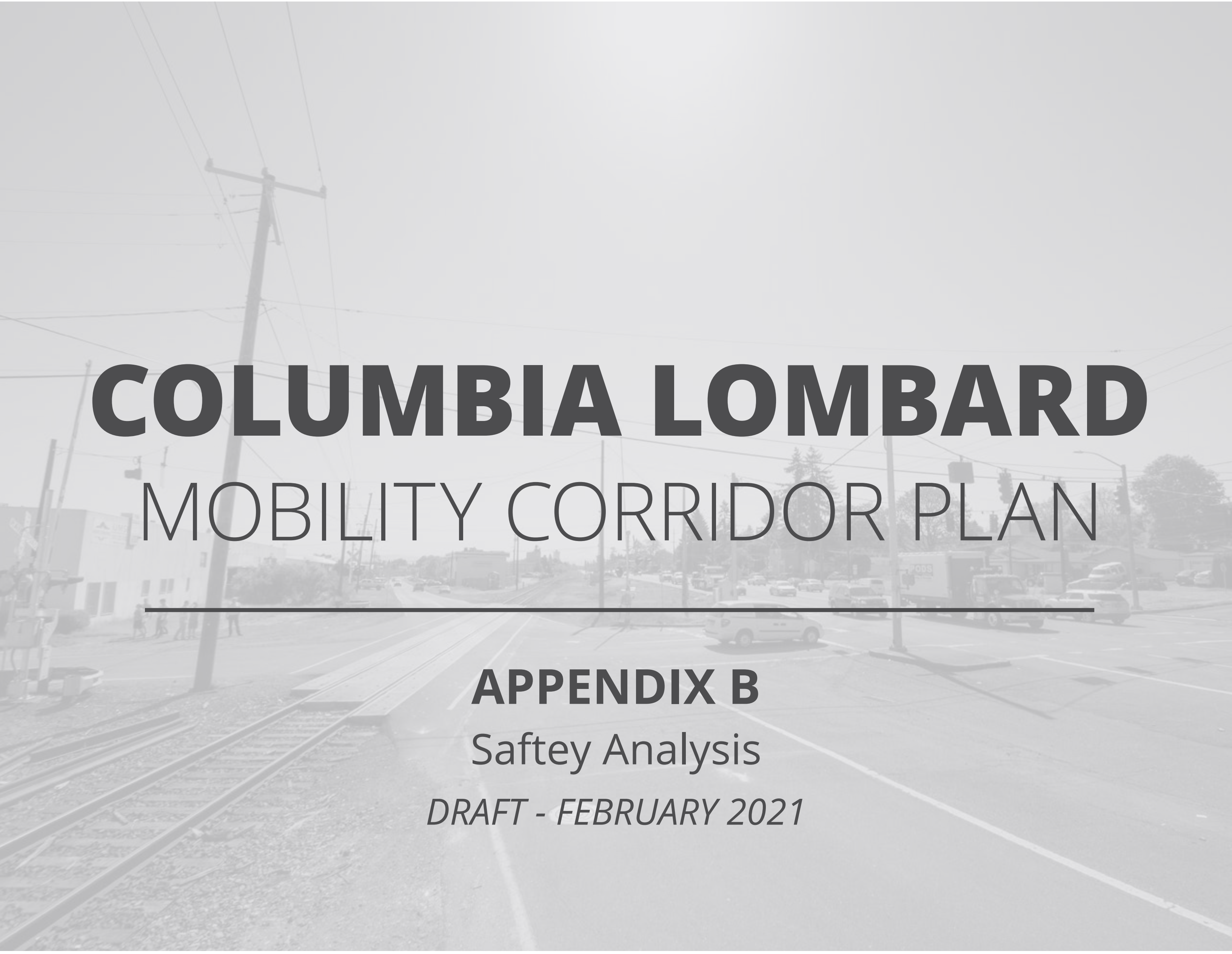

COLUMBIA LOMBARD

MOBILITY CORRIDOR PLAN

APPENDIX B

Saftey Analysis

DRAFT - FEBRUARY 2021

PBOT

PORTLAND BUREAU OF TRANSPORTATION

AREA + PROJECT PLANNING

APPENDIX B

SAFETY ANALYSIS

Originally Published July 2019

CONTENTS

ACRONYMS AND ABBREVIATIONS

AADT	average annual daily traffic
CMF	crash modification factors
HSM	Highway Safety Manual
NCHRP	National Cooperative Highway Research Program
ODOT	Oregon Department of Transportation
PBOT	Portland Bureau of Transportation
RRFB	rectangular rapid flashing beacons
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SPIS	Safety Priority Index System
TGM	Transportation and Growth Management

Introduction

The Columbia-Lombard Mobility Corridor Plan project objectives are to increase the safety, efficiency, and resiliency of multimodal and freight transportation of these two regional corridors. Currently, they are not operating optimally due to aging infrastructure, gaps in multimodal facilities, increased trucking activity, and safety issues.

Road safety is a significant concern on both Columbia Boulevard and Lombard Street. Portland Bureau of Transportation's (PBOT) Vision Zero Action Plan[1] has identified both corridors as being within the top 30 high crash streets throughout the city. In addition, the intersection of NE Killingsworth Street/I-205 East Ramp Terminal is identified in the same plan as being in the top 30 high crash intersections citywide. **The objectives of this analysis are to analyze crash trends for the most recent five years of data on both corridors, identify the risk factors associated with high frequency of crashes, and identify optional countermeasures for all travel modes to integrate into the project needs assessment and solutions development**. In particular, this analysis addresses the following:

- How many crashes occurred and what were the severities of the crashes?
- Who was involved in the crashes?
- What modes were involved?
- When, where, and how did crashes occur?
- What high risk behaviors were involved in crashes?
- Are there any Safety Priority Index System sites in the study area?
- What risk factors are associated with motor vehicle crashes?
- As crashes involving pedestrians and bicyclists tend to be higher severity, what risk factors are associated with these travel modes specifically?
- What countermeasures should be considered to improve safety for all travel modes?

Study Area Network and Data

The study network for this Safety Analysis consists of NE Columbia Boulevard from the intersection of US 30 Bypass/NE Sandy Boulevard to the intersection of NE Columbia Boulevard/N Interstate Place. The network also includes Lombard Street from the intersection of US 30 Bypass/NE Sandy Boulevard to the intersection of Lombard Street/N Woolsey Avenue.[2]

The entirety of the safety analysis is based on the most recent complete five years of crash data, from January 1, 2012, to December 31, 2016, from the Oregon Department of Transportation (ODOT) Crash Data System.[3] Throughout this analysis, crashes are categorized by the participant injury severity that resulted from the crash. Nationally, under the KABCO system, there are five classifications of crash injuries. Descriptions of each injury severity are as follows:[4]

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[1] Vision Zero Action Plan, Portland's High Crash Network. Portland Bureau of Transportation. https://www.portlandoregon.gov/transportation/54892.

[2] The Lombard Street limits consist of NE Lombard Street, N Lombard Street, NE Portland Highway, US 30 Bypass, and NE Killingsworth Street. In this analysis, all of these designations within the study limits are referred to collectively as "Lombard Street." The Columbia Boulevard limits include NE Columbia Boulevard and N Columbia Boulevard. These designations are referred to as "Columbia Boulevard" in this analysis.

[3] Crash Data System. Oregon Department of Transportation. https://zigzag.odot.state.or.us/uniquesig08615cf883bed667d26bcec3a7dc5c6b/uniquesig0/SecurezigzagPortalHomePage/.

[4] Manual on Classification of Motor Vehicle Traffic Accidents. American National Standards Institute. August 2007. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/07D16

- Fatal Injury (K): Participant died within 30 days as a direct result of injuries caused by a crash.
- Serious Injury (A): Participant suffered an incapacitating injury that "prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury occurred." Examples include sever lacerations and broken limbs.
- Evident Injury (B): Participant suffered an injury that is "evident to observers at the scene of the accident in which the injury occurred." Examples include bruises and minor lacerations.
- Possible Injury (C): Participant suffered an injury that is not a fatal, serious, or evident injury. Momentary unconsciousness and limping are included in this category.
- Property Damage Only (O): Participant did not suffer an injury.

Portland's Vision Zero Action Plan has a goal of eliminating traffic crashes that result in fatalities and serious injuries. To accomplish this goal, crash analyses focus on fatal and serious injury crashes, as well as all severity crashes involving the most vulnerable road users—people walking and people biking. **The Columbia-Lombard safety analysis focuses on these Vision Zero-Focused crashes unless details for other crashes are important for certain analyses**. These focus crash types are compared to the total number of crashes to provide a sense of relative scale. In the figures and tables throughout this analysis, "total crashes" refers to all crashes of any severity level. For example, "total crashes involving pedestrians" is equivalent to "crashes involving pedestrians, including all severities."

ODOT crash data uses the term "sex" for participants involved in crashes. In 2017, an option under the sex designation for "non-binary gender" was added. However, in the data set used for 2012-2016, the values for sex are limited to "male," "female,", and "unknown." In order to be consistent with the data source, these same designations are used in this analysis. The sex designation may be self-identified, based on a driver's license, or identified by the police officer at the scene of the crash. Data on participant race and/or ethnicity is not available in ODOT's crash data and is not reported in this analysis.

Data from ODOT's database for 2017 are considered preliminary until approximately July 2019. Table 1 shows the pedestrian, bicyclist, and motor vehicle fatalities and serious injuries that occurred within the study area network in 2017 through June 2019, as reported by PBOT. Data was not available for serious injuries in 2018 and 2019.

TABLE 1. **Columbia Boulevard and Lombard Street – Fatalities and Serious Injuries, 2017 through June 2019**

	FATALITIES			SERIOUS INJURIES		
Years	Pedestrian	Bicyclist	Motor Vehicle Occupant	Pedestrian	Bicyclist	Motor Vehicle Occupant
2017	2	0	2	6	0	16
2018	0	0	0	Data Not Available	Data Not Available	Data Not Available
2019	1	1	1	Data Not Available	Data Not Available	Data Not Available

Due to varying road geometrics and traffic characteristics, separate safety analyses were conducted for Columbia Boulevard and Lombard Street. For comparison purposes to citywide crash trends, data for all crashes in Portland as a whole are gathered from the 2016 Oregon Traffic Summary.[5]

[5] 2016 Oregon Traffic Crash Summary. Oregon Department of Transportation. July 2018. https://www.oregon.gov/ODOT/Data/Documents/Crash_Summary_2016.pdf.

Columbia Boulevard – Historic Crash Trends

As shown in Table 2, from 2012 to 2016 on Columbia Boulevard, there were **762 total crashes, four fatal crashes, and 12 serious injury crashes**. The percentage of crashes that were fatal (0.5 percent) was higher than the citywide average (0.3 percent).[6] Each fatal or serious injury crash resulted in one participant fatality or serious injury, respectively.

TABLE 2. **Columbia Boulevard – Total, Fatal, and Serious Injury Crashes**

Years	Total Crashes	Fatal Crashes	Serious Injury Crashes
2012	135	0	6
2013	158	0	2
2014	147	0	0
2015	141	3	1
2016	181	1	3
Total	762	4	12

The locations of the fatal and serious injury crashes, as well as relative total crash density, are shown in Figure 1. High crash density is shown near the I-205 ramp termini, as well as at high-volume intersections along the corridor. Fatal and serious injury crashes are distributed throughout Columbia Boulevard, though a cluster occurred at NE 33rd Avenue.

FIGURE 1. **Columbia Boulevard – Total Crash Density with Fatal and Serious Injury Crashes**

[6] There were 12,588 all severity crashes, 42 fatal crashes, and 6,211 nonfatal injury crashes in Portland in 2016.

Who Was Involved in Crashes?

Figure 2 shows the total number of pedestrian and bicyclist involved crashes on Columbia Boulevard. Between 2012 and 2016, there were 13 crashes that involved a pedestrian or bicyclist, or an average of 2.6 non-motorized crashes per year. Crashes involving pedestrians and bicyclists were relatively stable from 2012-2015, with an increase in crashes in 2016. However, the small sample sizes increase the uncertainty of the five year trend. **All 13 of the crashes resulted in injuries**, including two pedestrian serious injuries and one bicyclist serious injury. From 2012-2016, there were no pedestrian or bicyclist fatalities on Columbia Boulevard. According to data from PBOT, in 2017 there was one pedestrian fatal crash and two pedestrian serious injury crashes. There were no bicyclist-involved fatal or serious injury crashes in 2017.

Crashes involving pedestrians and bicyclists are shown geospatially in Figure 3. Crash clusters occurred east of NE 82nd Avenue. Serious injuries occurred at the intersections of Columbia Boulevard/N Vancouver Avenue, Columbia Boulevard/NE Martin Luther King Jr. Boulevard, and Columbia Boulevard/NE 47th Avenue.

FIGURE 2. **Columbia Boulevard – Total Crashes Involving Pedestrians and Bicyclists**

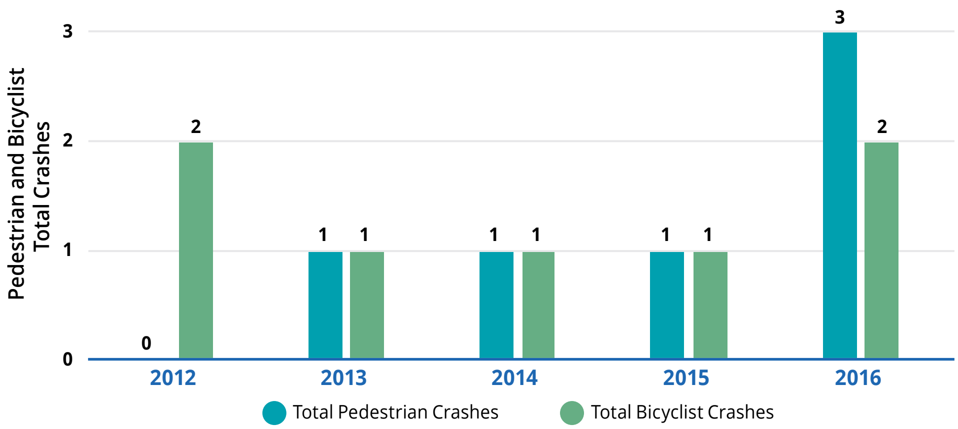


Table 3 shows the number of drivers involved in crashes by age and sex. The table is color-coded from light to darker green, where lighter shading represents the lowest number of crashes and darker represents the highest. The age range groupings are consistent with national crash reporting by the National Highway Traffic Safety Administration.[7]

Nearly two-thirds of crashes involved male drivers, which is nine percent higher than the city of Portland average.[8] The most frequently involved age group was 25-34 (22 percent of total drivers involved in crashes) which is consistent with the citywide age distribution of drivers involved in crashes.

TABLE 3. **Columbia Boulevard – Total Drivers Involved in Crashes by Age and Sex**[9]

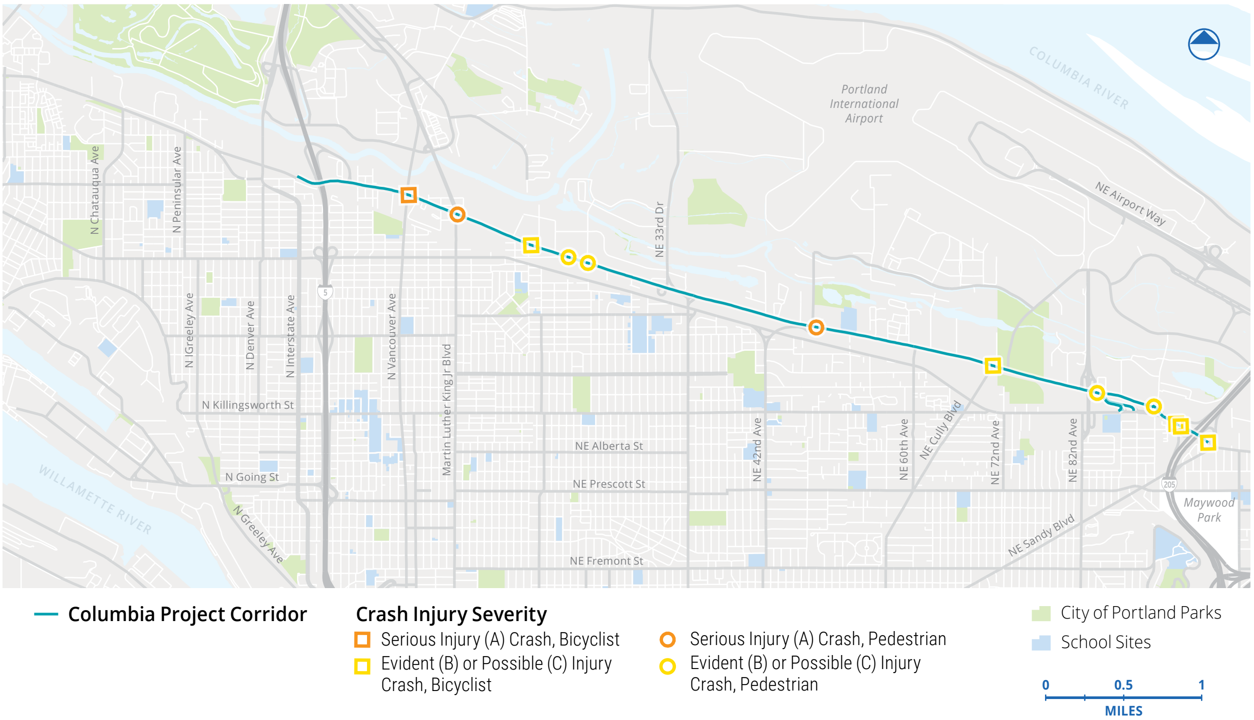
Driver Sex/Age	16-20	21-24	25-34	35-44	45-54	55-64	65-74	75+	Total
Male	28	56	175	171	140	124	49	13	756
Female	25	53	84	85	85	58	31	8	429
Total	53	109	259	256	225	182	80	21	1185

[7] Traffic Safety Facts Annual Report Tables. National Highway Traffic Safety Administration. 2017. https://cdan.nhtsa.gov/tsftables/tsfar.htm#

[8] Of the 12,150 drivers for which sex was stated in Portland, 6,677 drivers were male.

[9] There were 1,552 drivers involved in crashes. There were 217 drivers for which both age and sex were unknown, 148 drivers for which only age was unknown, and 2 drivers for which only sex was unknown. Therefore, the total number of drivers is 1,185.

FIGURE 3. **Columbia Boulevard – Crashes Involving Pedestrians and Bicyclists Locations**



Columbia Boulevard - Crashes by Severity (Pedestrian)

Crash Severity	Crashes by Severity
Fatal (K) Crash	0 (0.0%)
Serious Injury (A) Crash	2 (33.3%)
Evident Injury (B) Crash + Possible Injury (C) Crash	4 (66.7%)
Property Damage Only (O) Crash	0 (0.0%)
Total Crashes	6

Columbia Boulevard - Crashes by Severity (Bicyclist)

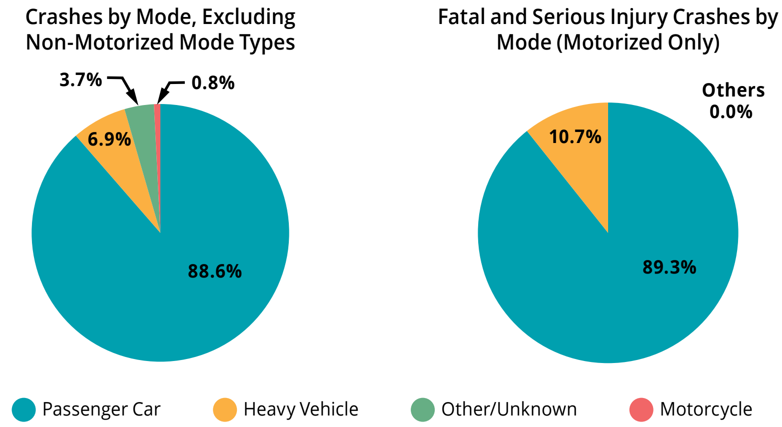
Crash Severity	Crashes by Severity
Fatal (K) Crash	0 (0.0%)
Serious Injury (A) Crash	1 (14.3%)
Evident Injury (B) Crash + Possible Injury (C) Crash	6 (85.7%)
Property Damage Only (O) Crash	0 (0.0%)
Total Crashes	7

The majority of crashes involved passenger cars, with seven percent of crashes involving heavy vehicles, as shown in Figure 4.[10] A total of 104 crashes occurred that involved heavy vehicles. The percentage of heavy vehicles involved in fatal or serious injury crashes was slightly higher than the percentage involved in total crashes (10.7 percent versus 6.9 percent), indicating heavy vehicle crashes tended to be more severe on average. **The percentage of involved vehicles that were heavy vehicles was nearly three times higher than the citywide average.**[11] Motorcyclists accounted for approximately one percent of all involved vehicles and were not involved in any fatal or serious injury crashes.

[10] Heavy vehicles include truck tractors with trailer/mobile home in tow, trucks with non-detachable bed, school buses, other buses, and truck tractors with no trailers.

[11] There were a total of 25,176 vehicles involved in crashes in Portland in 2016, of which 629 were heavy vehicles.

FIGURE 4. **Columbia Boulevard – Vehicles Involved in Total Crashes and Fatal or Serious Injury Crashes by Mode, Excluding Non-Motorized Mode Types**



When Did Crashes Occur?

Table 4 shows the number of fatal and serious injury crashes by month of year and lighting condition. The table is color-coded from light to darker green, similar to Table 3. The months with the most high severity crashes were April (three crashes) and December (three crashes), while **crashes occurred most frequently during dark conditions with street lights**.

Fatal and serious injury crashes were relatively evenly distributed throughout the year. No fatal and serious injury crashes occurred in the dark where there were not streetlights.

TABLE 4. **Columbia Boulevard – Fatal and Serious Injury Crashes Combined by Month of Year and Lighting Condition**

Month/Time	Daylight	Darkness – *With Street Lights*	Darkness – *No Street Lights*	Dawn *(Twilight)*	Dusk *(Twilight)*	Total
January	0	0	0	0	0	0
February	1	1	0	0	0	2
March	0	0	0	0	0	0
April	1	2	0	0	0	3
May	0	2	0	0	0	2
June	0	0	0	0	0	0
July	2	0	0	0	0	2
August	0	0	0	0	0	0
September	0	0	0	0	0	0
October	2	0	0	0	0	2
November	0	2	0	0	0	2
December	1	2	0	0	0	3
Total	7	9	0	0	0	16

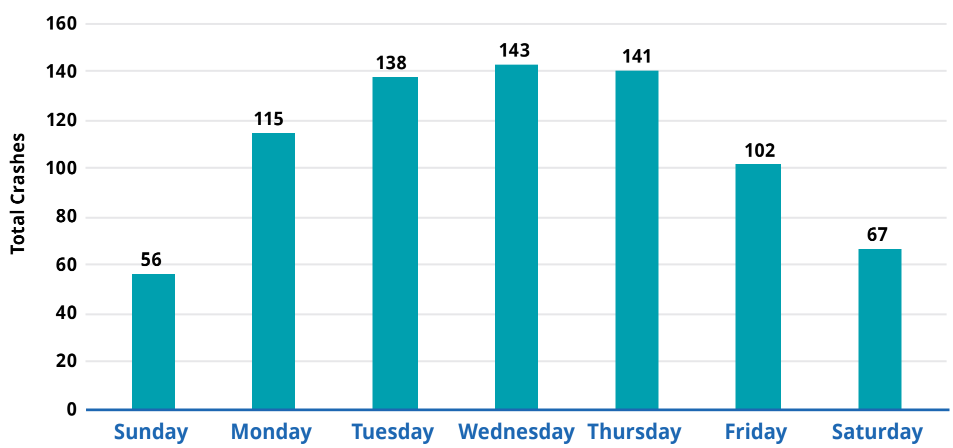
Over half of the crashes involving pedestrians and bicyclists occurred in darkness with street lights and slightly less than half occurred in September and October (Table 5). The percentage of crashes involving pedestrians and bicyclists that occurred in darkness with street lights was nearly double the percentage of all fatal and serious injury crashes in darkness.

TABLE 5. **Columbia Boulevard – Total Crashes Involving Pedestrians and Bicyclists Combined by Month of Year and Lighting Condition**

Month/Time	Daylight	Darkness – *With Street Lights*	Darkness – *No Street Lights*	Dawn *(Twilight)*	Dusk *(Twilight)*	Total
January	0	0	0	0	0	0
February	0	1	0	0	0	1
March	0	0	0	0	0	0
April	0	1	0	0	0	1
May	0	2	0	0	0	2
June	0	0	0	1	0	1
July	0	0	0	0	0	0
August	0	0	1	0	0	1
September	2	1	0	0	0	3
October	2	1	0	0	0	3
November	0	0	0	0	0	0
December	0	1	0	0	0	1
Total	4	7	1	1	0	13

The highest frequency of crashes by day of the week occurred on Wednesday (Figure 5). Weekend crashes accounted for 16 percent of the total crashes.

FIGURE 5. **Columbia Boulevard – Total Crashes by Day of Week**



Where Did Crashes Occur?

As shown in Table 6, **crashes were most frequent at intersections** (444 crashes).[12] **Fatal and serious injury crashes were more frequent at segments**, where four percent of crashes resulted in fatal and serious injuries. There were no fatalities from crashes at intersections. Serious injuries occurred three times as frequently along segments compared to intersections.

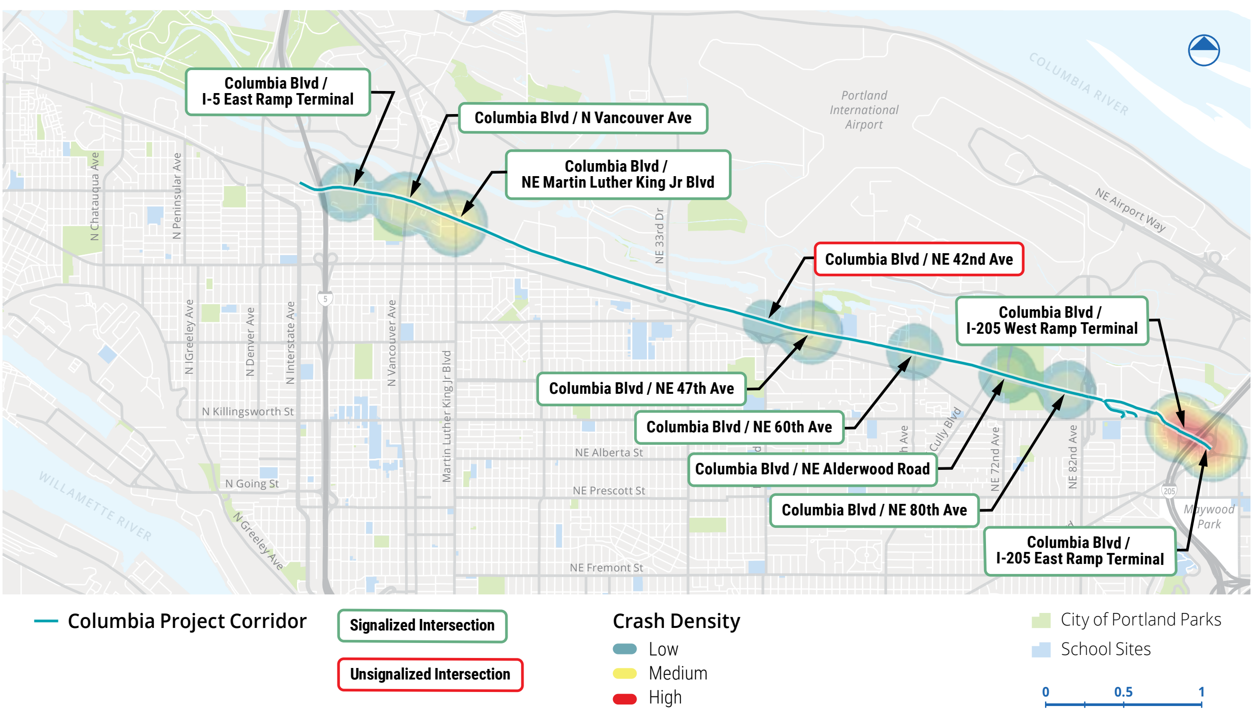
Approximately half of the pedestrian and bicyclist crashes occurred at intersections and half along segments. Five of the seven pedestrian and bicyclist intersection crashes occurred at signalized intersections.

TABLE 6. **Columbia Boulevard – Total, Fatal, Serious Injury, Pedestrian and Bicyclist Crashes by Location**

Junction Type	Intersection Type	Total Crashes	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Intersection	Total	444	0 (0%)	4 (1%)	3	4
	Signalized	333	0	4	2	3
	Unsignalized	111	0	0	1	1
Segment	–	318	4 (1%)	8 (3%)	3	3

The top 10 high crash intersections in the study period are shown in Table 7. The top 10 intersections accounted for 335 total crashes (75 percent of all intersection crashes) and four fatal and serious injury crashes (100 percent of all intersection fatal and serious injury crashes). One third of the intersection pedestrian crashes and 100 percent of the bicyclist intersection crashes occurred at the top 10 high crash intersections. The top 10 high

FIGURE 6. **Columbia Boulevard – Top 10 High Crash Intersections**



[12] ODOT classifies crashes as "intersectional" if the crash occurred within 50 feet of the limits of the intersection's curb returns. 2017 Motor Vehicle Traffic Crash Analysis and Code Manual. Oregon Department of Transportation. February 2018. https://www.oregon.gov/ODOT/Data/documents/CDS_Code_Manual.pdf.

crash intersections account for the majority of the intersection fatal, serious injury, pedestrian, and bicyclist crashes that occurred and are used as a representative sample of all intersections for risk factor analysis of crash and roadway/traffic control characteristics on Columbia Boulevard (see section titled “Risk Factor Analysis – Motorized Vehicles”).

The locations of the top 10 high crash intersections are shown in Figure 7. Seven of the 10 intersections are located east of NE 47th Avenue. The “heat level” in the map shows the relative number of crashes that occurred at each intersection. For instance, the I-205 ramp terminal intersections have the most heat in the map as they had the highest frequency of crashes.

TABLE 7. **Columbia Boulevard – Total, Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Top 10 High Crash Intersections**

Intersection Name	Total Crashes	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Columbia Blvd/I-205 West Ramp Terminal	97	0	0	0	1
Columbia Blvd/I-205 East Ramp Terminal	88	0	0	0	2
Columbia Blvd/NE Martin Luther King Jr Blvd	43	0	2	1	0
Columbia Blvd/N Vancouver Ave	28	0	1	0	1
Columbia Blvd/NE 47th Ave	19	0	0	0	0
Columbia Blvd/I-5 East Ramp Terminal	14	0	0	0	0
Columbia Blvd/NE 80th Ave	13	0	0	0	0
Columbia Blvd/NE Alderwood Rd	12	0	0	0	0
Columbia Blvd/NE 60th Ave	11	0	1	0	0
Columbia Blvd/NE 42nd Ave	10	0	0	0	0
Total	335 (75%)	0 (100%)	4 (100%)	1 (33%)	4 (100%)

Crashes by severity, mode, and crash density are shown in Table 8. **Almost a quarter of all segment crashes (75 of 318 segment crashes) occurred between the I-205 east ramp terminal and NE 82nd Avenue**. The crash density in this area was more than twice the density as occurred from NE 33rd Avenue to Martin Luther King Jr. Boulevard and almost three times the crash density at NE 82nd Avenue to NE 60th Avenue. **Two-thirds of the 12 segment fatal and serious injury crashes occurred between NE 60th Avenue and Martin Luther King Jr. Boulevard.** Crashes involving pedestrians and bicyclists were distributed throughout the segments, though no crashes occurred from Martin Luther King Jr. Boulevard and N Interstate Avenue. Table 8 is color coded from light to darker green, similar to previous figures and tables.

TABLE 8. Columbia Boulevard – Total, Fatal, Serious Injury, Pedestrian, Bicyclist Crashes and Crash Density by Segment

Segment Name	Segment Length (miles)	Total Crashes	Crash Density (crashes per mile)	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
I-205 East Ramp Terminal to NE 82nd Ave	0.90	75	0	0	1	1	83.3
NE 82nd Ave to NE 60th Ave	1.16	39	1	2	0	1	33.6
NE 60th Ave to NE 33rd Ave	1.43	71	2	2	1	0	49.7
NE 33rd Ave to MLK Jr. Blvd	1.60	67	1	3	1	1	41.9
MLK Jr. Blvd to N Interstate Ave	1.00	66	0	1	0	0	66.0
Total	6.09	318	52.2 (average)	4	8	3	3

Nearly half of all crashes along Columbia Boulevard were rear-end crashes (Table 9) and one-third of crashes were turning movement crashes. However, fixed object crashes were the most severe, as 14 percent of these crashes resulted in fatal or serious injuries. Collision types for bicyclists included turning movements, sideswipes, and angle crashes, which accounted for 86 percent of all bicyclist crashes. Table 9 shows the five most frequent collision types; not all collision types are shown.

TABLE 9. Columbia Boulevard – Total, Fatal and Serious Injury, Pedestrian, and Bicyclist Crashes by Most Frequent Collision Type

Collision Type	Total Crashes	Fatal and Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Rear-End	325	3	0	1
Turning Movement	247	3	0	2
Sideswipe – Overtaking	56	0	1	2
Angle	51	1	0	2
Fixed Object or Other Object	49	7	1	0

Table 10 shows the driver errors that resulted in the most frequent crashes. Failure to avoid a stopped or parked vehicle was the most frequent driver error, followed by not granting right-of-way and improper change of traffic lanes. One fatal or serious injury crash was caused by a driver disregarding a traffic control device. Note that only the most frequent five driver errors are shown in the table.

Table 10. Columbia Boulevard – Total Involved Drivers and Fatal or Seriously Injured Drivers by Most Frequent Driver Error

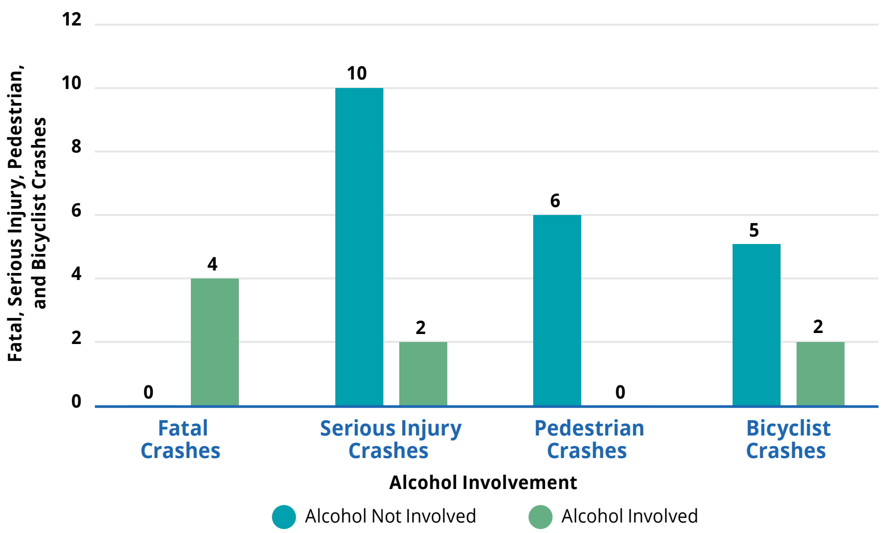
Behavioral Cause	Involved Drivers	Fatalities and Serious Injuries
Failed to avoid stopped or parked vehicle	242	0
Did not have right-of-way	111	0
Improper change of traffic lanes	44	0
Disregarded traffic signal	36	0
Disregarded traffic control device	33	1

High Risk Behavior

The percentage of fatal crashes that involved alcohol on Columbia Boulevard was nearly double the percentage of fatal crashes in the city of Portland as a whole. On Portland streets from 2004 to 2013, 56 percent of fatal crashes involved alcohol and/or drugs, compared to 100 percent on Columbia Boulevard. shows the number of fatal, serious injury, pedestrian, and bicyclist crashes that involved alcohol and did not involve alcohol. All four of the fatal crashes that occurred on Columbia Boulevard involved alcohol. Two of the 12 serious injury crashes, or 17 percent, involved alcohol. None of the fatal crashes involved drugs but two of the serious injury crashes did involve drugs. No overlap occurred between alcohol involvement and drug involvement in the fatal and serious injury crashes.[13] Forty percent of the bicyclist crashes involved alcohol.

The percentage of fatal crashes that involved alcohol on Columbia Boulevard was nearly double the percentage of fatal crashes in the city of Portland as a whole. On Portland streets from 2004 to 2013, 56 percent of fatal crashes involved alcohol and/or drugs, compared to 100 percent on Columbia Boulevard.[14]

FIGURE 7. **Columbia Boulevard – Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Alcohol Involvement**



Speeding drivers were involved in all four of the fatal crashes that occurred, as shown in Figure 8. There were two serious injury crashes that involved speeding. The percentage of fatal crashes on Columbia Boulevard which involved speeding (47%) was double the citywide percentage.[15] One of the pedestrian crashes, but no bicyclist crashes, involved speeding.

[13] ODOT's data flags alcohol involvement when an active participant in the crash had a blood alcohol content (BAC) of 0.01 or higher. Drug involvement is flagged when an active participant was reported to have used drugs.

[14] Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

[15] Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

FIGURE 8. **Columbia Boulevard – Fatal and Serious Injury Crashes by Speeding Involvement**

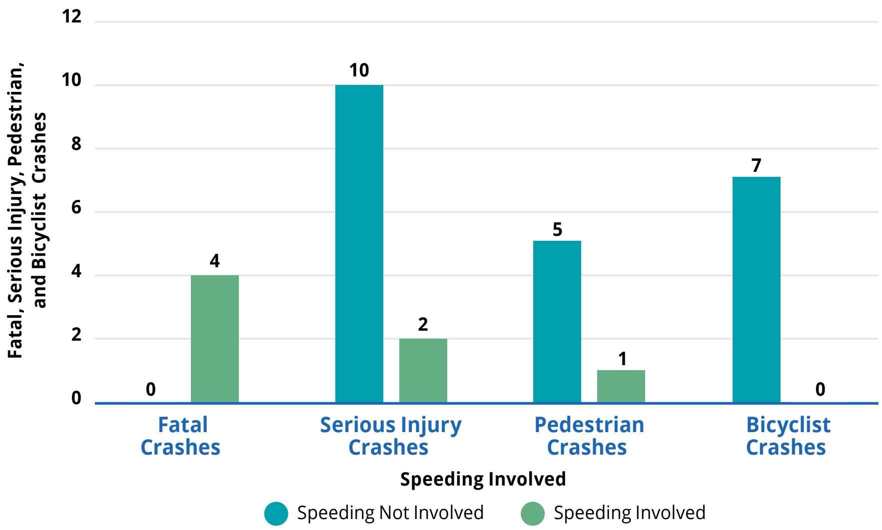


Table 11 shows the total number of crash participants that were wearing seatbelts and were not wearing seatbelts at the time of the crash. Four of the 12 unbelted participants experienced a fatal or serious injury. Half of the crash participants who were wearing a seatbelt experienced an injury, while 67 percent of unbelted participants experienced an injury.

Crash participants were significantly more likely to experience a high severity injury when not wearing a seatbelt, compared to participants who were wearing a seatbelt. Among belted crash participants, 0.3 percent experienced a fatality and 1.0 percent experienced a serious injury. Of all unbelted crash participants, 17 percent experienced a fatality and 17 percent experienced a serious injury. **A fatality was 56 times more probable and a serious injury was 15 times more probable when not wearing a seatbelt along the corridor**.

TABLE 11. **Columbia Boulevard – Injury Severity by Seatbelt Usage**

Seatbelt Use	Total Participants[16]	Fatalities	Serious Injuries[17]
Seatbelt Used	780	2	8
Seatbelt Not Used	12	2	2

No crashes with motorcyclists occurred in which the motorcycle rider did not wear a helmet.[18] Helmet use for bicyclists was not available in the Columbia Boulevard data set.[19]

[16] There were a total 1,675 participants involved in crashes. For 875 participants, the restraints used were unknown. Helmets were worn for eight participants. The total number of participants analyzed for use of restraints is 792.

[17] There were a total of 12 serious injuries in the analysis period. One serious injury involved a participant for which the use of restraints was unknown. Crash ID #1669287 was shown in the ODOT "crash level" database to have resulted in a serious injury, but the "participant level" data showed no injury occurred. This analysis assumes the "participant level" data are incorrect.

[18] A total of 13 crashes involving motorcyclists occurred. Eight of the motorcyclists wore helmets at the time of the crash and for six motorcyclists, helmet use was unknown.

[19] The participant data did not distinguish between motor vehicle drivers and bicyclist riders.

Lombard Street – Historic Crash Trends

There were a total of 958 all severity crashes, six fatal crashes, and 15 serious injury crashes on Lombard Street in the study area between 2012 and 2016 (Table 12). This factors to an **average of four crashes per week**.

TABLE 12. **Lombard Street – Total, Fatal, and Serious Injury Crashes**

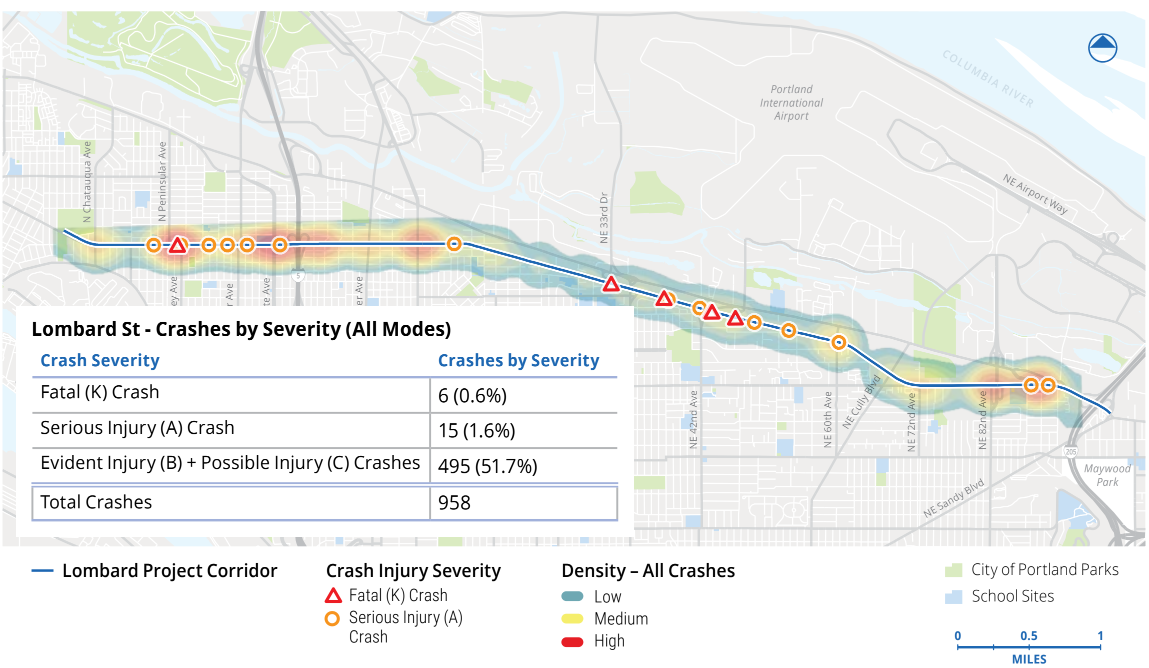
Years	Total Crashes	Fatal Crashes	Serious Injury Crashes
2012	200	3	4
2013	174	1	3
2014	183	0	2
2015	197	2	4
2016	204	0	2
Total	958	6	15

Though crashes that occurred in 2017 and 2018 were not included in this analysis, during these years there was one pedestrian fatality and two serious injuries, no bicyclist fatalities or serious injuries, and two vehicle occupant fatalities and eight serious injuries.

The fatal crashes on Lombard Street accounted for 3.4 percent of all fatal crashes in the city of Portland during that same time period.[20] The percentage of fatal crashes to total number of crashes on Lombard Street was 0.6 percent, twice the 2016 Portland citywide average of 0.3 percent.[21]

Fatal and serious injury crashes, with total crash density, are shown in Figure 9. **Crash density was highest on Lombard Street west of NE Martin Luther King Jr. Boulevard and east of NE 82nd Avenue.** Fatal and serious injury crashes were clustered west of Interstate 5 and from NE 33rd Avenue to NE 60th Avenue.

FIGURE 9. **Lombard Street – Total Crash Density with Fatal and Serious Injury Crashes (2012-2016)**



Lombard St - Crashes by Severity (All Modes)

Crash Severity	Crashes by Severity
Fatal (K) Crash	6 (0.6%)
Serious Injury (A) Crash	15 (1.6%)
Evident Injury (B) + Possible Injury (C) Crashes	495 (51.7%)
Total Crashes	958

[20] There were a total of 176 fatal crashes in Portland from 2012–2016. Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

[21] There were 12,588 all severity crashes, 42 fatal crashes, and 6,211 nonfatal injury crashes in Portland in 2016.

Who Was Involved in Crashes?

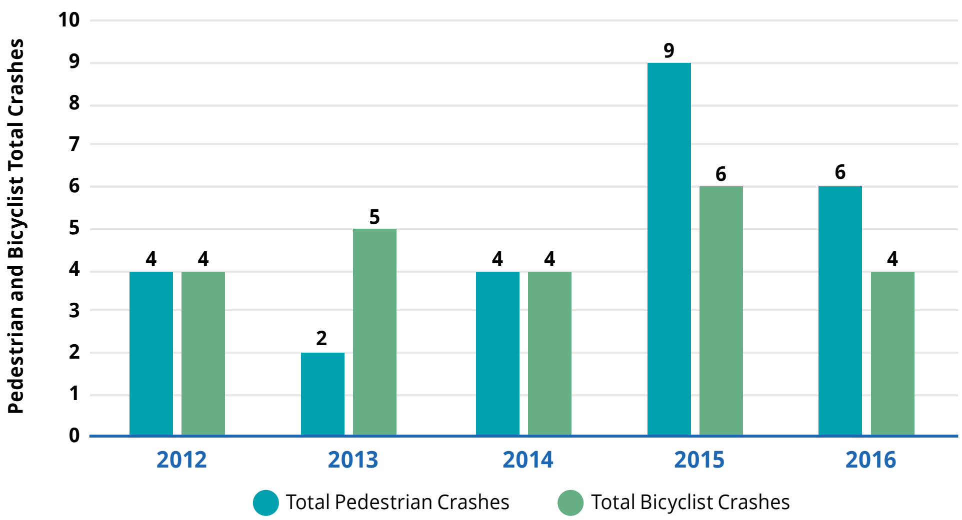
There were a total of 48 crashes involving pedestrians or bicyclists, as shown in Figure 10. These accounted for five percent of all crashes reported on Lombard Street between 2012 and 2016. **The number and percentage of crashes involving pedestrians and bicyclists relative to total crashes is significantly higher on Lombard Street than on Columbia Boulevard**.

All 25 crashes involving pedestrians resulted in injuries. Five of those resulted in a serious injury and one was fatal. The pedestrian injury crashes and pedestrian fatal crashes on Lombard Street accounted for 1.9 percent and 1.6 percent of citywide reports for their respective categories.[22]

All 23 crashes involving bicyclists also resulted in injuries, with one being fatal. **The bicyclist injury crashes on Lombard Street alone accounted for 1.5 percent of all bicyclist injury crashes in Portland**.[23] The fatal bicyclist crash was one of 10 bicyclist crashes that occurred throughout the entire city in the 5 year period.[24]

Crashes involving pedestrians or bicyclists are shown in Figure 11. **Both crashes involving bicyclists and pedestrians are densely concentrated west of Interstate 5**.

FIGURE 10. **Lombard Street – Total Crashes Involving Pedestrians and Bicyclists**

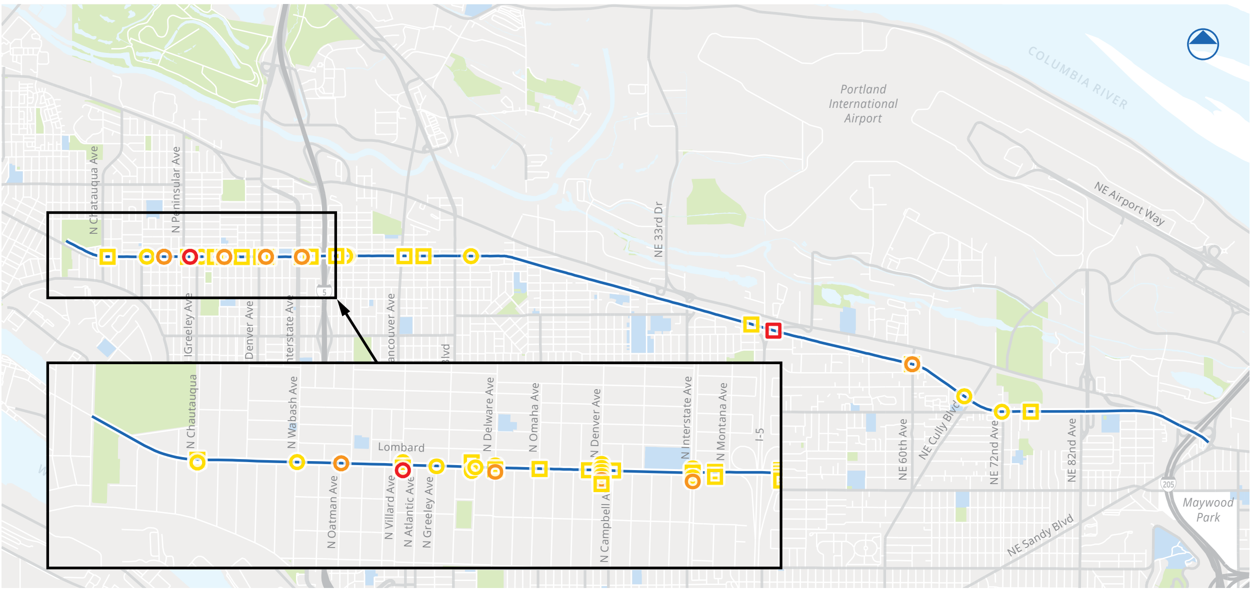


[22] There were 1,307 pedestrian injury crashes and 64 fatal crashes involving pedestrians between 2012 and 2016. Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

[23] There were 1,554 bicyclist injury crashes between 2012 and 2016. Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

[24] There were a total of 10 bicyclist traffic deaths between 2012 and 2016. Vision Zero Action Plan – Saving Lives with Safe Streets. City of Portland. December 2016. https://www.portlandoregon.gov/transportation/71730.

FIGURE 11. **Lombard Street – Crashes Involving Pedestrians and Bicyclists Locations (2012-2016)**



— Lombard Project Corridor

Crash Injury Severity

- Fatal (K) Crash, Bicyclist
- Evident (B) or Possible (C) Injury Crash, Bicyclist
- Fatal (K) Crash, Pedestrian
- Serious Injury (A) Crash, Pedestrian
- Evident (B) or Possible (C) Injury Crash, Pedestrian

City of Portland Parks
School Sites

0 0.5 1 MILES

Lombard St – Crashes by Severity (Pedestrian)

Crash Severity	Crashes by Severity
Fatal (K) Crash	1 (4.0%)
Serious Injury (A) Crash	5 (20.0%)
Evident Injury (B) + Possible Injury (C) Crashes	19 (76.0%)
Property Damage Only (O) Crash	0 (0.0%)
Total Crashes	25

Lombard St – Crashes by Severity (Bicyclist)

Crash Severity	Crashes by Severity
Fatal (K) Crash	1 (4.3%)
Serious Injury (A) Crash	0 (0%)
Evident Injury (B) + Possible Injury (C) Crashes	22 (95.7%)
Property Damage Only (O) Crash	0 (0.0%)
Total Crashes	23

Approximately 56 percent of the drivers involved in crashes were male and 44 percent female (Table 13). These proportions are consistent with the citywide reports for 2016.[25] **The majority of drivers involved in crashes were in the 25 to 34 age range**. This age group accounted for 27 percent of all drivers (comparable with citywide averages). Table 13 shows this information, with shading from light to darker green indicating lowest number of crashes to highest.

TABLE 13. **Lombard Street – Total Drivers Involved in Crashes by Age and Sex**

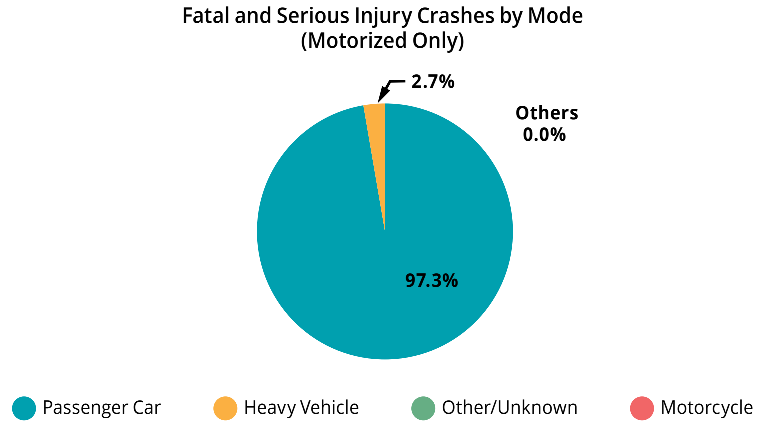
Driver Sex/Age	16-20	21-24	25-34	35-44	45-54	55-64	65-74	75+	Total
Male	54	62	209	145	144	127	52	30	823
Female	46	56	189	135	98	74	36	6	640
Total	100	118	398	280	242	201	88	36	1464[26]

[25] There were 6,677 male drivers and 5,473 female drivers reported in non-property damage only crashes.

[26] There were 1,935 drivers involved in crashes. There were 270 drivers for which both age and sex were unknown, 201 drivers for which only age was unknown, and no for which only sex was unknown. One driver was 15 when they experienced a crash. Therefore, the total number of drivers is 1,463.

As shown in Figure 12, both the total crashes and fatal and serious injury crashes largely involved passenger cars over other motorized vehicles. The percentages of heavy vehicle crashes and motorcycle crashes for both total crashes and fatal and serious injury crashes are significantly lower than those on Columbia Boulevard.

FIGURE 12. **Lombard Street – Vehicles Involved in Total Crashes and Fatal or Serious Injury Crashes by Mode, Excluding Non-Motorized Mode Types**



When Did Crashes Occur?

Half of the fatal and serious injury crashes on Lombard Street occurred during dark conditions with street lights (Table 14). No crashes occurred during dark conditions with no street lights. **The months with the highest numbers of fatal and serious injury crashes were June, November, and December, when 60 percent of the high severity crashes occurred**. Table 14 shows fatal and serious injury crashes by month and daylighting condition, with shading from light to darker green, representing the lowest number of crashes to the highest.

TABLE 14. **Lombard Street – Fatal and Serious Injury Crashes Combined by Month of Year and Lighting Condition**

Month/Time	Daylight	Darkness – *With Street Lights*	Darkness – *No Street Lights*	Dawn *(Twilight)*	Dusk *(Twilight)*	Total
January	0	1	0	0	0	1
February	1	0	0	0	0	1
March	1	0	0	0	0	1
April	0	1	0	0	0	1
May	0	1	0	0	0	1
June	1	2	0	1	0	4
July	1	0	0	0	0	1
August	1	0	0	0	0	1
September	0	0	0	0	0	0
October	1	0	0	0	0	1
November	2	1	0	0	1	4
December	0	4	0	0	0	4
Total	8	10	0	1	1	20[27]

[27] The lighting condition for one fatal or serious injury crash was listed as "unknown," Therefore the total fatal and serious injury crashes shown is 20, instead of 21.

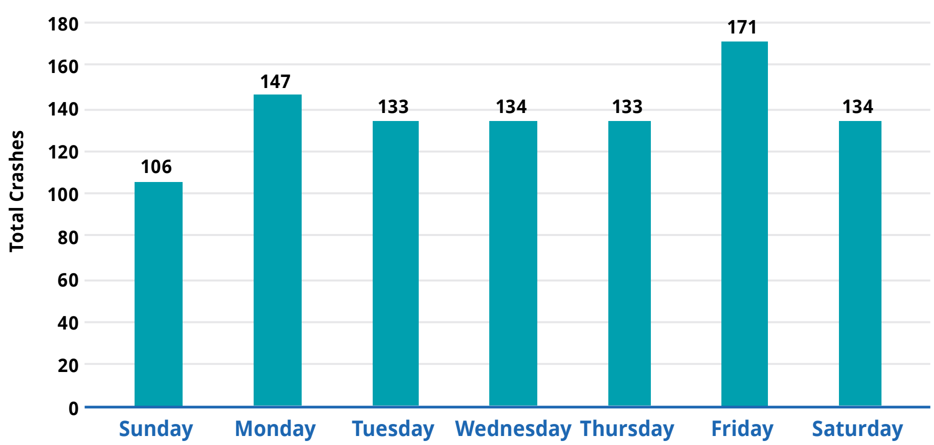
Pedestrian and bicyclist crashes mostly occurred during daylight, though one-third occurred during darkness with street lights (Table 15). Two pedestrian and bicyclist crashes occurred in the dark where there were no street lights. **Nearly one-third of crashes involving non-motorized travelers occurred in January and March**, while the remainder of the crashes were distributed throughout the rest of the year. Similar previous tables, light to darker green shading in Table 15 represents the lowest number to crashes to the highest.

TABLE 15. **Lombard Street – Total Crashes Involving Pedestrians and Bicyclists Combined by Month of Year and Lighting Condition**

Month/Time	Daylight	Darkness – *With Street Lights*	Darkness – *No Street Lights*	Dawn *(Twilight)*	Dusk *(Twilight)*	Total
January	0	5	0	1	1	7
February	0	1	1	0	0	2
March	4	1	1	0	1	7
April	5	0	0	0	0	5
May	2	2	0	0	0	4
June	2	0	0	0	0	2
July	4	0	0	0	0	4
August	3	0	0	0	0	3
September	2	2	0	0	0	4
October	2	0	0	0	0	2
November	0	2	0	0	2	4
December	1	3	0	0	0	4
Total	25	16	2	1	4	48

As shown in Figure 13, on Lombard Street, crashes occurred most frequently on Fridays (18 percent of total crashes). The number of crashes throughout the day on Monday to Thursday were evenly distributed, ranging from 14 to 15 percent of total crashes. Saturday and Sunday accounted for a quarter of the total crashes, which was higher than the proportion of weekend crashes on Columbia Boulevard (16 percent).

FIGURE 13. **Lombard Street – Total Crashes by Day of Week**



Where Did Crashes Occur?

On Lombard Street, more crashes occurred at intersections as compared to segments (Table 16). Serious injury crashes were more frequent at intersections, though all fatal crashes occurred on segments. **A larger percentage of pedestrian and bicyclist crashes occurred at intersections on Lombard Street than on Columbia Boulevard** (73 percent versus 54 percent). Intersection pedestrian and bicyclist crashes were concentrated at signalized intersections, where over 70 percent occurred.

TABLE 16. **Lombard Street – Total, Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Location**

Junction Type	Intersection Type	Total Crashes	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Intersection	Total	590	0 (0%)	10 (2%)	20	15
	Signalized	356	0	5	16	9
	Unsignalized	234	0	5	4	6
Segment	–	368	6 (2%)	5 (1%)	5	8

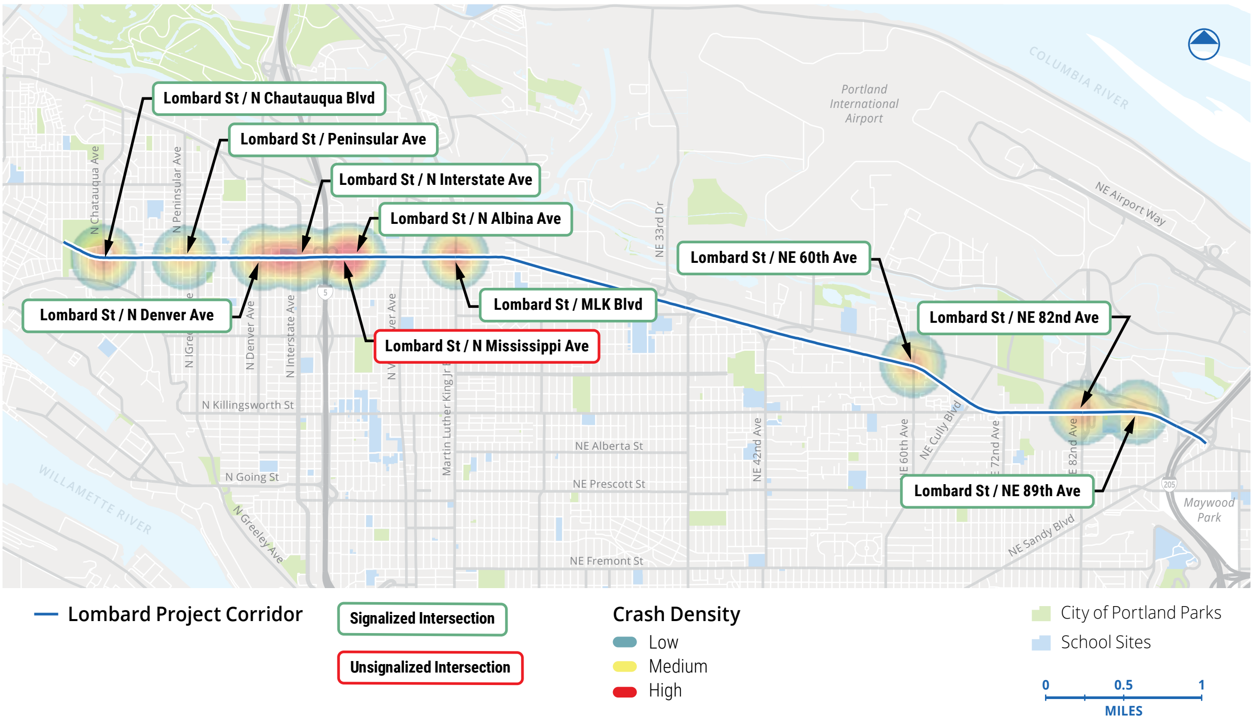
The top 10 high crash intersections on Lombard Street in the study period are shown in Table 17. These intersections account for 234 of the 590 intersection crashes, or 40 percent of all intersection crashes. In addition, four of the 10 serious injury crashes at intersections occurred at one of these intersections. Nearly two-thirds of the intersection pedestrian crashes and one-third of the intersection bicyclist crashes occurred at the top 10 high crash intersections. The top 10 high crash intersections provide a representative sample of all intersections throughout Lombard Street; these intersections are analyzed for crash and geometric/traffic control risk factors subsequently (see section titled "Risk Factor Analysis – Motorized Vehicles").

The locations of the top 10 high crash intersections are shown in Figure 14. **Seven of the top 10 high crash intersections are located between Lombard Street/Martin Luther King Boulevard and Lombard Street/Chautauqua Boulevard – just 2.25 miles**. The map contains "heat levels" which show the relative frequencies of crashes that occurred at each intersection.

TABLE 17. **Lombard Street – Total, Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Top 10 High Crash Intersections**

Intersection Name	Total Crashes	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Lombard St/N Interstate Ave	29	0	1	3	1
Lombard St/Martin Luther King Jr. Blvd	27	0	0	0	0
Lombard St/N Chautauqua Blvd	26	0	0	1	1
Lombard St/N Denver Ave	25	0	1	5	1
Lombard St/NE 60th Ave	24	0	2	1	1
Lombard St/NE 82nd Ave	24	0	0	0	0
Lombard St/NE 89th Ave	20	0	0	0	0
Lombard St/N Albina Ave	20	0	0	0	0
Lombard St/N Mississippi Ave	20	0	0	1	0
Lombard St/Peninsular Ave	19	0	0	1	1
Total	234 (40%)	0 (100%)	4 (40%)	12 (60%)	5 (33%)

FIGURE 14. **Lombard Street – Top 10 High Crash Intersections**



Non-intersection crashes on Lombard Street occurred most frequently along the segment of Lombard Street from Martin Luther King Jr. Boulevard to N Interstate Avenue, where 23 percent of all segment crashes occurred (Table 18). Crash density (crashes per mile) on this segment was also highest compared to the other segments, nearly three times the crash density along Lombard Street from NE 33rd Avenue to Martin Luther King Jr. Boulevard. Four of the total six fatal crashes and 20 percent of the total serious injury crashes on the corridor occurred on the segment stretching from NE 60th Avenue to NE 33rd Avenue. Pedestrian crashes were concentrated west of NE 33rd Avenue (80 percent) and bicyclist crashes occurred most densely west of Martin Luther King Jr. Boulevard, accounting for three-quarters of the segment bicyclist crashes. Light to darker green shading represents the lowest to the highest number of crashes and density.

TABLE 18. **Lombard Street – Total, Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes and Crash Density by Segment**

Segment Name	Segment Length (miles)	Total Crashes	Crash Density (crashes per mile)	Fatal Crashes	Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
I-205 East Ramp Terminal to NE 82nd Ave	0.90	53	0	1	0	0	58.9
NE 82nd Ave to NE 60th Ave	1.16	61	0	0	1	1	52.6
NE 60th Ave to NE 33rd Ave	1.43	52	4	3	0	1	36.4
NE 33rd Ave to MLK Jr. Blvd	1.60	45	1	0	1	0	28.1
MLK Jr. Blvd to N Interstate Ave	1.00	85	0	0	1	3	85.0
N Interstate Ave to N Woolsey St	1.56	72	1	1	2	3	46
Total	7.65	368	48.1 (average)	6	5	5	8

How Did Crashes Occur?

The most common crash collision type was rear-end, accounting for 47 percent of all crashes. The second most common collision type was turning movements (28 percent of all crashes). T**he most severe collision type, as a percentage of crashes that result in fatal or serious injury, was fixed object crashes**, with nine percent resulting in fatal or serious injuries. **Bicyclist crashes predominantly involved turning movements** (70 percent), while one pedestrian crash involved a turning vehicle. The five most frequent collision types are shown in Table 19.

TABLE 19. **Lombard Street – Total, Fatal and Serious Injury, Pedestrian, and Bicyclist by Most Frequent Collision Type**

Collision Type	Total Crashes	Fatal and Serious Injury Crashes	Pedestrian Crashes	Bicyclist Crashes
Rear-End	453	3	0	2
Turning Movement	266	3	1	17
Sideswipe – Overtaking	89	0	0	2
Angle	61	0	0	2
Fixed Object or Other Object	43	4	0	0

As shown in Table 20, the vast majority of crashes that involved driver error was attributed to failure to avoid stopped or parked vehicles. Frequent driver errors also included not having right-of-way, and improper lane changing. Not all driver errors are shown in Table 20.

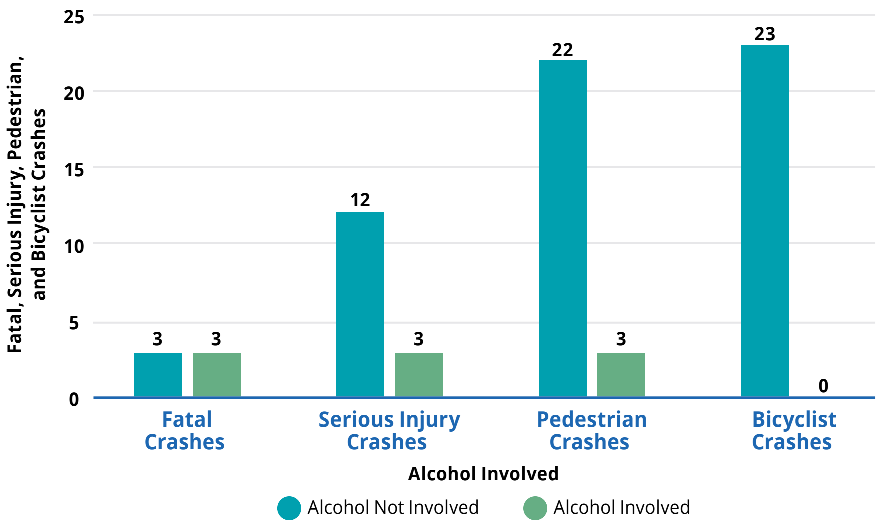
TABLE 20. **Lombard Street – Total Involved Drivers and Fatally or Seriously Injured Drivers by Most Frequent Driver Error**

Behavioral Cause	Involved Drivers	Fatalities and Serious Injuries
Failed to avoid stopped or parked vehicle	328	1
Did not have right-of-way	128	1
Improper change of traffic lanes	67	0
Disregarded traffic signal	53	0
Disregarded traffic control device	43	0

High Risk Behavior

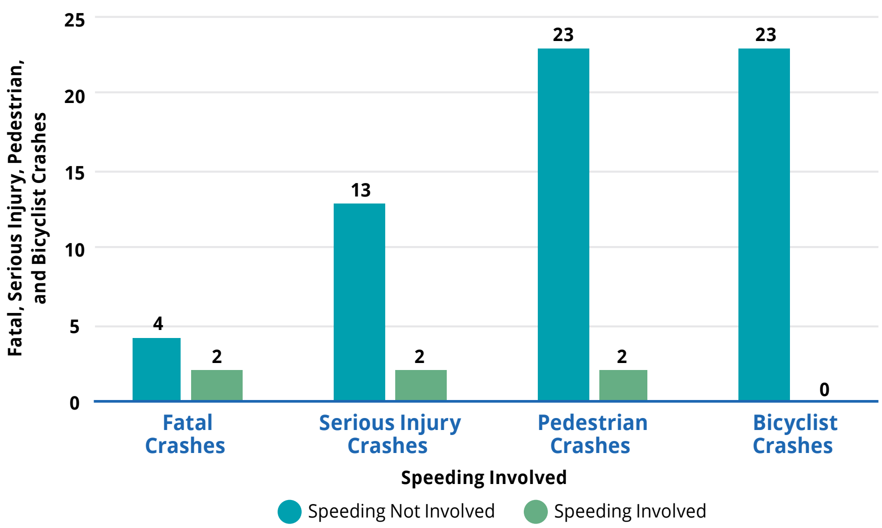
The number of fatal crashes and serious injury crashes linked to alcohol involvement is displayed in Figure 15. **Half of the fatal crashes and 20 percent of the serious injury crashes, or three fatal crashes and three serious injury crashes, involved alcohol.** The percentage of fatal crashes that involved alcohol on Lombard Street was half the percentage that involved alcohol on Columbia Boulevard (100 percent). In addition to alcohol, drugs were involved in 50 percent of fatal crashes on Lombard Street and 6.7 percent of serious injury crashes. One fatal crash involved both alcohol and drugs. Alcohol was not a factor in any of the bicyclist crashes but was involved in 14 percent of the pedestrian crashes.

FIGURE 15. **Lombard Street – Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Alcohol Involvement**



Speed is another high risk behavior that was involved in both the fatal crashes and serious injury crashes on Lombard Street (Figure 16). One-third of the fatal crashes and 13 percent of serious injury crashes (two fatal crashes and two serious injury crashes) involved speeding. **Compared to Columbia Boulevard, fewer of the fatal crashes and serious injury crashes involved speeding on Lombard Street**. Over 20 of the pedestrian crashes, though none of the bicyclist crashes, involved speeding.

FIGURE 16. **Lombard Street – Fatal, Serious Injury, Pedestrian, and Bicyclist Crashes by Speeding Involvement**

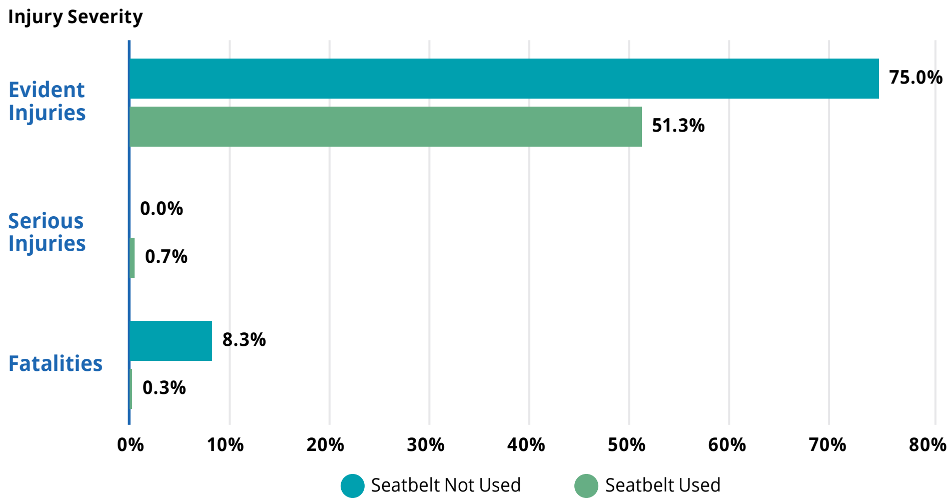


There were 1,048 crash participants for which seatbelt use was reported.[28] There were 12 participants that did not use a seatbelt: of these, eight percent experienced a fatality, compared to 0.3 percent of those who did use a seatbelt. Therefore, those who did not wear a seatbelt were 28 times more likely to experience a fatality in a crash.

[28] There were a total of 2,187 crash participants along Lombard Street. For 1,103 participants, the use of seatbelts was listed as "unknown," for 27 participants there was no entry for seatbelt use, and there were nine participants who were wearing a helmet. Therefore, the total participants analyzed for seatbelt use is 1,048.

The majority of those who did not use a seatbelt experienced an injury (83 percent). Approximately half of those who were wearing a seatbelt experienced an injury, or 31 percent less than those without a seatbelt. There were no serious injuries among those who did not use a seatbelt, and 0.6 percent of seatbelt users experienced a serious injury (Figure 17).

FIGURE 17. **Lombard Street – Percentage of Participants Who Experienced an Injury by Seatbelt Usage**



No motorcycle riders were not wearing a helmet at the time of the crash.[29] Two crashes occurred involving a bicyclist not wearing a helmet, which resulted in an evident (B) and possible (C) injury. Due to a small sample size, bicyclist crash severity by helmet use did not appear to show statistically significant correlation.

[29] Seven crashes involving motorcyclists occurred. Six of the motorcyclists were wearing helmets and for one motorcyclist the safety equipment used was listed as "unknown."

Summary of Historic Crash Analysis – Columbia Boulevard and Lombard Street

The major findings from the historic crash analysis for Columbia Boulevard and Lombard Street are shown in Table 21. It shows the most common crash characteristics and how those characteristics compare to the city of Portland as a whole. For characteristic percentages that were higher than citywide percentages, an upward arrow is used, while downward arrow is used when the characteristic percentages were lower. The most notable findings are as follows:

- The **proportion of crashes that were fatal was higher than the city of Portland for both Columbia Boulevard and Lombard Street** (1.7 times and 2 times the citywide average, respectively).
- All **four fatal crashes on Columbia Boulevard involved speeding drivers**, which was 53 percent higher than the proportion citywide. Though lower than the citywide percentage, 33 percent of Lombard Street fatal crashes, or two fatal crashes, involved speeding.
- The proportion of crashes that resulted in serious injuries on both Columbia Boulevard and Lombard Street was 27 percent lower than the citywide average.
- Crashes involving bicyclists and pedestrians accounted for a similar percentage of all crashes as the city of Portland, for both Columbia Boulevard and Lombard Street. Pedestrian and bicyclist volume data was not available to confirm whether pedestrian and bicyclist volumes were higher on the two corridors compared to citywide averages.
- **Heavy vehicles were involved in three times the percentage of all crashes on Columbia Boulevard as compared to the city of Portland**.
- Most of the fatal and serious injury crashes occurred on segments (not at intersections) on Columbia Lombard (75 percent), which is 25% higher than the citywide average. On Lombard Street, half of the fatal and serious injury crashes occurred at intersections and half on segments, similar to citywide averages.
- **Alcohol and/or drugs were involved in all four fatal crashes on Columbia Boulevard,** or a 44 percent higher proportion than citywide. **On Lombard Street, five of the six fatal crashes (83 percent) involved alcohol and/or drugs**, approximately 27 percent higher than the citywide average.

TABLE 21. **Summary of Historic Crash Analysis – Columbia Boulevard and Lombard Street**

	COLUMBIA BOULEVARD		LOMBARD STREET	
Crash Factor	**Number of Crashes/ Participants** *(Percentage of Total)*	**Compared to city of Portland**	**Number of Crashes/ Participants** *(Percentage of Total)*	**Compared to city of Portland**
Total Crashes	762	–	958	–
Fatal Crashes	4 (0.5%)	1.7x higher	6 (0.6%)	2x higher
Serious Injury Crashes	12 (1.6%)	Lower percentage (-27%)	15 (1.6%)	Lower percentage (-27%)
Crashes involving pedestrians	6 (0.8%)	Slightly lower (-1.8%)	25 (2.6%)	Same percentage
Crashes involving bicyclists	7 (0.9%)	Slightly lower (-1.3%)	23 (2.4%)	Same percentage
Participants by Age and Sex	Mostly male (64%) and mostly ages 25-34 (22%)	Higher percentage of males (+9%) and similar age distribution	Mostly male (56%) and mostly ages 25-64 (77%)	Similar percentage of males and ages 25-64
Involved Vehicles by Mode	Mostly passenger cars (89%). Heavy vehicles made up 7%.	Lower proportion of passenger cars (-5%) and 3x higher proportion of heavy vehicles	Mostly passenger cars (94%). Heavy vehicles made up 2.1%	Similar percentages of passenger cars and heavy vehicles
Crashes by Time of Day, Month of Year, and Day of Week	3 pm-6 pm was most common time (24.6%), most frequent month was October: (10.7%) and Wednesday was most common day (18.8%)	No data available for comparison	3 pm-6 pm was most common time (29%), most frequent month was January (9.4%), and Friday was most common day (18%)	No data available for comparison
Fatal and Serious Injury Crashes by Location	Mostly at segments (75% of fatal and serious injury crashes)	Higher percentage at segments (+25%)	Half at intersections, half on segments	Same percentage
Crashes by Collision Type	Rear-end was most common (43%), then turning movements (32%)	Lower proportion of rear-end crashes (-6%), no comparison available for turning movement crashes	Rear-end was most common (47%), then turning movements (28%)	Lower proportion of rear-end crashes (-2%), no comparison available for turning movement crashes
Involved Drivers by Driver Error	Failure to avoid stopped or parked vehicle was most common error (16%), next was not having right-of-way (7%)	No data available for comparison	Failure to avoid stopped or parked vehicle was most common error (17%), next was not having right-of-way (7%)	No data available for comparison
Fatal Crashes Involving Alcohol/Drugs, and/or Speeding	Alcohol and/or drugs in all 4 fatal crashes (100%), speeding also in all 4 (100%)	Significantly higher percentage for alcohol and/or drugs (+44%) and for speeding (+53%)	Alcohol and/or drugs in 5 of 6 fatal crashes (83%), speeding involved in 2 fatal crashes (33%)	Significantly higher percentage for alcohol and/or drugs (+27%) and lower percentage for speeding (-14%)
Participants by Seatbelt Use During Crash	Seatbelt used in large majority of crashes (99%)	No data available for comparison	Seatbelt used in large majority of crashes (99%)	No data available for comparison

Safety Priority Index System Sites

The ODOT Safety Priority Index System (SPIS) is a systemic scoring method that prioritizes locations on public roads for potential safety problems according to crash frequency, crash rate, and crash severity.[30] SPIS sites are first identified based on the presence of one of the following criteria in the previous three year period:

- Three or more crashes (all severities)
- One or more fatal crashes

Once SPIS sites are identified, they are scored using an equation consisting of three components: crash frequency, crash rate, and crash severity. Crash frequency and crash rate are assigned equal weights in the scoring, while crash severity is weighted twice as much as crash frequency and rate. The highest score possible is 100, which can only be assigned to a site with at least 150 crashes in the 0.10 mile segment, at least seven crashes per million vehicle miles travelled, and a combination of high severity crashes. SPIS sites may have higher or lower scores based on any combination of the three components of the score equation. SPIS sites ranked in the top 90th and 95th percentile (i.e., top 10 percent and top five percent of sites) are shown in Figure 18. The location, score, and percentile for the SPIS sites are shown in Table 22 and Table 23. The majority of the sites are clustered west of Interstate 5 and east of NE 82nd Avenue.

Not all of the 90 and 95th percentile SPIS sites overlap with the top 10 high crash intersections identified in the historic crash analysis. The following five intersections, contained in the top 10 high crash intersections on Lombard Street (Table 17), are not SPIS sites in the top five and 10 percentiles, potentially due to higher traffic volumes, which result in lower crash rates:

- **Lombard Street/N Interstate Avenue**
- **Lombard Street/NE 60th Avenue**
- **Lombard Street/NE 82nd Avenue**
- **Lombard Street/NE 89th Avenue**
- **Lombard Street/N Mississippi Avenue**

On Columbia Boulevard, the following six intersections, contained in the top 10 high crash intersections (Table 7), were not SPIS sites in the top five and 10 percentiles:

- **Columbia Boulevard/N Vancouver Avenue**
- **Columbia Boulevard/NE 47th Avenue**
- **Columbia Boulevard/I-5 East Ramp Terminal**
- **Columbia Boulevard/NE 80th Avenue**
- **Columbia Boulevard/NE Alderwood Road**
- **Columbia Boulevard/NE 42nd Avenue**

[30] Safety Priority Index System Reports. Oregon Department of Transportation. 2019. https://www.oregon.gov/ODOT/Engineering/Pages/SPIS-Reports-On-State.aspx

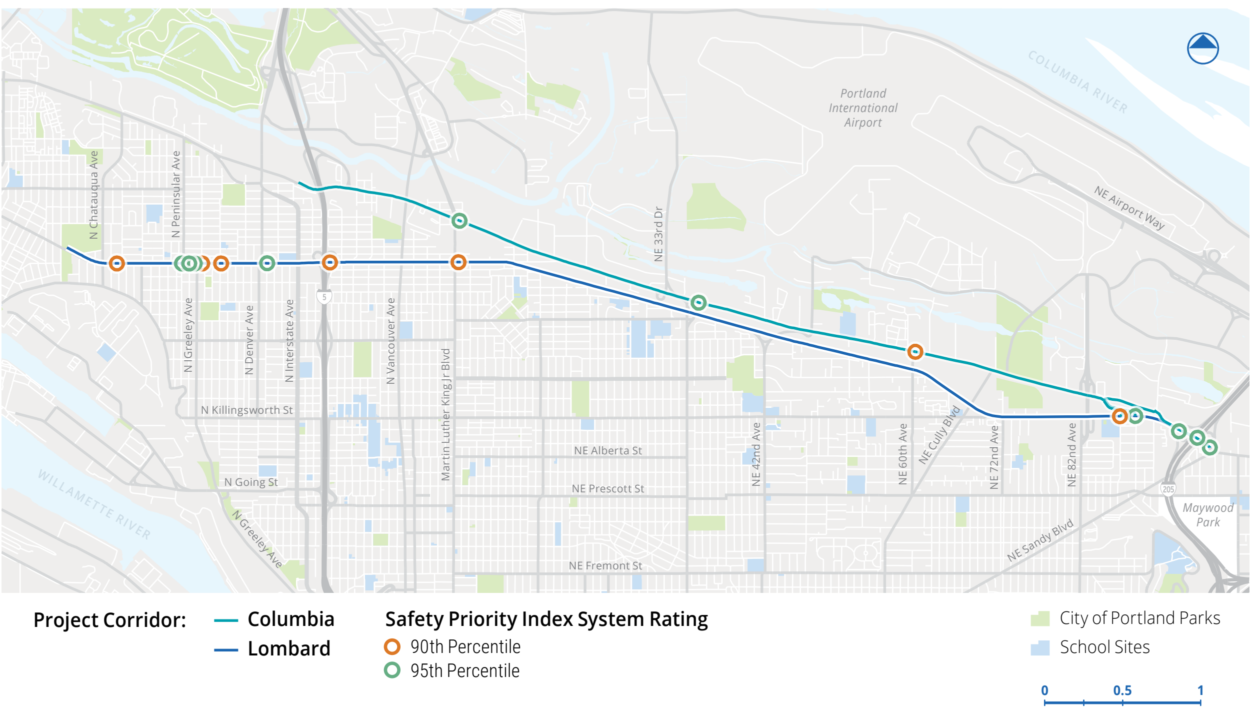
TABLE 22. **Columbia Boulevard – Safety Priority Index System Sites**

Location	Segment/Intersection	SPIS Score	Top percentile
Columbia Blvd/I-205 West Ramp Terminal	Intersection	82.08	95
Columbia Blvd/I-205 East Ramp Terminal	Intersection	79.06	95
Columbia Blvd/ Martin Luther King Jr. Blvd	Intersection	71.72	95
Columbia Blvd/NE 33rd Drive	Intersection	59.67	95
Columbia Blvd/NE 60th Ave	Intersection	48.26	90

TABLE 23. **Lombard Street – Safety Priority Index System Sites**

Location	Segment /Intersection	SPIS Score	Top percentile
Lombard St/N Atlantic Ave	Intersection	74.86	95
Lombard St/NE Columbia Pkwy (northbound)	Intersection	65.64	95
Lombard St/N Denver Ave	Intersection	60.5	95
Lombard St/N Peninsular Ave	Intersection	60.1	95
Lombard St/N Curtis Ave	Intersection	59.05	95
Lombard St/OR 99E	Intersection	52.82	90
Lombard St/NE Columbia Pkwy (southbound)	Intersection	52.36	90
Lombard St/N Chautauqua Blvd	Intersection	48.21	90
Lombard St/N Albina St to N Interstate Ave	Segment	46.99	90
Lombard St/N Greeley Ave	Intersection	46.86	90
Lombard St/N Delaware Ave to N Wilbur Ave	Segment	46.67	90

FIGURE 18. **Columbia Boulevard and Lombard Street – Safety Priority Index System Sites**



Risk Factor Analysis – Motorized Vehicles

The risk factor analysis evaluates common crash characteristics, such as crash type, vehicle movements, and driver behaviors at the top 10 high crash intersections and along the segments of the corridors, for Columbia Boulevard and Lombard Street separately. Subsequently, existing roadway and traffic control features that may be related to the common characteristics are identified, many of which are features identified to influence crash frequency in the Highway Safety Manual (HSM) Predictive Method for Urban and Suburban Arterials.[31] Subsequently, in the section titled "Countermeasures for Consideration – Motorized Vehicles," countermeasures are proposed that consider both the crash characteristics and the existing roadway and traffic control features that are present. An outline for the steps involved in the risk factor analysis is shown in Figure 19.

FIGURE 19. **Steps for Risk Factor Analysis**

STEP 1	STEP 2	STEP 3	STEP 4
Analyze crash characteristics at the top 10 intersections with the highest crash frequency	Analyze crash characteristics at segments along corridor	Gather information on existing features and potential areas of improvement throughout corridor related to crash characteristics	Propose countermeasures based on existing features and crash characteristics

Crash Characteristics on Columbia Boulevard

Crash characteristics at the top 10 high crash intersections (see Table 7) on Columbia Boulevard are shown in Table 24. Crash type, a description of the vehicle movements, total crashes, injury crashes, fatal and serious injury crashes, and crash behavior are tabulated. The crash types and corresponding frequencies shown in the table account for 70 percent of all crashes at the top 10 high crash intersections.

Rear-end crashes were the most frequent (160 crashes) and represented half of all crashes at the top 10 high crash intersections. Though injury severity was high in the rear-end crashes (55 percent of total crashes), a small proportion of the crashes, approximately three percent, or five crashes, involved speeding. **Angle crashes had the highest injury severity, with almost three-quarters resulting in injuries, mostly caused by drivers disregarding traffic signals**. Turning crashes were prevalent at the intersections and had the highest percentage of fatal and serious injury crashes, three-quarters of which were caused by drivers disregarding traffic control devices or not yielding right-of-way.

Crash characteristics for freight vehicle crashes, specifically, were similar to those for all vehicle crashes. However, turning crashes were more frequent, approximately half of all freight vehicle crashes at the top ten high crash intersections. Most of the turning crashes were caused by improper turning and not yielding right-of-way. One-third of the freight crashes were rear-end.

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[31] Highway Safety Manual, Volume 2, Chapter 12, "Predictive Method for Urban and Suburban Arterials."

TABLE 24. **Columbia Boulevard – Crash Characteristics of the Top 10 High Crash Intersections**

Crash Type	Vehicle Movement Description	Number of Crashes	Injury Crashes	Fatal and Serious Injury Crashes	Driver Behavior	Speeding/Alcohol and/or Drug Involvement
Rear-end	Major and minor street rear-end collisions with stopped vehicles	160	88 (55%)	0 (0%)	Following too closely (56%), Failure to avoid vehicle (33%)	Speeding was involved in 5 crashes. Alcohol and/or drugs were involved in 7 crashes.
Turning	Major street turning movement collisions with minor street through movements	38	20 (54%)	2 (5%)	Disregarding traffic control devices (42%), did not yield right-of-way (37%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 1 crash.
Angle	Major street through movement collisions with minor street through movements	33	24 (73%)	1 (3%)	Disregarding traffic control devices (58%)	Speeding was involved in 1 crash. Alcohol and/or drugs were involved in 2 crashes.

Similar to Table 24, crash characteristics for all segment crashes on Columbia Boulevard are shown in Table 25. The crashes in the table total to 233, accounting for 73 percent of all segment crashes.

Rear-end crashes with vehicles stopped in traffic represented 27 percent of all segment crashes on Columbia Boulevard, half of which resulted in participant injuries. **Same direction sideswipes were frequent along the corridor segments** and mostly occurred due to lane changing activity. Of all segment crashes, **eight percent, or 27 crashes, involved a single vehicle crash with a fixed object,** the majority of which were due to speeding or reckless driving. Nighttime crashes were not prevalent.

High frequency and all injury crashes (36 total, 22 injury) were associated with drivers making left turns from driveways on to Columbia Boulevard across both directions of traffic. Not yielding right-of-way was the most frequent driver behavior, and speeding was not involved in any of the turning crashes. Fixed object crashes were associated with the highest percentage of fatal and serious injury crashes (three crashes, or 11 percent of the fixed object crashes).

For freight vehicles, the most common crash types and driver behaviors were similar, though turning crashes were more frequent as a percentage of the total. **Not yielding right-of-way was more prevalent for freight vehicle crashes**.

TABLE 25. **Columbia Boulevard – Crash Characteristics by Segment**

Crash Type	Vehicle Movement Description	Number of Crashes	Injury Crashes	Fatal and Serious Injury Crashes	Driver Behavior	Speeding/Alcohol and/or Drug Involvement
Rear-end	Major street collisions with vehicles stopped in traffic	86	47 (55%)	1 (1%)	Following too closely (71%), Failure to avoid vehicle (15%)	Speeding was involved in 1 crash. Alcohol and/or drugs were involved in 1 crash.
Sideswipe	Major street collisions with same direction sideswipes	57	27 (47%)	2 (4%)	Improper lane changing (54%), Following too closely (18%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 1 crash.
	Major street collisions with opposite direction sideswipes	14	7 (50%)	2 (14%)	Drove left of centerline (71%)	Speeding was involved in 3 crashes. Alcohol and/or drugs were involved in 4 crashes.
Turning	Driveway to major street left turn crashes with major street through movements	36	22 (61%)	1 (3%)	Did not yield right-of-way (89%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 1 crash.
	Driveway to major street right turn crashes with major street through movements	13	5 (38%)	0 (0%)	Did not yield right-of-way (62%)	Speeding was not involved in any crashes. Alcohol and/or drugs were also not involved in any crashes.
Fixed Object	Major street collisions with fixed objects	27	16 (59%)	3 (11%)	Driving too fast for conditions (26%), other improper driving (19%), Reckless driving (15%)	Speeding was involved in 13 crashes. Alcohol and/or drugs were involved in 3 crashes.

Existing Roadway and Traffic Control Features on Columbia Boulevard

Existing features that may impact safety, including roadway geometry and traffic control devices, were investigated throughout Columbia Boulevard, specifically at the top 10 high crash intersections and along segments.

Existing Infrastructure Features – Top 10 High Crash Intersections

Rear-end, turning, and angle crashes were the most common crash types at the top 10 high crash intersections. **The majority of these crash types were associated with the following driver behaviors: following too closely, disregarding traffic control devices, and not yielding right-of-way**. The following characteristics are generally present at the top 10 high crash intersections:

- Some side streets do not have dedicated left turn lanes or protected left turn signal phasing.
- The majority of side street signal heads do not have signal backplates. Those that do have backplates are not reflectorized.
- Most of the signal heads are installed on spanwire, which are less conspicuous and visible compared to signal heads mounted on traffic signal mast arm poles.

The permissive-only left turns on the minor intersecting streets require drivers to have adequate sight distance and judgment to assess appropriate gap distances in through traffic when initiating the left turn on to Columbia Boulevard. Depending on the opposite direction through volumes, drivers may be more likely to initiate a turn without sufficient gap distance in order to avoid waiting through another signal cycle to complete the turn, particularly if opposing traffic is traveling at high speeds.

The lack of backplates on many of the side street signal heads may reduce visibility of the signal indication, potentially increasing the chances of unintentional disregard of signal indications. Spanwire installation may further reduce the conspicuity of the presence of a signalized intersection for drivers.

Existing Infrastructure Features – Segments

The following crash types were most common along Columbia Boulevard segments: rear-end, sideswipe, turning, and single vehicle fixed object crashes. **Following too closely, improper lane changing, driving left of the centerline, and not yielding right-of-way were the most frequent driver behaviors for these crash types**. Characteristics which may be related to these crash types and behaviors present throughout the majority of Columbia Boulevard are as follows:

- Driveway access density is high, particularly between NE 33rd Drive and N Interstate Avenue.
- Two-way left turn lanes are present throughout Columbia Boulevard.
- Medians are not present for restricting turns across opposite direction travel lanes.
- Utility poles are present on the south side of Columbia Boulevard.
- Roadway segment illumination is present on the north side of the corridor.
- Pedestrian crossings are not present outside of intersections.
- Small curb return radii are present at side streets and driveways.

Frequent turning of vehicles from Columbia Boulevard onto driveways and side streets may increase frequency of injury crashes, as research shows reducing driveway density may decrease crashes by 29 percent.[32] **The high access density may increase lane changing activity and consequently may increase sideswipe crashes with vehicles traveling in the same direction**. Vehicles stopping for pedestrians crossing the road outside of intersection crosswalks may also increase travel speed differentials.

The **lack of a raised median allows unrestricted left turns from driveways onto Columbia Boulevard**, requiring assessing sufficient gap distance for both directions of traffic. Gap distance may not be accurately assessed due to the high speeds on the corridor. In addition, the lack of a raised median results in no physical barrier that could prevent vehicles traveling in the opposite direction from crossing the centerline into oncoming traffic.

The presence of utility poles, illumination poles, and other fixed objects within the clear zone may increase the crash severity of drivers who have left the roadway due to speeding or reckless driving.

Crash Characteristics on Lombard Street

Considering the top 10 high crash intersections (see Table 17) on Lombard Street, rear-end crashes with stopped vehicles were less frequent proportionally than the same on Columbia Boulevard (49 percent versus 36 percent, respectively). In contrast, **the percentage of turning crashes was higher on Lombard Street than Columbia Boulevard**, approximately 20 percent versus 10 percent, respectively (Table 26). For the crash types shown, crash severity was lower at the Lombard Street intersections, where 30 percent of crashes resulted in injuries compared to 43 percent at Columbia Boulevard's top 10 high crash intersections.

Opposite direction left turn and through crashes accounted for 16 percent of crashes at the top 10 high crash intersections, nearly exclusively caused by drivers not yielding right-of-way. **Angle crashes resulted in the**

[32] Crash Modification Factor Clearinghouse (CMF ID=177). Federal Highways Administration. 2019. http://www.cmfclearinghouse.org/detail.cfm?facid=177

most injury crashes as a percentage, predominantly due to drivers disregarding traffic signals and other traffic control devices.

In terms of percentages, half as many crashes on Lombard Street involved speeding as on Columbia Boulevard (0.8 percent versus 1.8 percent). Alcohol and/or drugs were involved in proportionally equivalent numbers of crashes for the two corridors.

Freight vehicle crashes involved similar crash types and driver behaviors.

TABLE 26. **Lombard Street – Crash Characteristics of the Top 10 High Crash Intersections**

Crash Type	Vehicle Movement Description	Number of Crashes	Injury Crashes	Fatal and Serious Injury Crashes	Driver Behavior	Speeding/Alcohol and/or Drug Involvement
Rear-end	Major street collisions with vehicles stopped in traffic	85	35 (41%)	0 (%)	Following too closely (54%), Failure to avoid vehicle (35%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 4 crashes.
Turning	Major street left turn and opposite direction through collisions	24	13 (54%)	1 (4%)	Did not yield right-of-way (88%)	Speeding was involved in 1 crash. Alcohol and/or drugs were not involved in any crashes.
	Minor street left turn and opposite direction through collisions	14	6 (43%)	0 (0%)	Did not yield right-of-way (86%)	Speeding was involved in 1 crash. Alcohol and/or drugs were not involved in any crashes.
	Major street through and minor street right turn collisions	8	2 (25%)	0 (0%)	Did not yield right-of-way (63%)	Speeding was not involved in any crashes. Alcohol and/or drugs were also not involved in any crashes.
Angle	Major street through with minor street through collisions	29	16 (55%)	0 (0%)	Disregarding traffic control devices (83%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 2 crashes.

Nearly **half of all segment crashes on Lombard Street were rear-end crashes with vehicles stopped in traffic**, higher than the rear-end crash frequency, 27 percent, on Columbia Boulevard segments (Table 27). Crash severity was relatively high for these crashes as 98 crashes resulted in injuries. Speeding contributed to seven of the crashes while alcohol and/or drugs were involved in four of the crashes.

Turning crashes from driveways accounted for three percent of all segment crashes on Lombard Street, less than the percentage accounted for on Columbia Boulevard, approximately 15 percent. For the crash types shown, injury crash frequency was approximately equivalent, 38 percent of all segment crashes, for both Columbia Boulevard and Lombard Street.

Crash severity was high for single vehicle fixed object crashes, of which 65 percent of crashes resulted in participant injuries and 18 percent resulted in fatal and serious injuries. Head on collisions had the highest severity, as half of the crashes caused fatal and serious injuries. Speeding and alcohol/drugs were involved in a majority of both fixed object and head on crashes. For all crash types, nighttime crashes were a minority of the total crashes.

Segment crashes involving freight vehicles were exclusively rear-end, sideswipe, and turning crashes. Improper lane changing and turning were the most common driver behaviors.

TABLE 27. **Lombard Street – Crash Characteristics by Segment**

Crash Type	Vehicle Movement Description	Number of Crashes	Injury Crashes	Fatal and Serious Injury Crashes	Driver Behavior	Speeding/Alcohol and/or Drug Involvement
Rear-end	Major street collisions with vehicles stopped in traffic	166	98 (59%)	1 (1%)	Following too closely (63%), Failure to avoid vehicle (24%)	Speeding was involved in 7 crashes. Alcohol and/or drugs were also not involved in 4 crashes.
Sideswipe	Major street collisions with same direction sideswipes	89	34 (38%)	0 (0%)	Improper lane changing (64%), Following too closely (12%)	Speeding was involved in 3 crashes. Alcohol and/or drugs were involved in 5 crashes.
Turning	Major street left turn and opposite direction thru collisions	13	6 (46%)	0 (0%)	Did not yield right-of-way (100%)	Speeding was not involved in any crashes. Alcohol and/or drugs were involved in 1 crash.
	Driveway to major street left turn crashes with major street thru movements	12	5 (42%)	0 (0%)	Did not yield right-of-way (100%)	Speeding was not involved in any crashes. Alcohol and/or drugs were also not involved in any crashes.
Fixed Object	Major street collisions with fixed objects	17	11 (65%)	3 (18%)	Reckless driving (29%), Speeding (24%)	Speeding was involved in 6 crashes. Alcohol and/or drugs were involved in 6 crashes.
Head On	Major street head on collisions with opposite direction vehicles	8	6 (75%)	4 (50%)	Drove left of centerline (50%), Driving too fast for conditions (25%)	Speeding was involved in 2 crashes. Alcohol and/or drugs were involved in 3 crashes.

Existing Roadway and Traffic Control Features on Lombard Street

Existing roadway and traffic control features that may affect crash frequency were analyzed at the top 10 high crash intersections and along the segments throughout Lombard Street.

Existing Infrastructure Features – Top 10 High Crash Intersections

The majority of crashes at the top 10 high crash intersections were rear-end, turning, and angle crashes. Driving behaviors prior to crashes were predominantly turning vehicles not yielding right-of-way, disregarding traffic control devices, and following too closely. Overall, the following characteristics were found at the top 10 high crash intersections:

- The majority of side streets do not have dedicated left turn lanes or protected left turn signal phasing.
- Many of the major street approaches also do not have dedicated left turn lanes or left turn signal phasing. Left turns are permissive-only at these intersections.
- The majority of side street signal heads do not have signal backplates. Those that do have backplates are not reflectorized.
- Most of the signal heads are installed on spanwire.
- Some intersections have small intersection turning area for larger vehicles.

The permissive-only left turns on Lombard Street do not provide a dedicated phase for the movement crossing opposite direction lanes and require drivers to assess when sufficient gap distance is available to complete the turn safely. A high volume of opposite direction through traffic may result in difficulty in finding a sufficient gap, which may create queues of stopped vehicles in the inside through lane. Stopped vehicles in the through lane may be inconsistent with driver expectation, increase lane changing activity, and increase driver frustration.

Similar to Columbia Boulevard, backplates lacking on many of the intersection signal heads may increase the chances of drivers not seeing the indication light and disregarding the signal. Signals installed on spanwire may also be less visible to drivers.

Existing Infrastructure Features – Segments

Rear-end, sideswipe, and turning crashes are the majority of crashes along the segments on Lombard Street, while improper lane changing, following too closely, and not yielding right-of-way were the most frequent driver behaviors for these crash types. The following shows general trends in roadway and traffic control features that could potentially influence the frequency of the predominant crash types and driver behaviors:

- Driveway access density is high, particularly west of Martin Luther King Jr. Boulevard.
- Neither dedicated left turn lanes nor two-way left turn lanes are present within segments throughout the corridor.
- Medians are not present for restricting turns across opposite direction travel lanes.
- Utility poles are present on the south side of the corridor.
- On-street parking is present in locations on the north side of the corridor. The HSM predicts negative impacts to safety where on-street parking exists.
- Roadway segment illumination is present.
- Pedestrian crossings are not present outside of intersections.

Left turns are not restricted throughout the Lombard Street corridor. Vehicles turning left from Lombard Street into driveways and side streets must accurately assess gap distance for opposite direction through vehicles in order to make the turn safely. No restrictions are present for vehicles turning left from side streets and driveways on to Lombard Street, which requires drivers to access gap distance for both directions and across at least three lanes of traffic.

The lack of dedicated left turn lanes in the segments may cause vehicles on Lombard Street to stop in the inside through lane to wait for sufficient gap distance, possibly resulting in vehicle queues. The vehicle queues may cause drivers to change lanes to bypass the queue, possibly resulting in sideswipe crashes with vehicles traveling in the outside lane. Vehicles stopped in the inside through lane may also not be expected by drivers and require a sudden change in speed for the approaching vehicles to avoid rear-end collisions. In addition, the lack of pedestrian crossings may increase the rate of unexpected mid-block crossings, which could in turn increase sudden vehicle stopping.

Similar to Columbia Boulevard, utility poles and other fixed objects within the clear zone may increase the injury severity for lane departure crashes.

Risk Factor Analysis – Pedestrians and Bicyclists

The purpose of the risk factor analysis for pedestrians and bicyclists is to identify and locate areas within the study area where conditions may lead to increased risk of crashes involving people walking and biking. These risk factors are associated with specific crash risk types, such as unprotected left turn collisions involving pedestrians crossing the street and right-hook collisions with people biking on driveways and minor streets. In the section titled "Countermeasures for Consideration – Pedestrians and Bicyclists," a list of safety countermeasures that can be implemented to reduce the risk of crashes involving people walking and biking along the multimodal corridor is provided.

To assess the locations of risk for crashes involving people walking and biking in the study area, this assessment inventoried and analyzed crash risk factors that fall into the following: roadway characteristics that are known to contribute to crashes involving people walking and biking, and operational and planning characteristics that create exposure to conflict for people walking and biking. The analysis also drew from PedPDX, the Citywide Pedestrian Plan anticipated for adoption in June 2019, and the PBOT Existing Conditions Report prepared for this Plan.

While the historic crash analysis tells the story of locations where crashes have happened, this section analysis helps identify locations where there may be a heightened risk for future crashes to occur.

The following crash risk factors were included in the inventory:

- Missing bicycle facilities: measures (in feet) the distance that dedicated bicycle facilities do not exist along the segment being described as one-way. Segments without a measurement have dedicated bicycle facilities along the entire length being described. Dedicated bicycle lanes separate modes that travel at different speeds, which increase bicyclist safety and comfort.
- Crossing gaps: measures (in feet) sections of roadway that exceed the desired crosswalk spacing of 800 feet for city walkways and major city walkways outside of pedestrian districts, as described in PedPDX.
- Missing crosswalks: documents locations at major intersections, ramps/interchanges, intersections with irregular/confusing geometry, and intersections with wide crossing distance (in excess of 70 feet) where the addition of a marked crosswalk would enhance pedestrian connectivity, safety, and comfort.
- Deficient bicycle facilities: measures the percentage of a dedicated bicycle facility that provides inadequate separation/protection from motor traffic. Standard striped bicycle lanes are considered deficient within the context of this analysis due to traffic volumes, vehicle speeds, and frequency of potential conflict points along these portions of Columbia and Lombard.
- Driveway frequency: measures the average number of driveways per mile within the segment being described. A greater number of driveways increases the number of potential conflict points between cars and bicycle riders and pedestrians.
- At-grade railroad crossings: documents the number and location of rail crossings within each segment.
- Ramps/interchanges: records the number and location of ramp and interchange connections along the corridors.
- Presence of right turn lanes: records the number and location of right turn lanes at major intersections. Right turn lanes increase the chance of a "right-hook" collision with bicycle riders and pedestrians.
- Sidewalk gaps: measures (in feet) the distance sidewalks do not exist along each side of the street within the segment being described. Gaps in sidewalks do not provide adequate separation between pedestrians and travel lanes.
- Permissive left turn phasing at major intersections: documents whether left turn lanes at major signalized intersections provide for protected or unprotected turns. This was documented by examining the signal

head configuration in Google Streetview at major intersection locations where one or more left turn lanes exist.

The pedestrian and bicyclist crash risk analysis along the Columbia-Lombard corridor yielded the following overall findings:

- Due to significant gaps in both the bicycle lane and sidewalk network, and high vehicle and truck operating speeds and volumes, **the degree of existing modal separation is inadequate for safe and comfortable active transportation along the corridor segments**.
- **Gaps and sudden drop-offs in the bicycle network create unsafe or high-stress cycling conditions**, particularly in locations where a person on a bicycle is forced into the vehicular travel lane such as at N 11th Avenue/Lombard Place. This forces people on bicycles to use the sidewalk or street, in turn creating unsafe pedestrian conditions as well as vehicle conflicts.
- **The majority of the project area has been identified by PedPDX as a priority crossing gap location**. The PedPDX prioritization framework identified locations for investment based on factors Portlanders reported as the most important when prioritizing pedestrian improvements: equity, safety, and demand. These locations were assigned a prioritization value of Tier 1 to 5 to guide investment, from high to low, respectively. The majority of Columbia Boulevard (west of NE 82nd Avenue) is identified as a Tier 3 crossing gap, and almost the entirety of Lombard Street is identified as either a Tier 2 or Tier 3 crossing gap.

Countermeasures for Consideration – Motorized Vehicles

This section outlines potential countermeasures for motorized vehicle crashes to be considered based on the crash history, risk factors present, and existing infrastructure facilities on Columbia Boulevard and Lombard Street. The countermeasures identified are gathered from various sources, which include:

- Predictive Method for Urban and Suburban Arterials, Highway Safety Manual, American Association of State Highway Transportation Officials
- Crash Modification Factors Clearinghouse, Federal Highway Administration[33]
- ODOT's HSIP Countermeasures and Crash Reduction Factors, Oregon Department of Transportation[34]
- NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, National Cooperative Highway Research Program[35]
- Countermeasures That Work, National Highway Traffic Safety Administration[36]
- PBOT Vision Zero, City of Portland[37]
- Integrating Freight into Livable Communities, Transportation Research and Educations Center (TREC)[38]

The tables showing the countermeasures to be considered include the source of the countermeasure research, the crash modification factor (where applicable), the desired effect on safety, and the targeted crash types. Many countermeasures are found on the Federal Highway Administration's' Crash Modification Factors

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[33] http://www.cmfclearinghouse.org/

[34] ODOT's HSIP Countermeasures and Crash Reduction Factors, Oregon Department of Transportation. March 2018. https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/CRF-Appendix.pdf

[35] National Cooperative Highway Research Program, 2003-2009, http://www.trb.org/Main/Blurbs/152868.aspx

[36] National Highway Traffic Safety Administration, November 2015, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812202-countermeasuresthatwork8th.pdf

[37] Vision Zero, Portland Bureau of Transportation, https://www.portlandoregon.gov/transportation/66612

[38] Integrating Freight into Livable Communities, Transportation Research and Education Center, December 2015. https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1030&context=trec_reports

Clearinghouse, an online database that allows users to search and investigate countermeasures and their applicable crash modification factors (CMF).

CMFs are used to calculate expected future crash frequency after application of certain countermeasures. CMFs are multiplied by the historic crash frequency to compute an estimated number of future crashes. For example, a CMF with a value of 0.80 indicates an estimated 20 percent future crash reduction. A "CMF ID" is provided under the "Source" column in the tables to allow quick and easy searching on the Clearinghouse website. The corresponding "ODOT ID" is also provided for reference to the ODOT HISP Countermeasures and Crash Reduction Factors source. Where both Clearinghouse and ODOT HSIP CMFs are available, the ODOT CMF is provided. Otherwise, the Clearinghouse CMF is shown. All countermeasures from the CMF Clearinghouse are rated four out of five stars or better, unless otherwise noted, which indicates a high level of reliability in the research.

The majority of countermeasures identified in the tables are directed toward improving the physical environment to improve safety. However, three high risk behaviors that may require targeting throughout the corridor are 1) alcohol and/or drug involvement, 2) speeding, and 3) seatbelt use.

Given the high correlation between alcohol and/or drug impairment, speeding, and fatal crashes,[39] **targeted enforcement and education programs, specifically on Columbia Boulevard, may decrease the number of fatalities that are due to impaired driving and speeding**. In addition, fatal and serious injury risk during a crash is much higher for those not wearing a seatbelt,[40] particularly on Columbia Boulevard. Targeted enforcement and education to increase seatbelt use may reduce the number of fatalities and serious injuries along the corridor. Specifically, the PBOT Vision Zero Action Plan includes education and enforcement strategies targeted at reducing impaired driving and speeding. Strategies for education and enforcement are also outlined in Countermeasures That Work and the NCHRP Report 500.

Countermeasures to Consider on Columbia Boulevard

The countermeasures outlined in Table 28 for signalized intersections aim to reduce crashes related to vehicles making left turns from minor streets on to Columbia Boulevard and to reduce crashes caused by high risk driver errors, specifically disregarding traffic signals.

Providing **dedicated left turns for the minor streets**, though it requires a larger budget and more right-of-way, is expected to reduce crashes by 25 percent. In addition, **changing a permissive only left turn phase on a minor street approach to a protected left turn phase** is expected to reduce crashes by 99 percent (left turn crashes). Installing reflectorized backplates on signal heads may reduce crashes by 15 percent and is a **relatively inexpensive countermeasure**. Red light cameras have been shown to produce crash reduction for angle crashes, which tend to be higher severity, but increase rear-end crashes, by 15 percent.

For freight vehicles specifically, providing dedicated left turns enhances the driver's ability to safely navigate a turn with a larger vehicle. In addition, increasing the overall area for left turns within intersections may reduce freight vehicle turning crashes.

[39] Section titled "High Risk Behavior," six of the total 10 fatalities on Columbia Boulevard and Lombard Street involved alcohol/drugs and speeding.

[40] Section titled "High Risk Behavior," 33 percent of participants without a seatbelt experienced a fatality or serious injury, versus one percent of participants with a seatbelt. Three of the 10 participant who died from crashes were not wearing seatbelts.

TABLE 28. **Columbia Boulevard – Countermeasures to Consider for Signalized Intersections**

Potential Countermeasures	Source	Crash Modification Factor	Desired Effect on Safety	Targeted Crash Types
Install left turn lanes and protected left turn phases on major and minor street approaches	NCHRP 500, CMF Clearinghouse, (CMF ID=7996, ODOT ID=H12)	0.81 (19% reduction)	Eliminate need for turning drivers to assess gap distance	Minor street left turn to major street
Provide protected left turn phase for minor street approaches	CMF Clearinghouse (CMF ID=335, ODOT ID=I4)	0.01 (99% reduction, left turn crashes only)	Eliminate need for turning drivers to assess gap distance	Minor street left turn to major street; major street left turn to minor street (where protected left turns not present)
Install backplates and retro-reflective sheeting to signal heads	NCHRP 500, CMF Clearinghouse (CMF ID=1410)	0.85 (15% reduction)	Increase conspicuity of signals to increase compliance	All types involving drivers disregarding traffic control devices
Optimize clearance intervals	NCHRP 500, CMF Clearinghouse (CMF ID=4221, 4211)	0.64-0.80 (20%-36% reduction)	Increase time delay between phases to decrease angle crashes	All types involving drivers disregarding traffic control devices
Install red-light cameras	NCHRP 500, CMF Clearinghouse (CMF ID=420)	0.75 (25% reduction, angle crashes only), 1.15 (15% increase, rear-end crashes only)	Increase signal indication compliance	All types involving drivers disregarding traffic control devices
Replace spanwire signal installation with mast arms	CMF Clearinghouse (CMF ID=9404, 3 stars)	0.97 (3% reduction)	Increase conspicuity of signals to increase compliance	All types involving drivers disregarding traffic control devices

The countermeasures for segments on Columbia Boulevard (Table 29) are identified to reduce rear-end crashes, sideswipe crashes from the same direction, left turn crashes on to minor streets and into driveways, turning crashes from minor streets and driveways onto Columbia Boulevard, and single vehicle fixed object crashes. The countermeasures aim at reducing driver errors, including misjudging gap distance needed for permitted left turns, following too closely due to sudden stopping and differential travel speeds, and speeding.

Installing a raised median is expected to reduce crashes by 39 percent, though it may require acquisition of additional right-of-way on the corridor. By reducing the density of driveways, injury crashes are expected to decrease by up to 31 percent. Automated speed enforcement is identified in three different federal-level publications and may result in crash reduction up to 17 percent for injury crashes. An alternative to automated speed enforcement may be active speed warning signs, which have been shown to result in a 46 percent crash reduction, though the research was done in rural environments and effectiveness in urban corridors may differ. Freight vehicles may particularly benefit from increasing the curb radii at side streets and driveways.

TABLE 29. **Columbia Boulevard – Countermeasures to Consider for Segments**

Potential Countermeasures	Source	Crash Modification Factor	Desired Effect on Safety	Targeted Crash Types
Install raised median	CMF Clearinghouse (CMF ID=3034, ODOT ID=H34)	0.78 (22% reduction, injury crashes only)	Restrict permissive left turns across opposite direction though traffic	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Reduce driveway density	CMF Clearinghouse (CMF ID=177, ODOT ID=H30)	0.71 (29% reduction, injury crashes only)	Reduce differential speeds caused by vehicles slowing down to make left or right turns into driveways	- Major street rear-end, - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Employ signal coordination along corridor	NCHRP 500 (ODOT ID=I6)	0.83 (17% reduction)	Reduce speed differential caused by un-coordinated red light phase on Columbia Boulevard	- Major street rear-end - Major street sideswipe from same direction
Implement automated speed enforcement cameras	NCHRP 500, Countermeasures that Work, CMF Clearinghouse (CMF ID=4583)	0.83 (17% reduction, injury crashes only)	Reduce high severity crashes due to speeding	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Reduce fixed object density, increase offset to fixed objects	Highway Safety Manual, CMF Clearinghouse (CMF ID=35)	0.78 (22% reduction)	Reduce severity of lane departure crashes	Single vehicle collisions with fixed objects
Improve speed limit signage or install active speed warning signs	Highway Safety Manual, NCHRP 500, CMF Clearinghouse (CMF ID=78, ODOT ID=H47)	0.59 (41% reduction)	Reduce crash frequency due to speeding	All crash types
Increase curb return radii at side streets and driveways	TREC	Not available	Reduce turning crashes for freight vehicles due to large turning radii	Freight vehicle turning crashes

Countermeasures to Consider on Lombard Street

Many of the same risk factors, crash types, and driver behaviors that exist at Columbia Boulevard's signalized intersections are also present at Lombard Street's intersections. Consequently, many of the same potential countermeasures identified for Columbia Boulevard are also applicable to Lombard Street (Table 30).

The greatest difference between the two corridors' signalized intersections is that many of Lombard's Street's intersections do not have dedicated left turn lanes and protected phases on the major street approaches. **Adding dedicated left turns and protected phases should be considered on both the major and minor street approaches for Lombard Street**.

TABLE 30. **Lombard Street – Countermeasures to Consider for Signalized Intersections**

Potential Countermeasures	Source	Crash Modification Factor	Desired Effect on Safety	Targeted Crash Types
Install left turn lanes on major street approaches	NCHRP 500, CMF Clearinghouse, (CMF ID=7996, ODOT ID=H12)	0.81 (19% reduction)	Reduce stopped vehicle queues due to left turns waiting for gap distance, eliminate need for turning drivers to assess gap distance	- Major street rear-end - Major street left turn to minor street
Install left turn lanes on minor street approaches	NCHRP 500, CMF Clearinghouse, (CMF ID=7996)	0.75 (25% reduction)	Eliminate need for turning drivers to assess gap distance	Minor street left turn to major street
Provide protected left turn phase	CMF Clearinghouse (CMF ID=335, ODOT ID=I4)	0.01 (99% reduction, left turn crashes only)	Eliminate need for turning drivers to assess gap distance	- Major street left turn to minor street - Minor street left turn to major street
Install backplates and retro-reflective sheeting to signal heads	NCHRP 500, CMF Clearinghouse (CMF ID=1410)	0.85 (15% reduction)	Increase conspicuity of signals to increase compliance	All types involving drivers disregarding traffic control devices
Optimize clearance intervals	NCHRP 500, CMF Clearinghouse (CMF ID=4221, 4211)	0.64-0.80 (20%-36% reduction)	Increase time delay between phases to decrease angle crashes	All types involving drivers disregarding traffic control devices
Install red-light cameras	NCHRP 500, CMF Clearinghouse (CMF ID=420)	0.75 (25% reduction, angle crashes only), 1.15 (15% increase, rear-end crashes only)	Increase signal indication compliance	All types involving drivers disregarding traffic control devices
Replace spanwire signal installation with mast arms	CMF Clearinghouse (CMF ID=9404, 3 Stars)	0.97 (3% reduction)	Increase conspicuity of signals to increase compliance	All types involving drivers disregarding traffic control devices

Similar risk factors, crash types, and driver errors that were related to crashes on Columbia Boulevard's segments were also related to crashes on Lombard Street's segments (Table 31). Many of the potential countermeasures identified for Columbia Boulevard are also applicable to segment crashes on Lombard Street.

As an alternative to providing a raised median, a countermeasure to turning crashes from minor streets or driveways onto Lombard Street, reconfiguring a four-lane section to a three-lane section with a center two-way left turn lane, known as a road diet, may decrease all crashes by 29 percent. In addition to moving turning drivers out of the through lanes, the two-way left turn lane acts as a median buffer distance between drivers traveling in opposite directions.

Research also shows that removing facilities for on-street parking reduces injury crashes by 20 percent.

TABLE 31. **Lombard Street – Countermeasures to Consider for Segments**

Potential Countermeasures	Source	Crash Modification Factor	Desired Effect on Safety	Targeted Crash Types
Install raised median	CMF Clearinghouse (CMF ID=3034, ODOT ID=H34)	0.78 (22% reduction)	Restrict permissive left turns across opposite direction though traffic	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Convert 4-lane roadway to 3-lane roadway with center two-way left turn lane (road diet)	CMF Clearinghouse (CMF ID=199, ODOT ID=H48, BP16)	0.71 (29% reduction)	Reduce stopped vehicle queues due to left turns waiting for gap distance	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street
Reduce driveway density	CMF Clearinghouse (CMF ID=177, ODOT ID=H30)	0.71 (29% reduction, injury crashes only)	Reduce differential speeds caused by vehicles slowing down to make left or right turns into driveways	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Employ signal coordination along corridor	NCHRP 500 (ODOT ID=I6)	0.83 (17% reduction)	Reduce speed differential caused by uncoordinated red light phase on Columbia Boulevard	- Major street rear-end - Major street sideswipe from same direction
Prohibit on-street parking	CMF Clearinghouse (CMF ID=153)	0.80 (20% reduction, injury crashes only)	Reduce differential speeds caused by vehicles slowing down to park	- Major street rear-end - Major street sideswipe from same direction
Implement automated speed enforcement cameras	NCHRP 500, Countermeasures That Work, CMF Clearinghouse (CMF ID=4583)	0.83 (17% reduction, injury crashes only)	Reduce high severity crashes due to speeding	- Major street rear-end - Major street sideswipe from same direction - Major street left turn to minor street - Turning crashes from minor street to major street
Reduce fixed object density, increase offset to fixed objects	Highway Safety Manual, CMF Clearinghouse (CMF ID=35)	0.78 (22% reduction)	Reduce severity of lane departure crashes	Single vehicle collisions with fixed objects
Improve speed limit signage or install active speed warning signs	Highway Safety Manual, NCHRP 500, CMF Clearinghouse (CMF ID=78, ODOT ID=H47)	0.59 (41% reduction)	Reduce crash frequency due to speeding	All crash types
Increase curb return radii at side streets and driveways	TREC	Not available	Reduce turning crashes for freight vehicles due to large turning radii	Freight vehicle turning crashes

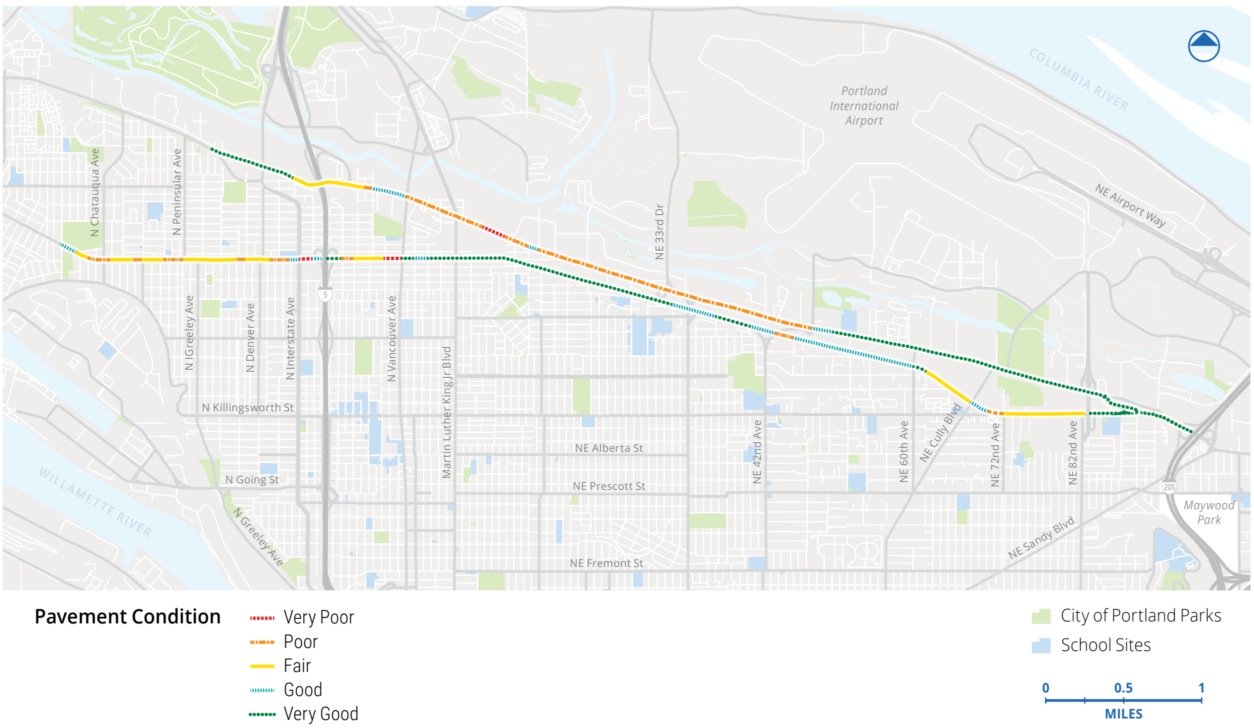
Countermeasures for Consideration – Pedestrians and Bicyclists

This section identifies countermeasures to consider for crashes involving pedestrians and bicyclists based on the present risk factors and infrastructure facilities.

Pavement Repair and Maintenance

Roadway repair for sections along Lombard that received a "poor" or "very poor" Pavement Condition Index rating (Figure 20, from the Existing Conditions Report of this Plan) may be needed. Poor pavement conditions will affect the path of travel of people on bicycles, leading to undesirable sidewalk riding, unpredictable maneuvering, and/or crashes due to a loss of control.

FIGURE 20. **Pavement Conditions**



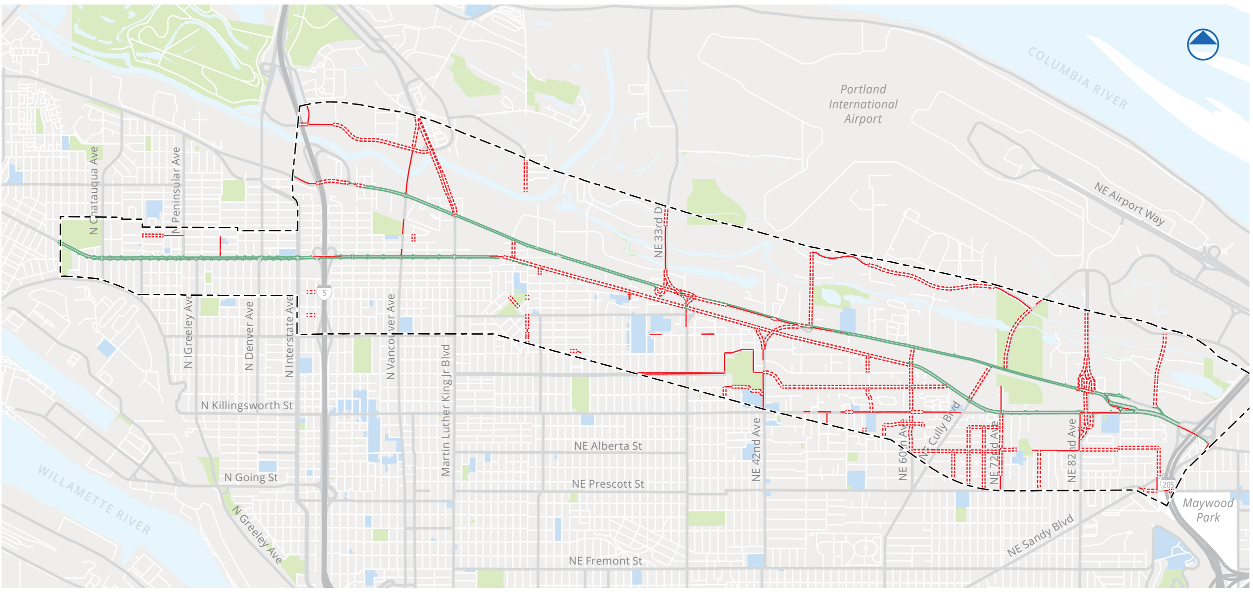
Sidewalk Infill

Sidewalk infill may be needed along major gaps along the corridor to provide safe, comfortable walking conditions (Figure 21). These include:

- 1,300 feet on the north side of Lombard Street between Columbia Boulevard and NE 82nd Avenue
- 14,500 feet (each) on the north and south sides of Lombard Street between NE 60th and NE 10th Avenues
- 1,300 feet on the north side of Columbia Boulevard between NE 92nd and NE 87th Avenues
- 1,550 feet on the south side of Columbia Boulevard between NE 92nd and NE 87th Avenues
- 500 feet (each) on the north and south sides of Columbia Boulevard between the east-bound NE 82nd Avenue ramps and westbound NE 82nd Avenue ramps
- 300 feet on the north side of Columbia Boulevard between NE 47th and NE 46th Avenues
- 6,200 feet on the south side of Columbia Boulevard between NE 47th and NE 33rd Avenue west ramp

- 1,600 feet on the north side of Columbia Boulevard between the NE 33rd west and NE 33rd Avenue east ramps
- 3,500 feet (each) on the north and south sides of Columbia Boulevard between N Borthwick and N Interstate Avenues

FIGURE 21. **Sidewalk Inventory**



Sidewalk Inventory

- Existing Sidewalk
- Sidewalk Missing on Both Sides
- Sidewalk Missing on One Side

City of Portland Parks
School Sites

0 0.5 1
MILES

Crossing Enhancements

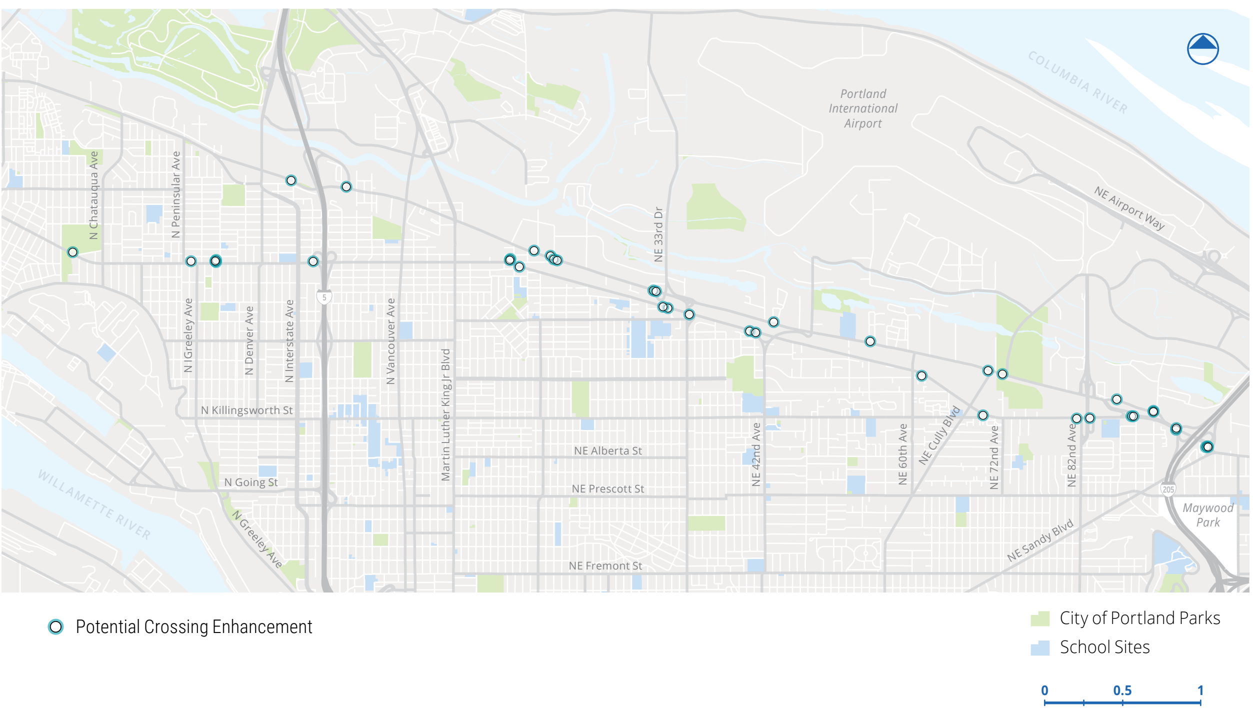
New marked crossings should be considered at locations where gaps have been identified through the analysis and per the PedPDX crossing guidelines. Strategically located marked crossings and can reduce the likelihood of uncontrolled mid-block crossing and unpredictable behavior that result in higher crash rates. Marked crossings are further enhanced by raised median safety islands and other crossing enhancements, such as pedestrian signals and HAWK beacons (at signalized intersections), and rectangular rapid flashing beacons (RRFB) at mid-block crossing locations. Further signal enhancements, such as leading pedestrian intervals, walk time extensions, and protected left turns, can further reduce the potential for vehicle turning conflicts.

Potential locations for new marked crossings include the following (see map in Figure 22):

- Columbia Boulevard/I-205 west ramp terminus (northeast and northwest legs)
- Columbia Boulevard/NE Sandy Boulevard (west leg)
- Columbia Boulevard/I-205 east ramp terminus (N and W legs)
- Columbia Boulevard/Lombard Street (east and west legs)
- Lombard Street/NE 82nd Avenue (south and southwest legs)
- Lombard Street/NE Killingsworth Street (south leg)
- Lombard Street/NE Ainsworth Street (south leg)
- Lombard Street/NE 42nd Avenue (southeast and SW leg)

- Lombard Street/NE 33rd Avenue (south leg)
- Lombard Street/NE Bryant Street (southwest leg)
- Lombard Street/NE 32nd Avenue (southeast leg)
- Lombard Street/NE Stafford Street (south leg)
- Lombard Street/NE 11th Avenue (north and northwest legs)
- Lombard Street/I-5 east ramp terminus (south leg)
- Lombard Street/N Russet Street (north leg)
- Lombard Street/N Delaware Avenue (west, north, and south legs)
- Lombard Street/N Greeley Avenue (west leg)
- Columbia Boulevard/NE 92nd Avenue (north and south legs)
- Columbia Boulevard/NE 87th Avenue (north leg)
- Columbia Boulevard/NE Alderwood Road (west leg)
- Columbia Boulevard/NE Cully Boulevard (south leg)
- Columbia Boulevard/NE 57th Avenue (north leg)
- Columbia Boulevard/Crossing between NE 46th Avenue/NE 42nd Avenue (north leg)
- Columbia Boulevard/ NE 33rd Avenue (southwest and southeast legs)
- Columbia Boulevard/NE Lombard Place (southeast and southwest legs)
- Columbia Boulevard/NE 17th Avenue (north leg)
- Columbia Boulevard/NE 14th Avenue (north leg)
- Columbia Boulevard/I-5 east ramp terminus (east leg)
- Columbia Boulevard/N Interstate Avenue (east leg)

FIGURE 22. Potential Crossing Enhancement Locations



Additional crossing opportunities for bicycles and pedestrians throughout the corridor potentially include crossing enhancement sites flagged in the Existing Conditions Report for this Plan:

- Lombard Street/N Wayland Avenue
- Lombard Street/N Washburne Avenue
- Lombard Street/N Omaha Avenue
- Lombard Street/I-5 west and east ramp termini
- I-5/N Terry Street
- Lombard Street/N Mississippi Avenue
- Lombard Street/N Commercial Avenue
- Lombard Street/NE Rodney Avenue
- Rosa Parks/NE Martin Luther King Jr. Boulevard
- Bryant/NE Martin Luther King Jr. Boulevard
- N Vancouver Avenue at the Columbia Slough Trail
- Columbia Boulevard/ NE 33rd Avenue
- Lombard Street/ NE 33rd Avenue

These locations should be further analyzed as final recommendations are developed.

Buffered and Protected Bicycle Lanes

Buffered or protected bicycle facilities on Lombard Street between NE 11th and 60th avenues, and on Killingsworth Street east of NE 72nd Avenue, would provide better physical separation from high speed vehicle traffic. Space for the buffer could be made by reallocating lane width and road diet and/or reconfiguring on-street parking. Protected bicycle lane transitions require special attention at intersections and high risk locations, such as ramps, right turn add lanes, and drop lanes. Protected bicycle facilities should also be considered on other segments as determined by the Needs Assessment.

Other Countermeasures

In addition to the above countermeasures, the following countermeasures, with the corresponding CMF and CMF ID (see section Countermeasures for Consideration – Motorized Vehicles for explanation of CMFs), may be considered for reducing pedestrian and bicyclist crashes at intersections:

- Install leading pedestrian intervals (CMF=0.63, ODOT ID=BP3)[41]
- Replace permissive or protected/permissive left turns to protected only (CMF=0.99, left turning crashes only, ODOT ID=I4)

Leading pedestrian intervals grant pedestrians and bicyclists at intersections a three to seven second head start to enter the crosswalk before the right turn vehicle phase begins, to increase the chances of vehicles seeing the pedestrian or bicyclist and yielding right of way. Installing leading pedestrian intervals may decrease crashes involving pedestrians by 37 percent.

By replacing permissive left turn phases with protected only phases, vehicles only complete the left turn when they have exclusive right of way without the need to yield to pedestrians in the crosswalk. Changing a permissive left turn phase to protected only may decrease left turn crashes by 99 percent, with significant decreases in pedestrian crashes that are caused by left turning vehicles.

[41] ODOT'sHSIPCountermeasuresandCrashReductionFactors.OregonDepartmentofTransportation.March2018.https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/CRF-Appendix.pdf

Safety Analysis Summary

The Columbia-Lombard Safety Analysis memo analyzed crash trends within the study area for the years 2012 to 2016, described risk factors based on crash characteristics and existing infrastructure, and identified countermeasures that may be considered for the Columbia Boulevard and Lombard Street corridors.

From 2012 to 2016, 10 people died and 27 people were seriously injured on the Columbia and Lombard corridors. Fatal crashes occurred at nearly double the percentage of the citywide average. The fatal crashes involved both speeding drivers and drivers under the influence of alcohol and/or drugs, as well as participants who were not wearing seatbelts. In the five year period, over 60 crashes occurred involving a pedestrian or bicyclist, approximately 12 crashes per year, all of which involved injuries to the pedestrian or bicyclist.

A large percentage of the total crashes were concentrated at the top 10 high crash intersections and overrepresented along specific segments on the corridors, particularly west of NE Martin Luther King Jr. Boulevard and near the I-205 ramp termini. **Approximately two-thirds of the crashes involving pedestrians and bicyclists occurred west of NE Martin Luther King Jr. Boulevard**.

At intersections, rear-end crashes on the major street were the most common, while angle and turning crashes, mostly caused by drivers disregarding traffic signals and not yielding right-of-way, resulted in the highest severity injuries. **Many of these intersections, particularly along Lombard Street, do not have dedicated left turn lanes or protected left turn signal phasing**. In addition, the lack of backplates on signal heads reduces the conspicuity of signal indications. **Along the corridor segments, rear-end, sideswipe, and single vehicle fixed-object crashes were the most frequent**. Driveway and side street density is high along both corridors, resulting in frequent lane changing and turning movements. Raised medians are not present and turning movements are generally not restricted.

The existing degree of modal separation for pedestrians and bicyclists is inadequate along both corridors for safe and comfortable active transportation, due to gaps in the bicycle lane and sidewalk networks, along with high vehicle speeds and volumes. Due to lack of sufficient marked crosswalks, the PedPDX plan classifies much of the corridors as Tier 2 or Tier 3 priority, where Tier 1 is the highest priority. Conflict sites, characterized by major intersections, railroad crossings, transit stops and driveways, ranged from nine to over 100 per segment, where the segments closer to the west extents had the highest number of conflict sites.

Potential countermeasures for vehicles at intersections include providing dedicated left turn lanes and protected left turn signal phasing, installing reflectorized signal backplates, and installing red-light cameras. Along segments, installing a raised median, reducing driveway density, and automated speed enforcement may be considered. Freight vehicles may specifically benefit from dedicated left turn lanes at intersections and increased curb return radii at side streets and driveways.

Specifically for crashes involving pedestrians and bicyclists, potential countermeasures to consider include pavement repair and maintenance, sidewalk infill, buffered and protected bicycle lanes, and crossing enhancements, such as new marked crosswalks and pedestrian crossing signals.

Appendix B-1: Major Intersection Inventory

Major Intersections	Traffic Signal(s)	Signalized Left Turn Lane(s)	Non-signalized Left Turn Lane(s)	Right Turn Lane(s)	Ramp(s)/ Inter-change(s)	Marked Cross-walk(s)	Pedestrian Activated Signal
Columbia Corridor							
Columbia Blvd at NE Killingsworth St	Y	3	1	1	2	3	Y
Columbia Blvd at NE Killingsworth St	Y	2	0	1	1	2	Y
Columbia Blvd at NE Columbia Parkway	Y	3	0	2	0	2	Y
Columbia Blvd at I-205 east ramp terminal	Y	4	0	2	2	2	Y
Columbia Blvd at I-205	Y	1	0	4	3	2	Y
Columbia Blvd at NE 89th Ave	Y	3	1	1	2	2	Y
NE Killingsworth St at Columbia Blvd	Y	2	0	1	1	2	Y
Columbia Blvd at NE 82nd Interchange	N	0	1	0	2	0	N
Columbia Blvd at NE 82nd Interchange	Y	2	0	1	2	2	Y
Columbia Blvd at NE 80th Ave	Y	1	0	1	0	3	Y
Columbia Blvd at NE Alderwood Rd	Y	1	0	0	0	2	Y
Columbia Blvd at NE 60th Ave	Y	3	0	1	0	3	Y
Columbia Blvd at NE 82nd Ave	Y	2	0	2	0	3	Y
Columbia Blvd at NE 72nd Ave	Y	2	0	0	0	4	Y
Columbia Blvd at NE Cully Blvd	Y	4	0	0	0	4	Y
Columbia Blvd at NE 60th Ave	Y	2	0	0	0	4	Y
NE Columbia Blvd at NE 47th Ave	Y	4	0	2	0	4	Y
Columbia Blvd at NE 33rd Ave	N	0	1	0	4	0	N
Columbia St at NE 21st Ave	Y	2	0	0	0	2	Y
Columbia Blvd at NE Martin Luther King Jr. Blvd	Y	4	0	1	0	4	Y
Columbia Blvd at N Vancouver Ave	Y	4	0	1	0	4	Y
Columbia Blvd at I-5	Y	2	0	1	2	1	Y
Columbia Blvd at N Interstate Ave	Y	1	0	0	0	2	Y
Lombard Corridor							
Lombard St at NE 42nd	N	0	1	0	2	0	N
Lombard St at NE 33rd	N	0	1	0	1	0	N
Lombard St at NE 27th Ave	Y	1	0	0	0	1	N
Lombard St at NE 11th Ave	Y	2	0	0	0	2	N
Lombard St at NE Martin Luther King Jr. Blvd	Y	4	0	0	0	4	Y
Lombard St at N Vancouver Ave	Y	4	0	0	0	4	N
Lombard St at N Albina St	Y	0	0	0	0	4	N
Lombard St at I-5	N	0	0	0	4	0	N
Lombard St at N Montana Ave	N	0	2	0	0	0	N
Lombard St at N Interstate Ave	Y	4	0	1	0	4	Y

Major Intersections	Traffic Signal(s)	Signalized Left Turn Lane(s)	Non-signalized Left Turn Lane(s)	Right Turn Lane(s)	Ramp(s)/ Inter-change(s)	Marked Cross-walk(s)	Pedestrian Activated Signal
Lombard St at N Fenwick Ave	N	0	0	0	0	2	Y
Lombard St at N Denver Ave	Y	4	0	1	0	4	N
Lombard St at N Delaware Ave	Y	0	0	0	0	1	Y
Lombard St at N Greeley Ave	Y	0	0	0	0	2	N
Lombard St at N Peninsular Ave	Y	1	0	1	0	2	N
Lombard St at N Drummond Ave	Y	0	0	0	0	1	Y
Lombard St at N Wabash Ave	Y	0	0	0	0	4	N
Lombard at N Chautauqua Ave	Y	0	0	0	0	4	N
Lombard St at N Woolsey Ave	Y	2	0	0	0	4	N

PBOT
PORTLAND BUREAU OF TRANSPORTATION