10:00 a.m.	-0.080	0.001	-68.51	-8.0%
1 if 10:00 a.m. to 4:00 p.m.	-0.068	0.001	-66.66	-6.8%
1 if 4:00 p.m. to 8:00 p.m.	-0.067	0.001	-63.00	-6.7%
Time-of-Week				
1 if Tuesday	-0.009	0.001	-6.45	-0.9%
1 if Wednesday	0.008	0.001	5.67	0.8%
1 if Thursday	0.027	0.001	20.39	2.7%
1 if Friday	0.039	0.002	24.44	3.9%
Spot Speed Location				
NE Glisan St Speed Zone				
1 if NE Glisan St East of NE 157th Ave	-0.055	0.001	-80.71	-5.5%
Model Summary				
Number of Observations	272,678			
R-squared	0.065			
Adjusted R-squared	0.065			

5.4 RESULTS SUMMARY

To assess speed compliance on the speed zones that were zoned under ODOT's new speed zoning method, spot speed data was collected and analyzed. For each speed zone, spot speed data was obtained for as many locations as possible that had before and after data (before being defined as before the new speed limit sign was installed and after being defined as after the sign was installed). In addition to matching before and after sites, some comparisons were considered for the descriptive analysis in which the sites were separated by a short distance, ranging from a couple hundred feet to 0.20 miles.

Overall, the descriptive analysis showed that mean speed decreased on each speed zone regardless of the speed limit reduction. The majority of spot speed comparisons (27 of 35, or 77.1%) had a decrease in mean speed after the new speed limit sign was installed. On the other hand, very few experienced decreases in the proportion of vehicles speeding or the proportion of vehicles exceeding 5 mi/h, 10 mi/h, and 15 mi/h over the posted speed limit. For proportion of vehicles speeding, just 4 of 35 (11.4%) locations experienced a decrease.[13] For proportion of vehicles exceeding 5 mi/h over the posted speed limit, 4 of 35 (11.4%) locations experienced a decrease. For proportion of vehicles exceeding 10 mi/h over the posted speed limit, slightly more locations experienced a decrease (7 of 35, or 20%). The same sites that experienced a decrease in proportion of vehicles exceeding 10 mi/h over the posted speed limit also experienced a decrease in proportion of vehicles exceeding 15 mi/h over the posted speed limit.

Despite limited research on speeding since the COVID-19 pandemic, there is some evidence that points toward increased speeds succeeding the pandemic (AAA Foundation for Traffic Safety, 2022; Insurance Institute for Highway Safety, 2022; Wang and Cicchino, 2023). Due the absence of peak-hour traffic during the pandemic, speeds increased and have not returned to pre-pandemic levels (Insurance Institute for Highway Safety, 2022). One survey found that despite more than 60% of individuals stating that they believe police would likely apprehend them for exceeding 15 mi/h over the speed limit, about one-half also indicated that they still exceed this threshold.

In Portland, the police disbanded the traffic division, which likely led to increased speeds due to decreased police presence. However, the traffic division was brought back in May 2023. It is unclear if increased presence of the traffic division has deterred higher speeds throughout the region, but data from some sites were collected after May 2023 and still show high speeds and a high proportion of vehicles exceeding speed thresholds. The decrease in speed limits resulting in a higher proportion of vehicles speeding (violators) also follows findings and recommendations from Florida's speed zoning manual (Florida Department of Transportation, 2018).

[13] Some of these comparisons were spot speed locations that were separated by a short length. This is also true for the speed thresholds.

Table 5.38: Summary of Spot Speed Locations with a Decrease in Speed Measures

Zone	Change (mi/h)	Number of Sites with Decrease in:				
		Mean Speed	% Speeding	% > 5 mi/h	% > 10 mi/h	% > 15 mi/h
NE 82nd Ave	35 to 30	7/9	0/9	0/9	0/9	0/9
NE 102nd Ave	35 to 30	1/1	0/1	0/1	0/1	0/1
NE 122nd Ave	35 to 30	4/6	1/6	1/6	3/6	3/6
SE Powell Blvd	35 to 30	2/4	0/4	0/4	0/4	0/4
NW Front Ave	35 to 30	1/2	0/2	0/2	0/2	0/2
NE Glisan St	35 to 30	1/2	1/2	1/2	1/2	1/2
	40 to 30	3/3	0/3	0/3	0/3	0/3
SE 52nd Ave	30 to 25	3/3	1/3	1/3	1/3	1/3
NE Killingsworth St	35 to 30	1/1	1/1	1/1	1/1	1/1
	30 to 25	1/1	0/1	0/1	0/1	0/1
SW Capitol Hwy	35 to 30	2/2	0/2	0/2	1/2	1/2
N Lombard St	35 to 25	1/1	0/1	0/1	0/1	0/1

From a safety perspective, the simple before-after analysis indicated an expected decrease in crashes in the 35 mi/h to 30 mi/h speed zone segments (estimated CMF of 0.728) and when considering all speed zone segments (estimated CMF of 0.815). On speed zone segments with a 30 mi/h to 25 mi/h reduction, there is an expected increase (estimated CMF of 1.076) in crashes. Although results indicate a decrease in the expected number of crashes on most speed zones (and when considering all speed zones together), the limitations of the simple before-after analysis and the small sample sizes must be considered. Overall, most speed zones had fewer than one year of crash data in the after period and the number of speed zones considered was low. This can be problematic, as the simple before-after analysis requires large samples to detect small changes in safety. Additionally, the simple before-after approach is unable to account for changes in other factors than the treatment, other programs and/or treatments, assumes that crash counts follow a Poisson process (equal mean and equal variance), and is unable to account for the regression-to-the-mean bias. Although results indicate an increase in safety after sign installation on the speed zones, the safety outcome analysis should be revisited when additional years of after data are available and alternate methods that address these limitations can be applied.

Although there was limited after data, the safety analysis results are in-line with previous studies. Elvik et al. (2004) found that a 5% reduction in mean speed resulted in a reduction of the expected number of crashes (CMF of 0.83 for fatal crashes, CMF of 0.93 for injury crashes, and a CMF of 0.95 for no injury crashes). Elvik et al. (2004) also found that a 10% reduction in mean speed and a 15% reduction in mean led to a reduction in the expected number of crashes for all injury types. A reduction in the expected number of crashes due a 5 mi/h reduction in the posted speed limit was found by Stokes et al. (2016) (CMF of 0.94). Reductions in the expected number of crashes due to lowering the posted speed limit were further confirmed by Son et al. (2022).

Lastly, the speed models confirmed what was observed in the descriptive analysis. This included decreases in mean speed after sign installation and increases in the proportion of vehicles

exceeding speed thresholds. Speed model specifications identified the following sites as locations in which higher observed speeds or increases in the likelihood of observing speeds exceeding the speed thresholds are expected:

- North of NE Shaver St (NE 102nd Ave speed zone)
- South of NE Holladay St (NE/SE 122nd speed zone)
- East of NE 85th Ave and West of NE 113th Ave (NE Glisan St speed zone)
- West of NW 19th Ave (NW Front Ave/NW Naito Pkwy speed zone)
- North of SW Vacuna St and North of SW Dickinson St (SW Capitol Hwy/SW 49th Ave speed zone)

Assessing context of these locations did not reveal any underlying similarities that may be leading to the expected increases in speed, as demographics, roadway characteristics, land use, and traffic volume vary among these locations.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of the current study was to determine if the new speed zone method is working based on speed compliance and safety outcomes. To accomplish this, a review of speed zoning and speed management practices was conducted, where each state within the U.S. was considered. Through the review it was determined that the speed zoning process is fairly consistent across each state. Specifically, an engineering and traffic study (accompanied by details of how the study should be conducted, data to be used, etc.), 85th percentile speed, 50th percentile speed, and various roadway characteristics were factors considered in each state reviewed. Also common was the manner in which speed zoning requests can be made, where each state allows for agencies and citizens to submit requests. Some states, however, require that citizens submit requests in conjunction with a city where the city formally does the request; this is true for Oregon. The use of USLIMITS2 for speed limit determination or validation was also a common theme, as was reference to the Manual on Uniform Traffic Control Devices. A less common theme was related to the authority in the speed zoning process, which makes Oregon unique in this regard.

Next, locations that were zoned under the new method were identified and speed data collected at these locations. In addition to speed data, roadway context through demographics, land use, roadway characteristics, and traffic volume were collected for each site. In total, 10 speed zones were considered for analysis with varying speed limit reductions (the most common being 35 mi/h to 30 mi/h).

The remaining tasks consisted of a data-driven analysis using speed data obtained from the Portland Bureau of Transportation and crash data obtained from the Oregon department of transportation. Using the speed data, a comprehensive descriptive analysis was conducted to determine changes in mean speed, median speed, 85th percentile speed, the proportion of vehicles exceeding the speed limit, the proportion of vehicles exceeding 5 mi/h over the posted speed limit, the proportion of vehicles exceeding 10 mi/h over the posted speed limit, and the proportion of vehicles exceeding 15 mi/h over the posted speed limit. The crash data was used to assess safety outcomes through a simple before-after analysis, where this method was chosen based on the availability of after crash data (after was defined as after the new speed limit sign was installed). The final analysis consisted of a set of speed models to identify associations between the after period and site-level variables on observed speed and the probability of observing speed over a given threshold. The models were explanatory in nature and not intended for causal inference, as an alternative method and additional data would be required. The following sub-chapters summarize the results of the data analyses. Following these summaries are recommendations.

6.1 SPEED COMPLIANCE

In general, mean speeds decreased after installation of the speed limit sign on the various speed zones. This does provide some evidence that the speed zone, and therefore method, is lowering operating speeds. However, despite decreases in mean speed, the average speed for most sites was still greater than the new posted speed limit (this was true for median speeds and 85th percentile speeds as well). Due to this, most sites experienced an increase in the proportion of vehicles

speeding and the proportion of vehicles exceeding 5 mi/h, 10 mi/h, and 15 mi/h over the posted speed limit. Previous research, although limited, has suggested that higher speed trends that began during the COVID-19 pandemic are the new normal. The Florida speed zoning manual also suggests that the number of vehicles exceeding the speed limit is likely to increase when speed limits are lowered. In addition, Portland experienced a time period in which no traffic division was present, although that division was brough back in May 2023, which is before some of the after data used for this study. Overall, despite decreases in mean speeds, a majority of drivers (based on data at the locations considered for analysis) are still exceeding the speed limit.

6.2 SAFETY OUTCOMES

Applying a simple before-after indicates a decrease in the expected number of crashes on speed zone segments with a 35 mi/h to 30 mi/h reduction and when considering all speed zone segments together. When considering only those segments with a 30 mi/h to 25 mi/h reduction, the estimated CMF indicated an increase in the expected number of crashes. Although results generally indicate an increase in safety, the limitations of the simple before-after approach must be considered (limited after crash data, small number of speed zones, factors other than the treatment, and regression-to-the-mean bias not accounted for).

6.3 SPEED MODELING

The speed models confirmed what was observed in the descriptive analysis. This included decreases in mean speed after sign installation and increases in the proportion of vehicles exceeding speed thresholds. Speed model specifications identified the following sites as locations in which higher observed speeds or increases in the likelihood of observing speeds exceeding the speed thresholds are expected:

- North of NE Shaver St (NE 102nd Ave speed zone)
- South of NE Holladay St (NE/SE 122nd speed zone)
- East of NE 85th Ave and West of NE 113th Ave (NE Glisan St speed zone)
- West of NW 19th Ave (NW Front Ave/NW Naito Pkwy speed zone)
- North of SW Vacuna St and North of SW Dickinson St (SW Capitol Hwy/SW 49th Ave speed zone)

Assessing context of these locations did not reveal any underlying similarities that may be leading to the expected increases in speed, as demographics, roadway characteristics, land use, and traffic volume vary among these locations.

6.4 RECOMMENDATIONS AND FUTURE WORK

Based on the analysis, the following recommendations are made.

6.4.1 Speed Compliance

The number of speed zones and the spatial distribution limits the analysis, as does the number of spot speed locations. To gain a better understanding of post-pandemic speed trends, and to better assess if the speed zones are indeed lowering speeds and reducing the proportion of vehicles exceeding given speed thresholds, it is recommended to include additional locations that meet the new speed zoning method criteria. With the addition of more locations, it is also recommended to include speed zones outside of the Portland Metropolitan area. However, expanding the number of locations also results in expanding data collection efforts to locations in which speed data is not routinely collected, which was a limitation for this study. For this work, the research team worked with the Portland Bureau of Transportation to collect speed data using pneumatic tubes at locations that expanded the number of spot speed measurement sites. This can serve as an opportunity for local agencies, the Oregon Department of Transportation, and research partners to collaborate on spot speed collection efforts. It is further recommended that consideration of the analyses to be done after policy or regulation changes be made prior to the change, as this permits data to be collected and formatted in a manner that can be used in before-after studies. If spot speed data is unavailable, the use of speed data from RITIS may be an alternative; however, this speed data does not allow for assessment of several speed measures due to its format. RITIS data may be able to provide general speed trends over predefined segments to determine if a policy or regulation change is working as intended but cannot provide information on proportion of vehicles speeding or exceeding speed thresholds.

In regards to roadway characteristics and context, active transportation counts were difficult to obtain, and active transportation is a key component of the new speed zoning process. It is recommended that these counts be obtained, or a demand modeling approach be applied to estimate the active transportation user counts along the speed zone. Recent ODOT research has been completed that may help in this regard.

6.4.2 Safety Outcomes

In addition to the low number of speed zones, the safety analysis was limited by the amount of after crash data. For most speed zones, the new speed limit sign was installed in 2021, which at the time of this report was the most recent year of Oregon crash data. As a result, the safety analysis was limited to a simple before-after approach. It is recommended, as with the speed compliance recommendations, that additional sites be included for analysis. It is further recommended that the safety assessment along speed zones zoned under the new method be revisited when at least three years of after crash data are available. With additional years of after crash data, the Empirical Bayes approach can be applied, which addresses all major limitations of the simple before-after analysis (e.g., factors other than the treatment, regression-to-the-mean bias, and others). The use of this approach allows for estimation of safety performance functions that can control for various factors that may have changed during the analysis period (e.g., traffic volume, roadway characteristics/geometry, context, and others).

Due to the limited amount of after data, the current study considered all crashes and crash types for the safety analysis. When the safety analysis is revisited with multiple years of after data, it is recommended to consider specific crash types and/or injury severities, such as bicycle and pedestrian crashes, injury-type crashes only, and fatal crashes only. If video data is available, the

evaluation of vehicle-active transportation conflicts may provide additional insight into the safety effects of the speed zone.

6.4.3 Speed Modeling

Although the speed models provide some explanatory information, they do not address causality. Additionally, information that likely impacts speeds (e.g., roadway characteristics) were unable to be included in model specifications. To address the former, an alternate approach can be applied to make causal inference but would require additional speed zones and more data. To address the latter, additional speed zones would result in more variation of site-specific characteristics, which would address the full rank issues encountered in the current study when estimating the speed models. The models can also be expanded to account for unobserved heterogeneity, thus allowing the models to capture characteristics that are unobserved (e.g., driver characteristics are unavailable) and provide additional explanatory power. Spatial-based models, or panel-based models, can also be explored to determine if additional insights can be revealed in regards to speed behavior and compliance on speed zones.

7.0 REFERENCES

AAA Foundation for Traffic Safety. (2022). 2021 Traffic Safety Culture Index. Retrieved April 2, 2024, from https://aaafoundation.org/2021-traffic-safety-culture-index/

Alabama Department of Transportation. (2015). *Alabama Speed Management Manual*. Montgomery, AL.

Anderson, J. C., Monsere, C., and Kothuri, S. (2022). Effect of Residential Street Speed Limit Reduction on Driving Speeds in Portland, Oregon. *Transport Findings*, *January*. https://doi.org/10.32866/001c.31956

California Department of Transportation. (2020). *California Manual for Setting Speed Limits*. Sacramento, CA.

Clark, J., Atkinson, J., Retting, R., Neuner, M., and Ercisli, S. (2017). *Colorado's Speed Management Action Plan*. Reston, VA. Leidos. FHWA Contract No. DTFH6116D00003/0001.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Connecticut Department of Transportation. (2021). *Guidelines on Establishing Speed Limits in the State of Connecticut*. Hartford, CT.

Elvik, R., Christensen, P., and Helene Amundsen, A. (2004). *Speed and Road Accidents: An Evaluation of the Power Model*. Oslo, NO. Transportøkonomisk Institutt.

Findley, D. J., Warchol, S., Chase, T., and Thomas, L. (2018). *Developing Guidelines and Documentation of Engineering Studies for Establishing NC Speed Limits*. Raleigh, NC. North Carolina Department of Transportation. Report No. NCDOT/NC/2017-10.

Florida Department of Transportation. (2018). *Speed Zoning for Highways, Roads and Streets in Florida*. Tallahassee, FL.

Hauer, E. (1997). *Observational Before-After Studies in Road Safety: Estimating the Effect of Highway and Traffic Engineering Measures on Road Safety*. Bingley, UK: Emerald Publishing.

Illinois Department of Transportation. (2011). *Policy on Establishing and Posting Speed Limits on the State Highway System*. Springfield, IL.

Insurance Institute for Highway Safety. (2022). Pandemic Lockdowns Made Rush-Hour Speeding, Risky Driving the New Normal. Retrieved April 2, 2024, from https://www.iihs.org/news/detail/pandemic-lockdowns-made-rush-hour-speeding-risky-driving-the-new-normal#:~:text=Those numbers suggest that the,driving also became more common.

Iowa Department of Transportation. (2006). Process for Establishing Speed Limits. In *Traffic and Safety Manual*. Des Moines, IA: Iowa Department of Transportation, Office of Traffic and Safety.

Kansas Department of Transportation. (2016). Establishing Speed Limits: A Case of "Majority Rule."

Kentucky Transportation Cabinet. (2021). *Traffic Operations Guidance Manual*. Frankfort, KY.

Leidos. (2016). *Speed Management Action Plan*. Harrisburg, PA. Pennsylvania Department of Transportation.

Massachusetts Department of Transportation. (2021). *Procedures for Speed Zoning on State and Municipal Roadways: Standards and Practices to Promote Safe and Efficient Travel in Massachusetts*. Boston, MA.

McFadden, D. (1981). Econometric Models of Probabilistic Choice. In C. F. Manksi and D. McFadden (Eds.), *Structural Analysis of Discrete Data with Econometric Applications* (pp. 198–269). Cambridge, MA: MIT Press.

Minnesota Department of Transportation. (2009). *Study and Report on Speed Limits*. Saint Paul, MN. Retrieved from http://www.dot.state.mn.us/speed/pdf/speedlimitaskforcereport.pdf

Minnesota Department of Transportation. (2015). *Traffic Safety Fundamentals Handbook*. Saint Paul, MN.

Minnesota Department of Transportation. (2019). Phase 1: Develop a Unified Speed Limit Vision. Retrieved June 2, 2022, from https://mnspeedlimitvision.org/mnspeedlimitvision/

Minnesota Department of Transportation. (2020). Phase 2: Develop an Updated Process for Setting Speed Limits. Retrieved June 2, 2022, from https://mnspeedlimitvision.org/mnspeedlimitvision/resources/vision-speedlimit.pdf

Monsere, C., Figliozzi, M. A., Kothuri, S. M., Razmpa, A., and Hazel, D. (2017). *Safety Effectiveness of Pedestrian Crossing Enhancements*. Salem, OR. Oregon Department of Transportation. ODOT Report No.SPR-778.

National Highway Traffic Safety Administration. (2011). *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* (6th ed.). Washington, DC: United States Department of Transportation.

National Highway Traffic Safety Administration. (2020). *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* (10th ed.). Washington, DC: United States Department of Transportation.

Nevada Department of Transportation. (2020). *Traffic Operations Process Memorandum 2020-03: Operations and Safety Study Process*. Carson City, NV.

North Carolina Executive Committee for Highway Safety. (2012). *NC Speed Management Draft Recommendations*. Raleigh, NC. The University of North Carolina Highway Safety Research Center.

North Dakota Department of Transportation. (2021). *Traffic Operations Manual*. Bismark, ND.

Ohio Department of Transportation. (2021a). Speed Zones. Retrieved June 2, 2022, from https://www.transportation.ohio.gov/programs/traffic-regulations/speed-zones#page=1

Ohio Department of Transportation. (2021b). Speed Zoning Committee. Retrieved June 2, 2022, from https://www.transportation.ohio.gov/programs/traffic-regulations/speed-zones/speed-zones-committee

Oregon Department of Transportation. (2022). *Speed Zone Manual*. Salem, OR. Traffic-Roadway Section and Delivery and Operations Division.

Sablan, K. (2019). *Department Memorandum: Speed Zone Change Procedures and Guidance on Engineering and Traffic Investigations and Studies*. Boise, ID. Idaho Department of Transportation.

Son, S., Park, J., Park, S., Cho, J., and Choi, S. (2022). Evaluation of Direct and Indirect Safety Effects of Speed-Limit Reduction on Urban Networks. *Journal of Transportation Engineering, Part A: Systems*, *148*(10), 04022071.

South Carolina Department of Transportation. (2019). *Traffic Calming Guidelines*. Columbia, SC.

South Dakota Department of Transportation. (2021). *Traffic Operations Manual*. Pierre, SD.

Stokes, A., Sarasua, W. A., Huynh, N., Brown, K., Ogle, J. H., Mammadrahimli, A., … Chowdhury, M. (2016). Safety Analysis of Driveway Characteristics Along Major Urban Arterial Corridors in South Carolina. *95th Annual Meeting of the Transportation Research Board*. Washington, DC.

Texas Department of Transportation. (2015). *Procedures for Establishing Speed Zones*. Austin, TX.

Thomas, L., Srinivasan, R., Lan, B., Hunter, W., Martell, C., and Rodgman, E. (2013). *Speed and Safety in North Carolina*. Raleigh, NC. North Carolina Department of Transportation. Report No. FHWA/NC/2011-08.

Vermont Agency of Transportation. (2016). *Setting Speed Limits - A Guide for Vermont Towns*. Montpelier, VT. Vermont Local Roads Program.

Wang, J., and Cicchino, J. B. (2023). Changes in Speeding on Virginia Roads During the Beginning of the COVID-19 Pandemic. *Traffic Injury Prevention*, *24*(1), 38–43.

Washington State Department of Transportation. (2021). *Traffic Manual*. Olympia, WA.

Wisconsin Department of Transportation. (2009). *Wisconsin Statewide Speed Management Guidelines*. Madison, WI.

Wisconsin Department of Transportation. (2021). Traffic Regulations: Speed Limits. In *Traffic Engineering, Operations and Safety Manual*. Madison, WI.

Zhang, Z., Yang, X. T., Liu, C., and Yuan, Y. (2019). *Investigation of Utah Highway Speed-Limit Compliance Rates and Evaluation of Speed-Limit Design in Towns Along Highways*. Salt Lake City, UT. Utah Department of Transportation. Report No. UT-19.26.

APPENDIX A

Appendix A provides figures for speed distributions, proportion of vehicles exceeding the posted speed limit, and the proportion of vehicles exceeding 5 mi/h, 10 mi/h, and 15 mi/h over the posted speed limit. The figures included in Appendix A are those for spot speed locations that had multiple before data collection periods and provides visual comparisons for each set of dates. The figures presented here accompany the statistics provided in Chapter 5.1.

The figures begin on the following page.

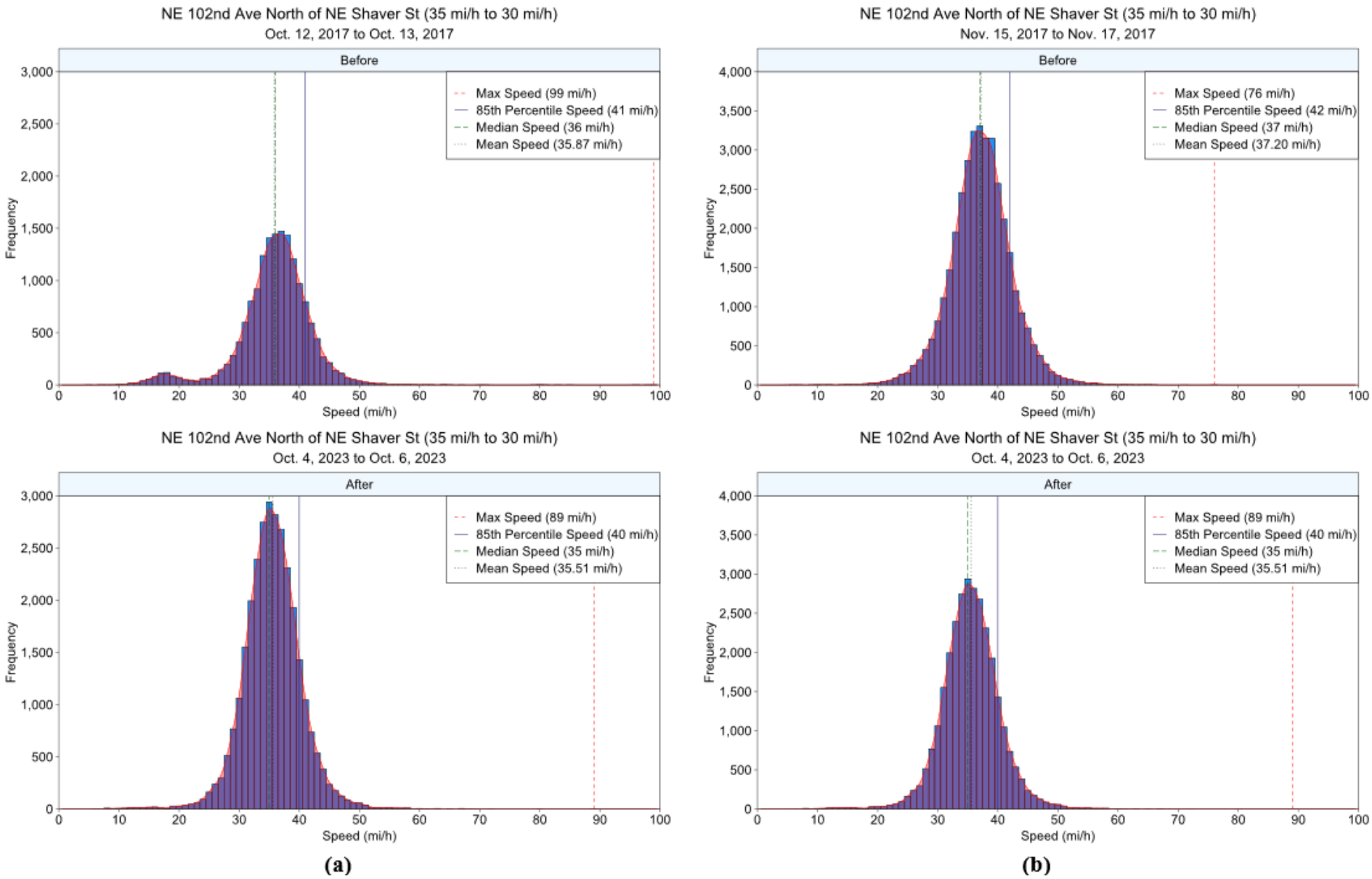


Figure A.1: Speed Distribution at (a) North of NE Shaver St with Oct. 2017 Before Data and (b) North of NE Shaver St with Nov. 2017 Before Data on NE 102nd Ave Speed Zone

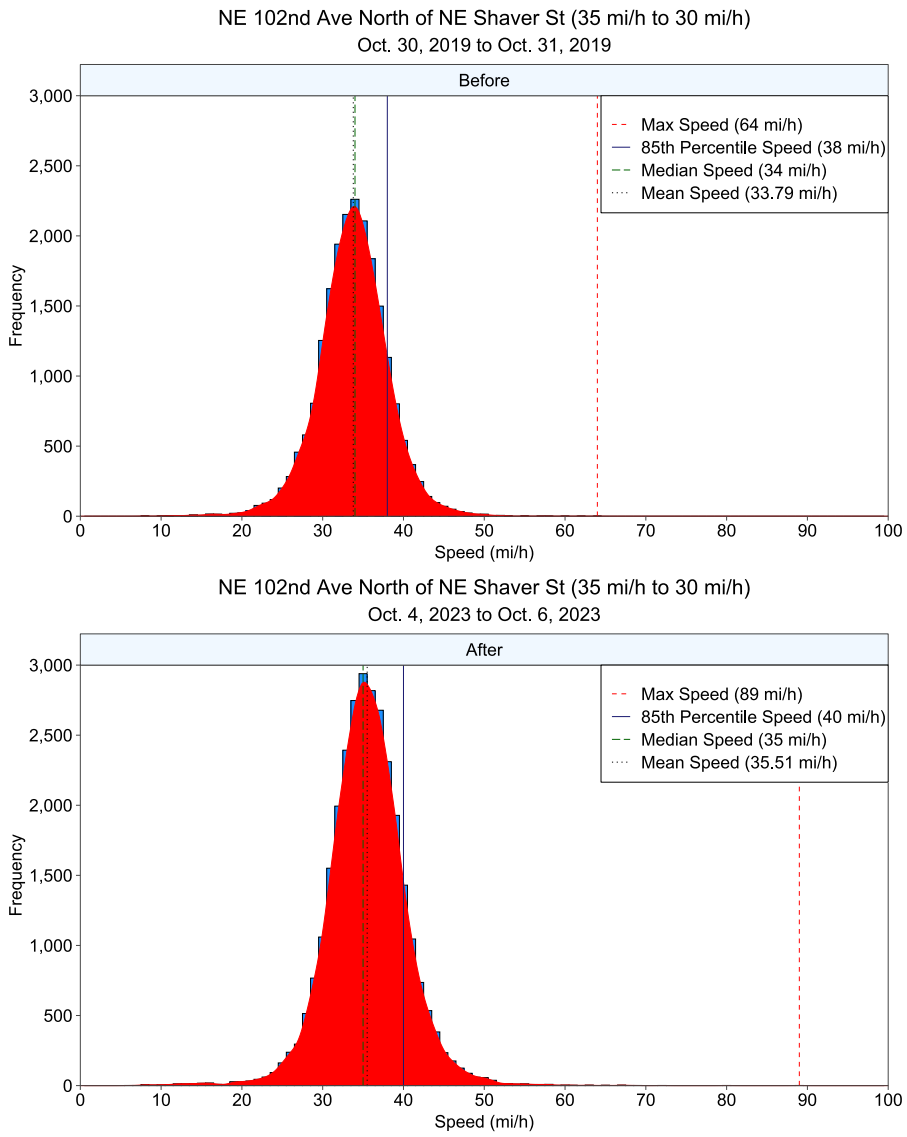
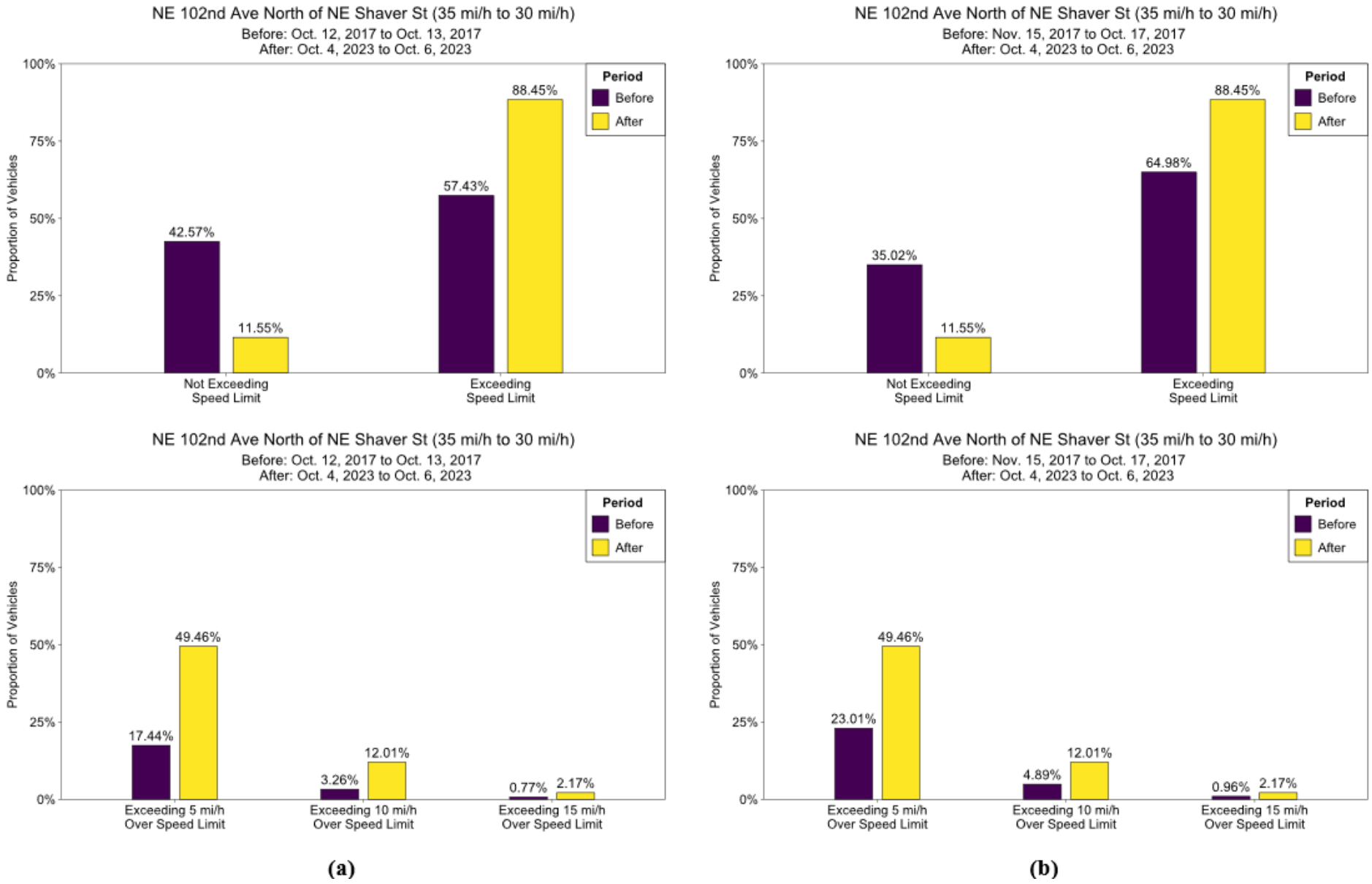


Figure A.2: Speed Distribution at North of NE Shaver St with Oct. 2019 Before Data



(a) **(b)**

Figure A.3: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) North of NE Shaver St with Oct. 2017 Before Data and (b) North of NE Shaver St with Nov. 2017 Before Data on NE 102nd Ave Speed Zone

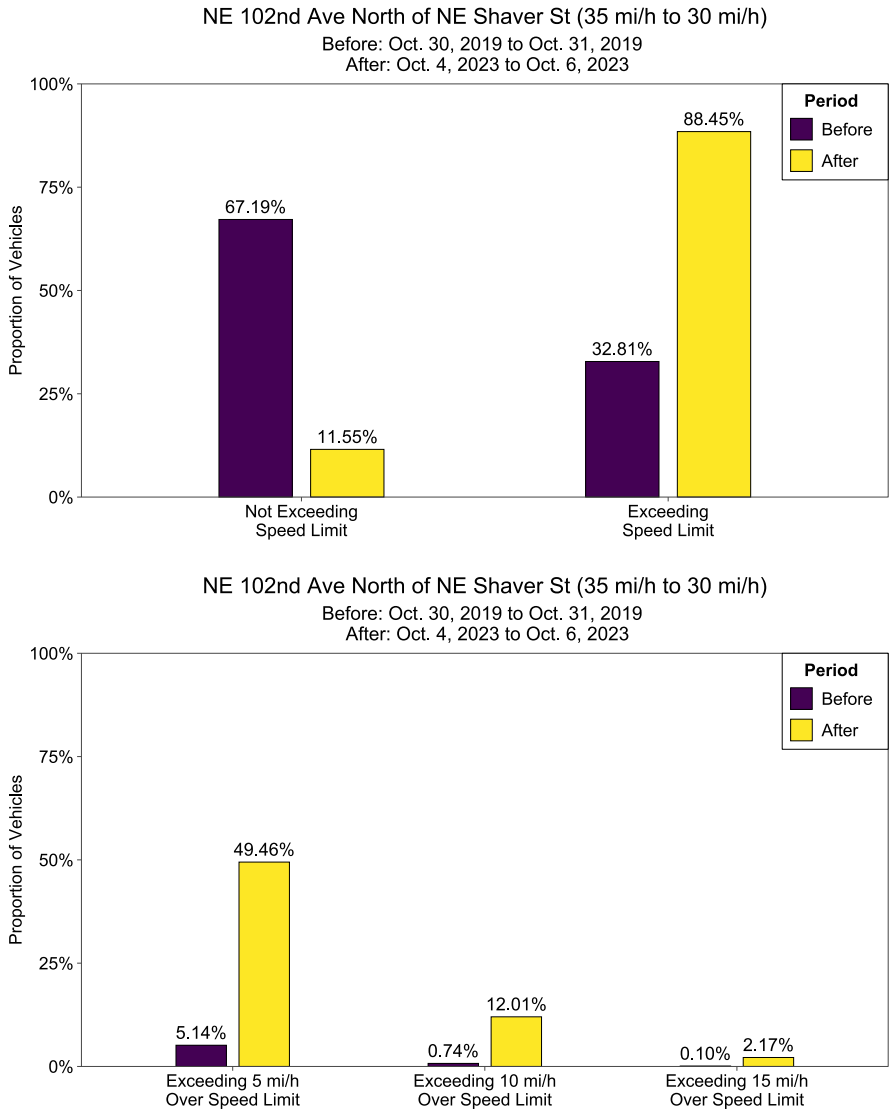


Figure A.4: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at North of NE Shaver St with Oct. 2019 Before Data on the NE 102nd Ave Speed Zone

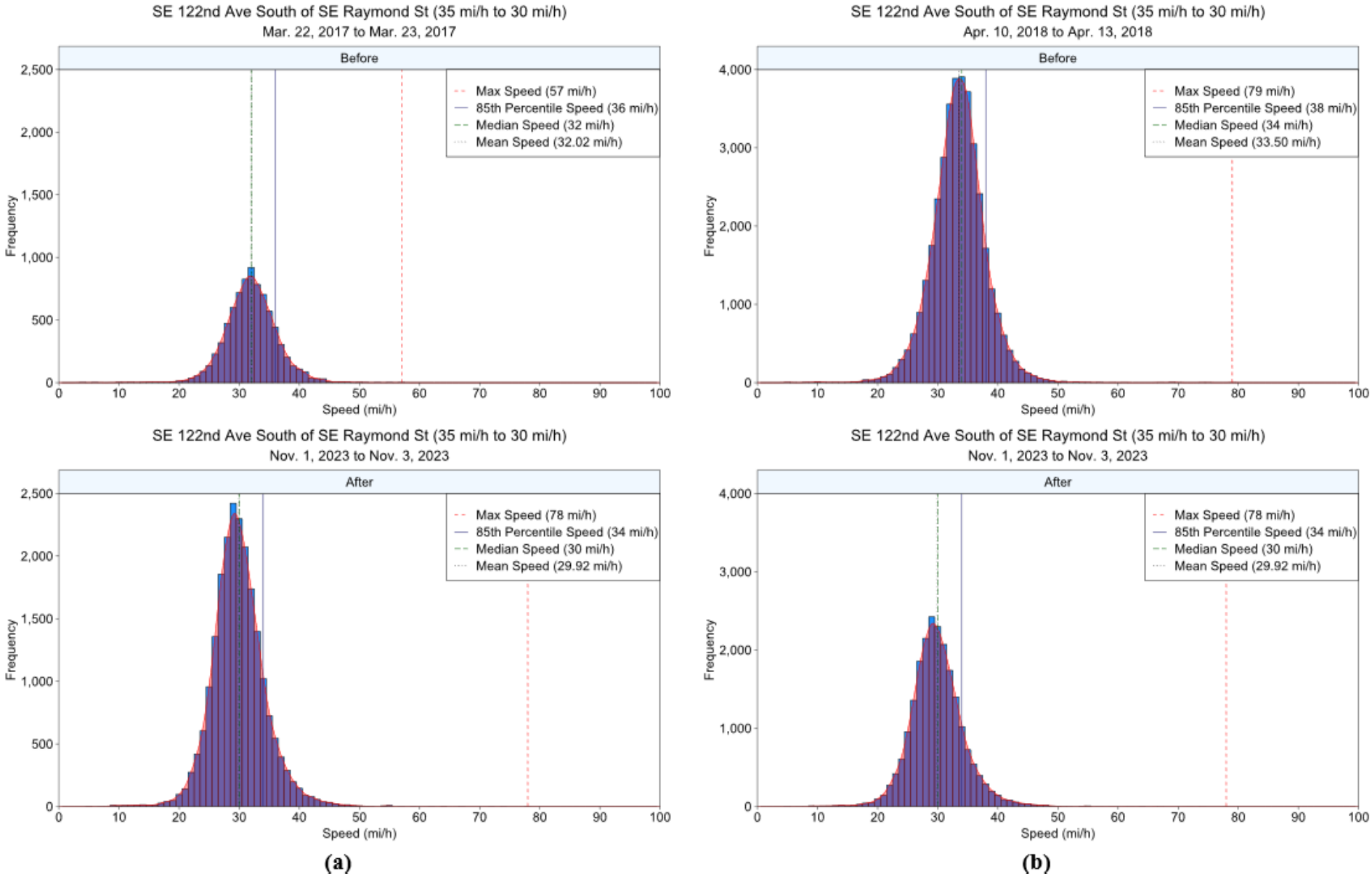


Figure A.5: Speed Distribution at (a) South of SE Raymond St with Mar. 2017 Before Data and (b) South of SE Raymond St with Apr. 2018 Before Data on the NE/SE 122nd Ave Speed Zone

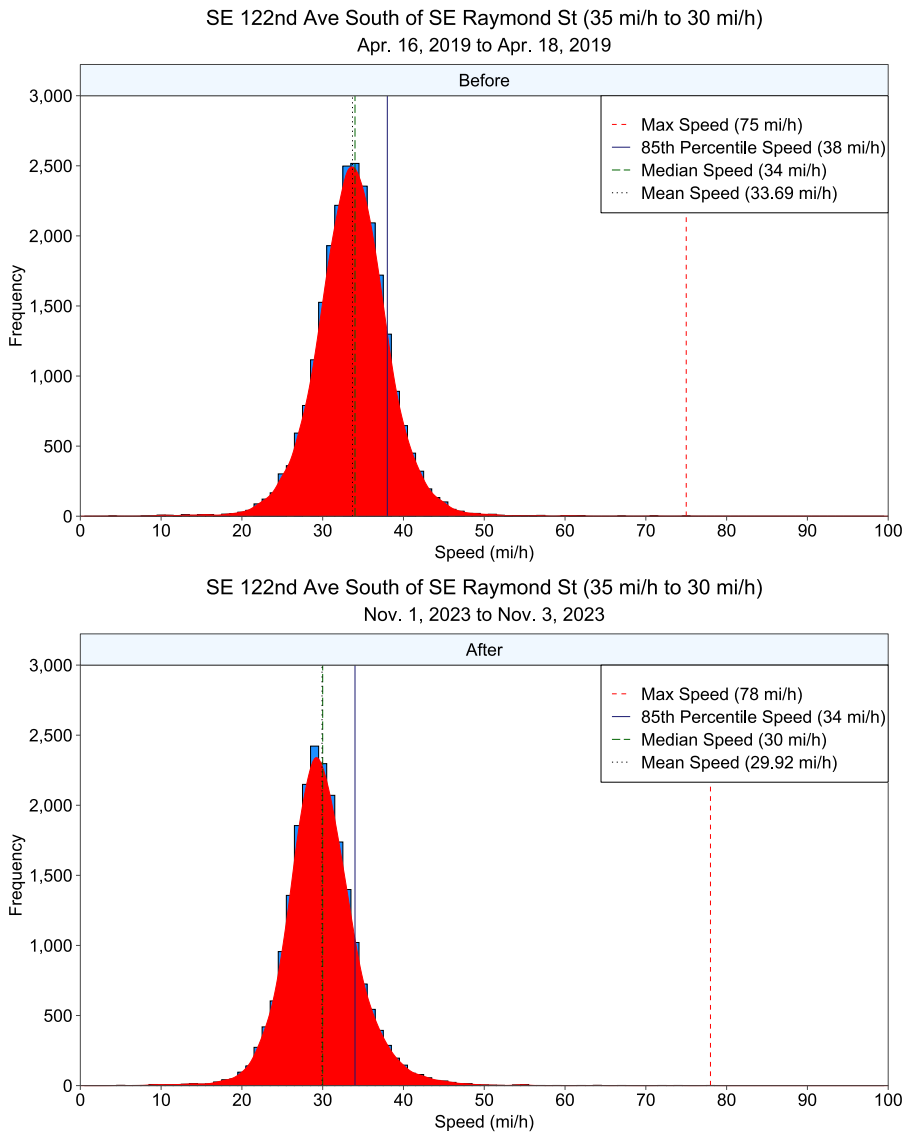


Figure A.6: Speed Distribution at South of SE Raymond St with Apr. 2019 Before Data on the NE/SE 122nd Ave Speed Zone

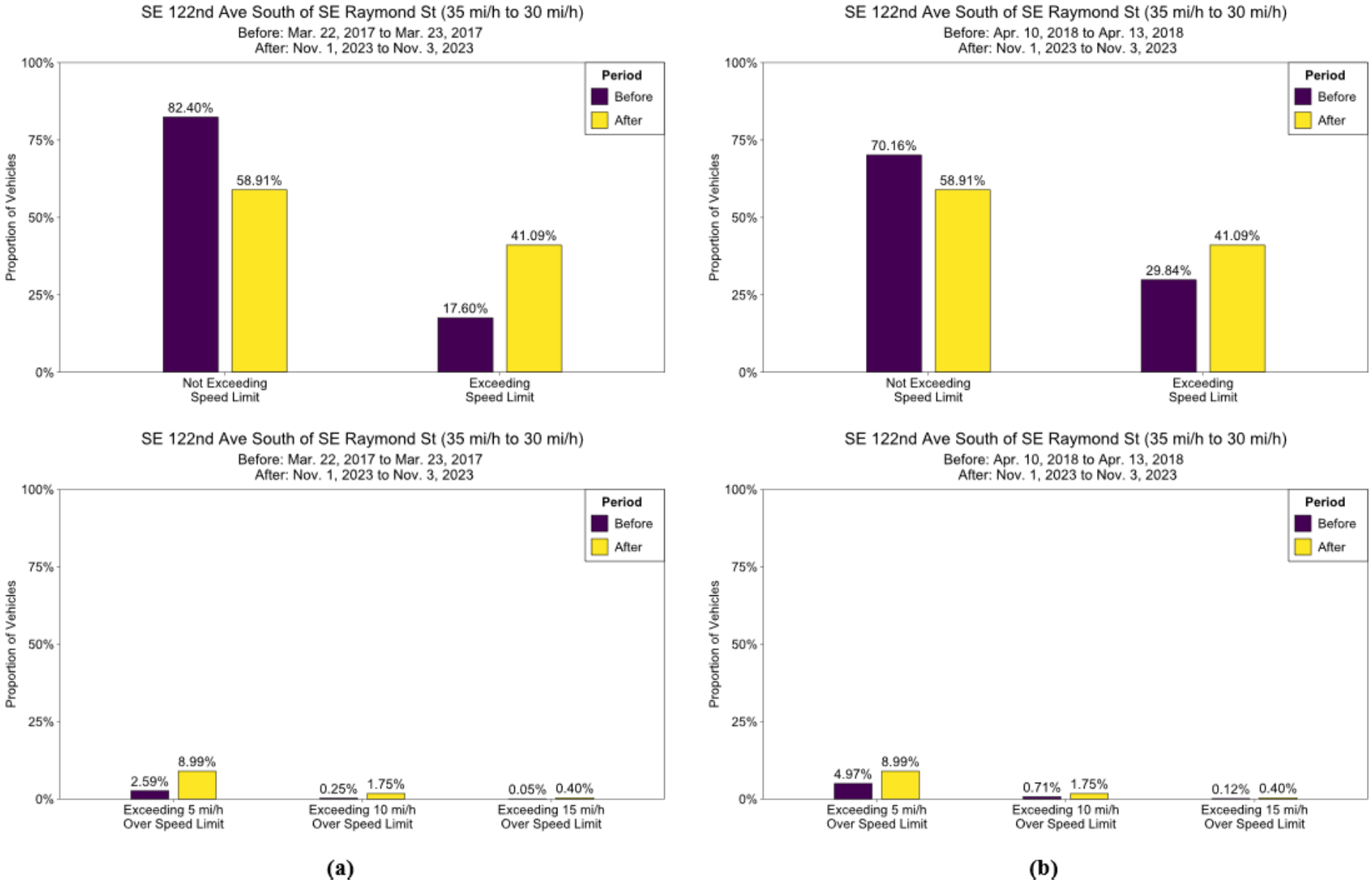


Figure A.7: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at (a) South of SE Raymond St with Mar. 2017 Before Data and (b) South of SE Raymond St with Apr. 2018 Before Data on the NE/SE 122nd Ave Speed Zone

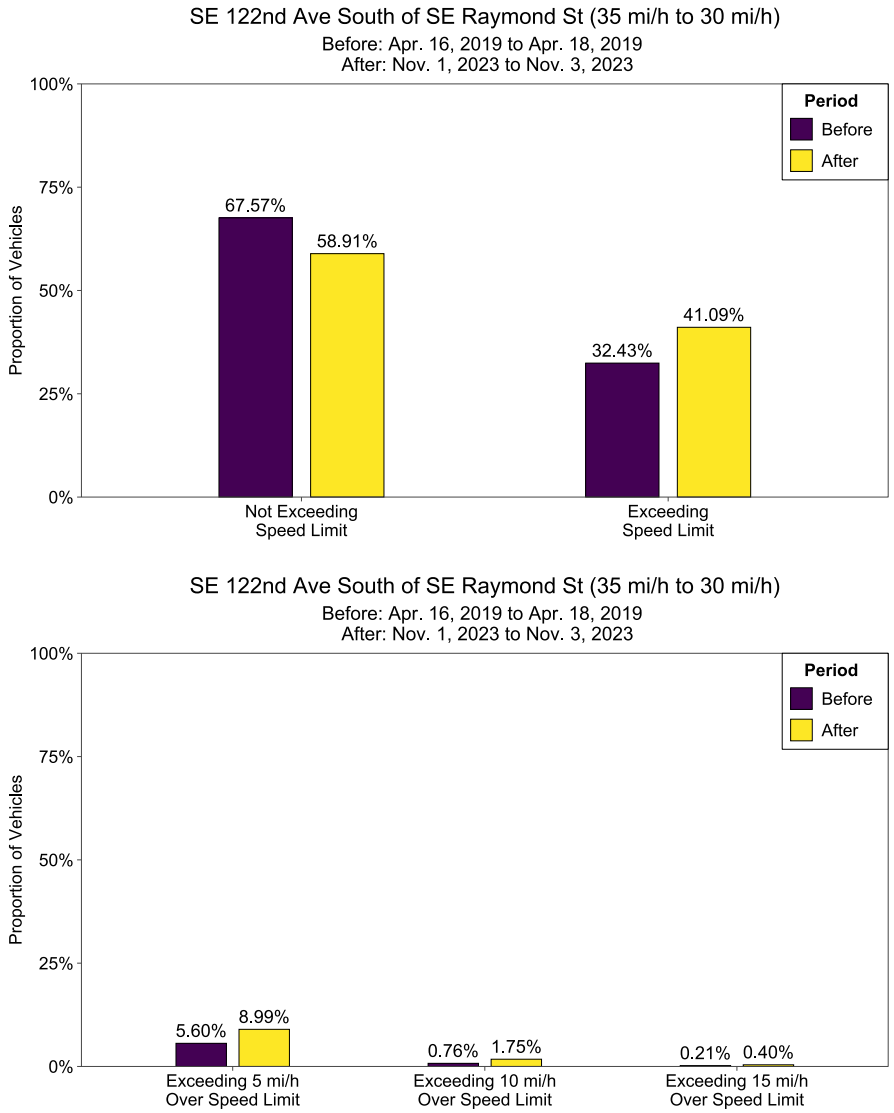


Figure A.8: Proportion of Vehicles Exceeding Speed Limit and Speed Thresholds at South of SE Raymond St with Apr. 2019 Before Data on the NE/SE 122nd Ave Speed Zone

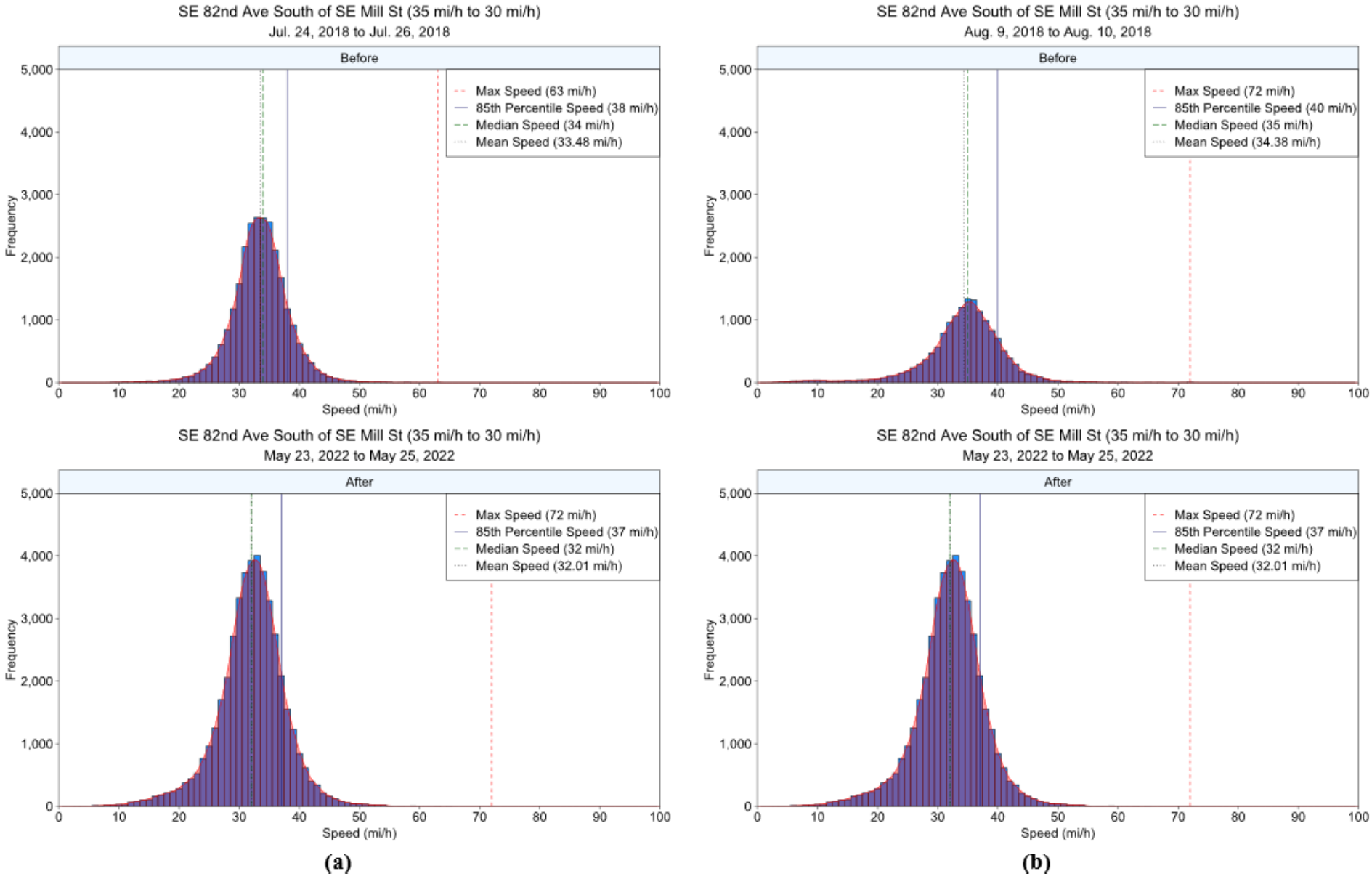
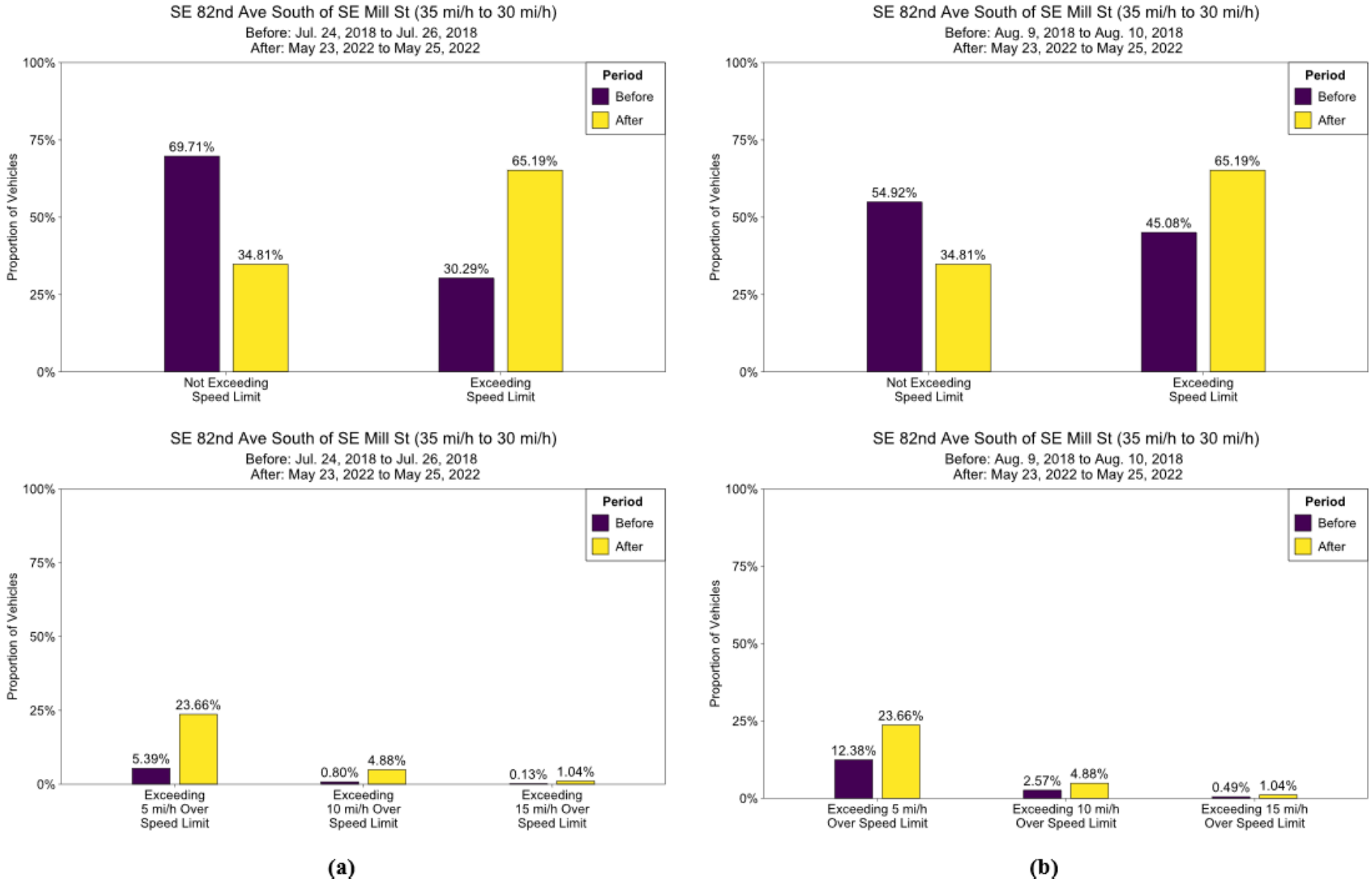
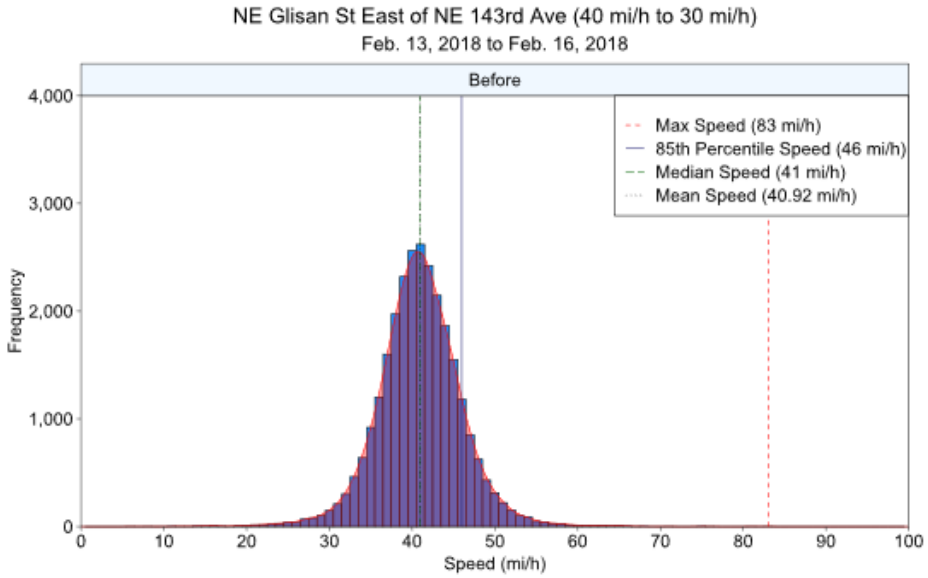


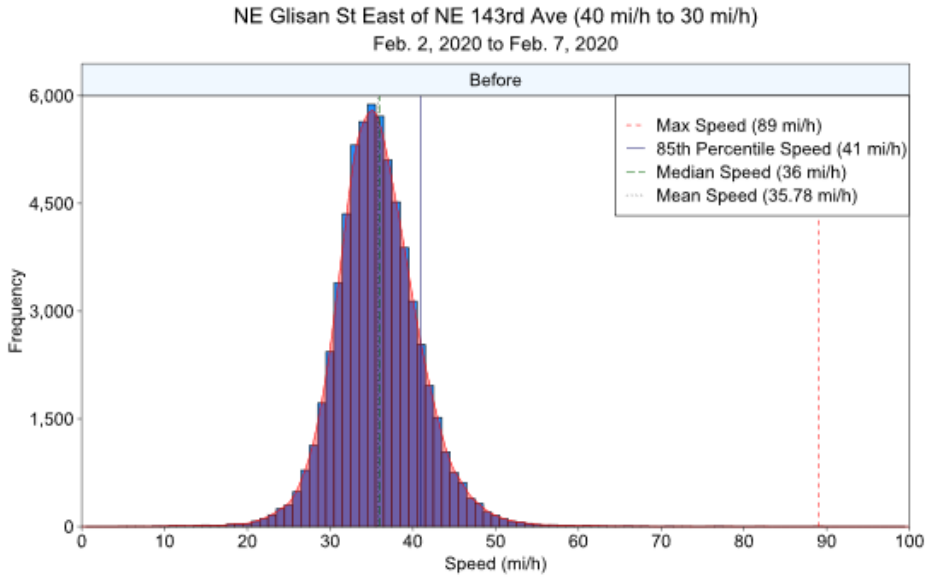
Figure A.9: Speed Distribution at (a) South of SE Mill St with Jul. 2018 Before Data and (b) South of SE Mill St with Aug. 2018 Before Data on the NE/SE 82nd Ave Speed Zone

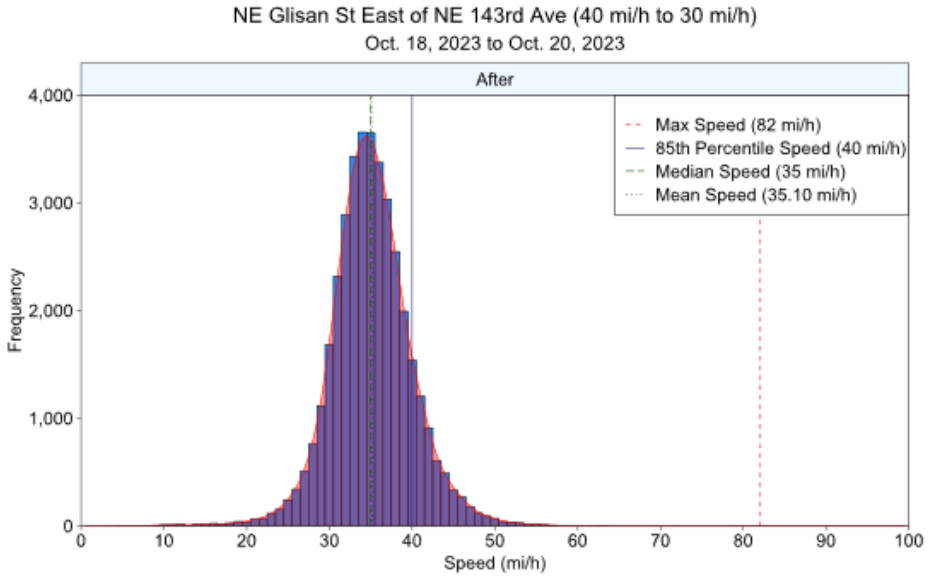


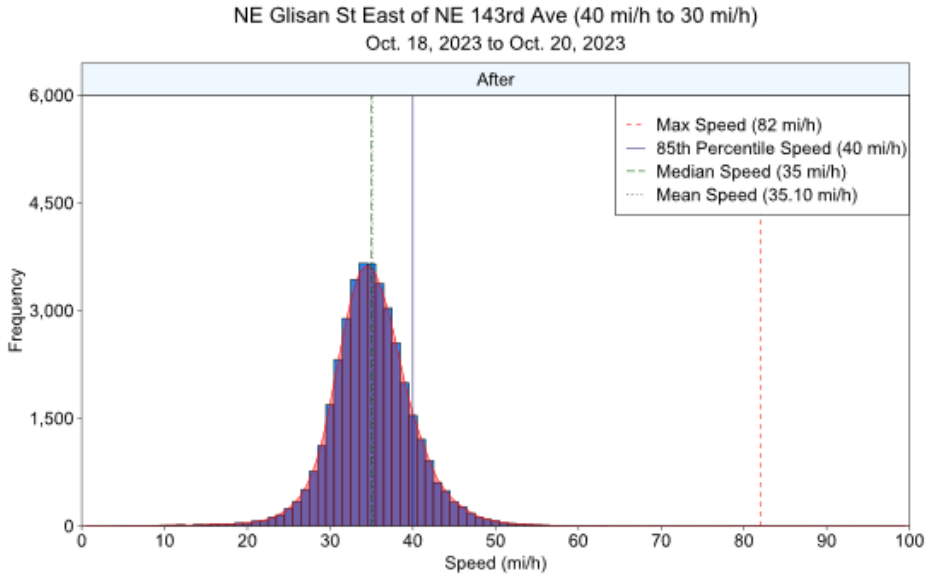
(a) **(b)**

Figure A.10: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) South of SE Mill St with Jul. 2018 Before Data and (b) South of SE Mill St with Aug. 2018 Before Data on the NE/SE 82nd Ave Speed Zone









(a) **(b)**

Figure A.11: Speed Distribution at (a) East of NE 143rd Ave with Feb. 2018 Before Data and (b) East of NE 143rd Ave with Feb. 2020 Before Data on the NE Glisan St Speed Zone

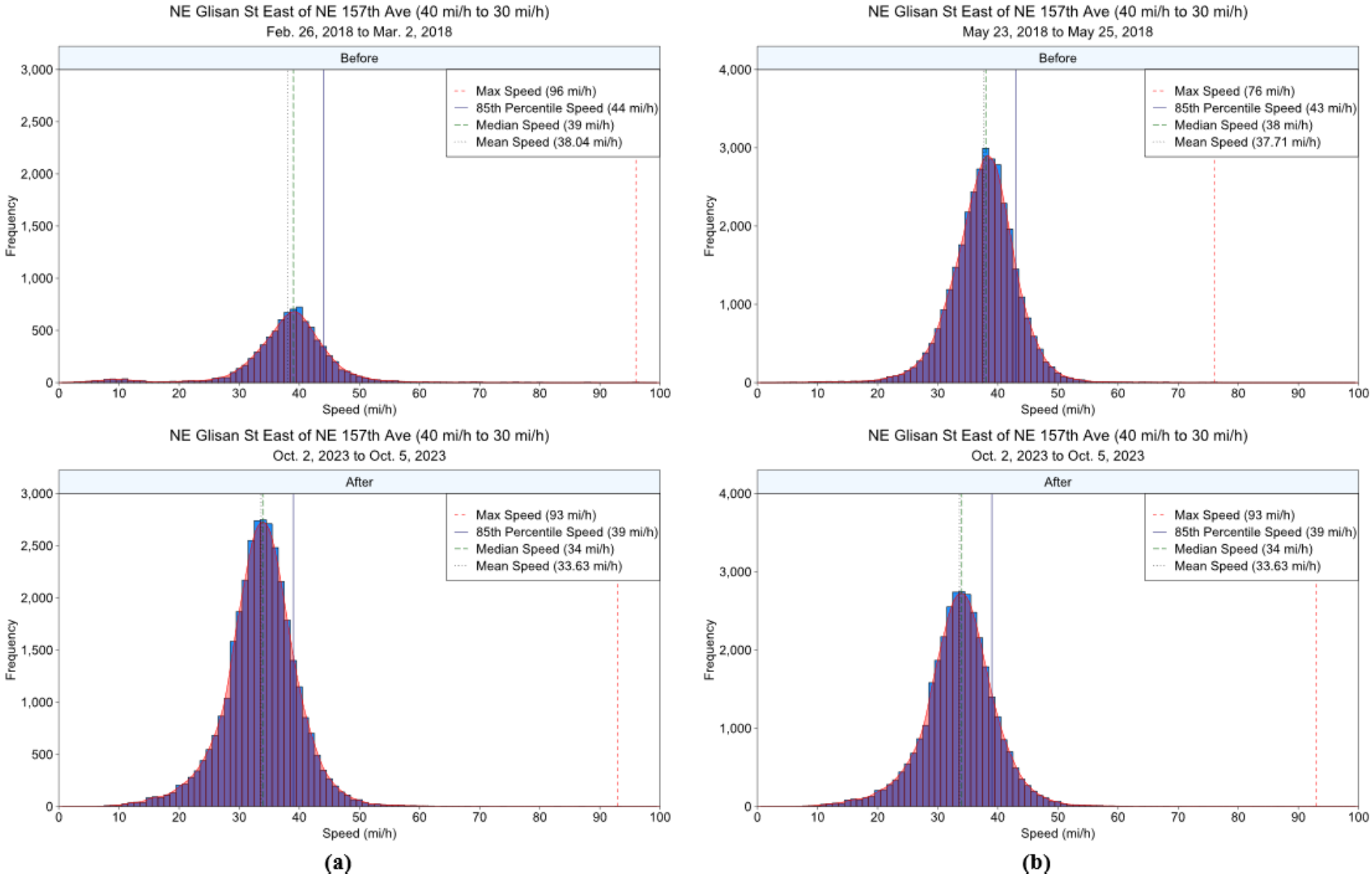


Figure A.12: Speed Distribution at (a) East of NE 157th Ave with Feb. 2018 Before Data and (b) East of NE 157th Ave with May 2018 Before Data on the NE Glisan St Speed Zone

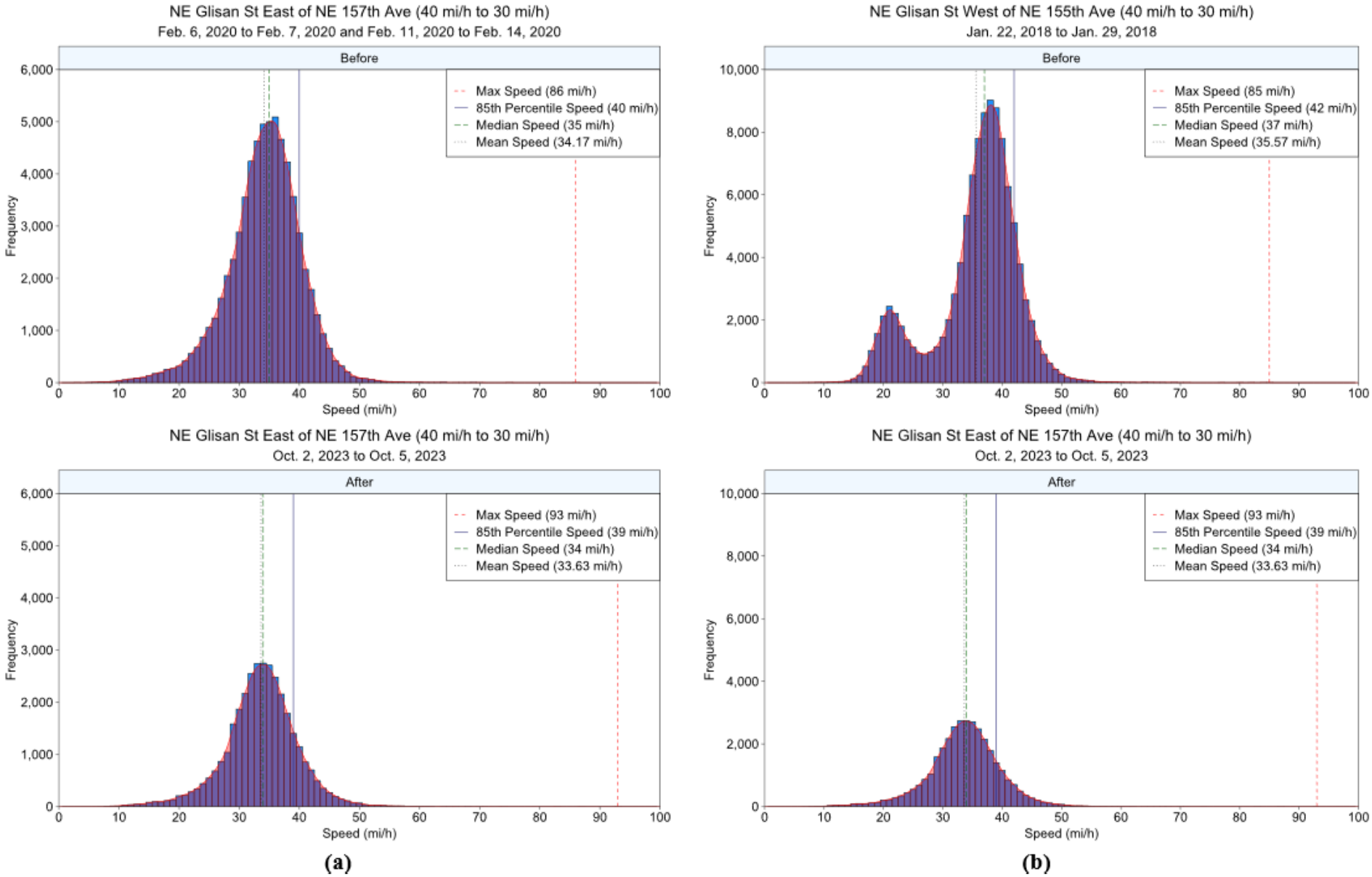


Figure A.13: Speed Distribution at (a) East of NE 157th Ave with Feb. 2020 Before Data and (b) West of NE 155th Ave with Jan. 2018 Before Data and East of NE 157th Ave on the NE Glisan St Speed Zone

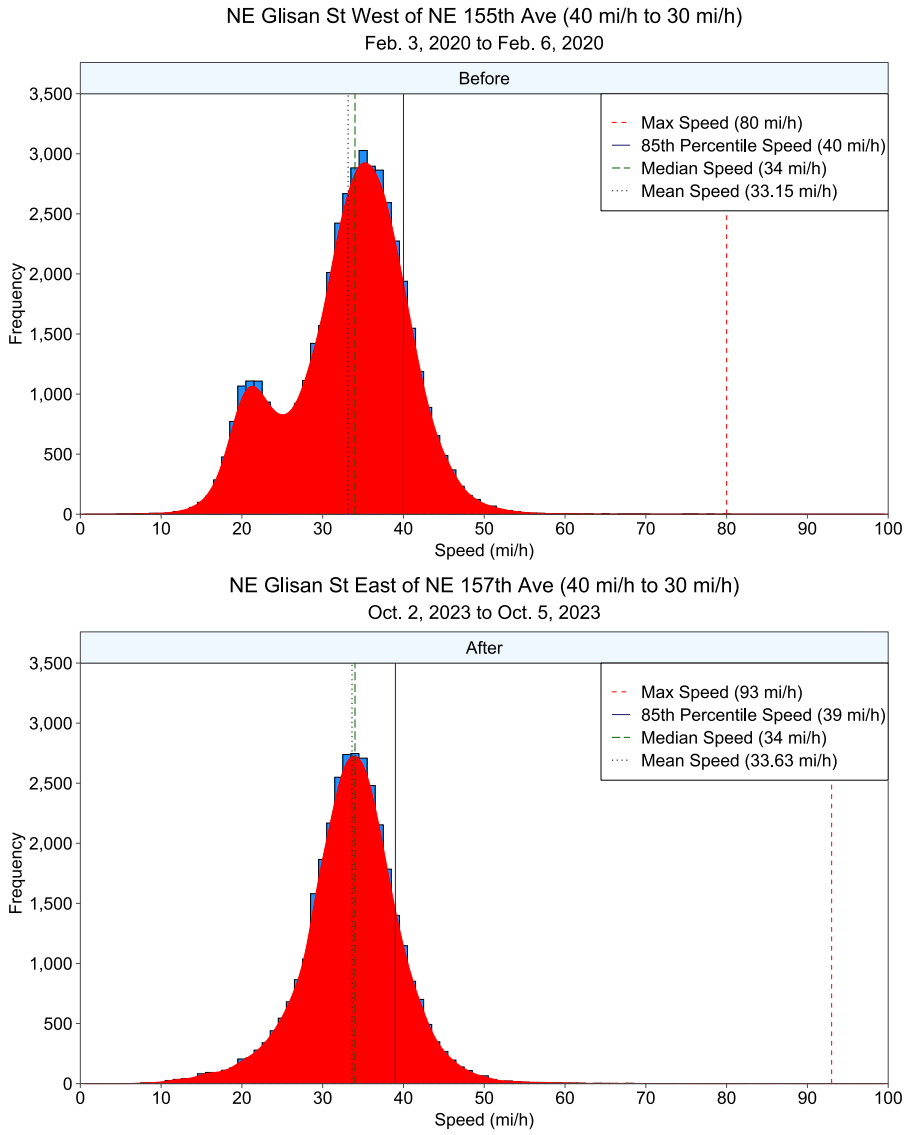


Figure A.14: Speed Distribution at West of NE 155th Ave with Feb. 2020 Before Data and East of NE 157th Ave on the NE Glisan St Speed Zone

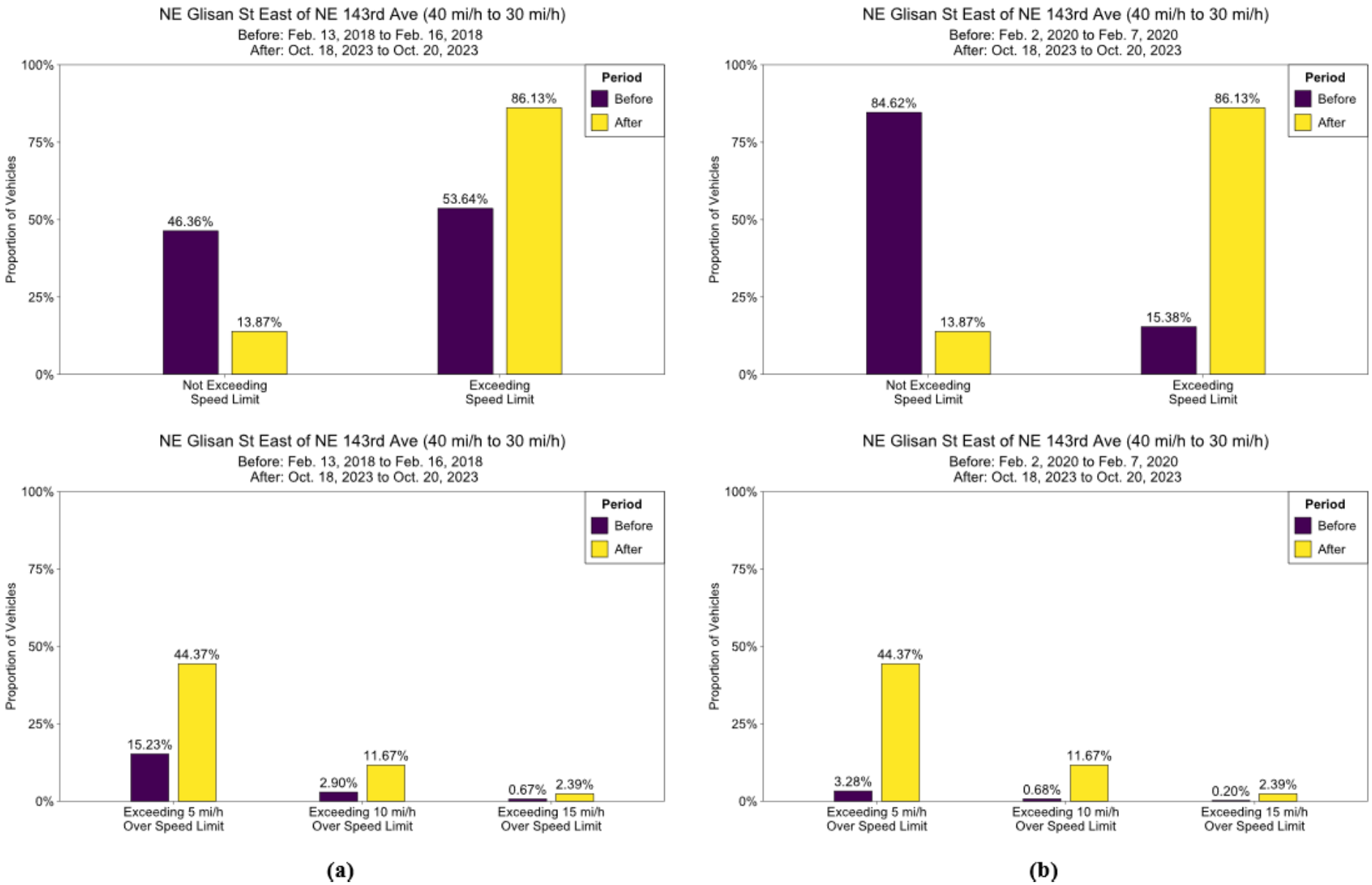


Figure A.15: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) East of NE 143rd Ave with Feb. 2018 Before Data and (b) East of NE 143rd Ave with Feb. 2020 Before Data on the NE Glisan St Speed Zone

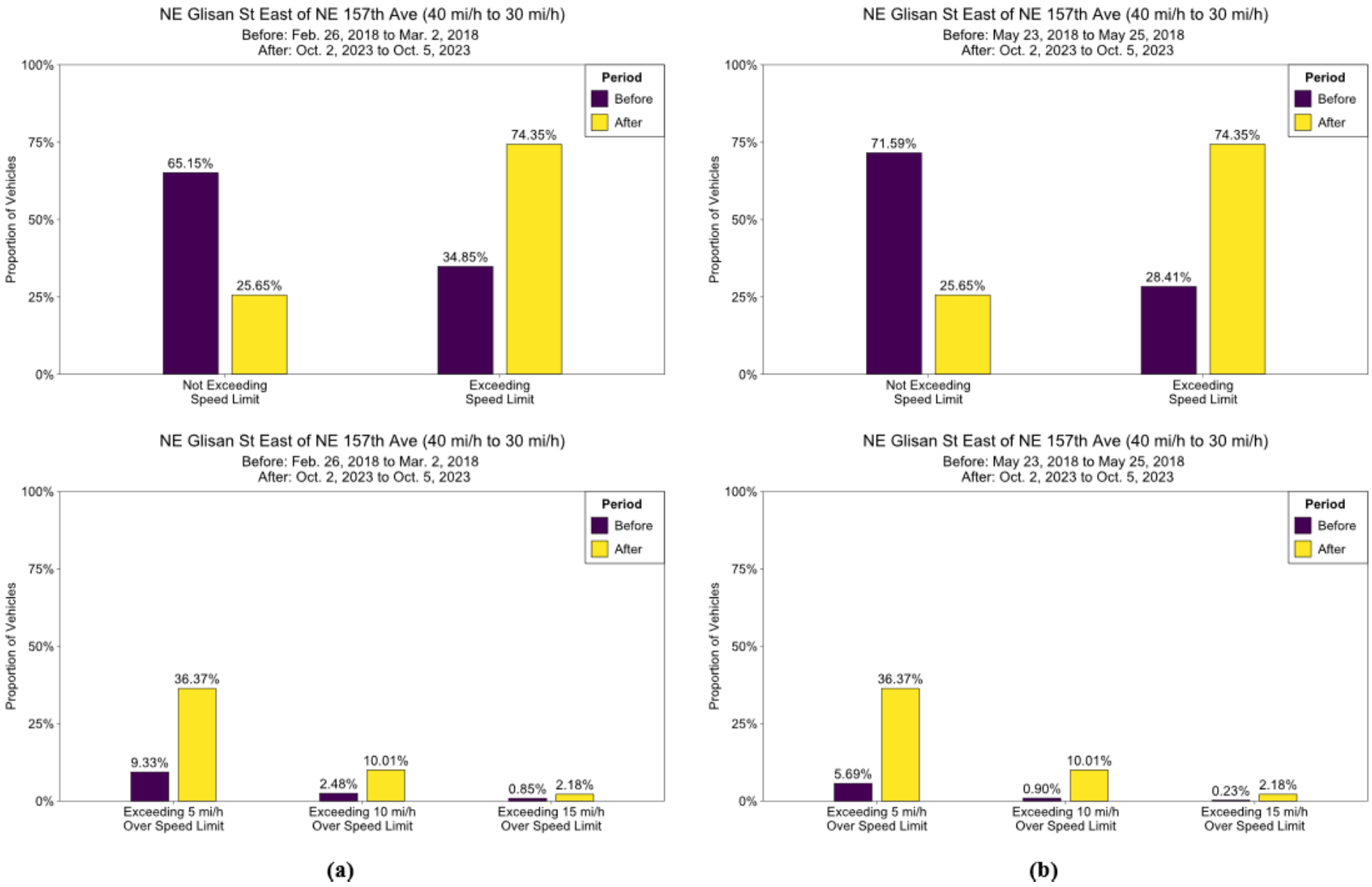


Figure A.16: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) East of NE 157th Ave with Feb. 2018 Before Data and (b) East of NE 157th Ave with May 2018 Before Data on the NE Glisan St Speed Zone

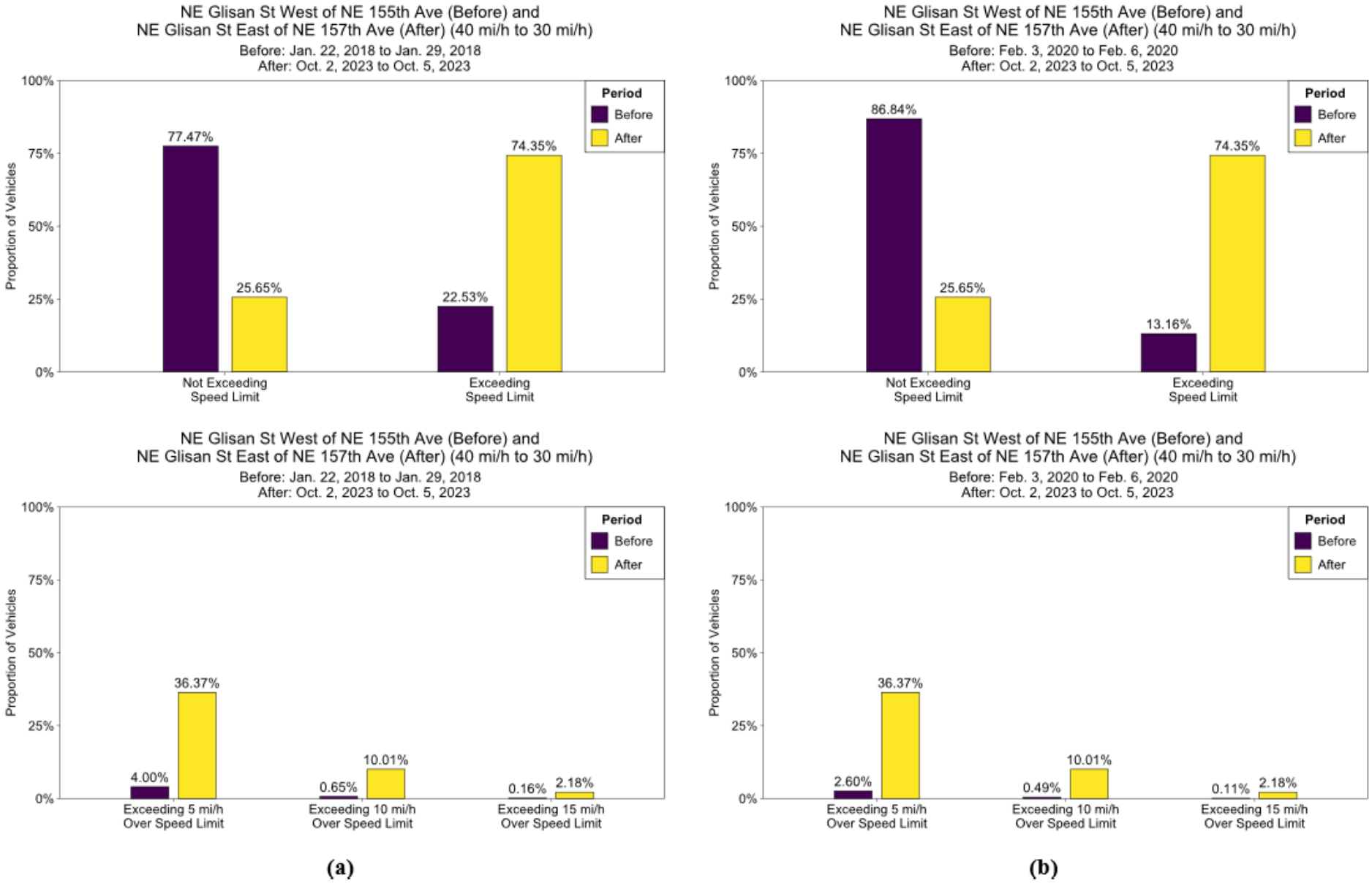


Figure A.17: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) West of NE 155th Ave with Jan. 2018 Before Data and East of NE 157th Ave, and (b) West of NE 155th Ave with Feb. 2020 Before Data and East of NE 157th Ave on the NE Glisan St Speed Zone

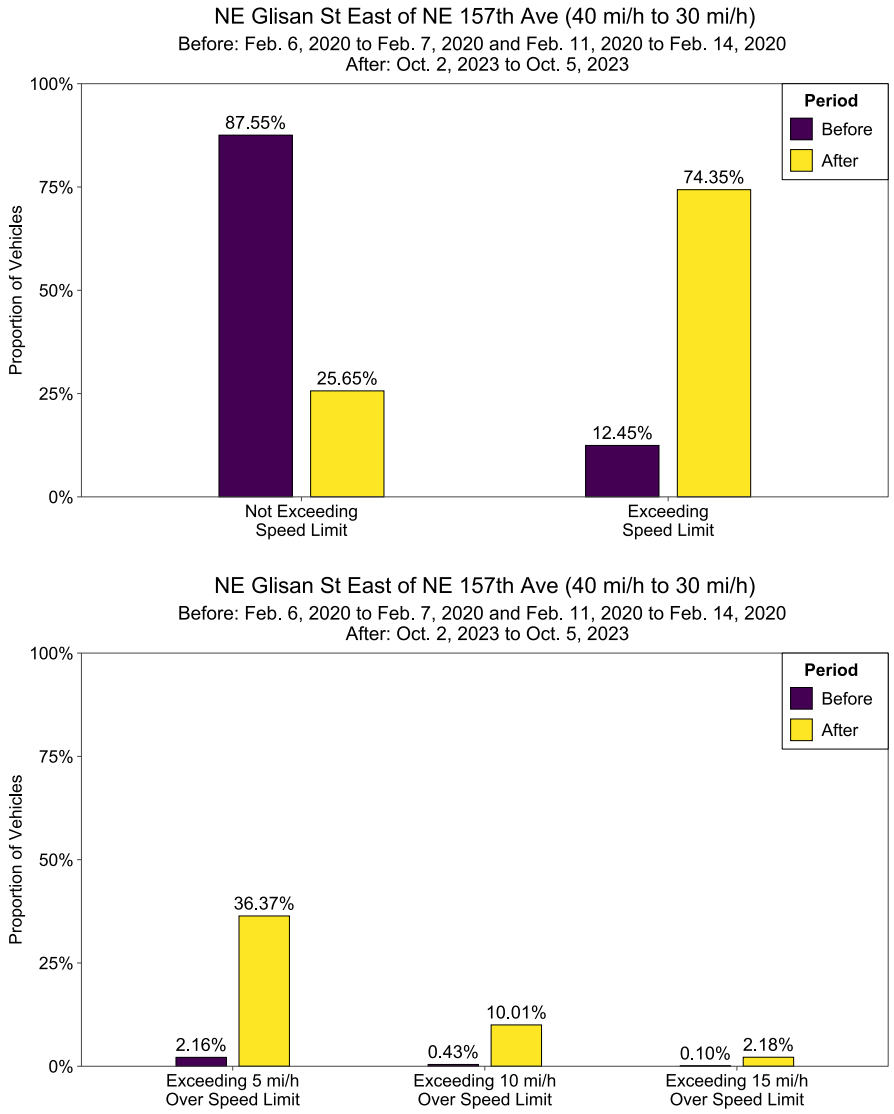


Figure A.18: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at East of NE 157th Ave with Feb. 2020 Before Data on the NE Glisan St Speed Zone

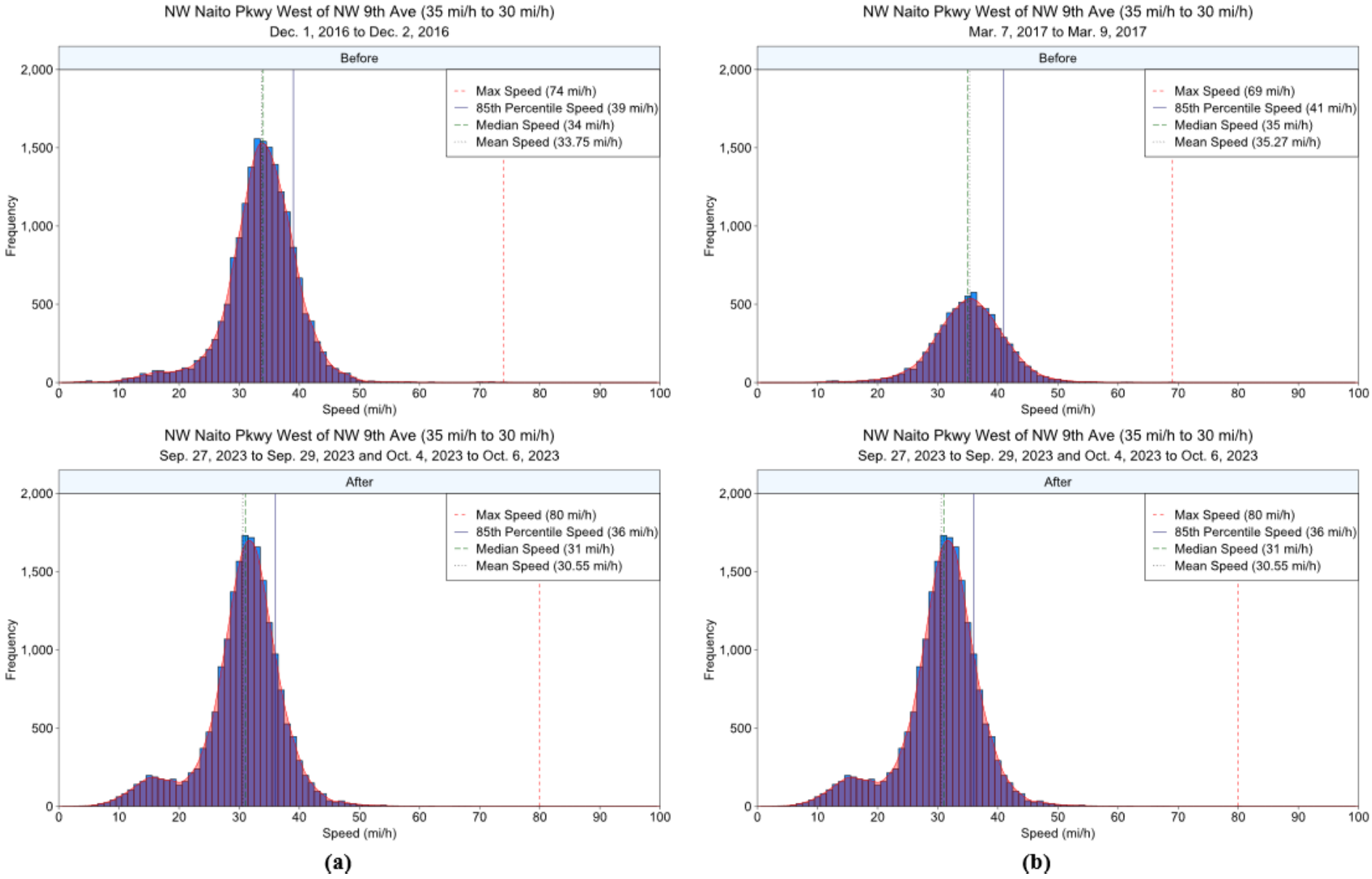
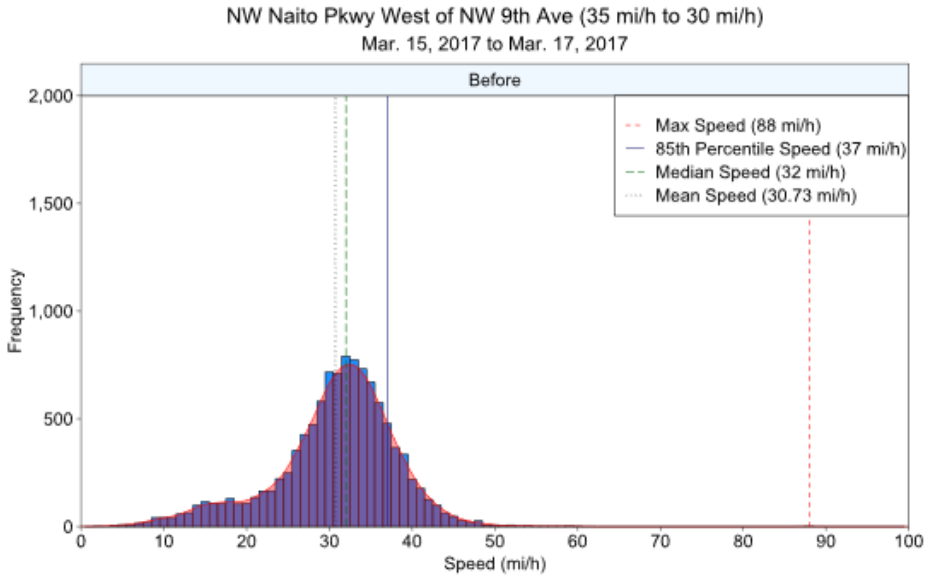
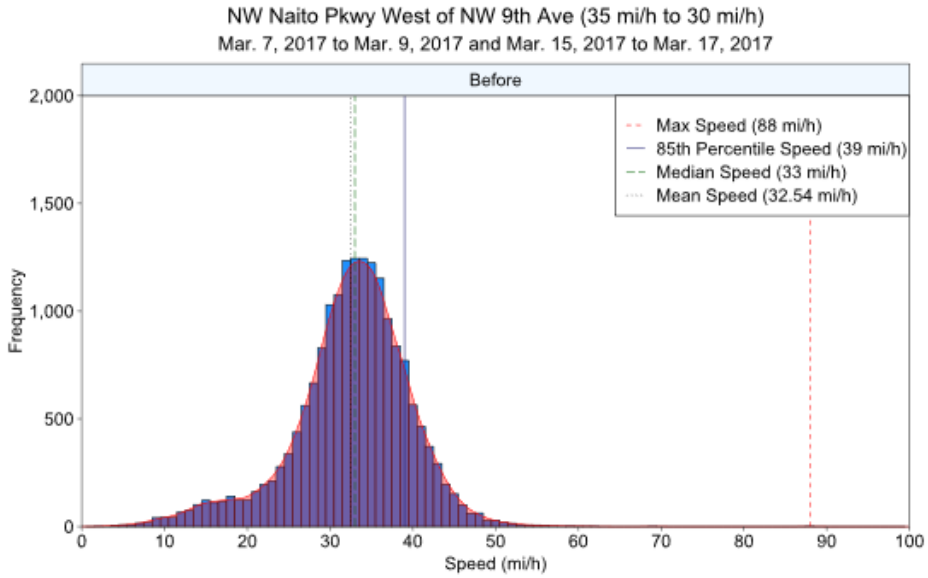
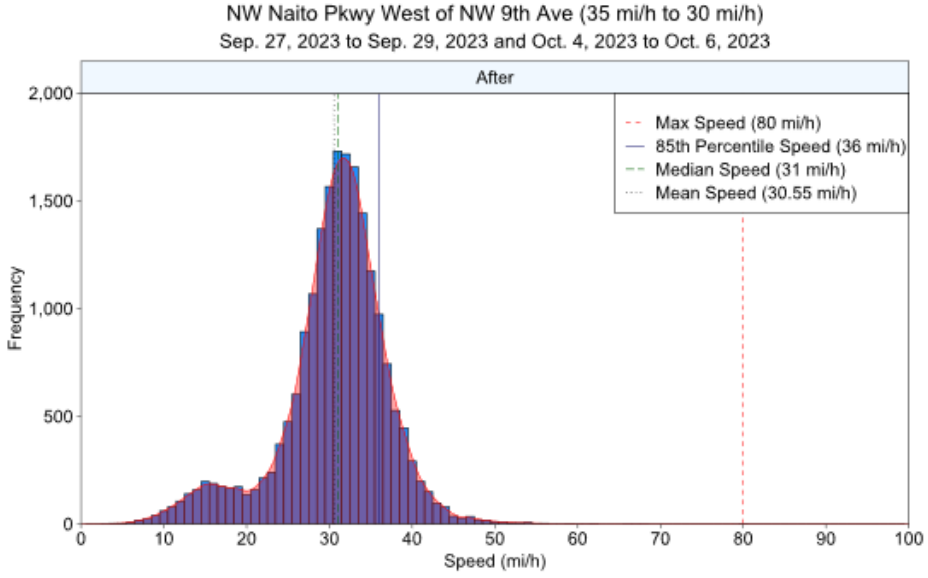
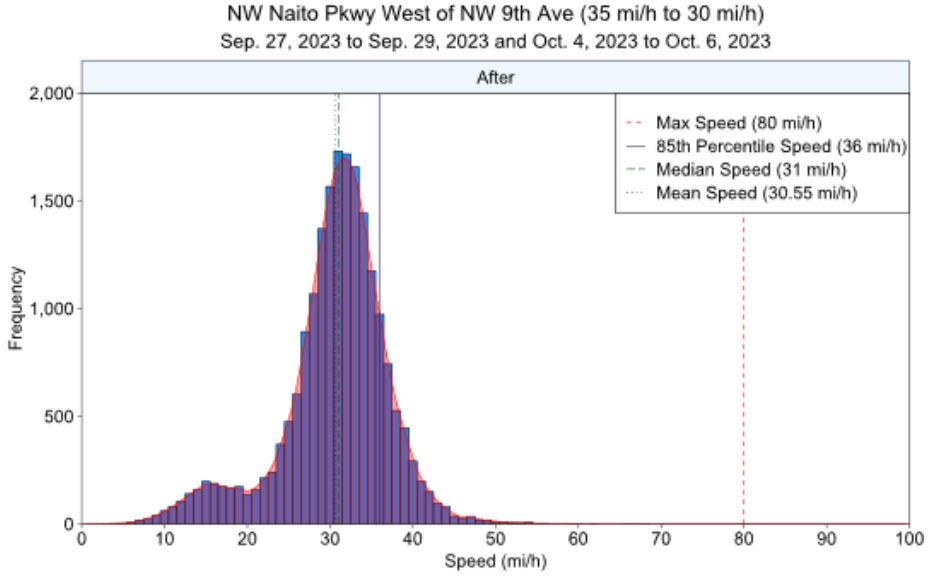


Figure A.19: Speed Distribution at (a) West of 9th Ave with Dec. 2016 Before Data and (b) West of 9th Ave with Mar. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone









(a) **(b)**

Figure A.20: Speed Distribution at (a) West of 9th Ave with Mar. 2017 Before Data and (b) West of 9th Ave with All Mar. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone

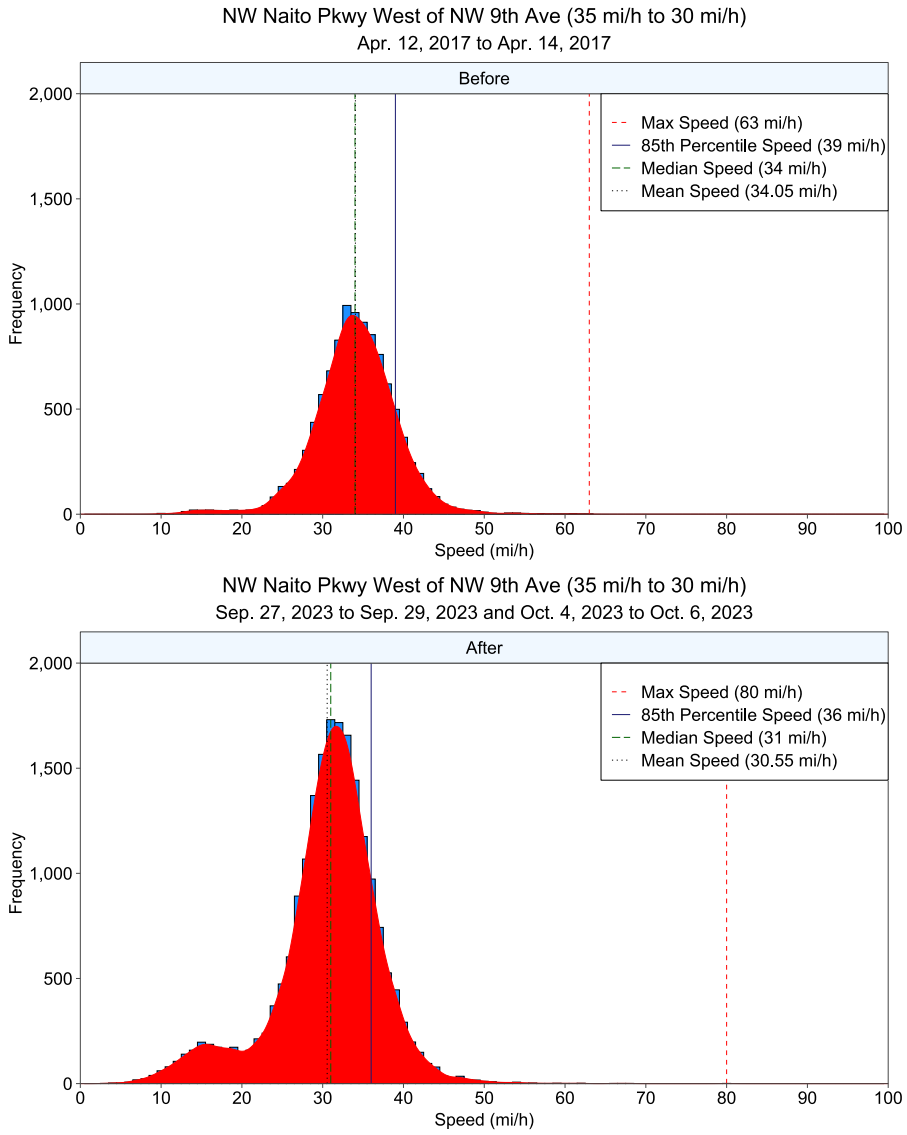


Figure A.21: Speed Distribution at West of 9th Ave with Apr. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone

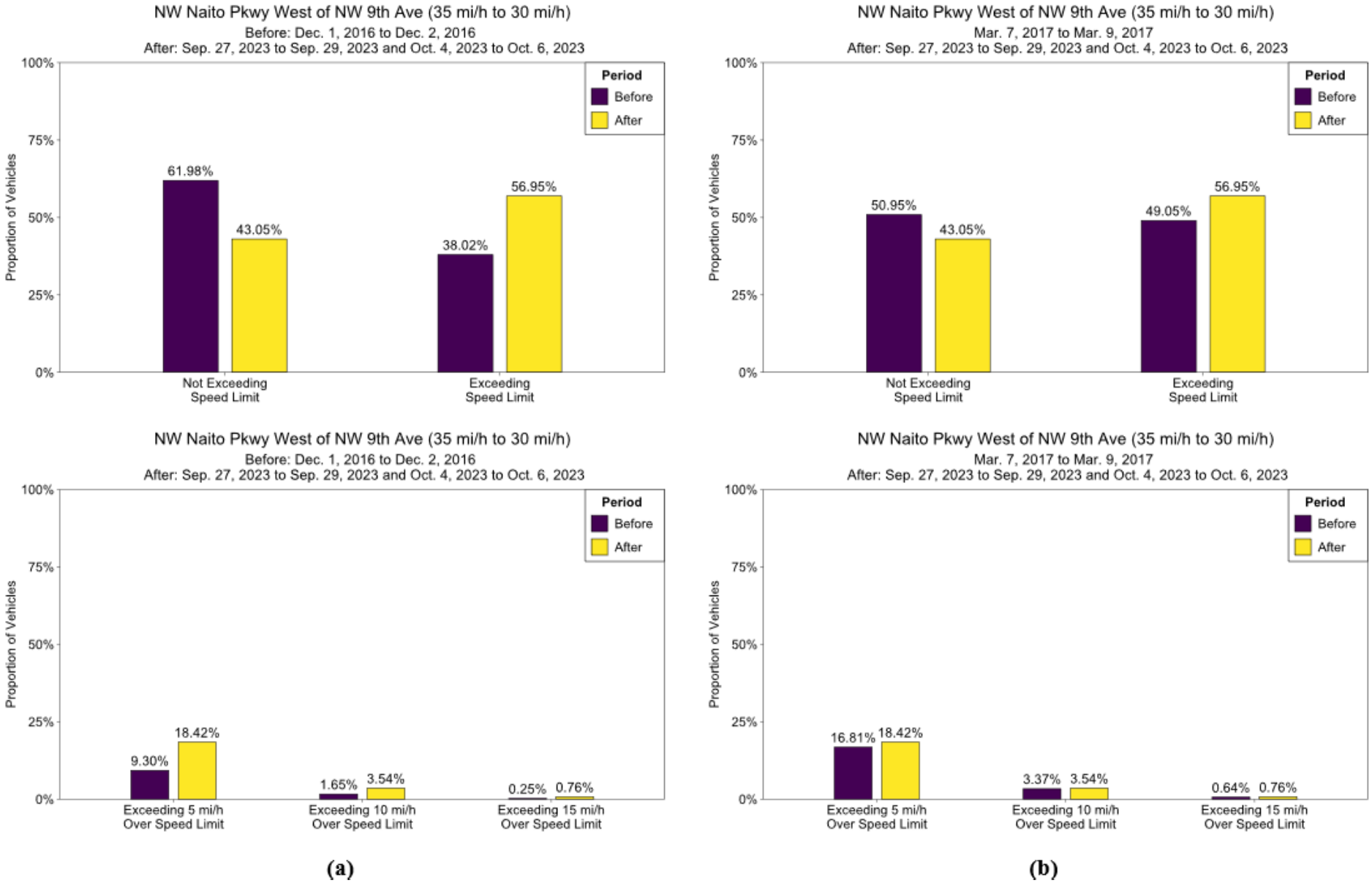


Figure A.22: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) West of 9th Ave with Dec. 2016 Before Data and (b) West of 9th Ave with Mar. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone

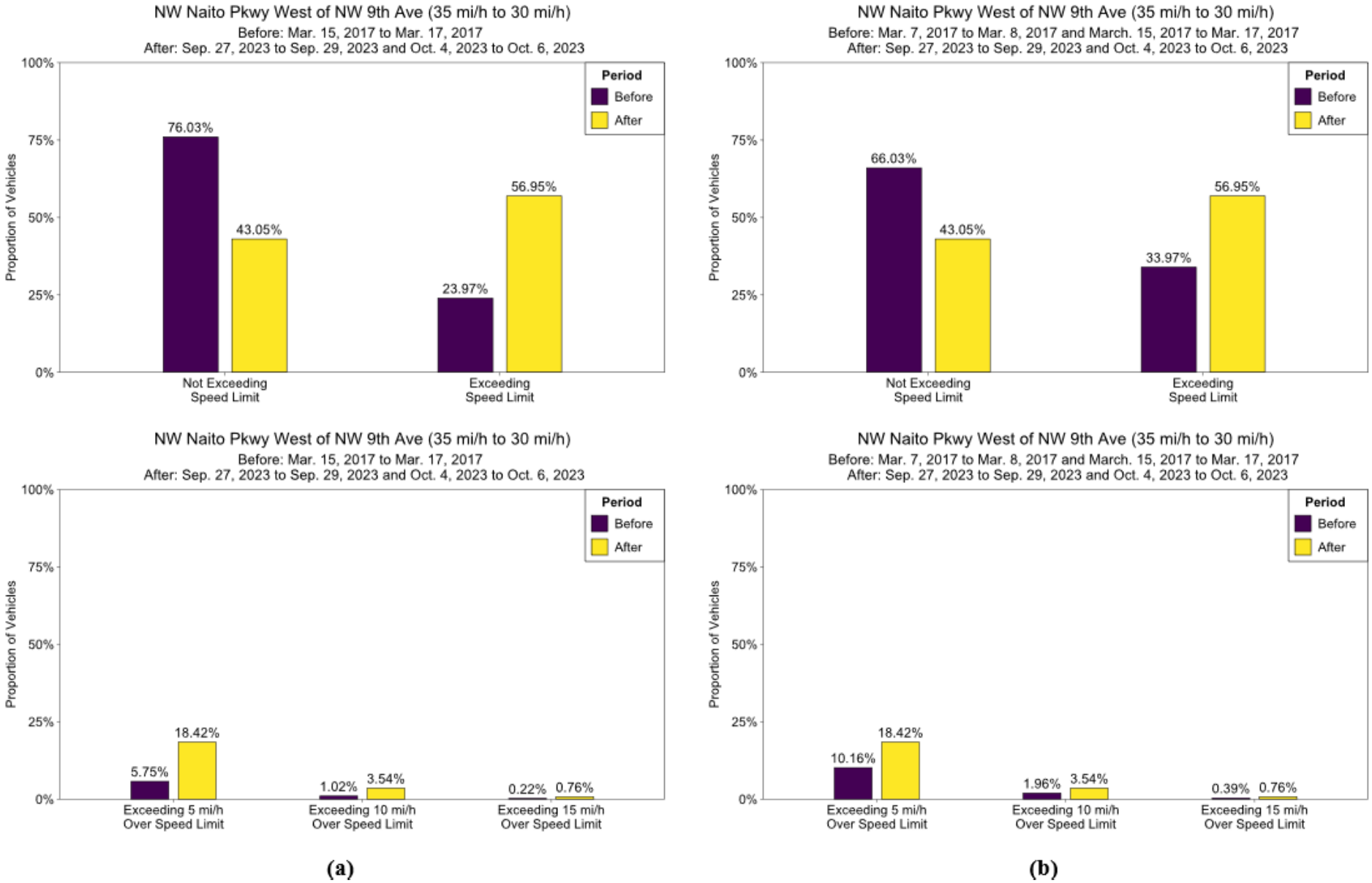


Figure A.23: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) West of 9th Ave with Mar. 2017 Before Data and (b) West of 9th Ave with All Mar. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone

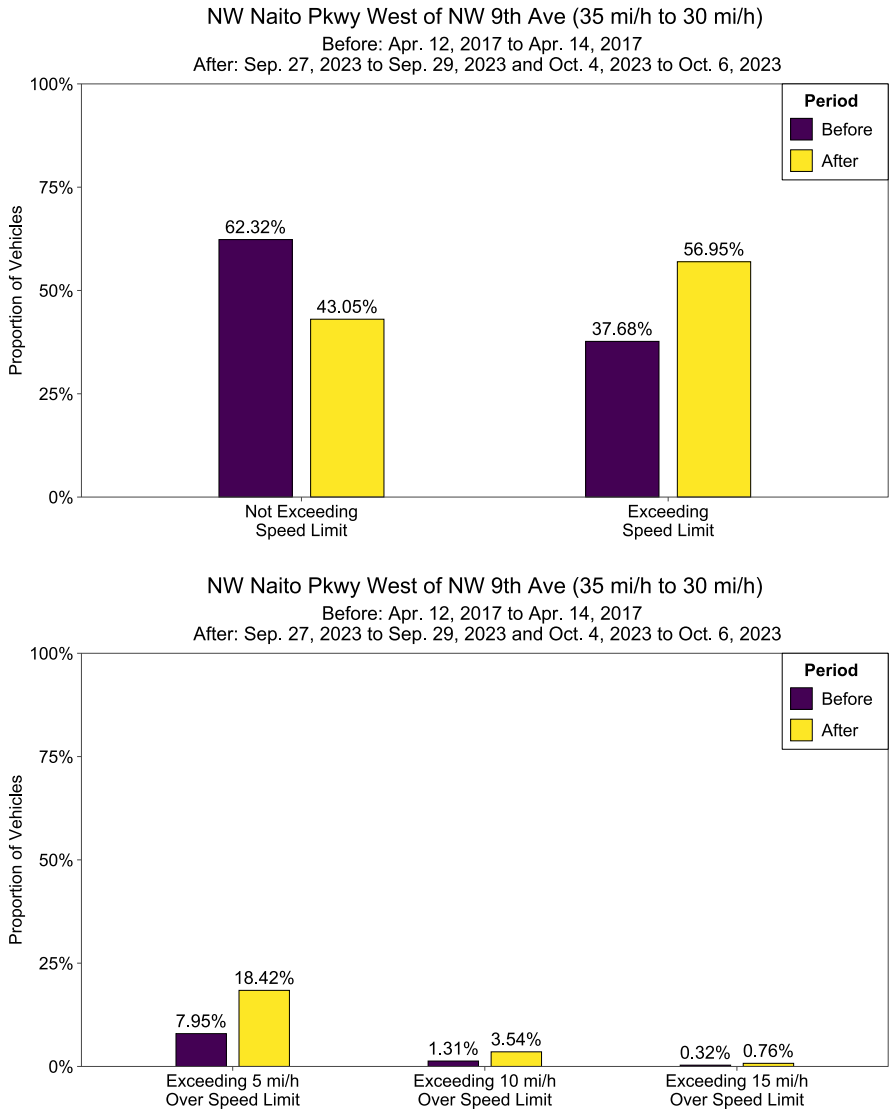


Figure A.24: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at West of 9th Ave with Apr. 2017 Before Data on the NW Front Ave/NW Naito Pkwy Speed Zone

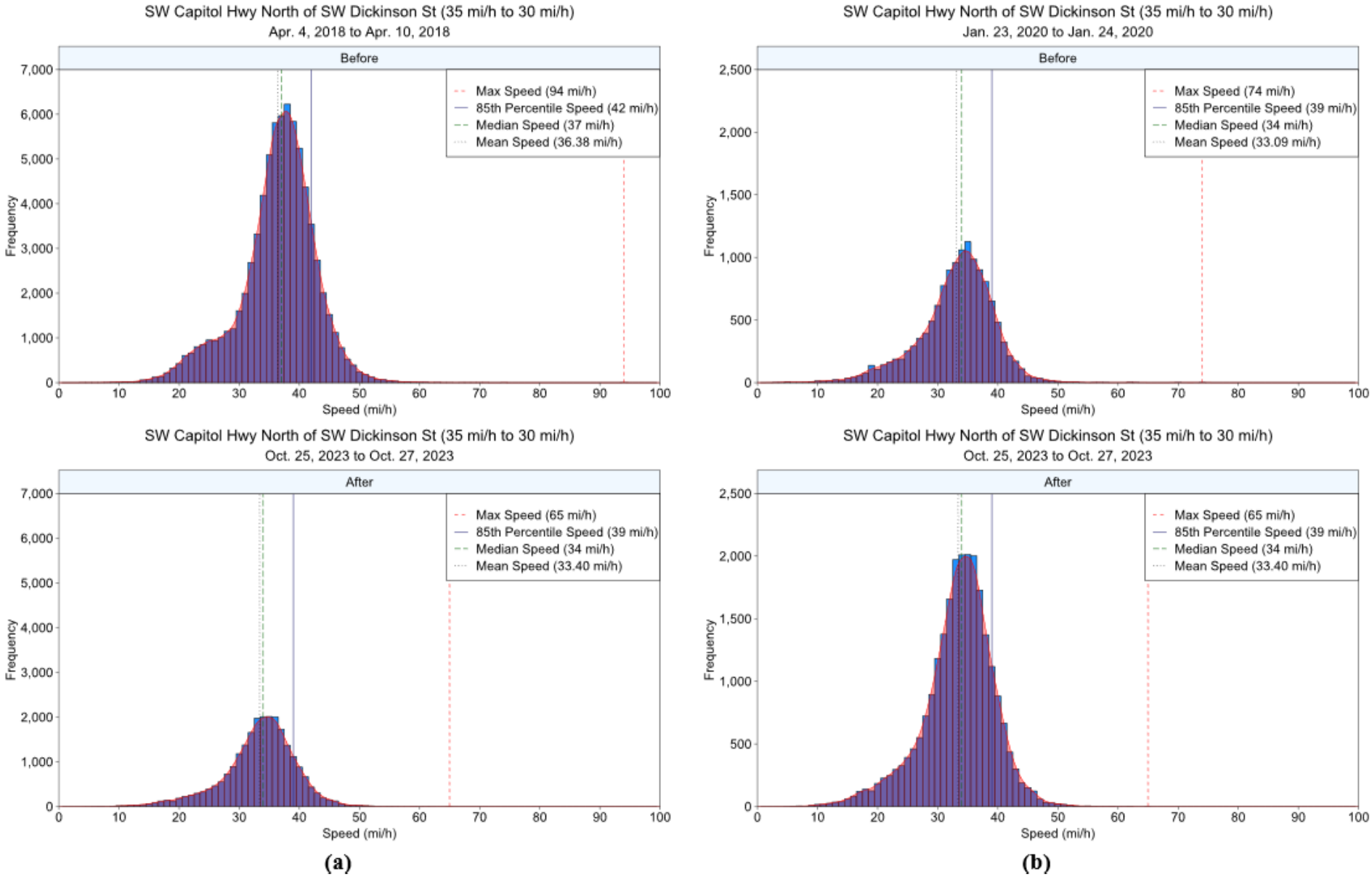


Figure A.25: Speed Distribution at (a) North of SW Dickinson St with Apr. 2018 Before Data and (b) North of SW Dickinson St with Jan. 2020 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone

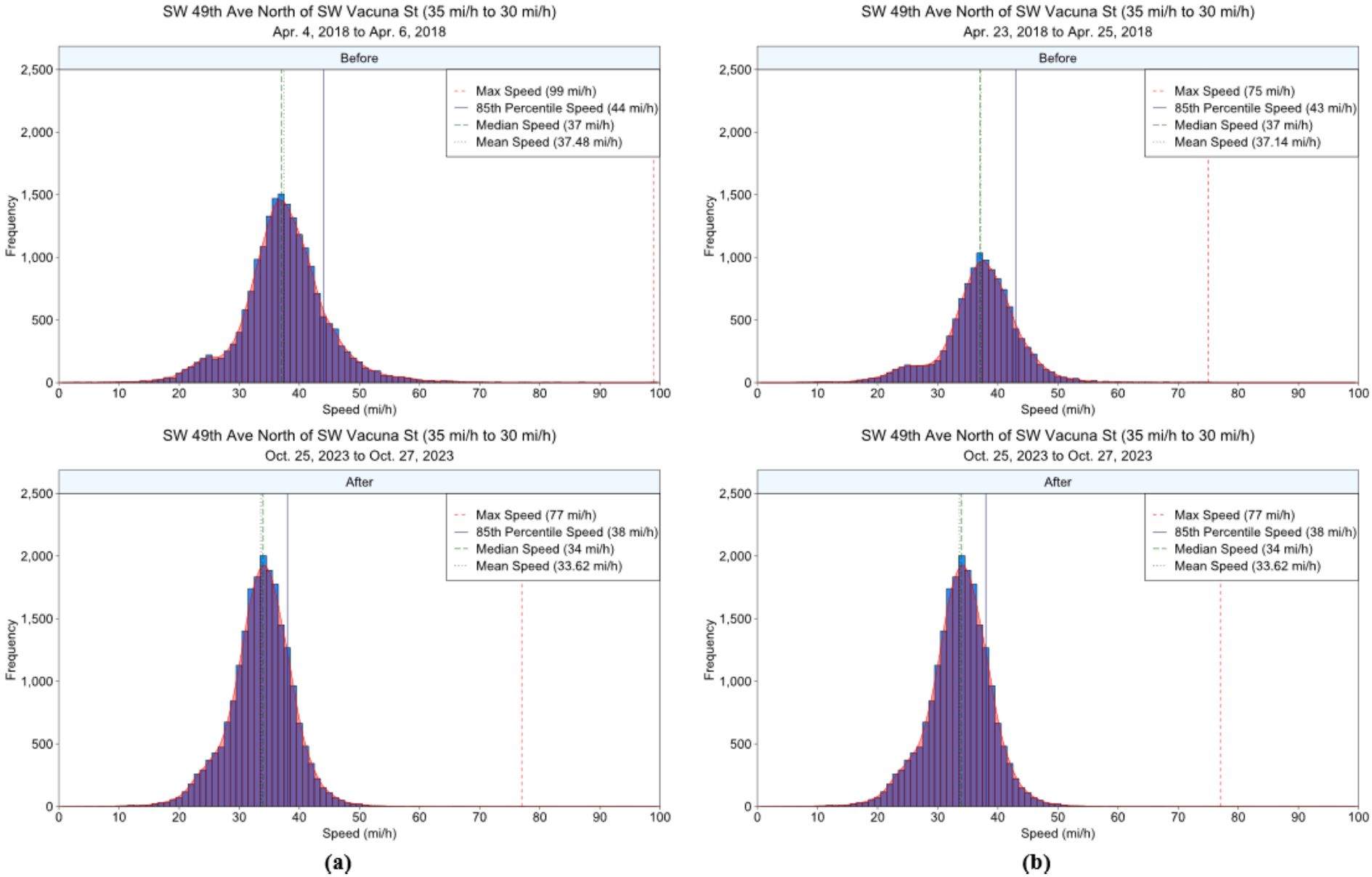


Figure A.26: Speed Distribution at (a) North of SW Vacuna St with Apr. 2018 Before Data and (b) North of SW Vacuna St with Apr. 2018 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone

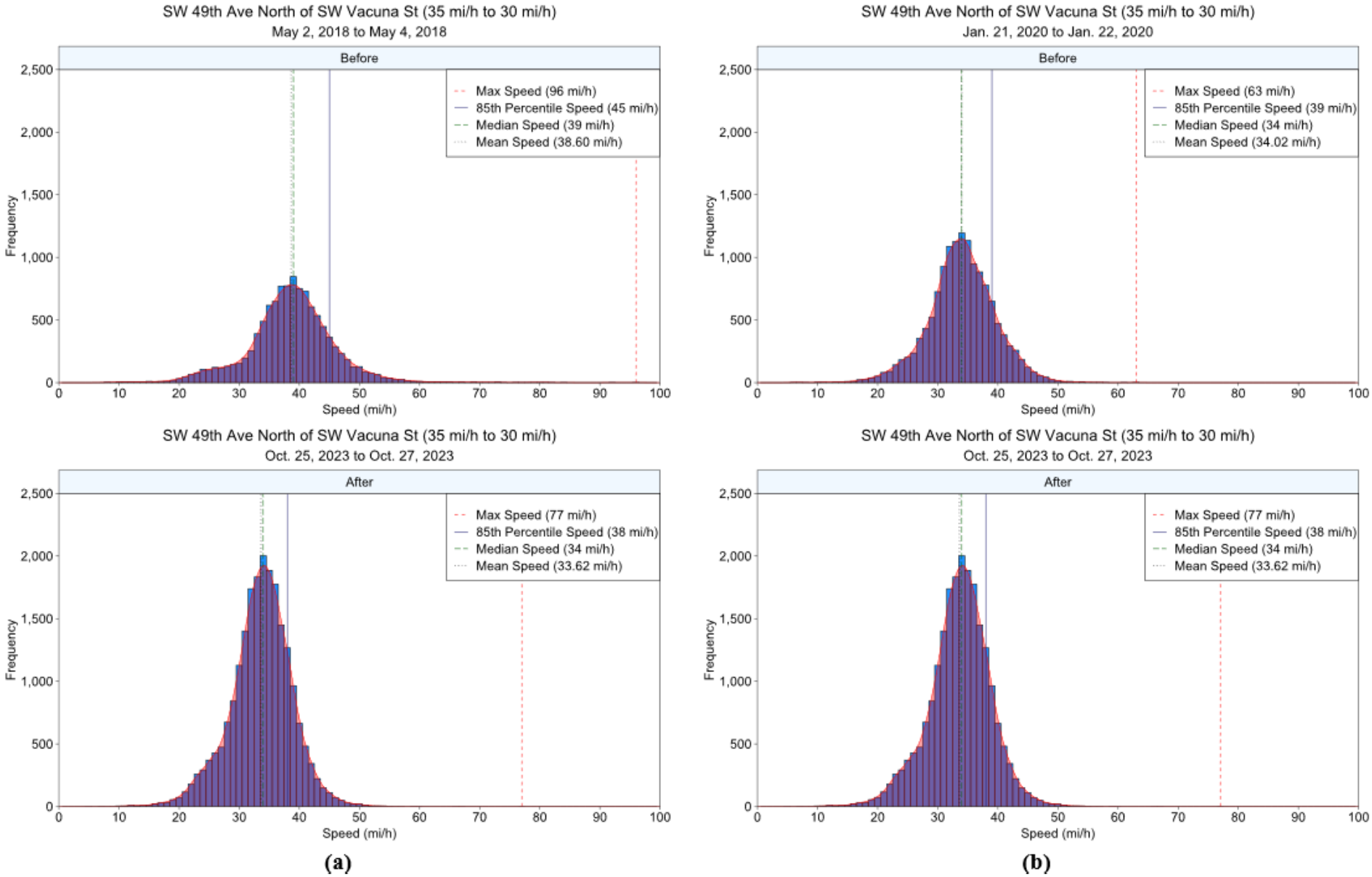


Figure A.27: Speed Distribution at (a) North of SW Vacuna St with May 2018 Before Data and (b) North of SW Vacuna St with Jan. 2020 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone

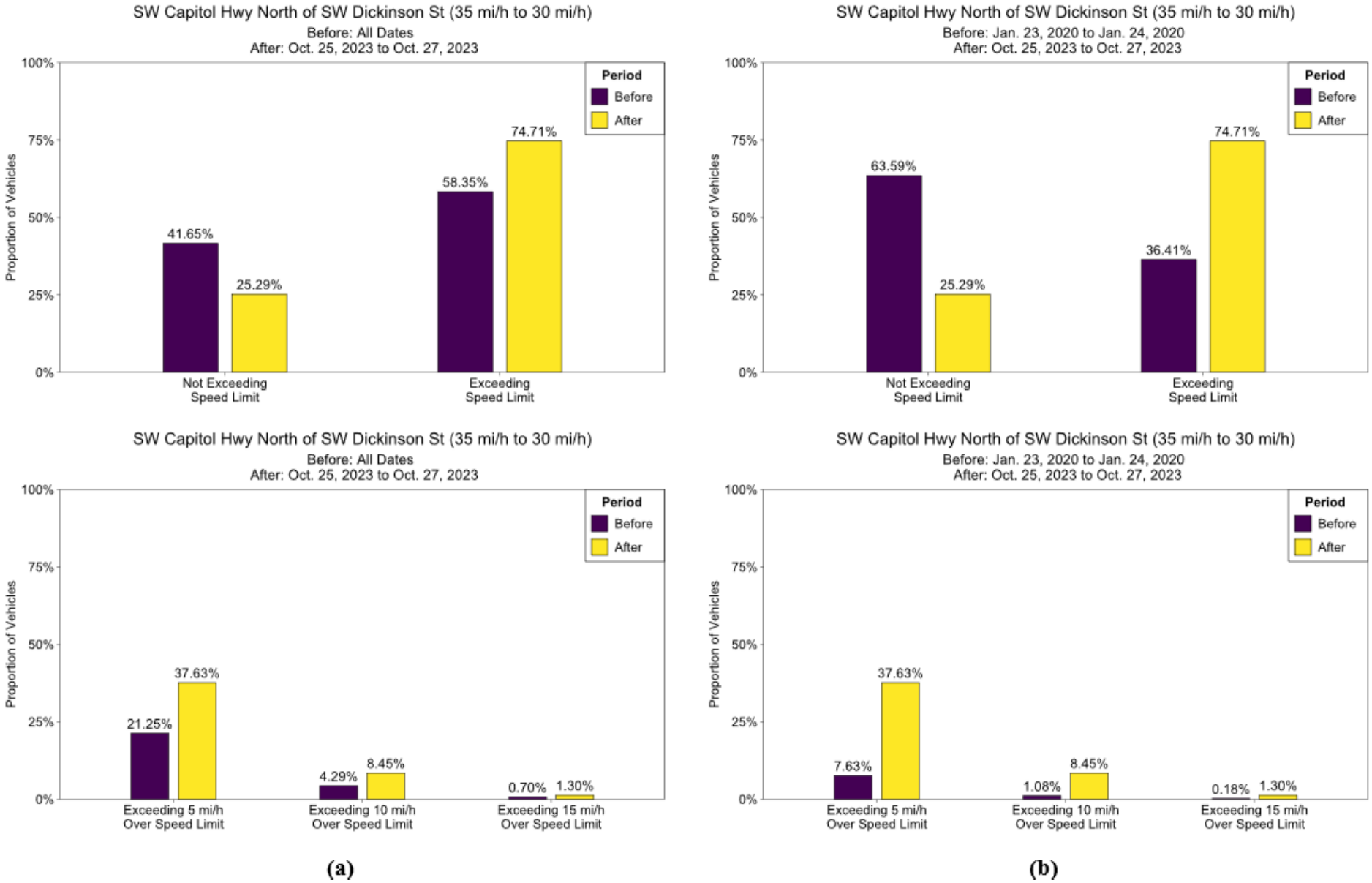
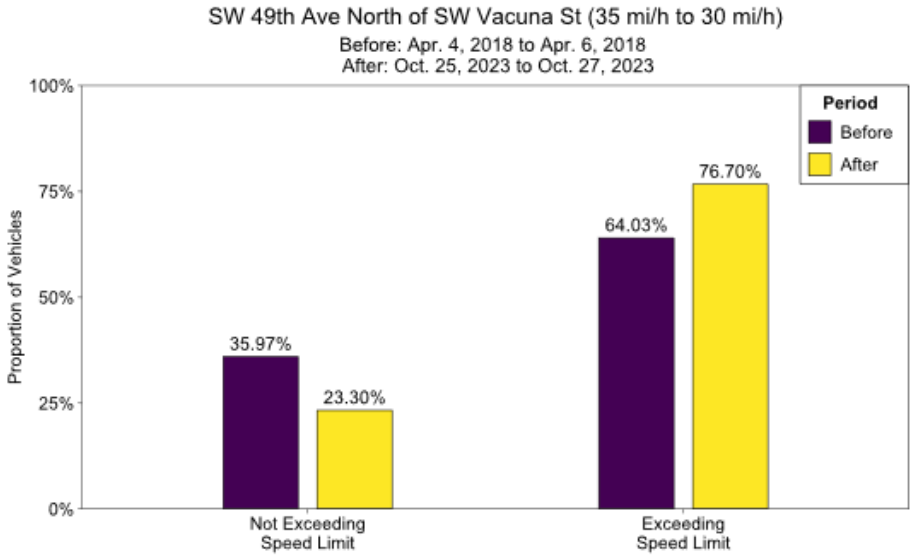
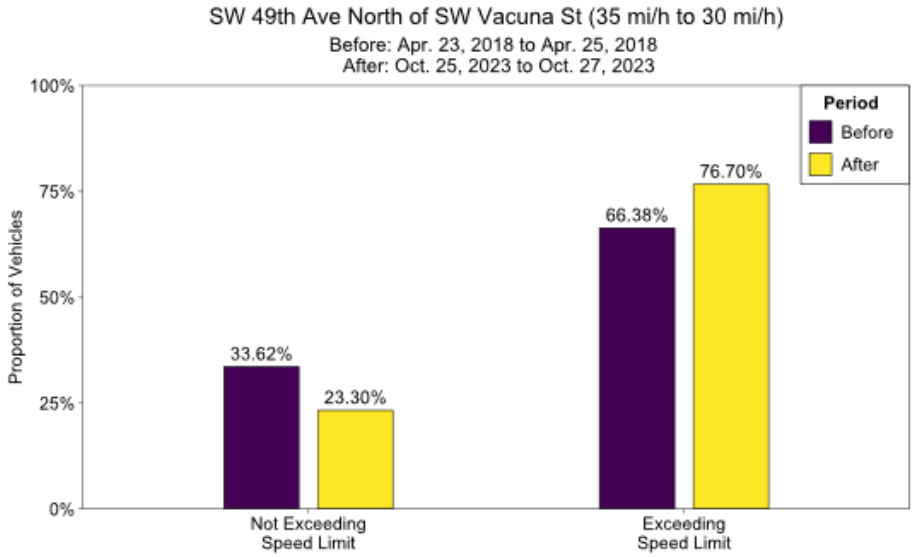
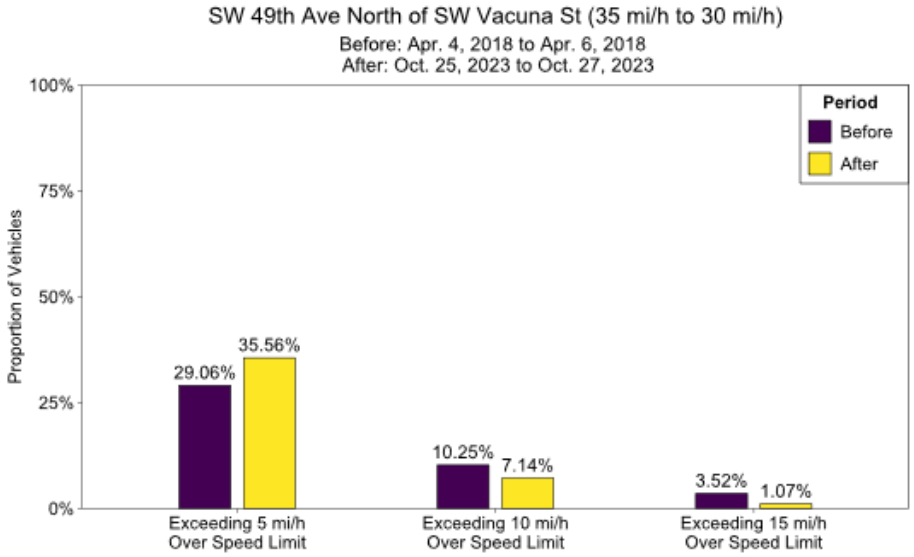
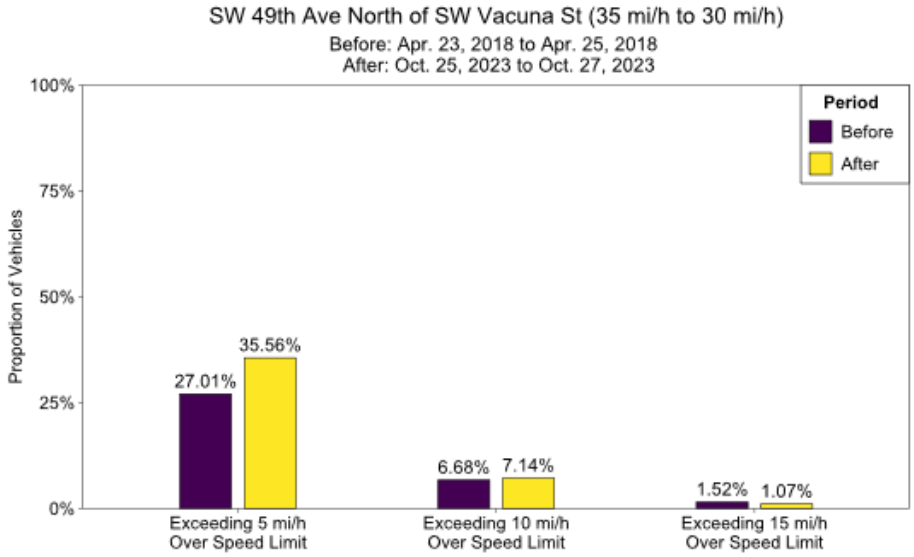


Figure A.28: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) North of SW Dickinson St with Apr. 2018 Before Data and (b) North of SW Dickinson St with Jan. 2020 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone



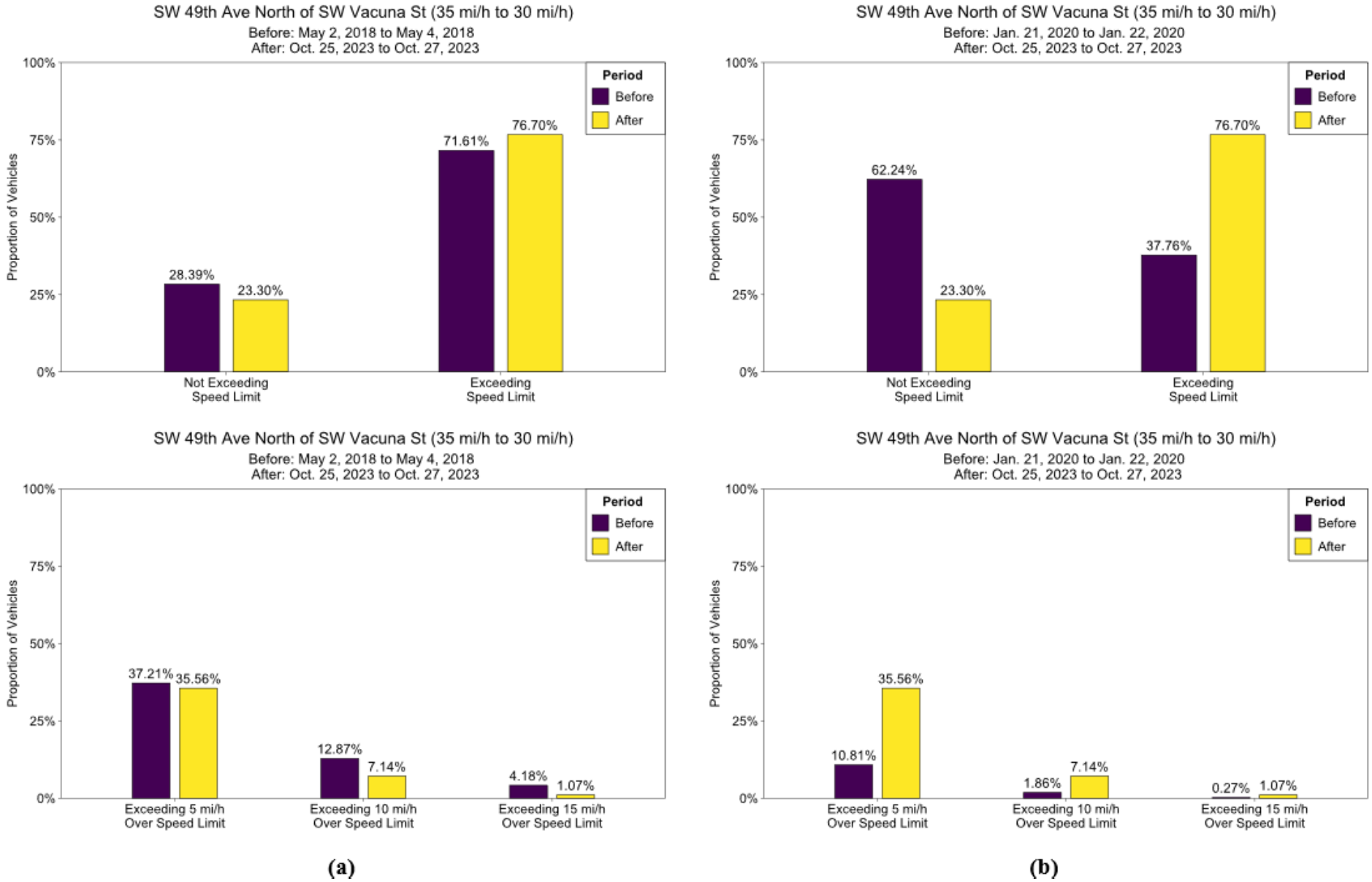






(a) **(b)**

Figure A.29: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) North of SW Vacuna St with Apr. 2018 Before Data and (b) North of SW Vacuna St with Apr. 2018 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone



(a) **(b)**

Figure A.30: Proportion of Vehicles Exceeding Speed Limit and Exceeding Speed Thresholds at (a) North of SW Vacuna St with May 2018 Before Data and (b) North of SW Vacuna St with Jan. 2020 Before Data on the SW Capitol Hwy/SW 49th Ave Speed Zone

APPENDIX B

Table B.1 shows the results of the simple before-after analysis, that includes SE Powell Blvd, on speed zone segments with a 35 mi/h to 30 mi/h reduction. Results show an estimated CMF of 0.786 with a standard deviation of 0.064. The 95% confidence interval does not include the value 1.0.

Table B.1: Simple-Before After Analysis for Speed Zones with 35 mi/h to 30 mi/h Reduction (Including SE Powell Blvd)

Parameter	Value
Number of Speed Zones	8
Total Number of Crashes in the After Period (λ)	179
Total Number of Crashes in the Before Period (π)	227.58
Estimated Change in the Total Number of Crashes (δ)	48.58
CMF (Index of Effectiveness) (θ)	0.786
Standard Deviation of δ	15.33
Standard Deviation of θ	0.064
CMF +/1 1 Std. Dev.	0.722 to 0.850
CMF 95% Confidence Interval	0.660 to 0.911

Table B.2 shows the results of the simple before-after analysis, that includes SE Powell Blvd, on all speed zone segments regardless of reduction. Results show an estimated CMF of 0.853 with a standard deviation of 0.060. The 95% confidence interval does not include the value 1.0.

Table B.2: Simple-Before After Analysis for all Speed Zones (Including SE Powell Blvd)

Parameter	Value
Number of Speed Zones	10
Total Number of Crashes in the After Period (λ)	244
Total Number of Crashes in the Before Period (π)	285.89
Estimated Change in the Total Number of Crashes (δ)	41.89
CMF (Index of Effectiveness) (θ)	0.853
Standard Deviation of δ	17.82
Standard Deviation of θ	0.060
CMF +/1 1 Std. Dev.	0.792 to 0.913
CMF 95% Confidence Interval	0.735 to 0.971

APPENDIX C

Table C.1: Binary Logit Specifications for Speeding in 35 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	1.206	0.017	70.96		
After Sign Installation					
1 if after speed zone sign installed	1.273	0.004	320.42	3.570	0.262
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.397	0.006	-62.27	0.672	-0.079
1 if 10:00 a.m. to 4:00 p.m.	-0.581	0.006	-104.33	0.559	-0.115
1 if 4:00 p.m. to 8:00 p.m.	-0.677	0.006	-115.49	0.508	-0.134
Time-of-Week					
1 if Tuesday	-0.111	0.007	-16.01	0.895	-0.022
1 if Wednesday	-0.105	0.007	-15.29	0.900	-0.021
1 if Thursday	-0.034	0.007	-4.57	0.967	-0.007
1 if Friday	0.186	0.009	20.43	1.205	0.037
Spot Speed Location					
NE 102nd Ave Speed Zone					
1 if NE 102nd Ave North of NE Shaver St	-0.401	0.017	-24.00	0.670	-0.079
NE/SE 122nd Ave Speed Zone					
1 if NE 122nd Ave North of NE Broadway	-1.578	0.017	-92.03	0.206	-0.290
1 if NE 122nd Ave South of NE Holladay St	0.035	0.020	1.75	1.036	0.007
1 if SE 122nd Ave South of SE Raymond St	-1.762	0.017	-103.99	0.172	-0.325
NE/SE 82nd Ave Speed Zone					
1 if NE 82nd Ave South of NE Beech St	-2.734	0.018	-155.15	0.065	-0.445
1 if NE 82nd Ave South of NE Davis St	-2.007	0.017	-119.48	0.134	-0.359
1 if NE 82nd Ave South of NE Eugene St	-1.699	0.017	-102.57	0.183	-0.314
1 if SE 82nd Ave South of SE Knapp St	-1.847	0.019	-98.14	0.158	-0.330
1 if SE 82nd Ave South of SE Mill St	-1.280	0.017	-76.25	0.278	-0.242
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 85th Ave	-0.223	0.017	-12.78	0.800	-0.044
1 if NE Glisan St West of NE 113th Ave	1.088	0.019	57.97	2.970	0.206
NW Front Ave/NW Naito Pwky Speed Zone					
1 if NW Front Ave West of NW 19th Ave	-0.332	0.021	-15.77	0.718	-0.066
1 if NW Naito Pkwy West of NW 9th Ave	-1.366	0.017	-79.01	0.255	-0.258
SE Powell Blvd Speed Zone					
1 if SE Powell Blvd East of SE 78th Ave	-1.195	0.016	-73.56	0.303	-0.228
1 if SE Powell Blvd West of SE 108th Ave	-0.883	0.017	-53.33	0.414	-0.170
1 if SE Powell Blvd West of SE 130th Ave	-1.305	0.017	-76.71	0.271	-0.244
SW Capitol Hwy/SW 49th Ave Speed Zone					
1 if SW 49th Ave North of SW Vacuna St	-0.352	0.017	-20.56	0.703	-0.070
1 if SW Capitol Hwy North of SW Dickinson St	-0.462	0.017	-27.93	0.630	-0.091
Model Summary					
Number of Observations	1,551,931				

Table C.2: Binary Logit Specifications for Exceeding 5 mi/h Over Posted Speed Limit in 35 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-0.271	0.015	-18.66		
After Sign Installation					
1 if after speed zone sign installed	1.117	0.005	238.93	3.055	0.164
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.441	0.007	-62.67	0.643	-0.059
1 if 10:00 a.m. to 4:00 p.m.	-0.663	0.006	-107.84	0.515	-0.091
1 if 4:00 p.m. to 8:00 p.m.	-0.727	0.007	-109.80	0.483	-0.096
Time-of-Week					
1 if Tuesday	-0.065	0.009	-7.41	0.937	-0.009
1 if Wednesday	-0.096	0.009	-11.12	0.909	-0.013
1 if Thursday	-0.050	0.009	-5.49	0.952	-0.007
1 if Friday	0.143	0.010	13.73	1.153	0.021
Spot Speed Location					
NE 102nd Ave Speed Zone					
1 if NE 102nd Ave North of NE Shaver St	-0.570	0.014	-40.88	0.565	-0.072
NE/SE 122nd Ave Speed Zone					
1 if NE 122nd Ave North of NE Broadway	-1.446	0.015	-94.61	0.236	-0.151
1 if NE 122nd Ave South of NE Holladay St	0.322	0.018	18.07	1.380	0.049
1 if SE 122nd Ave South of SE Raymond St	-2.320	0.018	-126.05	0.098	-0.198
NE/SE 82nd Ave Speed Zone					
1 if NE 82nd Ave South of NE Beech St	-3.012	0.021	-140.13	0.049	-0.218
1 if NE 82nd Ave South of NE Davis St	-2.146	0.016	-132.77	0.117	-0.194
1 if NE 82nd Ave South of NE Eugene St	-1.878	0.015	-123.64	0.153	-0.183
1 if SE 82nd Ave South of SE Knapp St	-2.219	0.022	-100.90	0.109	-0.186
1 if SE 82nd Ave South of SE Mill St	-1.494	0.015	-100.05	0.225	-0.155
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 85th Ave	-0.275	0.014	-19.31	0.760	-0.037
1 if NE Glisan St West of NE 113th Ave	0.711	0.014	52.34	2.037	0.116
NW Front Ave/NW Naito Pwky Speed Zone					
1 if NW Front Ave West of NW 19th Ave	-0.238	0.018	-12.95	0.788	-0.032
1 if NW Naito Pkwy West of NW 9th Ave	-1.563	0.017	-92.47	0.209	-0.158
SE Powell Blvd Speed Zone					
1 if SE Powell Blvd East of SE 78th Ave	-1.227	0.014	-90.65	0.293	-0.140
1 if SE Powell Blvd West of SE 108th Ave	-1.129	0.013	-83.79	0.323	-0.128

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
1 if SE Powell Blvd West of SE 130th Ave	-1.483	0.015	-100.29	0.227	-0.154
SW Capitol Hwy/SW 49th Ave Speed Zone					
1 if SW 49th Ave North of SW Vacuna St	-0.416	0.014	-29.08	0.660	-0.054
1 if SW Capitol Hwy North of SW Dickinson St	-0.589	0.014	-42.84	0.555	-0.075
Model Summary					
Number of Observations	1,551,931				

Table C.3: Binary Logit Specifications for Exceeding 10 mi/h Over Posted Speed Limit in 35 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-1.587	0.022	-72.75		
After Sign Installation					
1 if after speed zone sign installed	0.814	0.008	104.49	2.258	0.042
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.541	0.011	-49.15	0.582	-0.025
1 if 10:00 a.m. to 4:00 p.m.	-0.856	0.010	-88.07	0.425	-0.041
1 if 4:00 p.m. to 8:00 p.m.	-0.899	0.011	-83.37	0.407	-0.040
Time-of-Week					
1 if Tuesday	-0.009	0.017	-0.51	0.991	0.000
1 if Wednesday	-0.032	0.016	-1.96	0.969	-0.002
1 if Thursday	0.054	0.017	3.20	1.056	0.003
1 if Friday	0.220	0.019	11.81	1.245	0.012
Spot Speed Location					
NE 102nd Ave Speed Zone					
1 if NE 102nd Ave North of NE Shaver St	-0.897	0.021	-43.24	0.408	-0.035
NE/SE 122nd Ave Speed Zone					
1 if NE 122nd Ave North of NE Broadway	-1.428	0.024	-60.12	0.240	-0.047
1 if NE 122nd Ave South of NE Holladay St	0.608	0.024	25.58	1.838	0.038
1 if SE 122nd Ave South of SE Raymond St	-2.753	0.038	-72.76	0.064	-0.061
NE/SE 82nd Ave Speed Zone					
1 if NE 82nd Ave South of NE Beech St	-3.429	0.048	-71.70	0.032	-0.064
1 if NE 82nd Ave South of NE Davis St	-2.294	0.029	-80.19	0.101	-0.059
1 if NE 82nd Ave South of NE Eugene St	-2.042	0.026	-79.67	0.130	-0.057
1 if SE 82nd Ave South of SE Knapp St	-2.624	0.048	-54.67	0.072	-0.057

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
1 if SE 82nd Ave South of SE Mill St	-1.687	0.025	-68.83	0.185	-0.051
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 85th Ave	-0.400	0.020	-20.07	0.670	-0.018
1 if NE Glisan St West of NE 113th Ave	0.558	0.017	31.97	1.746	0.033
NW Front Ave/NW Naito Pwky Speed Zone					
1 if NW Front Ave West of NW 19th Ave	-0.162	0.026	-6.35	0.850	-0.008
1 if NW Naito Pkwy West of NW 9th Ave	-1.870	0.031	-61.10	0.154	-0.052
SE Powell Blvd Speed Zone					
1 if SE Powell Blvd East of SE 78th Ave	-1.252	0.020	-63.33	0.286	-0.046
1 if SE Powell Blvd West of SE 108th Ave	-1.457	0.020	-71.46	0.233	-0.050
1 if SE Powell Blvd West of SE 130th Ave	-1.796	0.024	-73.60	0.166	-0.053
SW Capitol Hwy/SW 49th Ave Speed Zone					
1 if SW 49th Ave North of SW Vacuna St	-0.546	0.021	-26.62	0.579	-0.023
1 if SW Capitol Hwy North of SW Dickinson St	-0.962	0.021	-46.51	0.382	-0.037
Model Summary					
Number of Observations	1,551,931				

Table C.4: Binary Logit Specifications for Exceeding 15 mi/h Over Posted Speed Limit in 35 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-2.890	0.044	-65.70		
After Sign Installation					
1 if after speed zone sign installed	0.549	0.015	36.30	1.732	0.008
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.695	0.020	-34.25	0.499	-0.008
1 if 10:00 a.m. to 4:00 p.m.	-1.108	0.018	-60.47	0.330	-0.014
1 if 4:00 p.m. to 8:00 p.m.	-1.094	0.021	-52.69	0.335	-0.012
Time-of-Week					
1 if Tuesday	0.004	0.037	0.10	1.004	0.000
1 if Wednesday	0.030	0.035	0.84	1.030	0.000
1 if Thursday	0.155	0.037	4.24	1.168	0.002
1 if Friday	0.377	0.039	9.57	1.457	0.006
Spot Speed Location					
NE 102nd Ave Speed Zone					
1 if NE 102nd Ave North of NE Shaver St	-1.157	0.042	-27.38	0.314	-0.010

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
NE/SE 122nd Ave Speed Zone					
1 if NE 122nd Ave North of NE Broadway	-1.364	0.047	-28.84	0.256	-0.011
1 if NE 122nd Ave South of NE Holladay St	0.839	0.041	20.34	2.315	0.016
1 if SE 122nd Ave South of SE Raymond St	-2.814	0.079	-35.66	0.060	-0.015
NE/SE 82nd Ave Speed Zone					
1 if NE 82nd Ave South of NE Beech St	-3.656	0.109	-33.39	0.026	-0.016
1 if NE 82nd Ave South of NE Davis St	-2.277	0.059	-38.28	0.103	-0.014
1 if NE 82nd Ave South of NE Eugene St	-1.973	0.052	-38.29	0.139	-0.014
1 if SE 82nd Ave South of SE Knapp St	-2.963	0.119	-24.88	0.052	-0.014
1 if SE 82nd Ave South of SE Mill St	-1.715	0.051	-33.90	0.180	-0.013
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 85th Ave	-0.541	0.039	-13.88	0.582	-0.006
1 if NE Glisan St West of NE 113th Ave	0.555	0.032	17.22	1.742	0.009
NW Front Ave/NW Naito Pwky Speed Zone					
1 if NW Front Ave West of NW 19th Ave	-0.080	0.047	-1.70	0.923	-0.001
1 if NW Naito Pkwy West of NW 9th Ave	-2.012	0.065	-30.90	0.134	-0.013
SE Powell Blvd Speed Zone					
1 if SE Powell Blvd East of SE 78th Ave	-1.227	0.039	-31.52	0.293	-0.011
1 if SE Powell Blvd West of SE 108th Ave	-1.800	0.045	-40.43	0.165	-0.014
1 if SE Powell Blvd West of SE 130th Ave	-1.939	0.052	-37.55	0.144	-0.014
SW Capitol Hwy/SW 49th Ave Speed Zone					
1 if SW 49th Ave North of SW Vacuna St	-0.455	0.039	-11.79	0.635	-0.005
1 if SW Capitol Hwy North of SW Dickinson St	-1.383	0.044	-31.26	0.251	-0.012
Model Summary					
Number of Observations	1,551,931				

Table C.5: Binary Logit Specifications for Speeding in 30 mi/h to 25 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	1.138	0.033	34.01		
After Sign Installation					
After speed zone sign installed	0.999	0.018	54.97	2.715	0.208
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.757	0.033	-22.73	0.469	-0.155

1 if 10:00 a.m. to 4:00 p.m.	-0.795	0.030	-26.41	0.451	-0.157
4:00 p.m. to 8:00 p.m.	-1.084	0.031	-34.97	0.338	-0.222
Time-of-Week					
1 if Tuesday	0.137	0.022	6.17	1.146	0.027
1 if Wednesday	0.202	0.026	7.81	1.224	0.040
1 if Thursday	0.234	0.035	6.60	1.264	0.046
1 if Friday	0.204	0.052	3.92	1.226	0.040
Spot Speed Location					
SE 52nd Ave Speed Zone					
1 if SE 52nd Ave North of SE Tolman St	-0.856	0.018	-48.18	0.425	-0.181
Model Summary					
Number of Observations	75,776				

Table C.6: Binary Logit Specifications for Exceeding 5 mi/h Over Posted Speed Limit in 30 mi/h to 25 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-0.937	0.034	-27.23		
After Sign Installation					
After speed zone sign installed	1.066	0.021	49.69	2.903	0.181
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.683	0.031	-21.95	0.505	-0.107
1 if 10:00 a.m. to 4:00 p.m.	-0.757	0.027	-27.59	0.469	-0.124
4:00 p.m. to 8:00 p.m.	-0.871	0.029	-30.04	0.419	-0.137
Time-of-Week					
1 if Tuesday	0.279	0.029	9.76	1.322	0.048
1 if Wednesday	0.275	0.032	8.49	1.316	0.048
1 if Thursday	0.343	0.037	9.37	1.410	0.062
1 if Friday	0.377	0.047	7.97	1.458	0.068
Spot Speed Location					
SE 52nd Ave Speed Zone					
1 if SE 52nd Ave North of SE Tolman St	-1.196	0.024	-49.34	0.302	-0.190
Model Summary					
Number of Observations	75,776				

Table C.7: Binary Logit Specifications for Exceeding 10 mi/h Over Posted Speed Limit in 30 mi/h to 25 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-2.818	0.073	-38.53		
After Sign Installation					
1 if after speed zone sign installed	0.960	0.046	20.71	2.612	0.039
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.986	0.053	-18.44	0.373	-0.038
1 if 10:00 a.m. to 4:00 p.m.	-1.113	0.046	-24.27	0.328	-0.049
1 if 4:00 p.m. to 8:00 p.m.	-1.152	0.050	-23.21	0.316	-0.046
Time-of-Week					
1 if Tuesday	0.452	0.069	6.54	1.571	0.022
1 if Wednesday	0.412	0.076	5.43	1.510	0.021
1 if Thursday	0.547	0.080	6.81	1.728	0.029
1 if Friday	0.568	0.095	5.95	1.764	0.032
Spot Speed Location					
SE 52nd Ave Speed Zone					
1 if SE 52nd Ave North of SE Tolman St	-1.259	0.058	-21.70	0.284	-0.044
Model Summary					
Number of Observations	75,776				

Table C.8: Binary Logit Specifications for Exceeding 15 mi/h Over Posted Speed Limit in 30 mi/h to 25 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-4.511	0.191	-23.65		
After Sign Installation					
1 if after speed zone sign installed	0.961	0.114	8.40	2.615	0.007
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-1.452	0.121	-12.01	0.234	-0.010
1 if 10:00 a.m. to 4:00 p.m.	-1.713	0.104	-16.49	0.180	-0.014
1 if 4:00 p.m. to 8:00 p.m.	-1.849	0.119	-15.47	0.157	-0.013
Time-of-Week					
1 if Tuesday	0.686	0.188	3.65	1.987	0.006
1 if Wednesday	0.560	0.203	2.75	1.750	0.005
1 if Thursday	0.793	0.211	3.76	2.211	0.008
1 if Friday	0.690	0.245	2.81	1.993	0.007

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Spot Speed Location					
SE 52nd Ave Speed Zone					
1 if SE 52nd Ave North of SE Tolman St	-1.325	0.151	-8.80	0.266	-0.007
Model Summary					
Number of Observations	75,776				

Table C.9: Binary Logit Specifications for Speeding in 40 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-0.804	0.020	-40.06		
After Sign Installation					
1 if after speed zone sign installed	2.786	0.011	242.52	16.215	0.581
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.812	0.016	-51.35	0.444	-0.125
1 if 10:00 a.m. to 4:00 p.m.	-0.649	0.014	-47.48	0.522	-0.104
1 if 4:00 p.m. to 8:00 p.m.	-0.623	0.014	-43.14	0.536	-0.099
Time-of-Week					
1 if Tuesday	0.050	0.020	2.53	1.051	0.008
1 if Wednesday	0.246	0.019	12.94	1.278	0.041
1 if Thursday	0.651	0.019	34.93	1.918	0.109
1 if Friday	0.875	0.022	39.30	2.398	0.154
Spot Speed Location					
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 157th Ave	-0.574	0.010	-59.73	0.563	-0.095
Model Summary					
Number of Observations	272,678				

Table C.10: Binary Logit Specifications for Exceeding 5 mi/h Over Posted Speed Limit in 40 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-2.392	0.028	-84.98		
After Sign Installation					
1 if after speed zone sign installed	2.543	0.013	198.53	12.722	0.350
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.725	0.020	-35.81	0.484	-0.064
1 if 10:00 a.m. to 4:00 p.m.	-0.676	0.017	-38.79	0.509	-0.063

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
1 if 4:00 p.m. to 8:00 p.m.	-0.680	0.018	-36.83	0.507	-0.062
Time-of-Week					
1 if Tuesday	0.130	0.026	5.00	1.139	0.013
1 if Wednesday	0.163	0.025	6.42	1.178	0.016
1 if Thursday	0.302	0.025	11.90	1.353	0.030
1 if Friday	0.385	0.030	13.00	1.469	0.040
Spot Speed Location					
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 157th Ave	-0.369	0.013	-27.68	0.692	-0.036
Model Summary					
Number of Observations	272,678				

Table C.11: Binary Logit Specifications for Exceeding 10 mi/h Over Posted Speed Limit in 40 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-4.033	0.053	-76.39		
After Sign Installation					
1 if after speed zone sign installed	2.484	0.025	97.49	11.984	0.098
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-0.836	0.034	-24.74	0.433	-0.023
1 if 10:00 a.m. to 4:00 p.m.	-0.783	0.028	-27.85	0.457	-0.024
1 if 4:00 p.m. to 8:00 p.m.	-0.829	0.031	-27.13	0.437	-0.024
Time-of-Week					
1 if Tuesday	0.177	0.047	3.80	1.194	0.006
1 if Wednesday	0.125	0.046	2.69	1.133	0.004
1 if Thursday	0.259	0.047	5.55	1.296	0.009
1 if Friday	0.276	0.054	5.12	1.318	0.010
Spot Speed Location					
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 157th Ave	-0.213	0.025	-8.38	0.808	-0.007
Model Summary					
Number of Observations	272,678				

Table C.12: Binary Logit Specifications for Exceeding 15 mi/h Over Posted Speed Limit in 40 mi/h to 30 mi/h Speed Zones

Variable	Coefficient	Std. Error	*t*-statistic	Odds Ratio	Marginal Effects
Constant	-5.325	0.107	-49.84		
After Sign Installation					
1 if after speed zone sign installed	2.200	0.051	43.32	9.021	0.020
Time-of-Day					
1 if 6:00 a.m. to 10:00 a.m.	-1.131	0.068	-16.58	0.323	-0.007
1 if 10:00 a.m. to 4:00 p.m.	-1.100	0.056	-19.79	0.333	-0.008
1 if 4:00 p.m. to 8:00 p.m.	-1.029	0.060	-17.05	0.357	-0.007
Time-of-Week					
1 if Tuesday	0.186	0.096	1.93	1.204	0.002
1 if Wednesday	0.194	0.095	2.04	1.214	0.002
1 if Thursday	0.282	0.096	2.95	1.326	0.002
1 if Friday	0.498	0.108	4.59	1.645	0.005
Spot Speed Location					
NE Glisan St Speed Zone					
1 if NE Glisan St East of NE 157th Ave	-0.112	0.051	-2.18	0.894	-0.001
Model Summary					
Number of Observations	272,678				