APPENDIX F:

Pedestrian Safety Existing Conditions Memo

NELSON
NYGAARD

MEMORANDUM

To: Michelle Marx, City of Portland

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Date: June 8, 2018

Subject: PedPDX Pedestrian Safety Existing Conditions Memo

INTRODUCTION

This memo summarizes the analyses of crashes involving people walking conducted for the Portland Citywide Pedestrian Plan (PedPDX) existing conditions chapter. General trends and patterns of pedestrian-involved crashes citywide between 2006 and 2015 are complemented with a detailed analysis of the Vision Zero High Crash Network (HCN)[1]. PedPDX is guided in part by the City of Portland's Vision Zero goal of eliminating fatal and serious injury crashes by the year 2025. Towards that end, the findings of this memo will help shape the infrastructure-related safety criteria for identifying needs and establishing investment priorities.

[1] The City of Portland provided the crash data for this analysis, which it received from the Oregon Department of Transportation (ODOT) Crash Analysis and Reporting Unit.

Key Findings

Figure 1 Key Findings, Implications and Recommendations

Finding	Potential Implications	Recommendations		
		Network	Prioritization	Countermeasures
Overall Trends				
Crashes are most concentrated on larger and higher-class roads and/or larger intersections. ▪ 25% of segment crashes occur on roads with 3 or more lanes, which account for less than 4% of centerline miles. ▪ 61% of segment crashes occur on arterials and highways, which account for 16% of centerline miles. ▪ Larger intersections have a significantly increased risk of both crash occurrence as well the likelihood of a severe injury or fatality resulting from a crash.	Focusing safety investments on larger streets and their intersections, including the High Crash Network identified in the Vision Zero Action Plan, is the most efficient way to reduce crashes.	▪ Focus on arterial corridors and intersections citywide, particularly within the High Crash Network ▪ Support investments on parallel streets if out of direction travel would be limited	▪ Streets with three or more travel lanes ▪ Arterial intersections ▪ Corridors and intersections identified in the Pedestrian High Crash Network (HCN)	▪ Road diets ▪ Median refuge islands ▪ Signal improvements (e.g., protected left turns, Leading Pedestrian Intervals, bicycle signals, additional signals at unsignalized high pedestrian/bicycle traffic crossings) ▪ Ensure that all crossing treatments meet current City design guidelines ▪ Arterial speed reduction
Crashes involving people walking are more frequent in the fall and winter months when hours of daylight are reduced (most of the additional crashes occur in dark conditions with streetlights present).	Visibility is an important issue for pedestrian safety in Portland, where there is a big swing in the number of daylight hours depending on the time of year.	▪ Focus on streets without pedestrian scale lighting	▪ Street segments and intersections with a high density of night-time KSI crashes	▪ Increase pedestrian lighting levels ▪ Close crossing gaps with appropriate crossing treatments ▪ High visibility crosswalks
What are the major crash types?				
Signalized intersections are not preventing crashes. ▪ Over 40% of crashes and 30% of severe/fatal crashes citywide occur at signalized intersections. ▪ Over a quarter of all crashes involve a turning driver failing to yield when the person walking has the right of way at the signal (20% left-turning drivers and 8% right turning drivers)	PedPDX can put an emphasis on additional pedestrian enhancements at signalized intersections.	▪ Focus on signalized intersection types with high risk of crash occurrence and severity.	▪ Signalized intersections with KSI high crash rates, which are typically larger intersections of multi-lane arterials.	▪ Leading pedestrian intervals ▪ No right turn on red ▪ Barnes crossing where high vehicle and pedestrian traffic co-exist ▪ Curb extensions ▪ Median islands at long crossings ▪ Protected left turn phasing ▪ Prohibit left turns ▪ High visibility crosswalks at signalized intersections ▪ Daylighting signalized intersections
Midblock crashes are common and more severe. 25% of crashes and 39% of serious/fatal crashes occur midblock. Midblock crashes are more likely to result in a serious or fatal injury. Nearly 20% of all crashes involve people walking across the road between intersections. Many of the remaining midblock crashes involve people being in the road for a variety of reasons, but not attempting to cross it.	Increase the frequency of marked pedestrian crossings to reduce the number of street segments that do not meet the city's crossing spacing guidelines.	▪ Focus on streets with long gaps between marked crossing treatments	▪ Street segments with a high density of KSI collisions	▪ Close crossing gaps with appropriate crossing treatments ▪ Increase awareness of the risks of hitting pedestrians where there are long distances between appropriate crossing treatments ▪ Utilize target speed for signal synchronization

Finding	Potential Implications	Recommendations		
		Network	**Prioritization**	**Countermeasures**
What is happening on the high crash network (HCN)?				
Nearly half of crashes (50%) on the HCN occur at signalized intersections. The most common action involves drivers turning left into a person walking across the high crash network street Nearly two thirds of crashes (64%) on the HCN involved pedestrians crossing the HCN. 30% of crashes involved pedestrians crossing at signalized intersections, while 15% of crashes involved pedestrians crossing at unsignalized intersections.	Provide additional pedestrian enhancements at signalized intersections (including those that reduce conflicts with left turning vehicles) and reduce the number of street segments that do not meet the city's crossing spacing guidelines.	▪ Include HCN streets and intersections that serve commercial, school, and residential land uses	▪ HCN network streets and intersections ▪ HCN network streets that serve land uses that support walking and transit trips	▪ Leading pedestrian intervals ▪ No right turn on red ▪ Barnes crossing where high vehicle and pedestrian traffic exist ▪ Curb extensions ▪ Median islands at long signalized crossings ▪ Median refuge islands ▪ Protected left turn phasing ▪ Prohibit left turns ▪ Close crossing gaps with appropriate crossing treatments ▪ Utilize target speed for signal synchronization ▪ High visibility crosswalks at signalized intersections ▪ Daylighting signalized intersections
What makes crashes more severe?				
People walking are ten times more likely than people driving to sustain a serious or fatal injury.	Speed at the time of impact is the critical factor in injury severity.	▪ Focus on streets where pedestrian experience is described as 'feeling unsafe' in survey ▪ Include streets with high prevailing speeds if they serve commercial, school, and residential land uses	▪ Locations on priority network with prevailing operating speeds in excess of 30 mph	▪ Utilize target speed for signal synchronization ▪ Close crossing gaps with appropriate crossing treatments ▪ Reduce operating speeds through road diets, lane narrowing, traffic calming
Approximately 17% of all pedestrian crashes result in a killed or seriously injured (KSI) pedestrian. The following crash types are even more likely to result in a KSI: ▪ People walking across the street between intersections (19% of all crashes; 25% are KSI) ▪ People walking across the street against the signal (8% of crashes; 25% are KSI) ▪ Driver going straight at unsignalized intersection fails to yield (4% of crashes; 22% are KSI) ▪ People walking across the street at unsignalized intersection and did not provide sufficient time for person driving to stop (6% of crashes; 25% KSI)	Crashes that involve crossing the road not at a signalized intersection are the most likely to result in a serious or fatal injury.	▪ None	▪ Unsignalized priority network crossings	▪ High visibility crosswalks ▪ Curb extensions ▪ Adjust transit stops to encourage crossing at intersections ▪ High visibility pedestrian heads ▪ Countdown pedestrian heads ▪ Protected crossings at unsignalized intersections of priority network ▪ Close crossing gaps with appropriate crossing treatments
Intersections of local streets with large (5+ lane) arterials are more likely to have severe crashes than other intersection types.	Over 80% of these intersections across the city are unsignalized. Intersections with high frequencies of crashes and severe crashes and/or high pedestrian volumes should be considered for signalization.	▪ Add traffic signals and other crossing improvements to local streets along high crash network	▪ Focus on unsignalized intersections of local streets (2 lanes) with arterials of five or more lanes	▪ Curb extensions ▪ Median refuge islands ▪ Traffic signals ▪ Protected left turn phasing

Finding	Potential Implications	Recommendations		
		Network	Prioritization	Countermeasures
Crashes are less common in the late evening/early morning hours, but are more likely to result in a serious or fatal injury.	Measures that increase lighting and prevent speeding can reduce the risk associated with crashes that occur during these hours.	▪ Include pedestrian scale and safety lighting on network	▪ Locations on HCN where high proportion of crashes occur in darkness	▪ High visibility crosswalks ▪ Increase pedestrian lighting levels ▪ Midblock safety lighting ▪ Reduce operating speeds through road diets, lane narrowing, traffic calming ▪ Implement time of day signal synchronization

CRASH TRENDS

Overall Trends

Pedestrian crashes are on the rise in Portland, with injury crashes increasing by 25% between 2006 and 2015 (see Figure 1). Even considering the 17% population growth over this time-period, the number of pedestrian crashes per 100,000 residents (a common way of comparing safety across cities) has been trending up (see Figure 2). On average in this time-period, there were 223 reported crashes per year, 38 (17%) of which were fatal or serious injury crashes. Pedestrian crashes are ten times more likely to result in a serious injury or fatality than vehicle-only crashes – where only 1.7% of crashes in Portland result in a serious injury or fatality.

Figure 1 Annual Pedestrian Crashes and Crash Severity

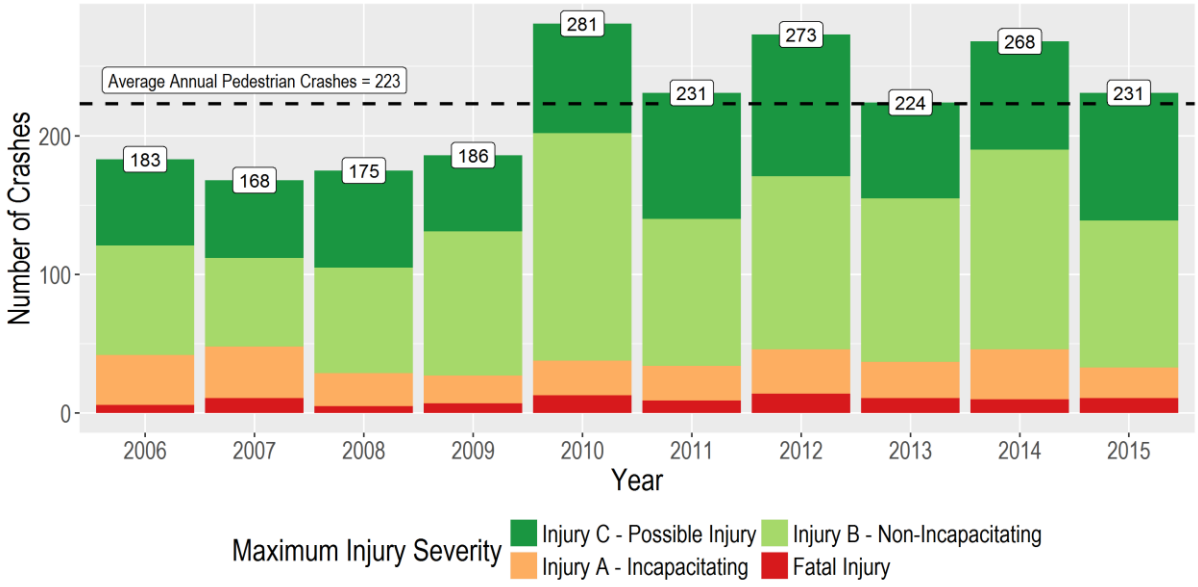


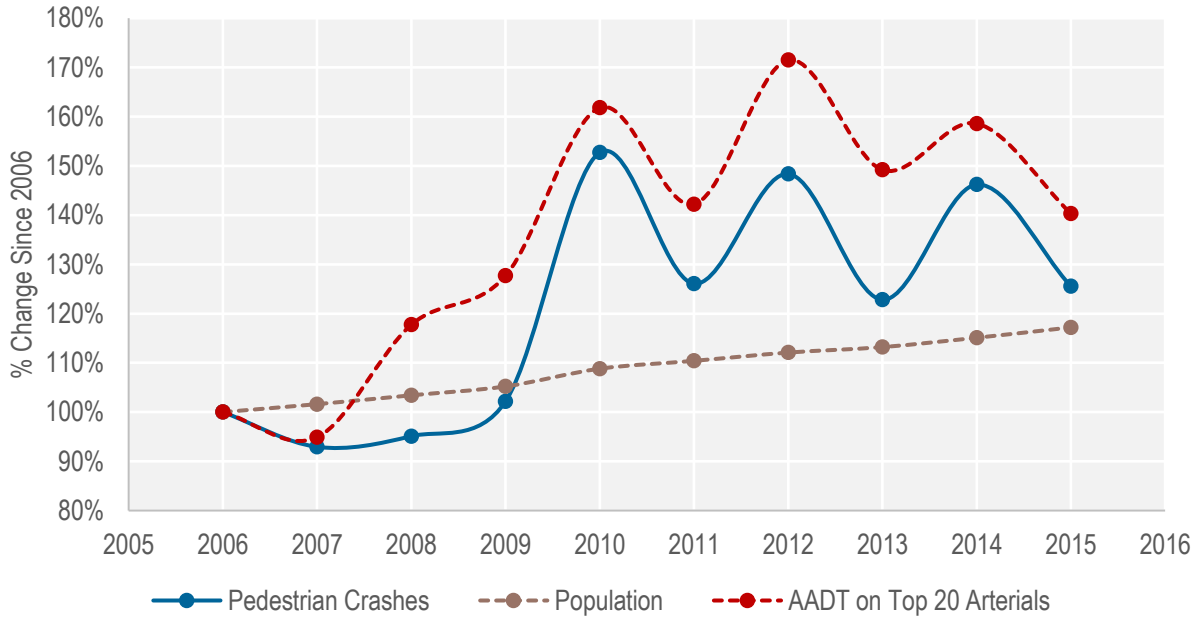
Figure 2 Annual Pedestrian Crashes vs. Population

Year	Pedestrian Crashes	Population[1]	Pedestrian Crashes per 100,000 Residents	Total AADT for Top 20 Portland Arterials	Pedestrian Crashes per 100,000 AADT
2006	184	538,091	34.2	554,500	33.2
2007	171	546,747	31.3	551,500	31.0
2008	175	556,442	31.4	516,300	33.9
2009	188	566,143	33.2	534,500	35.2
2010	281	585,478	48.0	519,000	54.1
2011	232	594,081	39.1	519,200	44.7
2012	273	603,124	45.3	517,700	52.7
2013	226	609,132	37.1	524,100	43.1
2014	269	619,334	43.4	534,900	50.3
2015	231	630,621	36.6	543,800	42.5
Average	**223**	**584,919**	**38.0**	**531,550**	**42.1**

Source: US Census American Community Survey

The growth in pedestrian crashes (ranging between 20% and 50% over 2006 in recent years) has exceeded the growth in both population (which has grown by 17% since 2006) and the change in AADT (which has decreased by 2% since 2006) on Portland's top 20 arterials – see Figure 3. This disproportionate growth in pedestrian crashes could be due to an increase in the volume of pedestrians walking and/or less safe roadway conditions for pedestrians.

Figure 3 Annual Pedestrian Crash Growth Relative to Population and AADT Growth

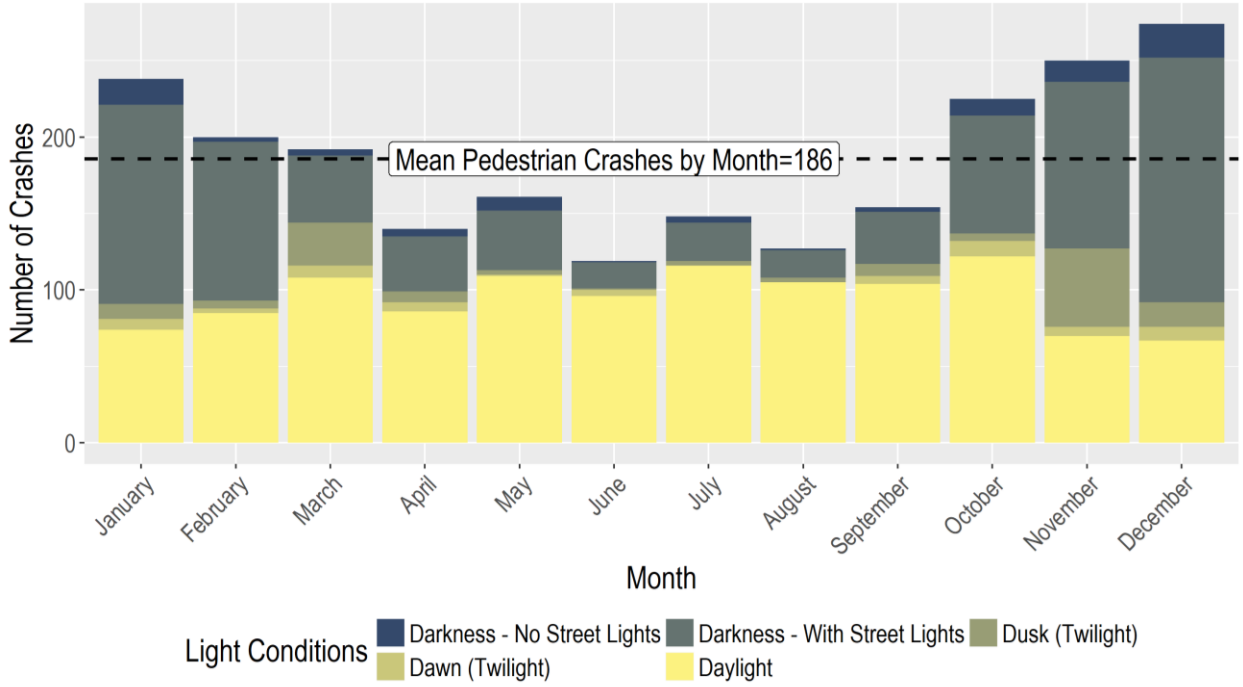


Temporal Trends (When)

Lighting Conditions

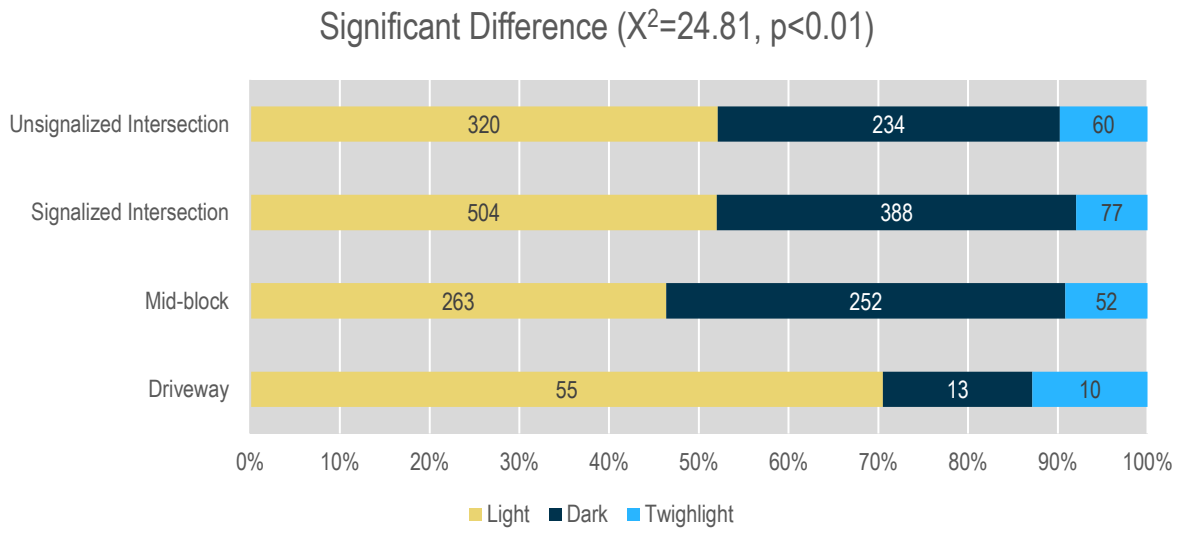
The fall and winter months see an increase in pedestrian crashes as compared to the spring and summer. This is despite the likelihood that there are more people walking in the warmer months. The number of crashes occurring in daylight is relatively constant throughout the year (Figure 4), while crashes in dark conditions increase dramatically in fall and winter, when there are fewer daylight hours. Pedestrian crashes after dark commonly have streetlights present, suggesting that streetlights alone are not sufficient to ensure motorists and pedestrians see each other. There is a noteworthy spike in crashes occurring at dusk in March and November, the months when daylight savings time begins and ends.

Figure 4 Pedestrian Crashes by Month of Year and Lighting Conditions



Collisions in different light conditions were also compared to roadway size and location type. There was not a statistically significant difference in the number of collisions as a function of lighting conditions across roadway size categories. Conversely, there was a statistically significant difference in the number of collisions occurring in dark or twilight conditions across location types – see Figure 5. Collisions in mid-block were most likely to be in dark or twilight conditions at mid-block locations, and were least likely to be in dark or twilight conditions at driveway locations.

Figure 5 Differences in Occurrence of Pedestrian Collisions by Lighting Conditions and Location Type



Time of Day

Pedestrian crash patterns are similar to overall travel patterns, with a large and long afternoon/evening peak period as compared to the morning. More pedestrian crashes occur in the late afternoon and early evening than any other time of day, particularly between 5 pm and 7 pm (Figure 6).

While there are fewer pedestrian crashes during the nighttime and early morning hours, crashes during these periods are more likely to result in a serious or fatal injury and are more likely to involve impairment (Figure 7).

Possible factors for the increased severity could include the following:

- Higher vehicle speeds when roads are less congested. This cannot be confirmed since actual prevailing vehicle speeds are not known. Paradoxically, a statistically higher proportion of severe and fatal collisions occur on lower speed limit streets, reinforcing the need for prevailing speed information.
- Reduced visibility during dark hours leaves less time for a driver to react after perceiving the presence of a person walking on the street.
- Intoxication affecting decision-making regarding appropriate driving speeds and the ability to judge when it is safe to cross the street. Intoxication has a statistically significant relationship with severity of collisions among collisions occurring between 9 p.m. and 6 a.m.

Figure 6 **Pedestrian Crashes by Hour and Severity**

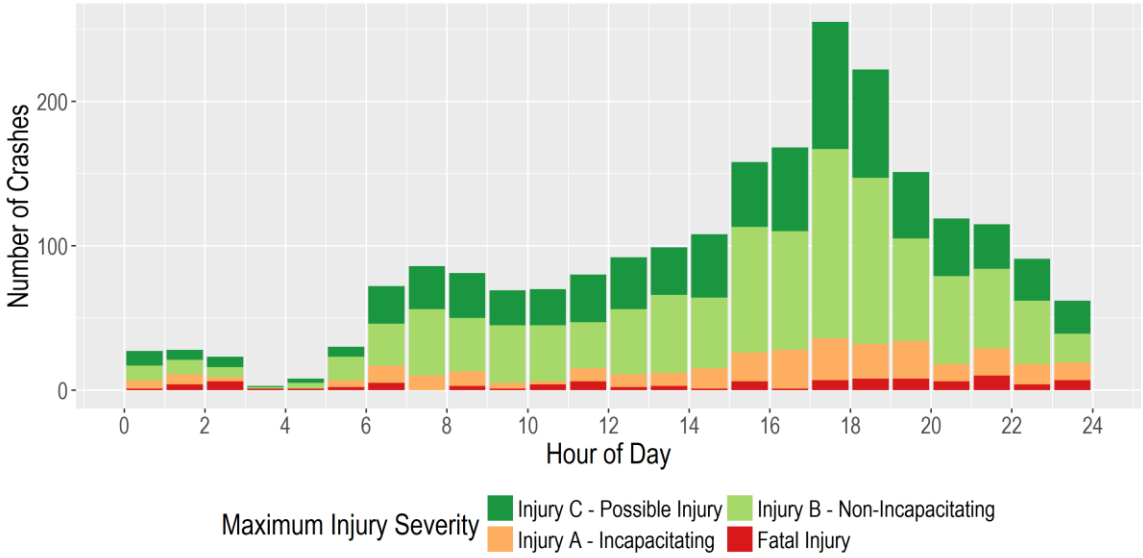
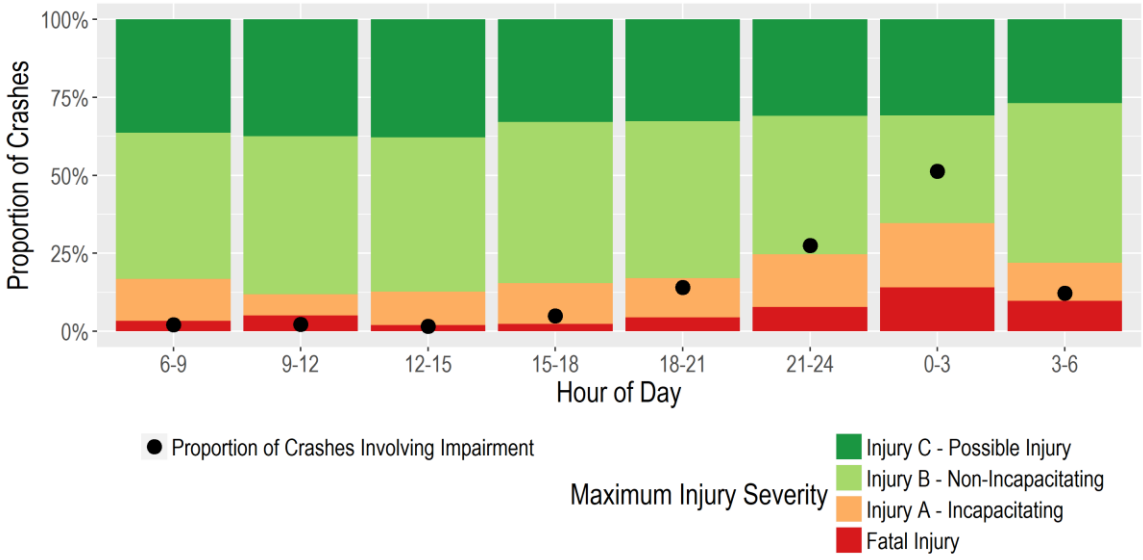


Figure 7 **Proportion of Pedestrian Crashes Resulting in Serious or Fatal Injury by Time of Day**



Demographic Trends (Who)

Age of Pedestrians and Drivers

Younger adult pedestrians (ages 20 to 24) were more frequently involved in crashes than other age groups, at over 10% of the total. Teenagers and younger adults ages 15 to 24 are disproportionately represented when compared to the population of Portland as a whole (Figure 8). Younger drivers (15-19) and drivers aged 25-39 are under-represented in pedestrian collisions compared to the Portland population (Figure 9). Middle aged and older drivers (except for those older than 85) are slightly over-represented.

Figure 8 Age Distribution of Pedestrians Involved in Crashes Compared to Portland Population

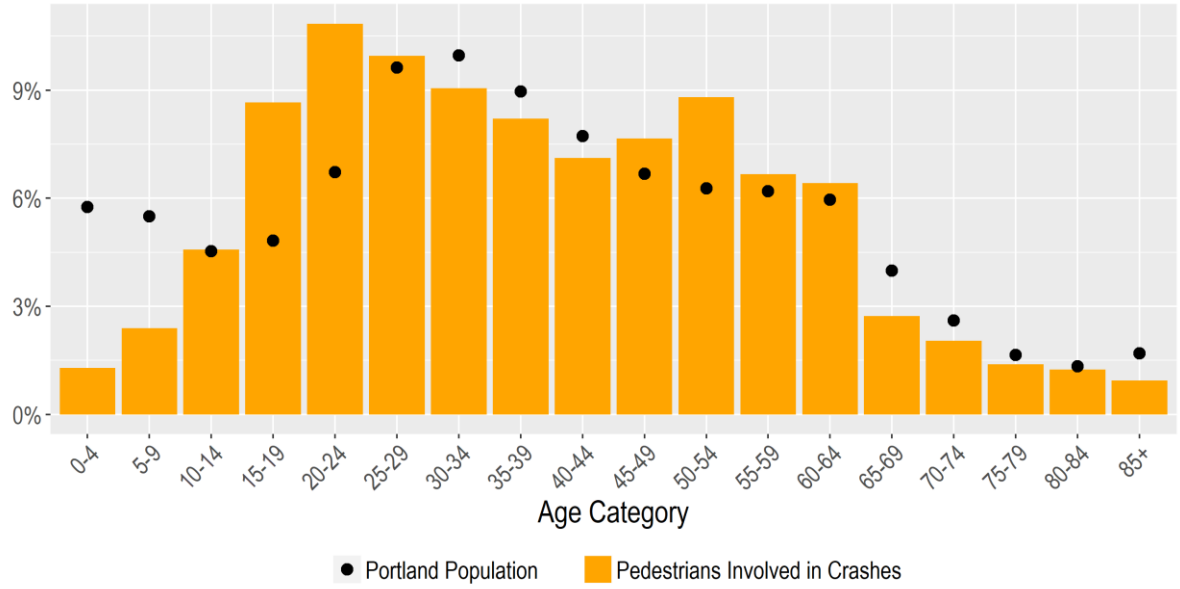
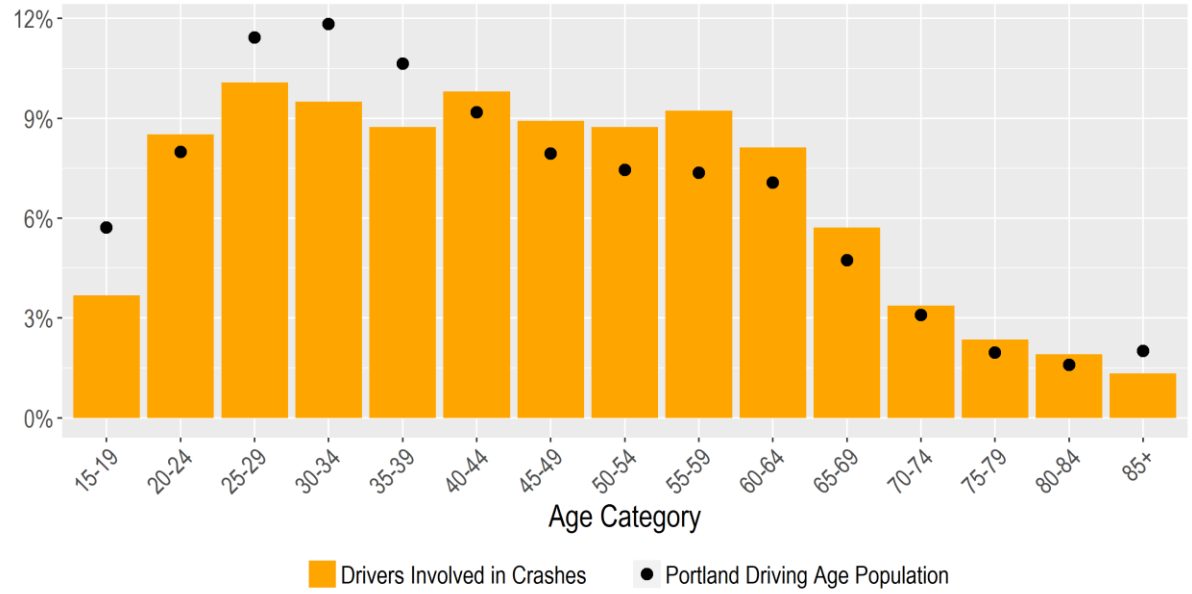


Figure 9 Age Distribution of Drivers Involved in Pedestrian Crashes Compared to Driving Age Population

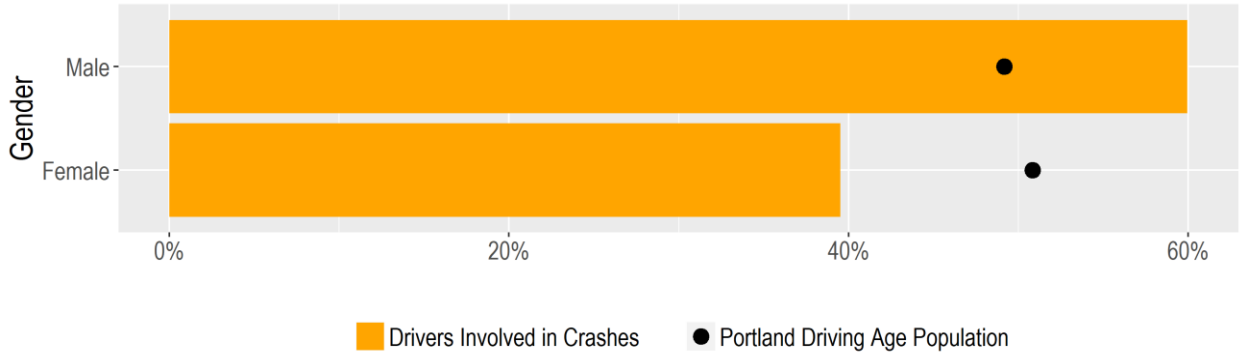


Source: US Census 2012-2016 American Community Survey 5-year estimates

Gender Distribution of Drivers

The gender distribution of drivers involved in pedestrian crashes relative to the Portland driving age population (15 and older) is shown in Figure 10. Male drivers are over represented by over 10 percentage points.

Figure 10 Gender Distribution of Drivers Involved in Pedestrian Crashes Compared to Driving Age Population



Location Trends (Where)

All collisions were classified into four location types, as identified in Figure 11. Over 2/3 of collisions (71%) occurred at intersections, while the remainder (29%) occurred on roadway segments at either driveway or mid-block locations. The majority of intersection collisions occurred at signalized intersections, while the majority of segment collisions occurred at midblock locations not adjacent to driveways. Mid-block collisions were the most likely to result in a severe injury or fatality at 26.1% -- this is 9 percentage points more likely than for all collisions.

Figure 11 Location Type Summary

Location Type	Number Crashes	Percent of Crashes	Number KSI Crashes	Percent of KSI Crashes	Probability of a KSI crash
Signalized Intersections	971	43.5%	97	33.4%	13.1%
Unsignalized Intersections	614	27.5%	127	25.5%	15.8%
Mid-block	567	25.4%	148	38.9%	26.1%
Driveway	78	3.5%	8	2.1%	10.3%
Total	**2,230**	**100%**	**380**	**100%**	**17.0%**

Roadway Segment Class

The citywide street network has a hierarchical functional classification that was simplified into five categories for the purposes of this collision analysis. The number of centerline miles as well as the associated pedestrian crashes are tallied in Figure 12. A crash occurrence risk factor was calculated to measure the proportion of crashes relative to the number of centerline miles of a given roadway class. For example, crashes were over nine times as likely to occur on primary arterials as they were to occur on all roadways. A KSI risk factor was also calculated to measure the proportion of KSI crashes relative to all crashes on a given roadway type. For example, crashes on freeway/highway type roadways were over twice as likely to result in a severe injury or fatality when compared to the roadway network as a whole.

Figure 12 Pedestrian Crash Summary by Roadway Class

Roadway Class	Centerline Miles		Crashes		Crash Occurrence Risk Factor[1]	KSI Crashes		Probability of KSI Crash	KSI Crash Risk Factor[2]
	#	%	#	%		#	%		
Local	1,895	72.3%	99	15.3%	0.21	14	9.0%	14.1%	0.58
Collector	298	11.4%	155	24.0%	2.11	32	20.5%	20.6%	0.85
Freeway/Highway	160	6.1%	25	3.9%	0.64	13	8.3%	52.0%	2.15
Primary Arterial	152	5.8%	267	41.4%	7.15	73	46.8%	27.3%	1.13
Secondary Arterial	116	4.4%	99	15.3%	3.46	24	15.4%	24.2%	1.00
Total	**2,621**	**100%**	**645**	**100%**	**1.00-**	**156**	**100%**	**24.2%**	**1.00**

Notes: 1) Crash Occurrence Risk Factor = % Crashes / % Centerline Miles. 2) KSI Crash Risk Factor = % KSI Crashes / % All Crashes

Roadway Size

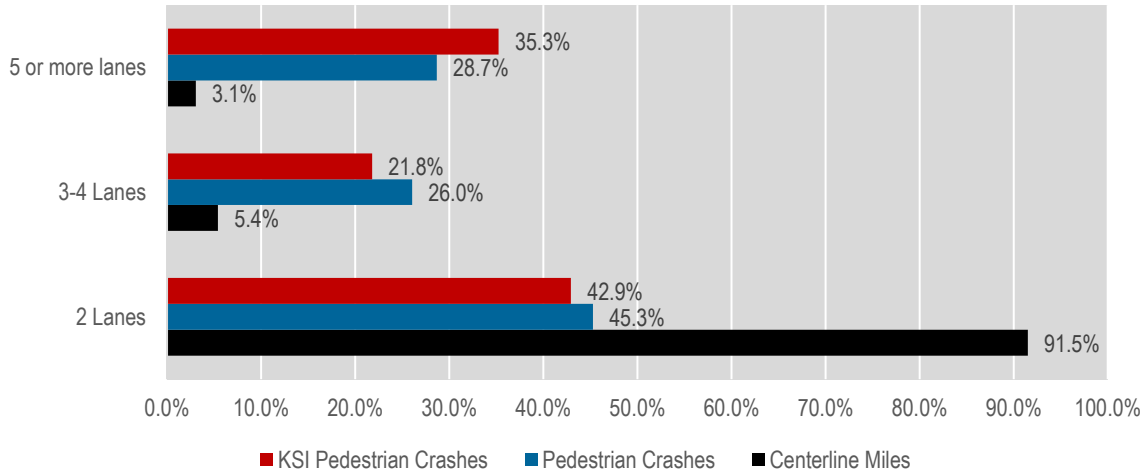
Figure 13 presents a summary of segment pedestrian crashes by roadway size (in terms of number of lanes). Pedestrian crashes are more likely to occur on larger roadways – they are over 4 times more likely on 3-4 lane roadways and nearly 10 times more likely on roads with 5 or more lanes. The differences in representation of pedestrian crashes on larger roads is illustrated in Figure 14.

Figure 13 Pedestrian Crash Summary by Roadway Size (segment crashes only)

Roadway Size	Centerline Miles		Crashes		Crash Occurrence Risk Factor[1]	KSI Crashes		Probability of KSI Crash	KSI Crash Risk Factor[2]
	#	%	#	%		#	%		
2 Lanes	2,399	91.5%	292	45.3%	0.49	67	42.9%	22.9%	0.95
3-4 Lanes	142	5.4%	168	26.0%	4.80	34	21.8%	20.2%	0.84
5 or More Lanes	81	3.1%	185	28.7%	9.33	55	35.3%	29.7%	1.23
Total	**2,621**	**100%**	**645**	**100%**	**1.00**	**156**	**100%**	**24.2%**	**1.00**

Notes: 1) Crash Occurrence Risk Factor = % Crashes / % Centerline Miles. 2) KSI Crash Risk Factor = % KSI Crashes / % All Crashes

Figure 14 Pedestrian and Centerline Mile Summary by Roadway Size (segment crashes only)



Roadway Speed

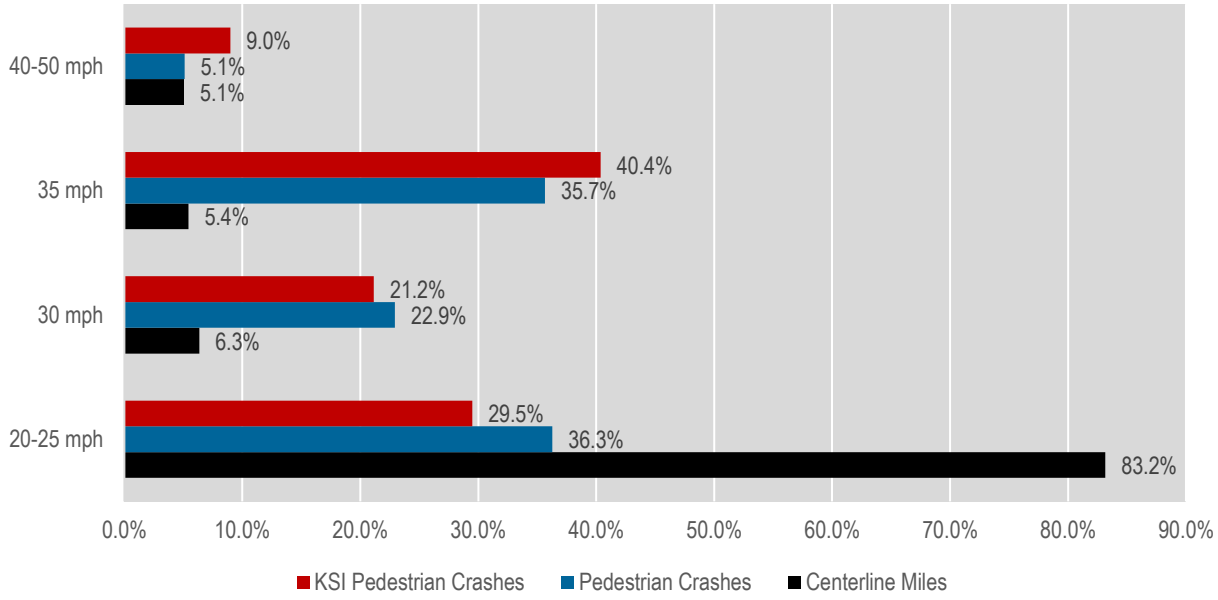
Figure 15 presents a summary of segment pedestrian crashes by posted speed. Pedestrian crashes are more likely to occur on roads with speeds between 25 and 35 mph than other roadways. The risk factor for pedestrian crashes on roads with speeds higher than 35 mph is lower than those for 25 – 35 mph – this is likely a function of where pedestrians typically walk (i.e., lower speed streets). Nevertheless, the KSI risk factor *does* increase steadily as a function of posted speed, which agrees with widely cited literature on KSI risk as a function of speed. Figure 16 visualizes these trends, emphasizing differences in representation of pedestrian crashes on higher speed roadways.

Figure 15 Pedestrian Crash Summary by Posted Speed Limit (Segment crashes only)

Posted Speed	Centerline Miles		Crashes		Crash Occurrence Risk Factor[1]	KSI Crashes		Probability of KSI Crash	KSI Crash Risk Factor[2]
	#	%	#	%		#	%		
20-25 mph	2,180	83.2%	234	36.3%	0.44	46	29.5%	19.7%	0.81
30 mph	166	6.3%	148	22.9%	3.61	33	21.2%	22.3%	0.92
35 mph	143	5.4%	230	35.7%	6.56	63	40.4%	27.4%	1.13
40 – 50 mph	133	5.1%	33	5.1%	1.01	14	9.0%	42.4%	1.75
Total	**2,621**	**100%**	**645**	**100%**	**1.00**	**156**	**100%**	**24.2%**	**1.00**

Notes: 1) Crash Occurrence Risk Factor = % Crashes / % Centerline Miles. 2) KSI Crash Risk Factor = % KSI Crashes / % All Crashes

Figure 16 Pedestrian Crashes and Centerline Miles by Posted Speed Limit (segment crashes only)



Intersection Size

Figure 17 presents a summary of pedestrian crashes by intersection size. Pedestrian crashes were significantly more likely at larger intersections, and were most likely to result in a KSI crash at intersections of 2 lanes and 5 lanes or more.

Figure 17 Pedestrian Crash Summary by Intersection Size (intersection crashes only)

Intersection Size	Intersections		Crashes		Crash Occurrence Risk Factor[1]	KSI Crashes		Probability of KSI Crash	KSI Crash Risk Factor[2]
	#	%	#	%		#	%		
2 Lanes & 2 Lanes	17,467	85.4%	467	29.5%	0.34	63	28.1%	13.5%	0.95
2 Lanes & 3-4 Lanes	1,609	7.9%	596	37.6%	4.78	72	32.1%	12.1%	0.85
2 Lanes & 5 or more lanes	625	3.1%	203	12.8%	4.19	42	18.8%	20.7%	1.46
>=3 Lanes & >=3 Lanes	756	3.7%	318	20.1%	5.43	47	21.0%	14.8%	1.05
Total	**20,457**	**100%**	**1,584**	**100%**	**1.00**	**224**	**100%**	**14.1%**	**1.00**

Notes: 1) Crash Occurrence Risk Factor = % Crashes / % Intersections. 2) KSI Crash Risk Factor = % KSI Crashes / % All Crashes

Intersection Class

Figure 19 presents a summary of pedestrian crashes by intersection class. Intersection classes were assembled based on the simplified roadway functional classification presented in Figure 12. In general, larger intersections carried a substantially higher risk of collision occurrence. For example, Primary Arterial – Collector intersections are nearly 14 times as likely to have a pedestrian crash as all other intersections, and Primary Arterial – Secondary Arterial intersections are over 17 times as likely to have a pedestrian crash as all other intersections. Some intersections are more likely to result in a severe injury or fatality – Primary Arterial –Local, Freeway/Highway, and Primary Arterial – Primary Arterial are all at least 30% more likely to have a KSI pedestrian collision.

Figure 18 illustrates how crashes occurred at intersection types relative to their signalization. The majority of crashes occurring at intersections involving a local roadway occurred at unsignalized locations. Primary – Arterial – Local intersections – which are nearly four times as likely to have a pedestrian crash, and 30% more likely have a KSI pedestrian crash, are often unsignalized. Intersections like this, especially those with high collision rates, should be considered for signalization.

Figure 18 Pedestrian Crashes by Intersection Type and Signalization

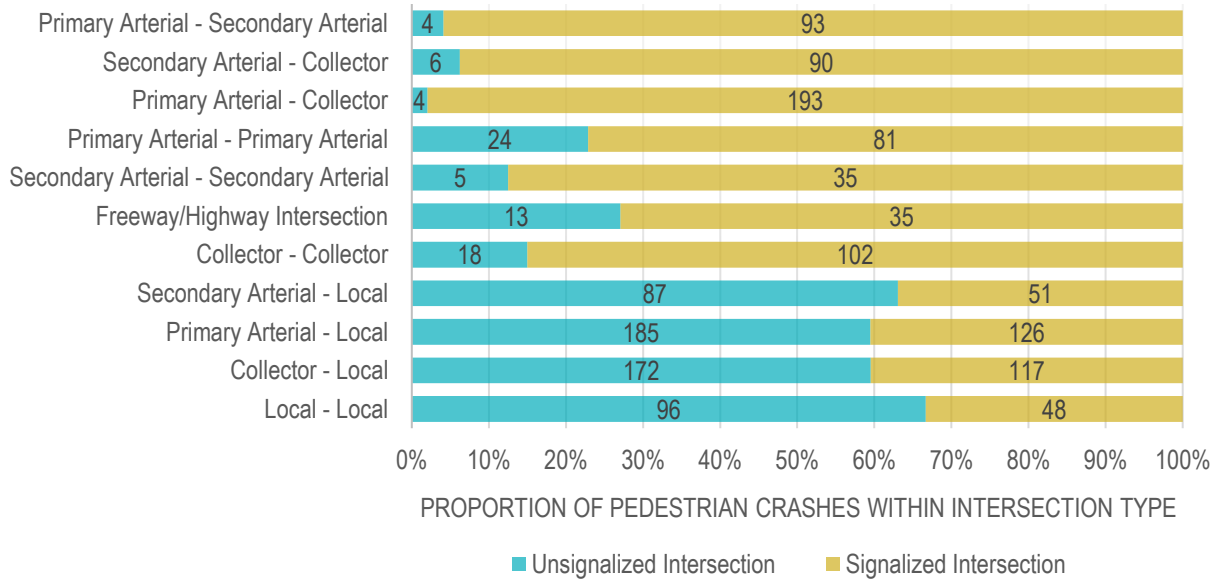


Figure 19 Pedestrian Crash Summary by Intersection Class

Intersection Class	Intersections		Crashes		Crash Occurrence Risk Factor[1]	KSI Crashes		Probability of KSI Crash	KSI Crash Risk Factor[2]
	#	%	#	%		#	%		
Local - Local	12,870	62.9%	144	9.1%	0.14	9	4.0%	9.3%	0.44
Collector - Local	2,986	14.6%	289	18.2%	1.25	33	14.7%	34.0%	0.81
Primary Arterial - Local	1,070	5.2%	311	19.6%	3.75	58	25.9%	59.8%	1.32
Secondary Arterial - Local	904	4.4%	138	8.7%	1.97	18	8.0%	18.6%	0.92
Collector - Collector	829	4.1%	120	7.6%	1.87	15	6.7%	15.5%	0.88
Freeway/Highway Intersection	651	3.2%	48	3.0%	0.95	9	4.0%	9.3%	1.33
Secondary Arterial - Secondary Arterial	393	1.9%	40	2.5%	1.31	3	1.3%	3.1%	0.53
Primary Arterial - Primary Arterial	356	1.7%	105	6.6%	3.80	22	9.8%	22.7%	1.48
Primary Arterial - Collector	182	0.9%	197	12.4%	13.96	30	13.4%	30.9%	1.08
Secondary Arterial - Collector	134	0.7%	96	6.1%	9.24	10	4.5%	10.3%	0.74
Primary Arterial - Secondary Arterial	71	0.3%	97	6.1%	17.62	17	7.6%	17.5%	1.24
Total	**20,446**	**100%**	**1,585**	**100%**	**1.00**	**224**	**100%**	**14.1%**	**1.00**

Notes: 1) Crash Occurrence Risk Factor = % Crashes / % Intersections. 2) KSI Crash Risk Factor = % KSI Crashes / % All Crashes

Crash Types (Why/How)

Land use and pre-crash behaviors were explored to develop locally specific crash types. The crash type analysis is provided in Figure 20.

Key findings include:

- **Crashes at signalized intersections are prevalent.** They account for over 40% of pedestrian crashes and 30% of serious or fatal crashes.
- **Turning vehicles are failing to yield to pedestrians at signalized intersections.** Over a quarter of pedestrian crashes involve a turning driver failing to yield when the pedestrian has the right of way when crossing at the signal (nearly 20% left-turning and 8% right-turning drivers).
- **Midblock crashes are also prevalent.** Over 20% of crashes involve pedestrians crossing between intersections. These crashes tend to be more severe (see below).
- **Certain crash types tend be to more severe.** Approximately 17% of pedestrian crashes result in a serious or fatal injury. The following crash types are more likely to result in a killed or seriously injured (KSI) pedestrian:
  - Pedestrian crossing between intersections (20% of all crashes; 25% are KSI)
  - Pedestrian crossing against signal (8% of crashes; 23% are KSI)
  - Driver going straight at unsignalized intersection fails to yield (7% of crashes; 22% are KSI)
  - Pedestrian crossing at unsignalized intersection did not provide sufficient time for vehicle to stop (6% of crashes; 22% are KSI)

Figure 20 Pedestrian Crash Type Definitions, Counts, and Percentages

Pedestrian Crash Type	Criteria Description	Count	% of Crashes	% of Type Resulting in a KSI	% of KSI Crashes	% of Crashes within Type with Marked Crosswalk Available
Signalized Intersections	**Crash at signalized intersection location (per reported Intersection field and geographic proximity to traffic signal)**	**971**	**43.5%**	**13.1%**	**33.4%**	**99.0%**
Left turning driver fails to yield to pedestrian	▪ Vehicle turning left preceding collision ▪ Driver assigned error code	453	20.3%	8.6%	10.3%	100.0%
Right turning driver fails to yield to pedestrian	▪ Vehicle turning right preceding collision ▪ Driver assigned error code	184	8.3%	9.2%	4.5%	98.9%
Pedestrian crossing against signal or outside of crosswalk	▪ Pedestrian assigned error code ▪ Error code = Disregarded traffic signal or crossing at intersection – traffic signal present	160	7.2%	25.0%	10.5%	98.8%
Driver going straight fails to yield	▪ Vehicle traveling straight preceding collision ▪ Driver assigned error code	88	3.9%	21.6%	5.0%	97.7%
Other	▪ All other crashes at signalized intersections	86	3.9%	14.0%	3.2%	95.3%
Unsignalized Intersections	**Crash at non-signalized intersection location (per reported Intersection field and no geographic proximity to traffic signal)**	**614**	**27.5%**	**15.8%**	**25.5%**	**38.3%**
Driver going straight fails to yield	▪ Vehicle traveling straight preceding collision ▪ Driver assigned error code	189	8.5%	20.1%	10.0%	30.2%
Left turning driver fails to yield	▪ Vehicle turning left preceding collision ▪ Driver assigned error code	159	7.1%	6.3%	2.6%	58.2%
Pedestrian crossing did not have the right-of-way	▪ Pedestrian assigned error code ▪ Non-motorist action indicated pedestrian crossing	135	6.1%	25.2%	8.9%	29.6%
Right turning driver fails to yield to pedestrian	▪ Vehicle turning right preceding collision ▪ Driver assigned error code	70	3.1%	7.1%	1.3%	31.4%
Other	▪ All other crashes at unsignalized intersection	61	2.7%	16.4%	2.6%	24.6%
Mid-block	**Crash at mid-block location (per reported Intersection field)**	**567**	**25.4%**	**26.1%**	**38.9%**	**6.0%**
Pedestrian crossing between intersections	▪ Non-motorist action – crossing between intersection	420	18.8%	24.5%	27.1%	6.2%
Other	▪ All other crashes at midblock locations	147	6.6%	30.6%	11.8%	5.4%
Driveway	**Crash located at driveway (per Road Character field)**	**78**	**3.5%**	**10.3%**	**2.1%**	**47.4%**
Driveway	▪ All crashes located at driveway	78	3.5%	10.3%	2.1%	47.4%
Total	**All collisions**	**2,230**	**100.0%**	**17.0%**	**100.0%**	**56.8%**

HIGH CRASH NETWORK

The City of Portland identified a High Crash Network (HCN) comprised of the 30 streets with the highest crashes for people driving (fatal and severe injury only), bicycling, or walking. Vision Zero was the guiding framework for developing the HCN, so only KSI crashes were considered for drivers, while all collisions were considered for pedestrians and bicyclists since the vulnerability of non-motorists means that nearly any collision could be severe or fatal.

This network was derived by combining the top 20 crash streets of each mode. The city's Vision Zero work is focused on these streets, many of which were in the top 20 for multiple modes. Portland's High Crash Network is illustrated in Figure 21. The total number of all and KSI crashes on each of these corridors are displayed in Figure 22. Additionally, crashes per mile are calculated to measure the risk of occurrence and this metric is compared to the network average. Corridors with higher than average crashes per mile have a higher risk of crash occurrence. The probability of a crash being KSI is also computed and compared to the network average – this difference indicates which corridors are more likely to have a KSI crash than the network average. The two of these difference metrics can aid in prioritizing high crash corridors for pedestrian related improvements, the values in red indicate, a location where one or the other is above the network average.

Figure 21 Portland's High Crash Network

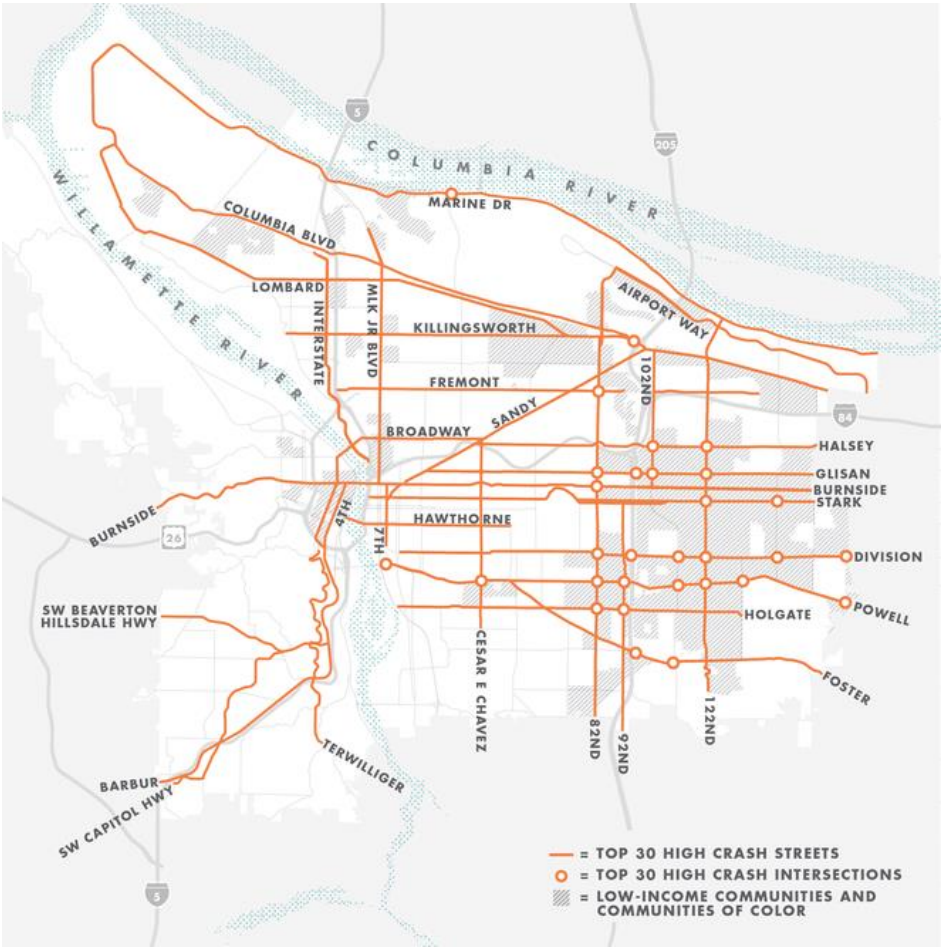


Figure 22 High Crash Corridor Summary

PBOT Corridor ID	Corridor Name	Length (mi)	Pedestrian Crashes[2]			KSI Pedestrian Crashes		
			#	Per Mile	Difference from Average per Mile	#	%	Difference from Average %
HCN1	E/W Burnside St	12.4	159	12.8	4.3	32	20.1%	1.5%
HCN2	N Interstate Ave	4.3	23	5.3	-3.2	7	30.4%	11.8%
HCN3	N/NE Fremont St	7.3	22	3.0	-5.5	2	9.1%	-9.5%
HCN4	N/NE Killingsworth St	6.7	39	5.8	-2.7	9	23.1%	4.5%
HCN5	N/NE Lombard St	12.6	78	6.2	-2.3	15	19.2%	0.6%
HCN6	NE 102nd Ave	2.5	28	11.1	2.6	2	7.1%	-11.5%
HCN7	NE Airport Way	5.5	2	0.4	-8.1	0	0.0%	-18.6%
HCN8	NE Columbia Blvd	10.3	6	0.6	-7.9	4	66.7%	48.1%
HCN9	NE Glisan St	7.1	79	11.1	2.6	12	15.2%	-3.4%
HCN10	NE Halsey St	6.3	36	5.7	-2.8	3	8.3%	-10.3%
HCN11	NE Marine Dr	15.7	3	0.2	-8.3	0	0.0%	-18.6%
HCN12	NE Martin Luther King Jr Blvd	4.7	60	12.6	4.1	7	11.7%	-6.9%
HCN22	NE/SE 122nd Ave	7.1	88	12.4	4.0	12	13.6%	-5.0%
HCN23	NE/SE 82nd Ave	8.4	155	18.5	10.0	46	29.7%	11.1%
HCN24	NE/SE Sandy Blvd	8.9	88	9.8	1.4	16	18.2%	-0.4%
HCN13	SE 7th Ave	1.1	9	7.9	-0.6	1	11.1%	-7.5%
HCN14	SE 92nd Ave	4.3	18	4.2	-4.3	2	11.1%	-7.5%
HCN15	SE Cesar E Chavez Blvd	3.5	51	14.6	6.1	7	13.7%	-4.9%
HCN16	SE Division St	8.3	135	16.2	7.7	36	26.7%	8.1%
HCN17	SE Foster Rd	6.2	46	7.4	-1.1	12	26.1%	7.5%
HCN18	SE Hawthorne Blvd	2.6	41	15.5	7.1	6	14.6%	-4.0%
HCN19	SE Holgate Blvd	6.4	41	6.4	-2.1	7	17.1%	-1.5%
HCN20	SE Powell Blvd	8.7	140	16.2	7.7	28	20.0%	1.4%
HCN21	SE Stark St	8.4	95	11.3	2.8	14	14.7%	-3.9%
HCN25	SW 4th Ave	1.3	38	29.1	20.6	5	13.2%	-5.5%
HCN26	SW Barbur Blvd	6.3	22	3.5	-5.0	3	13.6%	-5.0%
HCN27	SW Beaverton-Hillsdale Hwy	2.4	15	6.2	-2.3	3	20.0%	1.4%
HCN28	SW Capitol Hwy	4.7	20	4.3	-4.2	2	10.0%	-8.6%
HCN29	SW Terwilliger Blvd	4.9	7	1.4	-7.1	1	14.3%	-4.3%
HCN30	SW/N/NE Broadway	4.6	100	21.6	13.1	12	12.0%	-6.6%
Total		**193.6**	**1,644**	**8.5**	**0.0**	**306**	**19.0%**	**0.0%**

[2] Includes crashes within 100 feet of each high crash network street

Approximately two-thirds of pedestrian crashes on the HCN involve people attempting to cross (rather than walk along) the HCN. Nearly half of crashes involve people crossing at signalized intersections (49%), while the other half is split between crossing at midblock locations (25% of crashes) or at unsignalized intersections (23%). Left turning crashes are twice as likely as right turning crashes, and this difference is especially pronounced at signalized intersections. A summary of the key trends is provided in Figure 23 below.

Figure 23 Pedestrian Crash Trends on the High Crash Network

Trend	Potential Implication for Countermeasures
Signalized Intersections (49% of crashes)	
Driver turning onto the HCN corridor hits person walking across it ▪ 19% of crashes (> 1/3 of crashes at signals) ▪ 78% involve left turning motorists	Provide crossing enhancements or protected left turns on the minor legs of signalized intersections
Driver turning off the corridor hits person crossing the road while walking along it ▪ 9% of crashes ▪ 60% are left turns	
Unsignalized Intersections (23% of crashes)	
Driver traveling along the corridor hits person crossing it ▪ 12% of crashes; over ½ of crashes at unsignalized intersections	Upgrade pedestrian crossings so more streets meet the city's crossing spacing standards.
Driver turning on or off the corridor hits person crossing the road while walking along it ▪ 6% of crashes ▪ Over half are left turns	Consider access management or turning movement prohibitions, where appropriate or raise visibility of pedestrians using curb extensions.
Mid-block (25% of crashes)	
Driver traveling along the corridor hits person walking across it ▪ 18% of crashes; nearly ¾ of midblock crashes	Install midblock pedestrian crossings so more streets meet the city's crossing spacing standards.
Driveways (3% of crashes)	
Driver turning on to the corridor hits person walking along it ▪ 1% of crashes	This largest driveway category is only 1% of crashes citywide.

Figure 24 illustrates the actions preceding collisions in accordance to their relative frequency, within the context of roadway location.

Figure 24 Pedestrian Crashes in Relation to the High Crash Network Streets, Location Type, and Vehicle Movement

Relation to High Crash Network (HCN)	Signalized Intersection				Unsignalized Intersection				Mid-Block				Driveway				Totals
	Straight	Turning Left	Turning Right	Other	Straight	Turning Left	Turning Right	Other	Straight	Turning Left	Turning Right	Other	Straight	Turning Left	Turning Right	Other	
Driver Along HCN Segment | **Pedestrian** Across HCN Segment	102	0	0	0	154	0	0	0	231	0	0	0	0	0	0	102	**487**
Driver Turning On To HCN Segment | **Pedestrian** Across HCN Segment	0	204	37	0	0	23	5	0	0	3	0	1	0	8	0	0	**281**
Driver Turning Off Of HCN Segment | **Pedestrian** Along HCN Segment	0	81	40	0	0	36	11	0	0	0	1	2	0	2	0	0	**173**
Driver Across HCN Segment | **Pedestrian** Along HCN Segment	59	0	0	0	12	0	0	0	26	0	0	0	2	0	0	59	**99**
Driver Turning On To HCN Segment | **Pedestrian** Along HCN Segment	0	11	33	0	0	4	22	0	0	0	1	0	0	6	10	0	**88**
Driver Along HCN Segment | **Pedestrian** Along HCN Segment	17	0	0	0	15	0	0	0	19	0	0	0	0	0	0	17	**51**
Driver Turning Off Of HCN Segment | **Pedestrian** Across HCN Segment	0	8	24	1	0	4	6	0	0	0	0	4	0	3	0	0	**50**
Other	16	1	3	3	4	0	1	1	22	0	0	2	0	2	1	16	**56**
Totals	**194**	**305**	**137**	**4**	**185**	**67**	**45**	**1**	**298**	**3**	**2**	**9**	**2**	**21**	**11**	**1**	**1,285**

PEDESTRIAN PRIORITY NETWORK NEEDS

The PedPDX Pedestrian Network Needs Evaluation identified pedestrian infrastructure needs and deficiencies on the designated Pedestrian Priority Network (PPN). Nearly 96% of the 2,230 pedestrian crashes that occurred in Portland from 2006 to 2015 were on PPN streets, which is unsurprising since the network includes all of the collectors and arterials in the city, and those streets are disproportionately prone to pedestrian crashes (see Figure 12). This section examines the crashes that took place along and across PPN streets through the lens of identified needs and deficiencies on the network. For a description of PPN roadway designations and a summary of gaps and deficiencies, see the PedPDX Network Needs Evaluation memo.

Key Findings

- Crashes involving a person crossing at an unmarked location are more likely to occur where marked crosswalks are too far apart to meet the City of Portland's spacing guidelines than where the spacing guidelines are met
- Crashes at marked crossings are more likely to occur where the existing crossing design is deficient
- Crashes at deficient crossings are more likely to result in a KSI
- Crashes involving people walking along the roadway are more likely to result in a KSI when they occur in a block with missing sidewalks

Crossing the Roadway

Gaps

The majority (82%) of pedestrian crashes that occurred on the Pedestrian Priority Network streets involved people walking across a Major City Walkway or City Walkway. On most City Walkways and Major City Walkways, marked crossings are not sufficiently close together to meet crossing spacing guidelines. The guidelines set the standard of 530 feet between marked crossings within pedestrian districts, and 800 feet between marked crossings elsewhere. Nearly 80% of street centerline miles are within a crossing gap. One would expect that more pedestrian crossing crashes would occur in gap locations, and in fact about 60% of crossing crashes on the pedestrian priority network occur where crossings do not meet the spacing guidelines.

More than half of crossing crashes took place at a location with a marked crosswalk. The likelihood that a crash occurred at a marked crossing was higher in places where crossings are sufficiently spaced than in places where they are not. In non-gap locations, marked crossing crashes outnumber unmarked crossing crashes nearly 2 to 1. Within gaps, there were only 1.3 times more crashes at marked crossings than at unmarked locations (see Figure 25). This suggests that in locations where marked crossings are not sufficiently close together, people may be more likely to cross at an unmarked location rather than walk the extra distance to a marked location.

Figure 25 Pedestrian Crashes and Crossing Gaps on the Pedestrian Priority Network

Crossing Gap Status	Crossing Type	Percent of All Crossing Crashes
Not a gap[1]	Marked crossing	19.0%
	Not at marked crossing	10.9%
In a gap[2]	Marked crossing	34.0%
	Not at marked crossing	26.2%

1. The distance between marked crossings is 530 feet or less within a pedestrian district, or 800 feet or less elsewhere
2. The distance between marked crossings is more than 530 feet within a pedestrian district, or more than 800 feet elsewhere

The average length of the gap between marked crossings where a crash occurred was just over 1/3 of a mile, which is not significantly different than the overall average gap length. The risk of a fatality or serious injury is higher when people cross in between marked crosswalks, but is not any higher where the crossing spacing does not meet the guidelines than it is where the spacing guidelines are met.

Deficiencies

The PedPDX Needs Evaluation analyzed existing marked crossings on Major City Walkways and City Walkways on the Pedestrian Priority Network and identified those that do not meet the City of Portland's crossing design guidelines. Five percent of the marked crossings evaluated were found to be potentially deficient. A disproportionate number of the pedestrian crashes that occurred at marked crossings on the Pedestrian Priority Network took place at one of these potentially deficient marked crossings, at 7% of the total. Crashes that resulted in a severe injury or fatality were even more likely to occur at deficient crossings, with over 8% taking place at a potentially deficient crossing location.

Along the Roadway

Gaps

Crashes involving people walking along the road (which includes crashes that occur at driveways) are much less common than crashes involving people crossing the road, representing just over 10% of the total. Of the along-the-roadway pedestrian crashes on the Pedestrian Priority Network, 34% occurred in a block with a sidewalk gap on one or both sides of the street. It should be noted that many blocks with sidewalk gaps also have a partial sidewalk present, and collision reports do not always indicate whether the pedestrian was on the sidewalk or not. In 47 of the 79 crashes that took place in a block with missing sidewalks, the crash report specifically indicates that the person was in the roadway, on the shoulder, or in the bike lane.

On the Pedestrian Priority Network, 45% of street centerline miles have a sidewalk gap present on one or both sides of the street, so the number of crashes occurring in those locations is not disproportionately high. This may reflect the fact that locations without sidewalks are less appealing to people walking, and thus people avoid these streets. The rate of fatality or severe injury, however, is disproportionately high in locations with sidewalk gaps. While 34% of the total along-the-roadway crashes took place in a sidewalk gap location, over 45% of the along-the-roadway crashes that resulted in a fatality or severe injury took place in a location with a sidewalk gap.