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CITY SAFETY PLAN

FEBRUARY 2022

PREPARED FOR THE CITY OF WASHOUGAL

PREPARED BY DKS ASSOCIATES

Southwest Washington Regional Transportation Council

Acknowledgements

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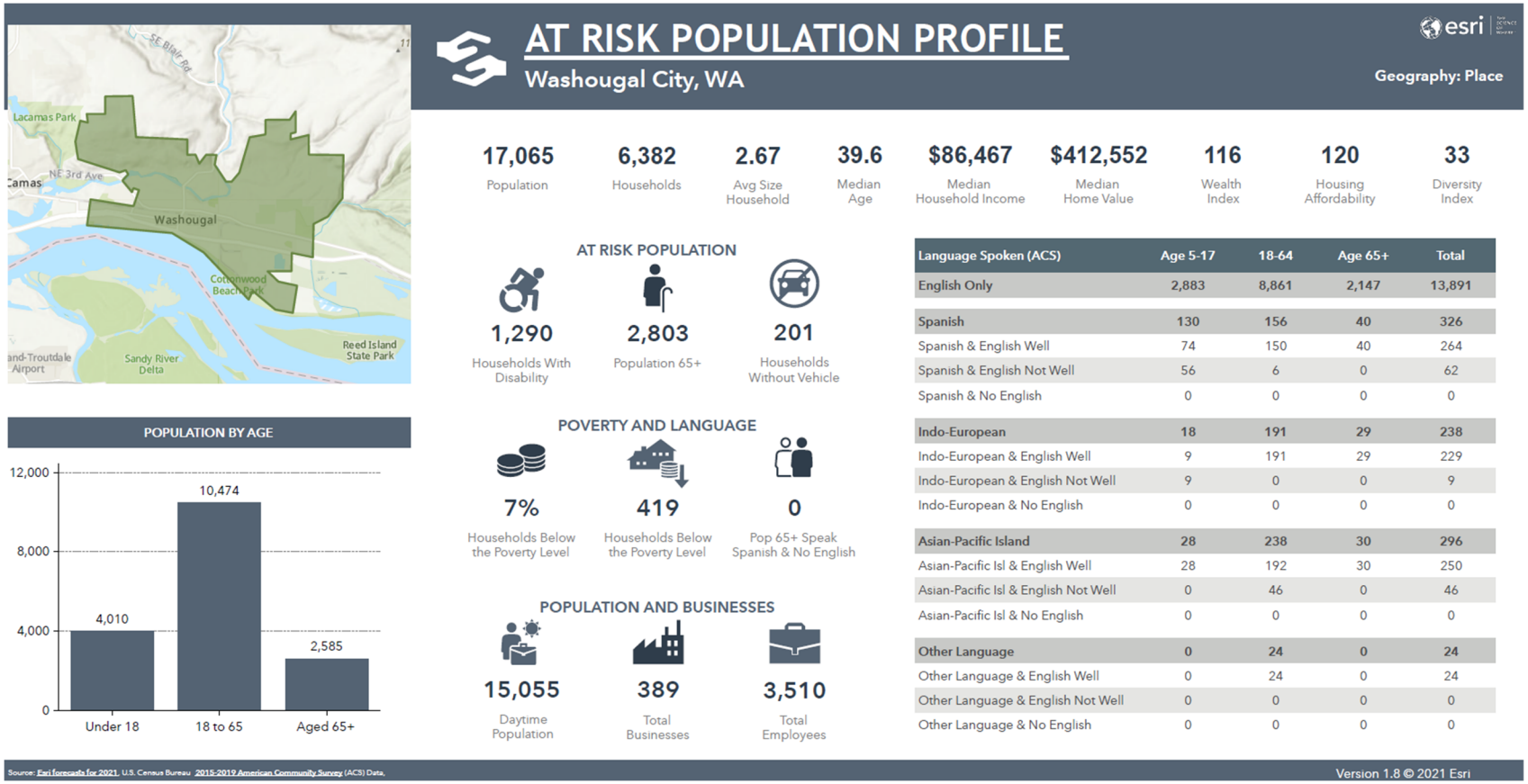
Contents

INTRODUCTION

The City of Washougal is located along the Columbia River and east of the City of Camas. Washougal is home to approximately 17,000 residents with around 390 businesses within the city limits. The following 'At Risk Population Profile' provides key population and equity statistics based on 2021 data.[1]



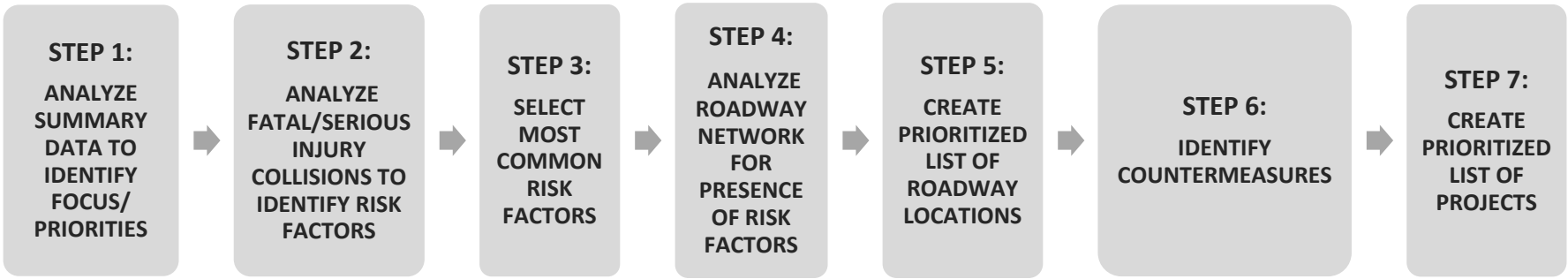
Language Spoken (ACS)	Age 5-17	18-64	Age 65+	Total
English Only	2,883	8,861	2,147	13,891
Spanish	130	156	40	326
Spanish & English Well	74	150	40	264
Spanish & English Not Well	56	6	0	62
Spanish & No English	0	0	0	0
Indo-European	18	191	29	238
Indo-European & English Well	9	191	29	229
Indo-European & English Not Well	9	0	0	9
Indo-European & No English	0	0	0	0
Asian-Pacific Island	28	238	30	296
Asian-Pacific Isl & English Well	28	192	30	250
Asian-Pacific Isl & English Not Well	0	46	0	46
Asian-Pacific Isl & No English	0	0	0	0
Other Language	0	24	0	24
Other Language & English Well	0	24	0	24
Other Language & English Not Well	0	0	0	0
Other Language & No English	0	0	0	0

[1] Source: ESRI Business Analysis Tool. https://storymaps.arcgis.com/stories/52764a9948074c4b9d527a390aefdc67

CITY SAFETY PLAN PROCESS

The purpose of the City Road Safety Plan is to analyze crash data from within the city in order to effectively identify trends, contributing factors, associated risk factors and deficiencies present in the City's road network. Following this approach allows for the effective identification of appropriate, low cost countermeasures to be implemented for the purpose of crash reduction. The following plan includes a summary of existing safety conditions in Washougal, identification of safety needs, and recommended treatments to address high-priority collision types and locations.

The sections below describe the process of collecting and analyzing available data and identifying safety needs from that analysis.



The data used and process followed are consistent with WSDOT's guidelines from the 2022 City Safety Program. The recommended safety countermeasures are limited to infrastructure-based treatments eligible for one or more of the following grant programs:[2]

- WSDOT grant programs: City Safety, Safe Routes to School, Bicycle-Pedestrian, and Railway-Highway Grade Crossings
- Transportation Improvement Board (TIB) grants, including Complete Streets
- Several RTC grants

[2] Additional details regarding available grant programs are available in Appendix B, Grant Programs.

Appendix A, Safety Countermeasure Toolbox, includes a description of each treatment, when it should be used, estimated costs, and crash modification factor.

The sections below describe the process of collecting and analyzing available data and identifying safety needs from that analysis.

STEP 1: ANALYZE SUMMARY DATA TO IDENTIFY FOCUS/PRIORITIES

The study team worked with the City of Washougal, Southwest Washington Regional Transportation Council (RTC), and WSDOT Transportation Data to acquire the following data sets.

- WSDOT database of all collisions on City of Washougal streets, Jan 2016 - Dec 2020 (provided by WSDOT Transportation Data)
- City of Washougal Citizen Feedback (provided by Rob Charles, City of Washougal)

The study team reviewed the quality and accuracy of the data sets, communicated with WSDOT on discrepancies, and solicited and received the desired data from the State.

DATA ANALYSIS OVERVIEW

As illustrated in Figure 1, over the past five years, there were a total of 11 fatal and serious injury collisions on City-owned roads. During the five-year study period, there were two fatal collisions that occurred in 2019. One fatality involved a train hitting a truck at the railroad crossing on SE Whitney St/3rd Street, where the driver disregarded the crossing signal. The other fatality involved a hit-and-run on N Shepherd Rd where a driver, under the influence of alcohol, hit a person located off the roadway in an adjacent park.

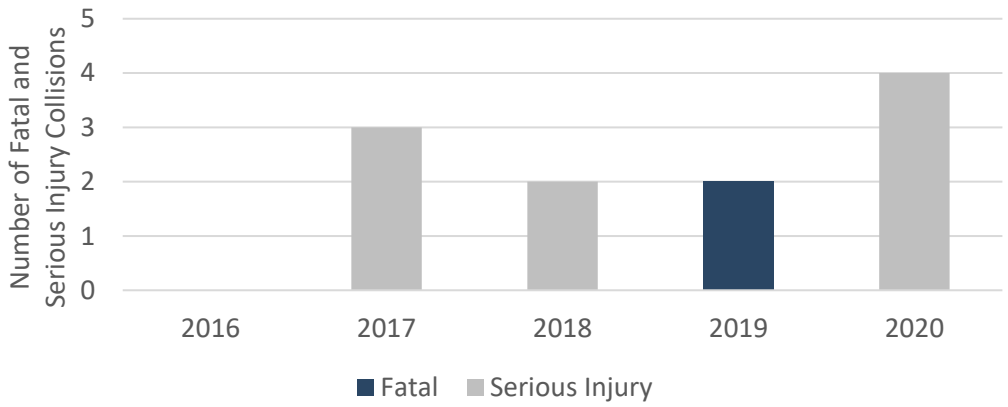


Figure 1. Fatal and Serious Injury Collisions in Washougal, 2016-2020.

The number of all reported collisions (regardless of severity) has ranged between 39 and 84 per year, as shown in Figure 2. In the most recent year of data available, 2020, the city experienced 39 reported crashes (a 50% decline from 2016). The impacts of the COVID-19 pandemic response and associated travel patterns likely had a significant influence on crash frequency and severity in 2020.

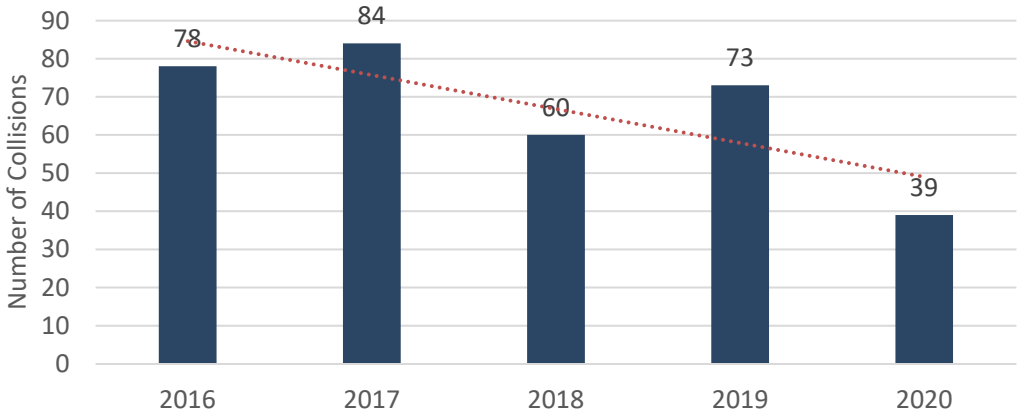


Figure 2. All Reported Collisions in Washougal, 2016-2020

Figure 3 shows the heat map of fatal and serious injury collisions over the five-year study period. Figure 4 provides a heat map of all reported collisions that occurred on City-owned streets in Washougal during the study period.

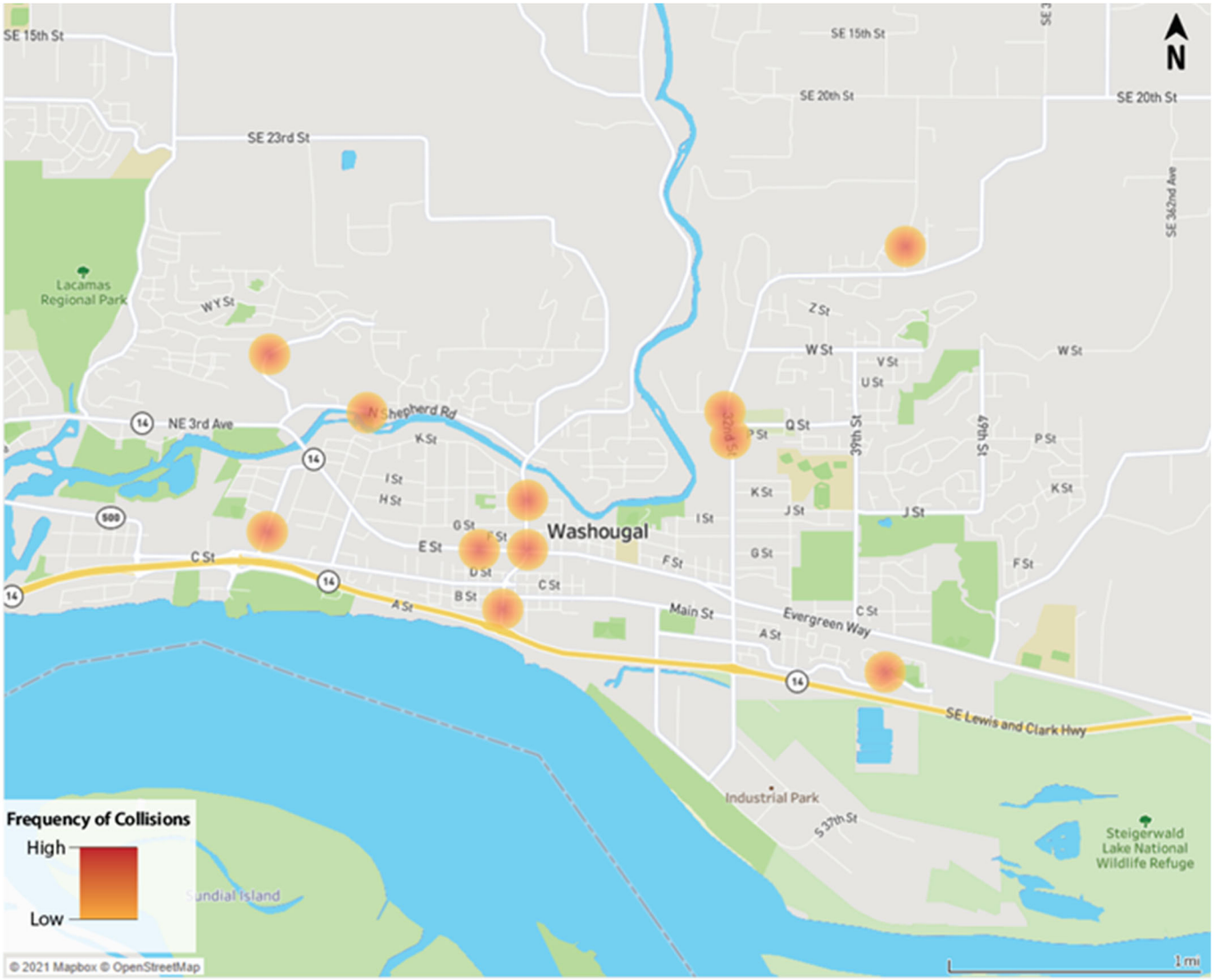


Figure 3. Heat Map of Fatal and Serious Injury Collisions in Washougal, 2016-2020.

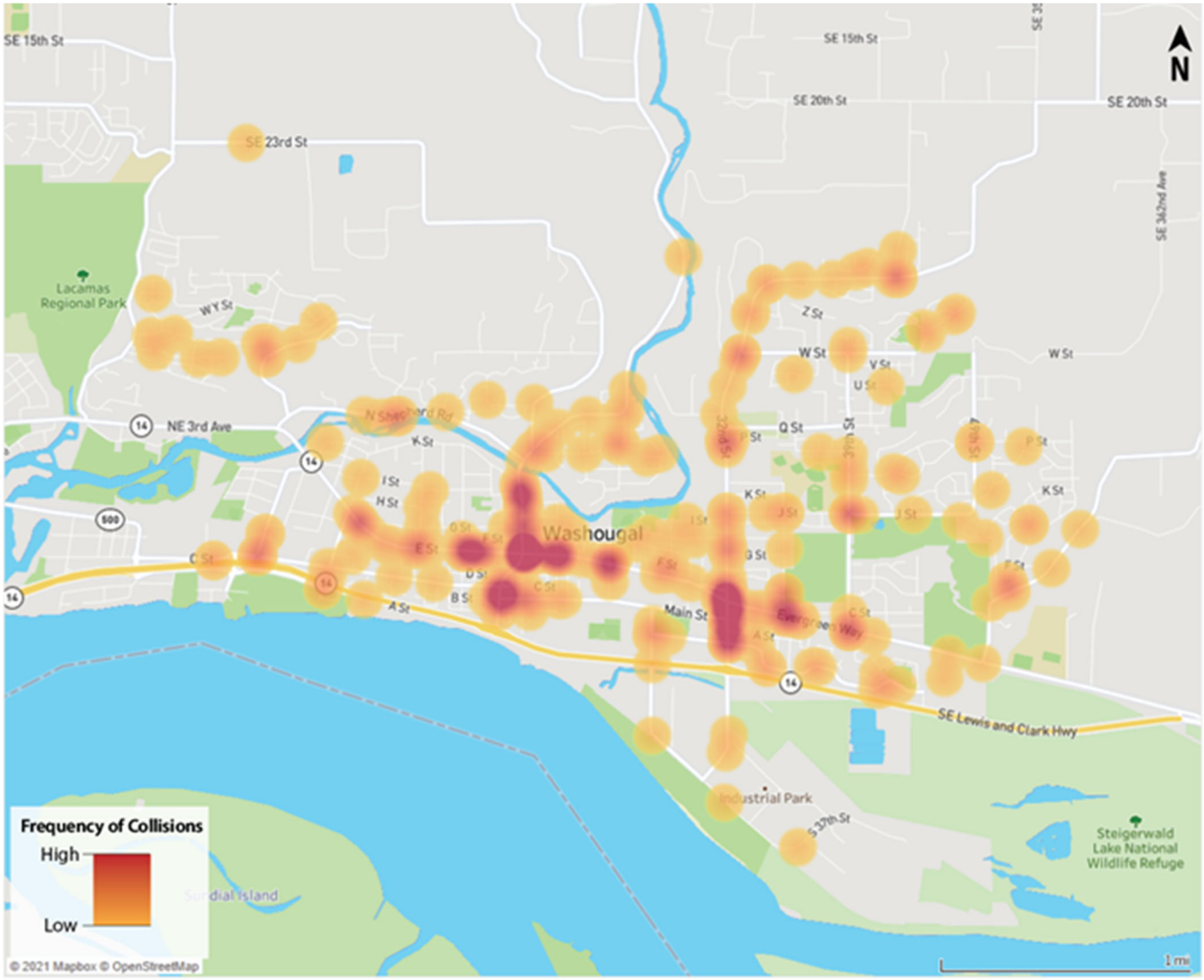


Figure 4. Heat Map of All Reported Collisions in Washougal, 2016-2020.

CITIZEN FEEDBACK

Citizens of the city are an important source for traffic safety concerns. They have a vested interest in keeping travel safe for themselves and their families, and they bring their first-hand experience. In particular, citizens sometimes identify issues occurring at night and on weekends that agency staff may not identify during typical daytime reviews.

The City of Washougal provided a history of transportation safety-related citizen requests made over the past few years. Of the 20 requests reviewed, most focused on the following topics:

Pedestrian Safety

- Request for pedestrian crossing at locations that do not currently have them.
- Request for new bike lanes on roads that currently do not have them and to fill gaps to connect existing bike routes.

High Vehicle Speeds

- Request for change to the posted speed limit and speed limit enforcement.

Sight Distance

- Visibility issues at intersections due to parked cars.
- Request for improvements at intersections with limited sight distance.

The following locations in the city were most commonly noted in citizen feedback:

Intersections:

- Stiles Road & 32nd Street
- E Street & 9th Street
- E Street & 32nd Street

Corridors:

- Lookout Ridge Drive
- West Y Street from Lookout Ridge Drive to West X Street.
- Evergreen Way from 32nd Street to Sunset View Road

STEP 2: ANALYZE FATAL/SERIOUS INJURY COLLISIONS TO IDENTIFY RISK FACTORS (COLLISION ATTRIBUTES)

The team studied each risk factor (collision attribute) to determine which would be most useful for future steps. Table 1 shows some of the most common attributes present in collisions that occur on City-owned streets in Washougal.

TABLE 1. MOST COMMON COLLISION ATTRIBUTES, WASHOUGAL, 2016-2020

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Washougal Collisions with this Attribute [1]	Percent of F&SI Washougal Collisions with this Attribute [2]
Citywide	*Any*	334	2	9		
Collision Type	Roadway Departure	72	1	3	22%	36%
	Head-On	3	0	2	1%	18%
	Entering at Angle	58	0	0	17%	0%
Contributing Circumstance (For at least one vehicle)	Exceeding Reasonable Safe Speed or Exceeding Stated Speed Limit	21	0	1	6%	9%
	Alcohol-Impaired [3]	31	1	2	9%	27%
	Drug-Impaired [3]	3	0	0	1%	0%
	Inattention / Distraction	76	0	3	23%	27%
Motor Type Involved	Motorcycle	5	0	2	1%	18%
	Heavy Vehicle	72	0	3	22%	27%

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Washougal Collisions with this Attribute (1)	Percent of F&SI Washougal Collisions with this Attribute (2)
Lighting Condition	Dark/Dusk/Dawn	29	0	0	9%	0%
Intersection	At Intersection or Intersection Related	158	1	1	47%	18%
	Signalized Intersection	22	0	0	7%	0%
	Unsignalized Intersection	136	1	0	41%	9%
Road User	Pedestrian Involved	8	1	1	2%	18%
	Cyclist Involved	11	0	0	3%	0%
Roadway Surface	Wet	72	0	3	22%	27%
	Ice	7	0	0	2%	0%
Age	Driver Age 16 to 25 Involved	116	0	1	35%	9%
	Driver Over Age 65 Involved	58	1	1	17%	18%
Restraint (Seat Belt) Usage	No Restraints Used	9	0	4	3%	36%

(1) For example, in Washougal 22% of all collisions involved roadway departure.
(2) For example, in Washougal 18% of all fatal and serious injury collisions were head-on crashes.
(3) As of this writing, WSDOT has identified an issue with 2020 impaired driving data and is looking into the details.

The study team identified the following notable trends from this analysis:

- Intersections are the most common type of location for collisions (all severities) to occur (158 of 334; 47%).
- Roadway departure collisions are the most common fatal and serious collision type, resulting in 4 of the 11 fatal and serious injury outcomes (36%).
- Young drivers (age 16 to 25) were involved in more than one-third of all collisions.

STEP 3: SELECT MOST COMMON RISK FACTORS (COLLISION ATTRIBUTES)

Based on the findings of Step 1 and Step 2, the study team identified the following collision attributes correlated with the highest frequency or severity of collisions. These collision attributes are the focus of the network analysis in Step 4:

1. Roadway Departure
2. At Intersection or Intersection Related
3. Wet Roadway Surface Conditions
4. Vulnerable Users (Pedestrian/Bike Involved)
5. Inattention/ Distraction
6. Speeding

STEP 4: ANALYZE ROADWAY NETWORK FOR PRESENCE OF RISK FACTORS (COLLISION ATTRIBUTES)

Following WSDOT's recommended procedure[3], the City applied the most common risk factors in fatal/serious injury crashes to the entire network using frequency of collisions based on the most common risk factors / collision attributes.

The City mapped crash frequency based on the seven most common risk factors in fatal and serious injury crashes. The heat maps in Appendix C illustrate the locations of crashes with these attributes.

[3] WSDOT Local Road Safety Plans Guidance, https://www.wsdot.wa.gov/sites/default/files/2014/02/27/LP_Local-Road-Safety-Plans.pdf

STEP 5: CREATE PRIORITIZED LIST OF ROADWAY LOCATIONS

The tables below include intersections and corridors ranked by the number of risk factors / collision attributes identified. A location received a "point" for a risk factor if it experienced a relatively high frequency of crashes with that attribute compared to the rest of the city roadway network. An additional point was added if that location was identified as a citizen concern.

TABLE 2. PRIORITIZED INTERSECTION SAFETY NEEDS BY NUMBER OF RISK FACTORS

Intersection	Roadway Departure	Wet Road Surface	Ped/Bike	Distracted/ Inattention	Speeding	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
E St and Washougal River Rd	✓	✓	✓	✓	-	✓	✓	**6**
3rd St and C St	✓	✓	✓	✓	✓	-	✓	**6**
Evergreen Way and 32nd St	-	✓	✓	✓	-	-	✓	**4**
E St and 20th St	✓	✓	-	✓	-	-	✓	**4**
Evergreen Way and 34th St	✓	✓	-	✓	-	-	✓	**4**
E St and 24th St	✓	-	-	✓	-	-	✓	**3**
J St and 39th St	-	✓	✓	✓	-	-	-	**3**

Intersection	Roadway Departure	Wet Road Surface	Ped/Bike	Distracted/ Inattention	Speeding	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
J St and 32nd St	-	✓	-	-	✓	-	✓	**3**
Addy St and 27th St	✓	✓	-	-	-	-	-	**2**
Main St/ B St and 32nd St	-	✓	✓	✓	-	-	-	**2**
E St and 12th St	-	-	-	✓	-	-	✓	**2**

TABLE 3. PRIORITIZED CORRIDOR SAFETY NEEDS BY NUMBER OF RISK FACTORS

Segment	Roadway Departure	Wet Road Surface	Ped/Bike	Distracted/ Inattention	Speeding	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
N Washougal River Rd from N 18th St to E St	✓	✓	✓	✓	✓	✓	-	**6**
E St from SE Lechner St to 22nd St	✓	✓	-	✓	✓	✓	✓	**6**
S 32nd St from Q St to Addy St	✓	✓	-	✓	✓	✓	✓	**6**
Evergreen Way from E St to SE Sunset View Rd	-	✓	-	✓	-	-	✓	**3**
N Shepherd Rd from NE 3rd Ave to N Washougal River Rd	✓	-	✓	-	-	✓	-	**3**

STEPS 6 & 7: IDENTIFY COUNTERMEASURES TO ADDRESS PRIORITIZED LOCATIONS AND DEVELOP A PRIORITIZED LIST OF PROJECTS

The City compared the list of prioritized intersections and corridors identified in Step 5 to recent and already-funded projects to identify the most pressing safety current needs, and then analyzed collision data and existing conditions at the following locations:

TABLE 4. PRIORITIZED SAFETY STUDY LOCATIONS

Intersection	Roadway Departure	Wet Road Surface	Ped/Bike	Distracted/ Inattention	Speeding	At Least 1 Fatal or Serious Injury Crash	Citizen Request
1. Intersection: E St and Washougal River Rd *	✓	✓	✓	✓	-	✓	✓
2. Intersection: 3rd St and C St	✓	✓	✓	✓	✓	-	✓
3. Segment: N Washougal River Rd from N 18th St to E St	✓	✓	✓	✓	✓	✓	-
4. Segment: E St from SE Lechner St to 22nd St	✓	✓	-	✓	✓	✓	✓
5. Segment: S 32nd St from Stiles Road to Addy St	✓	✓	-	✓	✓	✓	✓

* Although this intersection and surrounding area experienced several collisions meeting each of the criteria, in the end it was not a preferred candidate for treatment under the current grant programs.

Upon completion of that analysis and identification of potential countermeasures, the City selected the priority spot location and systemic safety projects shown below.

TABLE 5. PRIORITIZED SAFETY PROJECTS TO PURSUE

Prioritized Location or Systemic Collision Type	Safety Project	Next Step
1. S 32nd Street from Addy Street to Stiles Road	Profiled edgeline pavement marking Shoulder widening; Lighting; Guardrail	Apply for 2022 WSDOT City Safety Program grant funding
2. 27th Street from Main Street to Index Street	Shared use path for pedestrians and bicyclists	Apply for Transportation Alternatives Program (TAP) grant funding
3. E Street from SE Lechner Street to 22nd Street	Access management; ped crossing; median islands; speed feedback signs	Apply for future grant funding opportunities
4. N Washougal River Road from N 18th Street to E Street	Lighting; Bridge Rail Protection; Profiled Edge Line Striping	Apply for future grant funding opportunities
5. Systemic Stop-controlled Intersections	Signing, Pavement Marking	City-funded, low-cost treatments
6. Systemic Roadway Departure	Citywide Horizontal Curve Safety Treatments; Enhanced Signing, Pavement Marking, Rumble Strips	Apply for future grant funding opportunities
7. 39th Street from Evergreen Way to J Street	Sidewalk Infill	Apply for 2022 Safe Routes to School or future grant funding

The following sections detail existing conditions, countermeasures, and estimated project costs, monetary value of estimated safety benefits, and the estimated benefit/cost ratio of each recommended safety project. The projects are organized by City priority, with the highest-priority projects first.

PRIORITY 1: 32ND STREET FROM ADDY STREET TO STILES ROAD

Identified Safety Needs. 32nd Street is a north-south undivided street that serves as one of the main access points to SR 14 on the east side of the city and provides access to the Evergreen Marketplace. Along 32nd Street, the speed limit is 25 mph until north of L Street, where it increases to 35 mph. From Stiles Road to K Street, there are no shoulders or sidewalks present. From K Street to F Street, the road widens to allow for some on-street parking and sidewalks are present on both sides of the road. South of F Street to Addy Street, the cross-section changes to three lanes with a center two-way left-turn lane and no on-street parking permitted.

There were 14 non-intersection collisions reported along this segment, including one suspected serious injury. The suspected serious injury collision involved a head-on collision just south of Q Street.

Figure 5. Facing northbound on 32nd St at K St.

Safety Treatments

- ***Profiled Center Line Pavement Marking.*** Particularly for the segment between Stiles Road and K Street, this area along 32nd Street would benefit from having a profiled centerline profiled (raised) striping to improve drivers' awareness and reducing the likelihood of head-on collisions.
- ***Profiled Edge Line Pavement Marking.*** This technique to raise the profile of edge line striping can provide some audible and vibratory warning to drivers leaving their travel lane.

- ***Widen Shoulders.*** Increasing the shoulder width by 2 feet would provide additional recovery area for vehicles that depart their lane, reducing the frequency and severity of collisions.
- ***Supplemental Lighting.*** Add luminaires to existing utility poles.
- ***Guardrail.*** Install guardrail at two locations, both on the east side of 32nd St as described below:
    - From 160 feet south of Y Street to 700 feet north of Y Street
    - From P Street south for approximately 475 feet

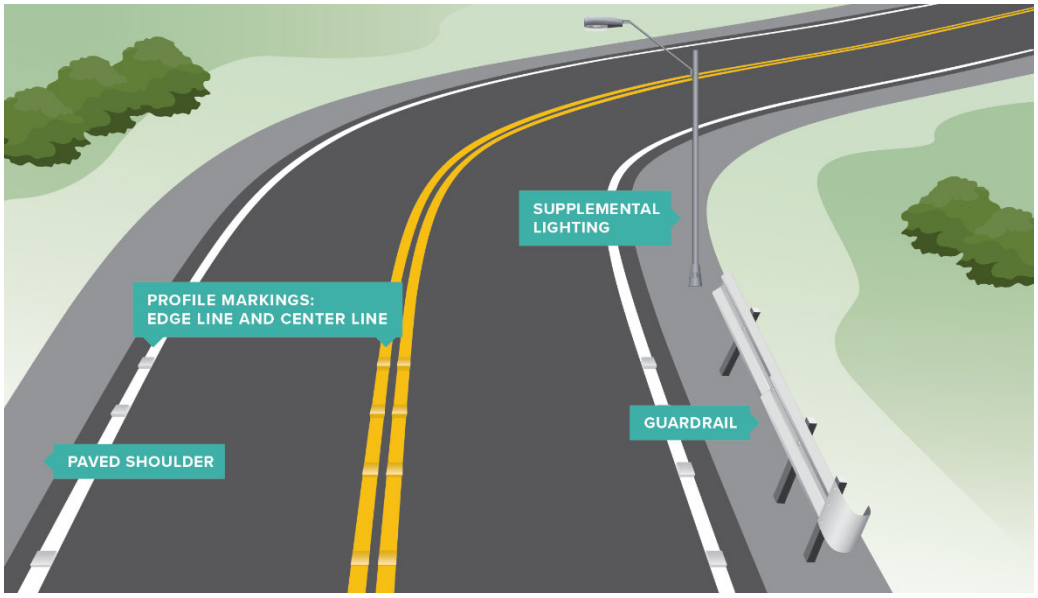


Figure 6. 32nd Street Proposed Safety Treatments

32nd Street from Addy Street to Stiles Road

Project Description

Provide profiled pavement markings and shoulders for the length of the segment. Add luminaires to existing utility poles. Provide guardrail at two strategic locations

Cost Estimate

$896,000

Benefit / Cost Ratio

3.01

Time Frame

Long-term

Crash Reduction

~28%

Combined reduction for all treatments along the corridor

History: 14 collisions observed from 2016-2020.

Expected Benefit: 0.77 fewer crashes per year

PRIORITY 2: 27TH STREET FROM MAIN STREET TO INDEX STREET

Identified Safety Needs. Pedestrians and bicyclists use the two lane road to walk to Captain William Clark Park on the Columbia River. This same route is used by trucks to travel to and from the port, which introduces potential conflicts between heavy trucks and vulnerable road users.

Potential Safety Treatments. To address the identified need, the City proposes a 10-foot separated shared use path from the railroad tracks north to Main Street.

Figure 7. Facing northbound on 27th Street north of Index Street.

PRIORITY 3: E STREET FROM SE LECHNER STREET TO 22ND STREET

Identified Safety Needs. E St is a primary east-west corridor in Washougal that provides access to transit, commercial, residential, and recreational opportunities. E St is a three-lane cross-section with a center two-way left-turn lane, no on-street parking, and a high density of driveways. Based on the past five years of collision history, there have been a total of 27 non-intersection related crashes, including two suspected serious injuries. One of the common collision types that occurred along this corridor is roadway departure crashes, all of which occurred in dark conditions.

Figure 8. Facing westbound on E Street near the intersection of 12th Street.

Potential Safety Treatments. To address the identified needs at this intersection, the City will consider the following safety countermeasures:

- ***Access Management.*** Suggest reducing the number of access points by consolidating driveways along the corridor.
- ***Median Islands*.** Median islands are protected spaces where vehicles are restricted in their turning movement opportunities. Consider installing median pedestrian refuge islands with mid-block pedestrian crossings (similar to the one located near 20th St) to support safe pedestrian movements.
- ***Speed Feedback Signs.*** Immediate speed feedback signs can encourage drivers to slow down along the corridor and pay attention to their driving speeds.

PRIORITY 4. N WASHOUGAL RIVER ROAD FROM N 18TH STREET TO E STREET

Identified Safety Needs. Washougal River Road is a primary north-south corridor in Washougal and provides one of the two bridge crossings over Washougal River to reach the northern area of the city. From E Street to N Shepherd Road, the two-lane road is wide with paved sidewalks on both sides. Land use is mixed with low-density residential and commercial. North of N Shepherd Road, lanes are narrow and there are no sidewalks present. Based on the past five years of collision history, there have been a total of 15 non-intersection related crashes, including two suspected serious injuries. One of the common collision types that occurred along this segment is roadway departure and all of those collisions occurred in dark conditions.

Figure 9. Facing northbound on Washougal River Road and approaching bridge crossing.

Potential Safety Treatments. To address the identified needs along this segment, the City will consider the following safety countermeasures:

- ***Improved Segment Lighting.*** With crashes in dark conditions prominent, analyzing and improving lighting along the corridor, particularly near the bridge, would support safety at night.
- ***Improve Protection Bridge at Rail Endpoints.*** Currently, the bridge rail ends at a blunt face with a yellow/black object marker to warn drivers of the fixed object. Improving the protection for the bridge rail endpoints and/or providing delineation or lighting along the bridge would help drivers see the bridge curvature at night.
- ***Profiled Edge Line and Center Line Striping***. This technique to raise the profile of edge line striping can provide some audible and vibratory warning to drivers leaving their travel lane.

PRIORITY 5. SYSTEMIC STOP-CONTROLLED INTERSECTIONS

Identified Safety Needs. In Washougal, entering at angle collisions were a high proportion of collisions, contributing to 17% of all collisions (regardless of severity) during the study period. Additionally, 64% of entering at angle collisions occurred at intersections, particularly at two-way stop-controlled intersections.

Potential Safety Treatments. Two-way stop-controlled intersections with patterns of angle collisions can be related to the lack of driver awareness of the presence of the intersection. The ability of approaching drivers to perceive them can be enhanced by installing low-cost systemic safety countermeasures such as doubled-up signs, additional pavement marking, double-wide stop bars, advance warning signs, oversize signs, and improving sight distance to the intersection (clear sight triangle).

To address the safety risks at intersections and take advantage of due to the low cost of recommended treatments, the City will consider a combination of these countermeasures at the following stop-controlled intersections (and others with similar features):

- 3rd Street and C Street
- 32nd Street and Addy Street
- 32nd Street and A Street
- 32nd Street and B Street
- 32nd Street and W Street
- 28th Street and F Street
- 28th Street and H Street
- Washougal River Road and A Street
- Washougal River Road and C Street
- 49th Street and P Street

Sample Intersection: 3rd Street and C Street. Located in the southeastern corner of the city near "The Crossing" Plaza, 3rd St and C St is a three-legged intersection with a stop control for the southbound approach on 3rd St. Along C St, the current speed limit is 25 mph and there is evidence of people running along the south side of C St where there are no pedestrian facilities. Collision data over the past five years revealed that both pedestrian and bicycle crashes occurred in dark conditions. Currently, there is one street light on the northeastern corner of the intersection.

Figure 10. 3rd Street and C Street facing Northeast

Figure 11. Facing southbound along 3rd Street approach

Currently, there are edge line pavement markings along C Street from the N 2nd Street roundabout to 3rd Street, delineating a shoulder area. However, this striping does not continue after 3rd Street. Providing a shoulder along C Street can provide more space for pedestrians.

PRIORITY 6. SYSTEMIC ROADWAY DEPARTURE

Roadway departure collisions were the most common crash type, contributing to 22% of all collisions (regardless of severity) during the study period. Additionally, 36% of fatal and serious injury collisions involved roadway departure. Figure 12 illustrates the frequency and density of roadway departure collisions.

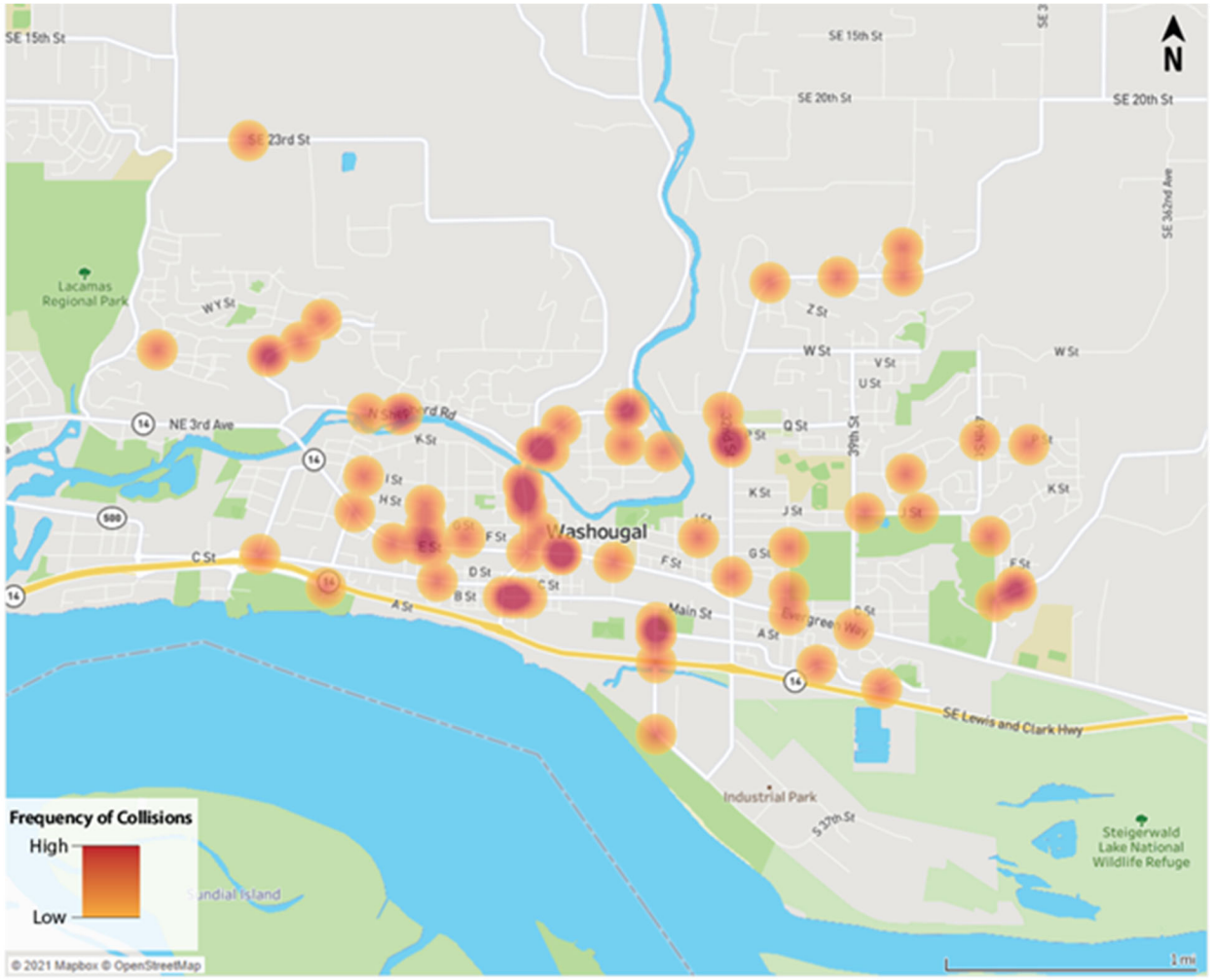


Figure 12. Roadway Departure Collisions, Washougal, 2016-2020.

6.1 Citywide Horizontal Curve Safety Improvements

The City proposes horizontal curve safety improvements for two important reasons. First, motorists are more than three times as likely to be involved in a collision on a curve than a tangent section. Second, the most recent MUTCD (2009) included a legal requirement for every publicly-owned road with 1,000+ vehicles per day to meet horizontal curve requirements by December 31, 2019.

This safety project will provide current MUTCD standard curve warning signs at all horizontal curves on arterials and major collectors in the city limits (approximately 30 curves).

- Conduct a horizontal curve inventory study and posted speed limit study to assess existing conditions
    - Collect advisory speed data for each curve and turn
    - Collect operating speeds near each curve and turn, then analyze that data using current methodologies to determine the most appropriate posted speed limit.[4]
    - Calculate the difference between advisory speed and posted speed limit (per MUTCD)
- Design signing treatments
    - Determine the required (shall) and recommended (should) sign package for each curve per MUTCD Table 2C-5 (e.g., advanced warning sign, advisory speed plaque, chevrons, and/or one direction large arrow).
    - Confirm sign placement feasibility via field review
    - Produce plans, specifications, and estimates (PS&E) for curve signing
- Install horizontal curve warning signs

[4] Experts have identified potential "too low" posted speed limits in La Center that have, as a result, reduced the horizontal curve warning sign requirements, since that requirement is tied directly to the posted speed limit per the MUTCD.

6.2 Combined Roadway Departure Treatments Along Select Corridors

Low-cost roadway departure treatments focus primarily on keeping vehicles on the road and in their lane, and since motorists can depart the roadway at an infinite number of locations (versus the finite number of intersections in a jurisdiction), blanketing an entire corridor with roadway departure treatments can prevent future collisions, even at locations that have not experienced one in the past. The following treatments should be considered along select corridors.

- ***Enhanced Curve Safety Package.*** On top of the minimum requirements, horizontal curve signing will be enhanced to provide additional warning for motorists: doubled-up signs, oversized signs fluorescent yellow sheeting, chevrons alignment signs, flexible delineators, flashers, speed feedback warning, and pavement marking. Additionally, High Friction Surface Treatment may be appropriate at select curves.
- ***Rumble Strips or Profiled Pavement Marking.*** Provide visual, tactile, and auditory feedback to drivers - either via rumble strips or profiled pavement marking - depending on the surrounding land use.
- ***Nighttime Delineation.*** Provide delineation via vertical delineators or products added to current appurtenances (e.g., guardrail) to improve visibility of roadway alignment in dark conditions.
- ***Fixed Object Treatments.*** For each fixed object within the right-of-way (with priority for those objects in the clear zone), address each using the following hierarchy per FHWA:
    a. Remove the obstacle.
    b. Redesign the obstacle so it can be safely traversed.
    c. Relocate the obstacle to a point where it is less likely to be struck.
    d. Reduce impact severity by using an appropriate breakaway device.
    e. Shield the obstacle with a longitudinal traffic barrier designed for redirection or use a crash cushion.
    f. Delineate the obstacle if the previous alternatives are not appropriate.

The City has identified these priority corridors for systemic roadway departure treatments.

- N Lebrun Dr
- N Washougal River Rd
- Addy St
- SE Sunset View Rd
- 32nd St
- N Shepherd Rd

PRIORITY 7. 39TH STREET FROM EVERGREEN WAY TO J STREET

Identified Safety Needs. This segment of 39th Street, south of Washougal High School and Gause Elementary School, lacks sidewalks to support pedestrian activity, including students and their families navigating the roadway before and after school.

Potential Safety Treatments. Approximately 0.5 miles of sidewalk in-fill from Evergreen St to J Street–along one or both sides of the road–would provide additional support for pedestrians to travel this corridor.

Figure 13. 39th Street, looking northbound, one block south of schools

OTHER LOCATIONS TO CONSIDER

The following intersections have been identified by the City as potential safety needs to be considered for future grant funding opportunities.

E Street and 32nd Street Intersection. This location operates as an offset 4-leg intersection (one leg is a commercial driveway) and is located very close to a busy signalized intersection. Treatments may include an urban roundabout design to better handle traffic operations and safety.

Main St and Washougal River Rd Intersection. This signalized intersection could benefit from retiming and changes to phasing. Red light running is an issue. Treatments may include additional all-red clearance time and protected-only left turn phasing.

Signalized Intersection: E St and Washougal River Rd Intersection. Located near the center of the city, this is a busy four-legged signalized intersection with left turn lanes on all approaches and protected-permissive left turn phasing with Flashing Yellow Arrows. Data over the past five years revealed that collisions were primarily angle/turning crashes, and more than half of the collisions involved a left-turning vehicle and an opposing straight vehicle. There have also been concerns regarding capacity issues.

Treatments may include protected-only left turn phasing, countdown pedestrian signals, and lead pedestrian intervals.

Figure 14. E Street and 32nd Street Intersection

APPENDICES

APPENDIX A: Safety Countermeasures Toolbox

APPENDIX B: Grant Programs

APPENDIX C: Collision Heat Maps

Appendix A Countermeasures Toolbox

Signalized Intersections

S1. Improve Intersection Lighting

A permanent source of artificial light applied to signalized intersections that have a disproportionate number of night-time crashes and do not currently provide sufficient lighting at the intersection or at its approaches.

Benefit-Cost

» Implementation of this treatment reduces nighttime injury crashes by 38% and nighttime pedestrian crashes by 42%. (WSDOT)

» 20 years of expected life

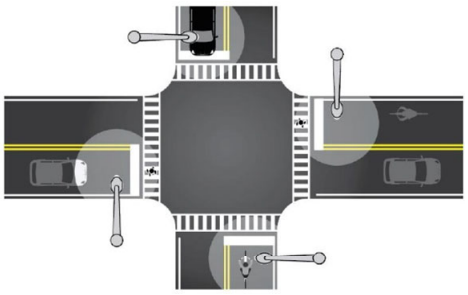
» Estimated $75,000

» The provision of lighting involves both a fixed cost for lighting installation and an ongoingmaintenance and power cost which results in a moderate to high cost.

Sources: CA-Local Roadway Safety Manual, FHWA, WSDOT

EXISTING CONDITION

IMPLEMENTATION



S2. Improve Signal Hardware (lenses, back-plates, mounting, size, number of heads)

Applicable at signalized intersections with a high frequency of right-angle and rear-end crashes because drivers are unable to see traffic signals sufficiently in advance to safely negotiate the intersection being approached. Examples include increasing the size of indications from 8 in. to 12 in. and adding supplemental heads (e.g., side-mount, near-side mount).

Benefit-Cost

» Implementation of this treatment can reduce crashes by 3-7% (WSDOT).

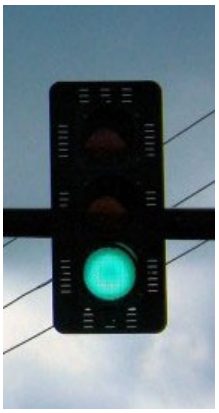
» 10 years of expected life

» Estimated $40,000 per intersection

» Cost varies based on size/number of signal heads.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION

S3. Improve Signal Timing (coordination, phasing, clearance intervals)

EXISTING CONDITION

Effective at locations that have a crash history at multiple signalized intersections. Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations. This treatment addresses all types of crashes that occur on the approaches / influence area of the new signal timing. For projects coordination signals along a corridor, the crashes related to side-street movements should not be applied.

Benefit-Cost

» Implementation of this treatment reduces all crashes by 16%, and particularly angle crashes by 32% (WSDOT).

» 10 years of expected life

» Estimated $1,000 per intersection

» Cost variation based on number of signal heads and number of movements.

IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

S4. Install Left-turn Lane and Add Turn Phase

EXISTING CONDITION

Installed at signalized intersections that have a significant crash problem and the only alternative is to change the nature of the intersection itself. This treatment addresses all type of crashes and the measure can be very effective at intersection with complex geometry and intersection with frequent left-turn movements. A properly timed protected left-turn phase can also help reduce rear-end, broadside, and sideswipe crashes between left-turning vehicles and the through vehicles as well as vehicles behind them. This countermeasure only applies to crashes occurring on the approaches / influence area of the new left turn phases.

Benefit-Cost

» Implementation of this treatment reduces all crashes by 35% and head on crashes by 69% (WSDOT).

» 20 years of expected life

» Estimated $12,000 per intersection

» If the existing traffic signal only requires a minor modification to allow for a protected left-turnphase, then the cost would also be low (installation is short because no actual construction). In-house signal maintainers can perform this operation once the proper signal phasing is determined so the cost is low.

IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

S5. Pavement Marking and RPMs through Intersection

Raised Pavement Markers (RPMs) and pavement marking installed in intersections where the lane designations are not clearly visible to approaching motorists. Can also be applied at intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection.

Benefit-Cost

» Implementation of this treatment reduces run off road, opposite direction and night crashes by 21% (WSDOT).

» 10 years of expected life

» Estimated $2,000 per installation

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

S6. Improve Pavement Friction (High Friction Surface Treatment

Improvement for signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance. In addition, treatment also addresses night crashes all other crashes. This treatment does not apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.

Benefit-Cost

» Implementation of this treatment reduces crashes by 40% (WSDOT).

» 10 years of expected life

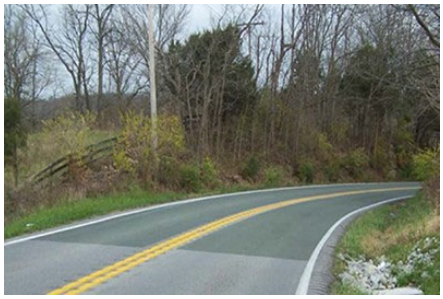
» Estimated $5,000 per intersection for materials and equipment

» Cost variation based on size of intersection and material (Estimated $30/sq.yd.).

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION



S7. Add Median Openings to Allow or Restrict Left-turns and U-turns

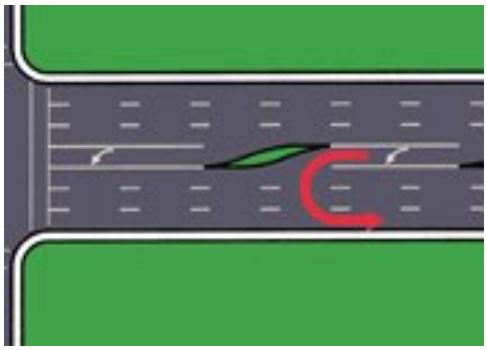
Install medians to reduce crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. This treatment only applies to crashes occurring in the intersection/influence area of the new directional openings.

EXISTING CONDITION

Benefit-Cost

- Implementation of this treatment reduces crashes by 51% (WSDOT).
- 20 years of expected life
- Estimated $75,000 per installation
- The cost of this strategy will depend on the treatment.

IMPLEMENTATION



Sources: CA-Local Roadway Safety Manual

S8. Install Right-turn Lane

Setting up right-turn lane may be appropriate in situations where there are an unusually high number of rear-end collisions on a single major road approach. The need for right turn lanes should be assessed on an individual approach basis. It is also important to ensure that the right-turn lanes are of sufficient length to allow vehicles to decelerate and "queue up" before turning, ideally without affecting the flow of through traffic. This treatment addresses read-end crashes. When considering new right-turn lanes, potential impacts to non-motorized user should be considered and mitigated as appropriate.

EXISTING CONDITION

Benefit-Cost

- Implementation of this treatment reduces crashes by up to 8% for all crashes and 17% for fatal/injury crashes (WSDOT).
- 20 years of expected life
- Estimated $300,000 per right turn lane
- Installing right turn lanes require substantial time for development and construction that canvary the cost.

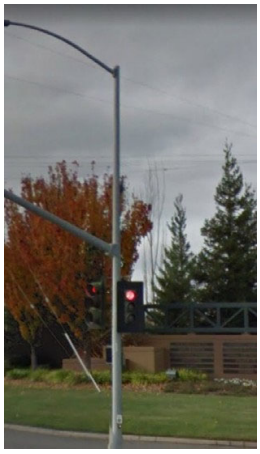
IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

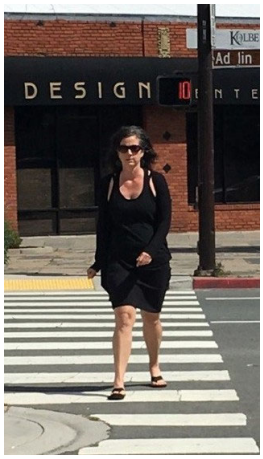
S9. Install Pedestrian Countdown Signal Heads

Install at signals that have signalized pedestrian crossing with WALK / DON'T WALK indications and where there have been pedestrian-vehicle crashes. The countermeasure addresses both pedestrian and bicycle collisions. This countermeasure only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the newcountdown heads.

EXISTING CONDITION



IMPLEMENTATION



Benefit-Cost

- Implementation of this treatment reduces pedestrian crashes by 70% (WSDOT).
- 20 years of expected life
- Estimated $1,500 per signal head (does not include push button or pole cost)
- Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. This countermeasure can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek stateor federal funding.

Sources: CA-Local Roadway Safety Manual

S10. Flashing Yellow Arrow Left Turn Signal

Flashing yellow arrow (FYA) traffic signals feature a flashing yellow arrow in addition to the standard red, yellow, and green arrows. When illuminated, the flashing yellow arrow allows waiting motorists to make a left-hand turn after yielding to oncoming traffic.

A national study demonstrated that drivers found flashing yellow left-turn arrows more understandable than traditional yield-on-green indications (green ball). Flashing yellow arrow treatment at signalized intersections can reduce the likelihood of left-turn crashes during permissive left-turn phasing. They can be used in either permissive-only or protected-permissive left-turn phasing schemes.

EXISTING CONDITION

IMPLEMENTATION

Benefit-Cost

- Implementation of this treatment reduces left turn crashes by 19% (WSDOT).
- 10 years of expected life
- Estimated $200,000 per intersection (assuming 4 new installations)
- Depending on the existing signal heads, signal controller, and signal cabinet, this treatment may require a controller replacement, which would increase the cost of installation.

Sources: FHWA, NACTO, Minnesota DOT

S11. Leading Pedestrian Interval

A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter the crosswalk at an intersection 3-7 seconds before vehicles are given a green indication. Using this "head start," pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn right or left.

LPIs provide increased visibility of crossing pedestrians and increased likelihood of motorists yielding to pedestrians. This results in reduced conflicts between vehicles and pedestrians, improving intersection safety. LPI is particularly useful at signalized intersections with a high volume of turning movements.

Benefit-Cost

» Implementation of this treatment reduces pedestrian-vehicle crashes by 13-48% (FHWA, WSDOT, City of Seattle).

» 10-20 years of expected life

» Estimated $200-10,000 (based on whether existing controller can accommodate the change)

Sources: FHWA, City of Seattle, WSDOT

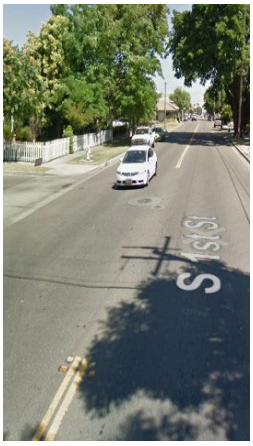
IMPLEMENTATION

Countermeasures for Non-Signalized Intersections

NS1. Add Intersection Lighting

Effective at unsignalized intersections that have a disproportionate number of nighttime crashes and do not currently have lighting. This treatment improves the safety of the intersection during nighttime by making drivers more aware of the surroundings at the intersection, enhancing driver'savailable sight distances and improving the visibility of non- motorists. This countermeasure only applies to nightcrashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.

EXISTING CONDITION



IMPLEMENTATION

Benefit-Cost

- Implementation of this treatment reduces nighttime injury crashes by 38% and nighttime pedestrian crashes by 42% (WSDOT).
- 20 years of expected life
- Estimated $8,000 per intersection
- Cost variation based on cost for lighting installation and an ongoing maintenance and powercost.

Sources: CA-Local Roadway Safety Manual

NS2. Convert to All-way Stop Control

Applicable at unsignalized intersection locations (currently with two-way stop control or two-way yield control) with a crash history and have no controls on the major roadway approaches. The all-way stop control is suitable only at intersections with moderate and relatively balanced volume levels on the intersection approaches. This treatment addresses to all type of crashes and only applies to crashes occurring in the intersection and /or influence area ofthe new control. All-way stop warrant should be considered.

EXISTING CONDITION

IMPLEMENTATION

Benefit-Cost

- Implementation of this treatment reduces crashes by 18-75% (ODOT).
- 10 years of expected life.
- Estimated $5,000 per intersection.
- Cost variation based on numbers of locations.

Sources: CA-Local Roadway Safety Manual

NS3. Install Roundabout

Effective at intersections that have a high frequency of right-angle and left-turn type crashes, primarily at unsignalized intersections with moderate-volumes. This countermeasure only applies to crashes occurring inthe intersection and/or influence area of the new control and is not eligible for use at existing all-waystop intersections.

Benefit-Cost

» Implementation of this treatment at 2-way stop controlled intersection reduces crashes by 25% and fatal/injury crashes by 35% (WSDOT).

» 20 years of expected life.

» Estimated $750,000 per intersection.

» Cost variation based on the environmental process, right-of-way acquisition and implementationunder an agency's long-term capital improvement program.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

NS4. Implement Unsignalized Intersection Signing and Marking Improvements

Target unsignalized intersections with patterns of rear-end, right- angle, or turning collisions related to lack of driver awareness of the presence of the intersection. The set of low-cost countermeasures is designed to increase drivers' alertness to the presence of the intersection and reduce potential conflicts with other entering vehicles. These treatments can include advanced intersection warning signs, oversized signs, doubled-up signs, stop ahead signs or painted on side street to supplement STOP sign.

Benefit-Cost

» Implementation of this treatment reduces crashes by 25% (WSDOT).

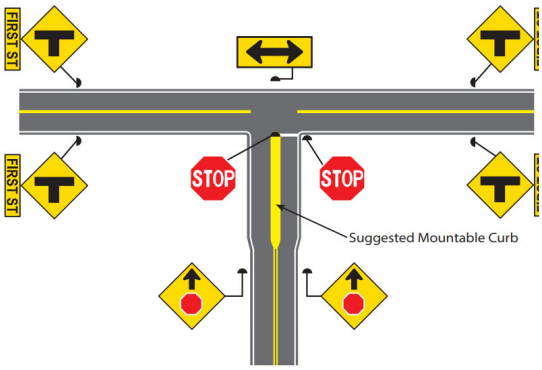
» 10 years of expected life.

» Estimated $700 per intersection.

» Cost variation based on the number of signs.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION



NS5. Install Transverse Rumble Strips

Transverse rumble strips are installed in the travel lane for providing an auditory and tactile sensation for each motorist approaching the intersection. They can be used at any stop or yield approachintersection, often in combination with advance signing to warn of the intersection ahead. This countermeasure applies to all crashes occurring on the approach / influence area of the new rumble strips.

Benefit-Cost

- Implementation of this treatment reduces all crashes by up to 6% and fatal/injury crashes by 7% (WSDOT).
- 10 years of expected life.
- Estimated $5,000 per intersection.
- Cost variation based on the length of the rumble strips.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

NS6. Install Raised Median

Used at Intersections noted as having turning movement crashes near the intersection as a result of insufficient access control. Application of this countermeasure should be based on current crash data and a clearly defined need to restrict or accommodate the movement. Angle crashes are addressed through this countermeasure. When agencies opt to install landscaping in conjunction with new raised medians, these locations must be excluded from their federally funded HSIP application scope. This countermeasure only applies to crashes occurring on the approaches / influence area of the new raised median.

Benefit-Cost

- Implementation of this treatment reduces all crashes by up to 39% and fatal/injury crashes by 44% (WSDOT).
- 20 years of expected life.
- Estimated $200,000+ (depends on length, right-of-way, and surface treatment).
- Cost variation based on the size of the new median.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

NS7. Install Right-turn Lane

Applicable when many collisions at unsignalized intersections are related to right-turn maneuvers. This countermeasure provides exclusive right-turn lanes, particularly on high-volume and high-speed major-roadapproaches to minimizing the collisions and applies to crashes occurring on the approaches / influence area of the new right-turn lanes.

Benefit-Cost

» Implementation of this treatment reduces all crashes by up to 8% and fatal/injury crashes by 17% (WSDOT).

» 20 years of expected life.

» Estimated $200,000 per intersection.

» Cost variation based on how wide the new right lane.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

NS8. Install Enhanced Pedestrian Crossing wish Advanced Features

Applicable at non-signalized intersections without a marked crossing, where pedestrians are known to cross, that involve significant vehicular traffic. They are important at school crossings and intersections with right and/or left turns pockets. Rectangular rapid flashing beacons (RRFBs), overhead flashing beacons, curb extensions, advanced stop or yield lines and other safety features should be added to complement the standard crossing elements. This countermeasure reduced pedestrian crashes occurring in the crossing (influence area) with the new enhanced safety features.

Benefit-Cost:

» Implementation of this treatment reduces pedestrian crashes by 40% (WSDOT).

» 20 years of expected life

» Estimated $ 50,000 per intersection

» Cost variation based on the length of the pedestrian crossing and the amount of safety signs.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION

NS9. Install Pedestrian Crossing (signs and markings only)

Applicable when many collisions at unsignalized intersections are related to left-turn maneuvers. This countermeasure provides exclusive left-turn lanes, particularly on high-volume and high-speed major-road approaches to minimizing the collisions. This countermeasure applies to crashes occurring on the approaches /influence area of the new left- turn lanes, but is not eligible for use at existing all-way stop intersections.

Benefit-Cost

- Implementation of this treatment reduces pedestrian crashes by 40% (WSDOT).
- 20 years of expected life
- Estimated $200,000 per intersection
- Cost variation based on how wide the new left lane.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

Countermeasures for Roadway Segments

R1. Add Segment Lighting

Applied to night-time crashes. In particular, patterns of rear-end, right-angle, turning or roadway departure collisions on the roadways may indicate that night-time drivers can be unaware of the roadway characteristics. This treatment addresses only to all night type crashes.

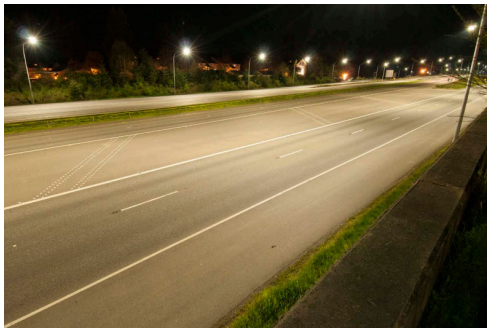
Benefit-Cost

- Implementation of this treatment reduces injury crashes by 28% (HSM).
- 20 years of estimated life
- Estimated $8,000 per installation
- Cost variation depending if lighting connected to signal box.

Sources: CA-Local Roadway Safety Manual, Highway Safety Manual

EXISTING CONDITION

IMPLEMENTATION



R2. Remove or Relocate Fixed Objects

Applicable to known locations or roadway segments prone to collisions with fixed objects such as utility poles, drainage structures, trees, and other fixed objects, such as the outside of a curve, end of lane drops, and in traffic islands. This treatment addresses fixed object crashes that occur within the current clear zone.

Benefit-Cost

- Implementation on this treatment reduces run off road crashes by 38% (WSDOT).
- 20 years of expected life
- Varies. Up to estimated $50,000 per deployment
- Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

R3. Install Guardrail

Guardrail is installed to reduce the severity of lane departure crashes. This treatment addresses fixed object and run-off road crashes. Its value in reducing collisions should only be applied to locations where past crash data or engineering judgement suggests the guardrail may result in a few or less severe crashes because the guardrail itself is a fixed object.

Benefit-Cost

- Implementation on this treatment reduces run off road crashes by 7-34% (ODOT).
- 20 years of expected life
- Estimated $50,000 per installation

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

R4. Install Roadside Impact Attenuators

Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. This treatment addresses fixed object and run-off road that occur with the limits of the new attenuators. This countermeasure and corresponding collision reduction benefits should only be applied to locations where past crash data or engineering judgement applied to existing conditions suggests the upgraded attenuators may result in a few or less severe crashes.

Benefit-Cost

- Implementation of this treatment reduces crashes by 25%.
- 10 years of expected life
- Estimated $5,000 for steel railing, $2,500 for traffic barrels
- Costs depending on the scope of the project, type(s) used, and associated ongoing maintenance costs.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION

IMPLEMENTATION

R5. Add 2 ft Paved Shoulder

Installed in roadways that have a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. The probability of a safe recovery is increased if an errant vehicle is provided with an increased paved area in which to initiate such a recovery. This type of countermeasure addresses Fixed object, Run-off Road, and Sideswipe collisions.

Benefit-Cost

- Implementation on this treatment reduces crashes by 5-13% (ODOT).
- 20 years of expected life.
- Estimated $150,000 (cost depends on need for right-of-way or if roadside modification isneeded).
- Shoulder widening costs would depend on whether new right-of-way is required and whether extensive roadside modification is needed. Since shoulder widening can be a relatively expensive treatment, one of the keys to creating a cost-effective project with at least a medium B/C ratio is targeting higher-hazard roadways.

EXISTING CONDITION

IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

R6. Add Unpaved Shoulder

Appropriate to roadways with a frequent incidence of vehicles leaving the travel lane resulting inan unsuccessful attempt to reenter the roadway. This countermeasure addressed all types of crashes. Unless shoulder widening requires additional right-of-way and environmental impacts, these treatments can be implemented in a relatively short timeframe. This countermeasure only applies to crashes occurring within the limits of the new shoulder.

Benefit-Cost

- Implementation on this treatment reduces crashes by 3-6% (ODOT).
- 20 years of expected life
- Estimated $50,000 (varies)
- The cost of adding a navigable non-paved shoulder would depend whether extensive roadside modification and shoulder stabilization are required.

IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

R7. Install Chevron Signs on Horizontal Curves

IMPLEMENTATION

Set up on roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. Ideally this type of safety countermeasure would be combined with other sign evaluations and upgrades (install warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards). This treatment can address all types of crashes; but, specifically, run-offroad crashes occurring near curves. This treatment only applies to crashes occurring within the influence area of the new signs (i.e. only through the curve).

Benefit-Cost:

- Implementation of this treatment reduces crashes by 64% (WSDOT).
- 10 years of expected life.
- Estimated $1,000 per curve
- Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low-cost improvements are usually funded through localfunding by local maintenance crews. However, this treatment can be effectively and efficientlyimplemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

Sources: CA-Local Roadway Safety Manual

R8. Add Speed Feedback Signs

IMPLEMENTATION

This type of treatment addresses all crashes caused by motorist traveling too fast, including horizontal curves. Before choosing this treatment, the agency needs to confirm the ability to provide power to the site (solar may be an option).

Benefit-Cost

- Implementation on this treatment reduces crashes by 46% (WSDOT).
- 10 years of expected life
- Estimated $20,000-100,000
- Cost varies by type of implementation.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION

R9. Install Edge Line and Centerline Pavement Marking

Applicable on any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment. This treatment addresses all types, specifically impacts head-on and run-off road crashes. It only applies to crashes occurring within the limits of the new centerlines and/or edge lines. The treatment is not intended to be used for general maintenance activities (i.e. the replacement of existing striping) and must include upgraded safety features over the existing striping. For two lane roadways allowing passing, a striping audit must be done to ensure the passing limits meeting the MUTCD standards. Both the centerline and edge lines are expected to be upgraded.

Benefit-Cost

» Implementation on this treatment reduces run off road, opposite direction and nighttime crashes by 21% (WSDOT).

» 10 years of expected life

» Estimated $4,000 (depends on number and length of segment, as well as striping material)

» Costs for implementing this strategy are nominal and depend on the number and length of segment as well as the striping material (paint, thermoplastic, etc.). This countermeasure can be effectively implemented using a systemic approach with numerous and long locations.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION

R10. Install No Passing Zone

Installed on roadways that have a high percentage of head-on crashes suggesting that many head-on crashes may relate to failed passing maneuvers. No Passing Zones should be installed where drivers' "passing sight distance" is not available due to horizontal or vertical obstructions. This treatmentaddresses all types of crashes that occur when drivers cannot differentiate the centerline markings between passing and no-passing area. This treatment only applies to crashes occurring within the limits of the new or extended no-passing zones.

Benefit-Cost

» Implementation of this treatment reduces crashes by 45%.

» 10 years of expected life

» Estimated $2,000 (varies)

» When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This treatment can be effectivelyand efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federalfunding.

R11. Install Centerline Rumble Strips/Stripes

IMPLEMENTATION

Center Line rumble strips/stripes should be used on segments with a history of head-on crashes. This treatment addresses head-on and opposite-direction side-swipe crashes by alerting drivers who travel into the oncoming travel lane.

Benefit-Cost

- Implementation of this treatment reduces crashes by 20%.
- 10 years of expected life
- Estimated $3,000 per mile
- Costs for implementing this strategy are nominal and depend on the number and length oflocations.

Sources: CA-Local Roadway Safety Manual

R12. Install Edge Line Rumble Strips/Stripes

IMPLEMENTATION

Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes. This treatment addresses run-off road crashes by providing an auditory and tactile warning when driven on, alerting drivers drifting outside their travel lanes.

Benefit-Cost

- Implementation of this treatment reduces opposite direction crashes by 40% and fatal/injury crashes by 8%.
- 10 years of expected life
- Estimated $3,000 per mile
- Costs for implementing this strategy are nominal and depend on the number and length oflocations.

Sources: CA-Local Roadway Safety Manual

R13. Rail Crossing Treatments

IMPLEMENTATION

Four Quadrant Gates extend across all roadway lanes on both the approach and the departure side of the crossing. Unlike two-quadrant gate systems, four-quadrant gates provide additional visual constraints and inhibit most traffic movements over the crossing after the gates have been lowered. Safe guards are put in place to ensure vehicles are not trapped on the tracks.

Four Quadrant Gate

Wayside Horns can be used as an adjunct to train-activated crossing warning systems to provide audible warning of an approaching train for traffic on each approach to the highway-rail crossing. A wayside horn system consists of a horn or series of horns located at a public highway-rail crossing and directed at oncoming motorists. The wayside horn system simulates a train horn and sounds at a minimum of 15 seconds prior to the train's arrival at the highway-rail crossing, until the lead locomotive has traversed the crossing. It is typically used at locations where the train horn is not sounded.

Wayside Horn

Benefit-Cost

- Quantified benefits unknown.
- 10 Years of expected life
- Estimated $700,000 for four quadrant gate system
- Estimated $500,000 for wayside horn system

Sources: FHWA, FRA

R14. No Passing Zone Signs

IMPLEMENTATION

A No Passing Zone, indicated by a solid yellow line on the left side of the driver's direction of travel, indicates a zone through which sight distance is restricted or where other conditions make overtaking and passing inappropriate. No Passing Zones are regulatory and legally enforceable.

In situations where head-on collision history is observed, a NO PASSING ZONE pennant can provide additional information to drivers at the beginning of the No Passing Zone, discouraging passing maneuvers. The NO PASSING ZONE sign is installed on the left side of the roadway.

Additionally, DO NOT PASS signs can be added as a supplement to No Passing Zone pavement markings to emphasize the restriction on passing. It can be installed at the beginning of, and at intervals within, the No Passing Zone.

Benefit-Cost

- Quantified benefits unknown.
- 10 Years of expected life
- Estimated $200 per sign

Sources: FHWA

Figure Links

S1a https://www.aaroads.com/california/ca-238.html S1b https://www.aaroads.com/california/ca-262.html
S2a https://safety.fhwa.dot.gov/provencountermeasures/lighting.cfm
S2b http://wishtv.com/2016/02/16/new-traffic-signals-aim-to-reduce-crashes/
S3a http://www.k-state.edu/roundabouts/ada/news/USNews.htm
S3b https://parade.com/19072/marilynvossavant/what-would-traffic-light-synchronization-cost/
S4a https://www.fhwa.dot.gov/publications/research/safety/09036/index.cfm
S4b http://www.madriverunion.com/samoa-boulevard-traffic-light-system-changed-up/
S5a https://dohanews.co/qatars-civil-defense-junction-is-now-a-proper-intersection/
S5b http://www.gulf-times.com/story/461946/Ashghal-opens-signal-controlled-intersection-on-New-Rayyan-Road
S6a http://www.cochraneeagle.com/article/Cochrane-familes-celebrate-cultural-diversity-20170803
S6b https://rspcb.safety.fhwa.dot.gov/noteworthy/html/edccasestudy_ky.aspx
S7a https://bouldercolorado.gov/transportation/median-maintenance
S7b Unknown
S8a Google Streetview
S8b https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/through-bike-lanes/
S9a Google Streetview
S9b Google Streetview
S10 https://www.sacbee.com/news/local/article239121918.html
S11 https://safety.fhwa.dot.gov/provencountermeasures/lead_ped_int.cfm

NS1a Google Streetview
NS1b Google Streetview
NS2a Google Streetview
NS2b http://www.ite.org/uiig/types.asp
NS3a https://www.flickr.com/photos/repowers/2933707788/
NS3b Google Streetview
NS4a https://alchemistsdiary.wordpress.com/2017/07/22/
NS4b https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa09020/fhwasa09020.pdf
NS5a http://www.cleveland.com/berea/index.ssf/2012/11/berea_changes_stop_sign_parkin.html
NS5b https://radiobintangsembilan.com/2016/03/07/hindari-kecelakaan-anak-sekolah-warga-minta-garis-kejut/
NS6a http://www.jurist.org/hotline/2014/03/zachary-heiden-maine-panhandling.php
NS6b https://www.edmonton.ca/transportation/on_your_streets/neighbourhood-traffic-concerns.aspx
NS7a Google Streetview
NS7b https://ux.stackexchange.com/questions/42867/how-does-the-projection-angle-of-road-arrows-change-drivers-expectations-of-the
NS8a https://en.wikipedia.org/wiki/Uncontrolled_intersection
NS8b https://safety.fhwa.dot.gov/provencountermeasures/crosswalk-visibility.cfm
NS9a Google Streetview
NS9b https://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/major-street-crossing/

R1a https://www.shutterstock.com/nb/video/clip-9830723-4k-driving-car-on-highway-roadway-night
R1b https://www.wsdot.wa.gov/research/reports/fullreports/847.1.pdf
R2a Google Streetview
R2b Google Streetview
R3a Google Streetview
R3b https://www.reddit.com/r/funny/comments/4zcplq/a_local_plumbers_truck_decal/
R4a Unknown
R4b http://lslee.com/attenuators/Impact-Attenuators
R5a Unknown
R5b https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11018/
R6b https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm

R7b https://safety.fhwa.dot.gov/provencountermeasures/enhanced_delineation.cfm
R8b https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm
R9b https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm
R10b https://www.shutterstock.com/nb/search/double+yellow+lines
R11b https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/bike_ig/
R12b https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/bike_ig/
R13a https://cms.cityoftacoma.org/PublicWorks/RR_Crossing/Dome_OldTown/Option4_S_C_St_Poster_1of2.pdf
R13b https://safety.fhwa.dot.gov/hsip/xings/com_roaduser/fhwasa18040/
R14a https://safety.fhwa.dot.gov/older_users/fhwasa15088/ch4.cfm
R14b https://driving-tests.org/road-signs/do-not-pass-sign/

Appendix B Grant Programs

Based on the projects included in the City Safety Plan, the City may be eligible to submit projects to the following grant programs.

WSDOT City Safety Program

WSDOT Local Programs sends out a call for projects each even-numbered year. This program's funding is for projects enhancing safety on city streets by reducing the severity of crashes and utilizing transportation engineering improvements and countermeasures.
https://wsdot.wa.gov/LocalPrograms/Traffic/CitySafetyProgram

WSDOT Pedestrian and Bicycle Program

WSDOT Active Transportation Program sends out a call for projects each even-numbered year. The Pedestrian and Bicycle Program objective is to improve the transportation system to enhance safety and mobility for people who choose to walk or bike.
https://wsdot.wa.gov/LocalPrograms/ATP/funding.htm

WSDOT Safe Routes to School Program

WSDOT sends out calls early in even numbered years for project awards in the following biennium. The purpose of the Safe Routes to Schools program is to improve safety and mobility for children by enabling and encouraging them to walk and bicycle to school. Funding from this program is for projects within two-miles of primary, middle and high schools (K-12).
https://wsdot.wa.gov/LocalPrograms/SafeRoutes/funding.htm

WSDOT Railway-Highway Crossings Program

Open call for projects depends on future federal funding and Washington State priorities. This program's funding is for projects enhancing safety at public grade crossings by reducing the severity of crashes and installing or upgrading protective mechanisms at railroad crossings.
https://wsdot.wa.gov/localprograms/traffic/railway-crossings-program

Transportation Improvement Board (TIB) Complete Streets

The Complete Streets Award is a funding opportunity for local governments that have an adopted complete streets ordinance. Board approved nominators may nominate an agency for showing practice of planning and building streets to accommodate all users, including pedestrians, access to transit, cyclists, and motorists of all ages and abilities.
http://www.tib.wa.gov/grants/grants.cfm?inav=3#other2

Surface Transportation Block Grant (STBG) - Urban

STBG – Urban is for jurisdictions above 5,000 population. The grant is approximately $6 million per year, with grant applications due in July and grant awards in September. Previous funded projects include bringing urban roads and intersections up to urban standards. Projects need to have a balance of capacity, safety, and economic development to get funding.
https://www.rtc.wa.gov/programs/tip/docs/tipcrit21.pdf

STBG - Rural

STBG – Rural is for smaller jurisdictions and rural areas awards approximately $1 million every other year (even-numbered years). Selection occurs with applications due in July and grant awards in September. Criteria are less stringent than urban, but support capacity, safety, and economic development. It has funded downtown improvements in smaller cities and for arterial preservation/safety on county road arterials that access cities.
https://www.rtc.wa.gov/programs/tip/call/

Congestion Mitigation and Air Quality (CMAQ) Improvement Program

This is available for projects that improve air quality. Available funding is approximately $3 million per year, with applications due in July and September grant awards. CAQ has the same criteria as STBG-Urban, but air quality points are tripled. Mostly funded projects are signalized intersections and transit-related projects.
https://www.rtc.wa.gov/programs/tip/call/

Transportation Alternatives (TA)

Approximately $1.3 million available every odd year (2023, 2025, etc.). Grant application due in April with grant awards in July. Criteria and process is outlined in https://www.rtc.wa.gov/programs/tap/docs/taGuidebook.pdf. Has funded pedestrian/bicycle improvements.

APPENDIX C: Collision Heat Maps

Following WSDOT's recommended procedure, the study team applied the most common attributes present in fatal/serious injury collisions to the entire network by mapping collisions based on those attributes.

Figures C1 through C5 show the locations of crashes with these attributes.

Figure C1 illustrates that roadway departure collisions are most common along E St (SR 14), Washougal River Rd, and S 32nd St.

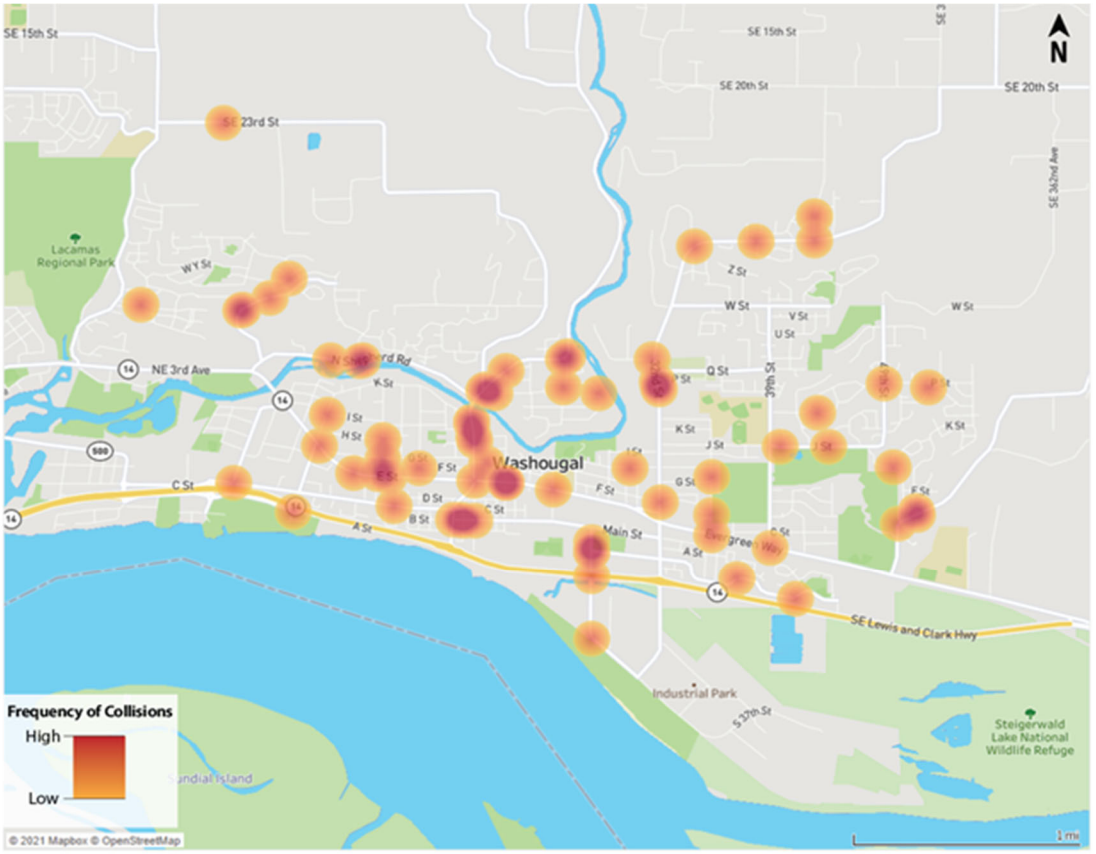


Figure C1. Roadway Departure Collisions, Washougal, 2016-2020.

Figure C2 shows some hot spots of at-intersection or intersection-related collisions at the following locations:

- E Street (SR 14) and Washougal River Road.
- Main Street and S 32nd Street.
- Main Street and Washougal River Road.
- Evergreen Way (SR 14) and S 32nd Street.

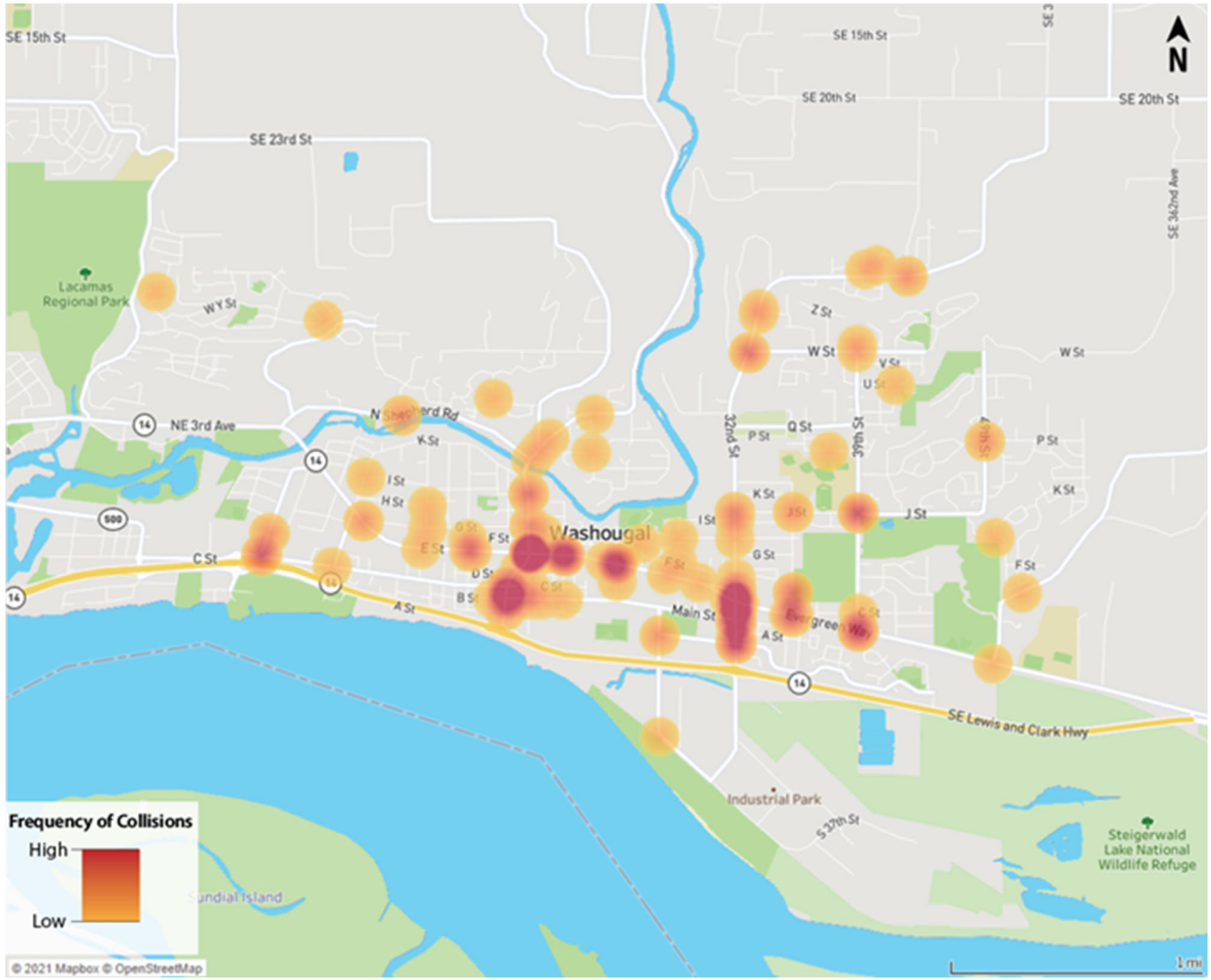


Figure C2. At Intersection or Intersection Related Collisions, Washougal, 2016-2020.

Figure C3 shows collisions occurring on wet roads along SR 14, Washougal River Rd, and S 32nd St.

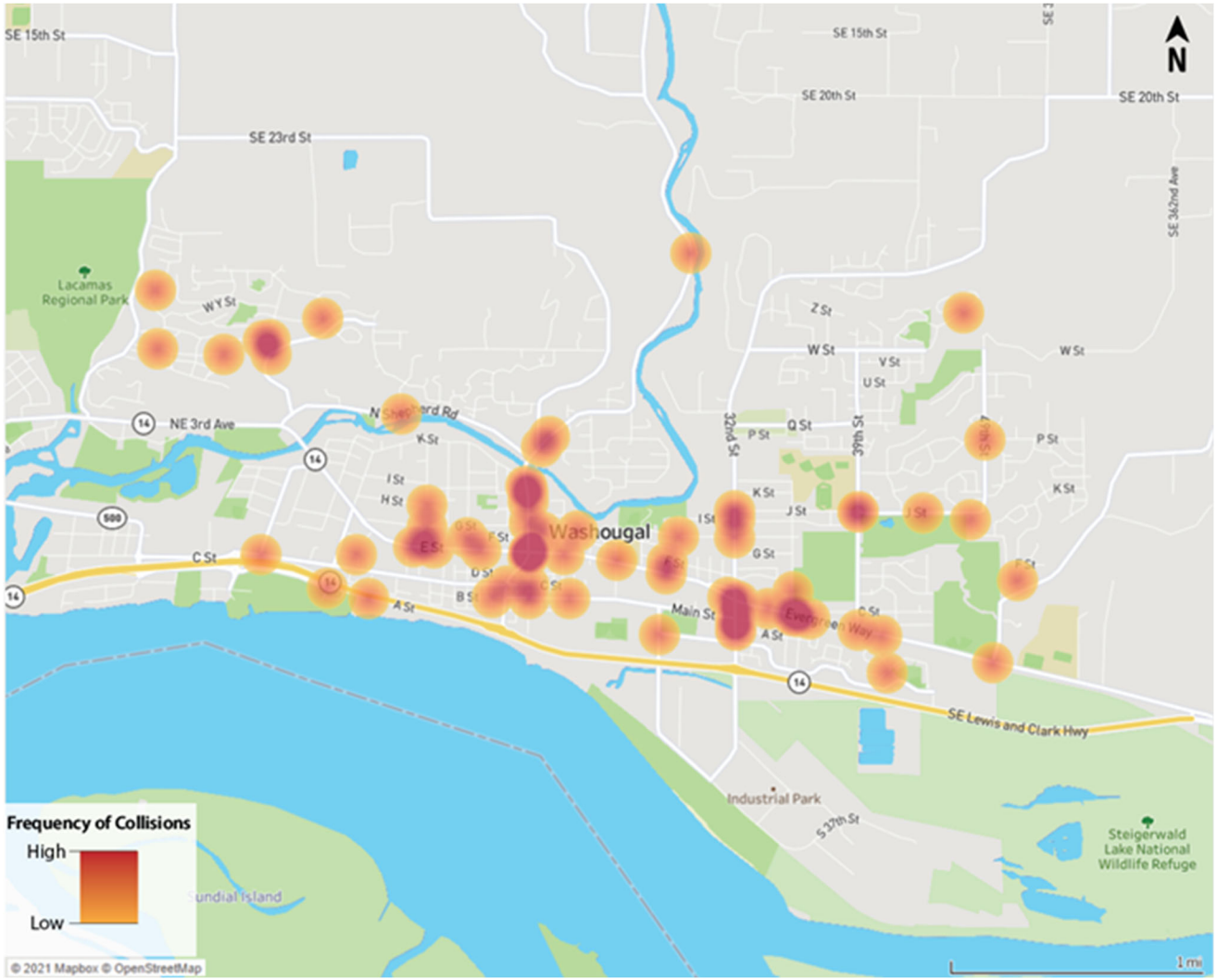


Figure C3. Collisions on Wet Roads, Washougal, 2016-2020.

Figure C4 presents the heat map of all the collisions that involved a pedestrian or bicyclist. The intersection of E St (SR 14) and Washougal River Rd have experienced more than one pedestrian-involved collisions.

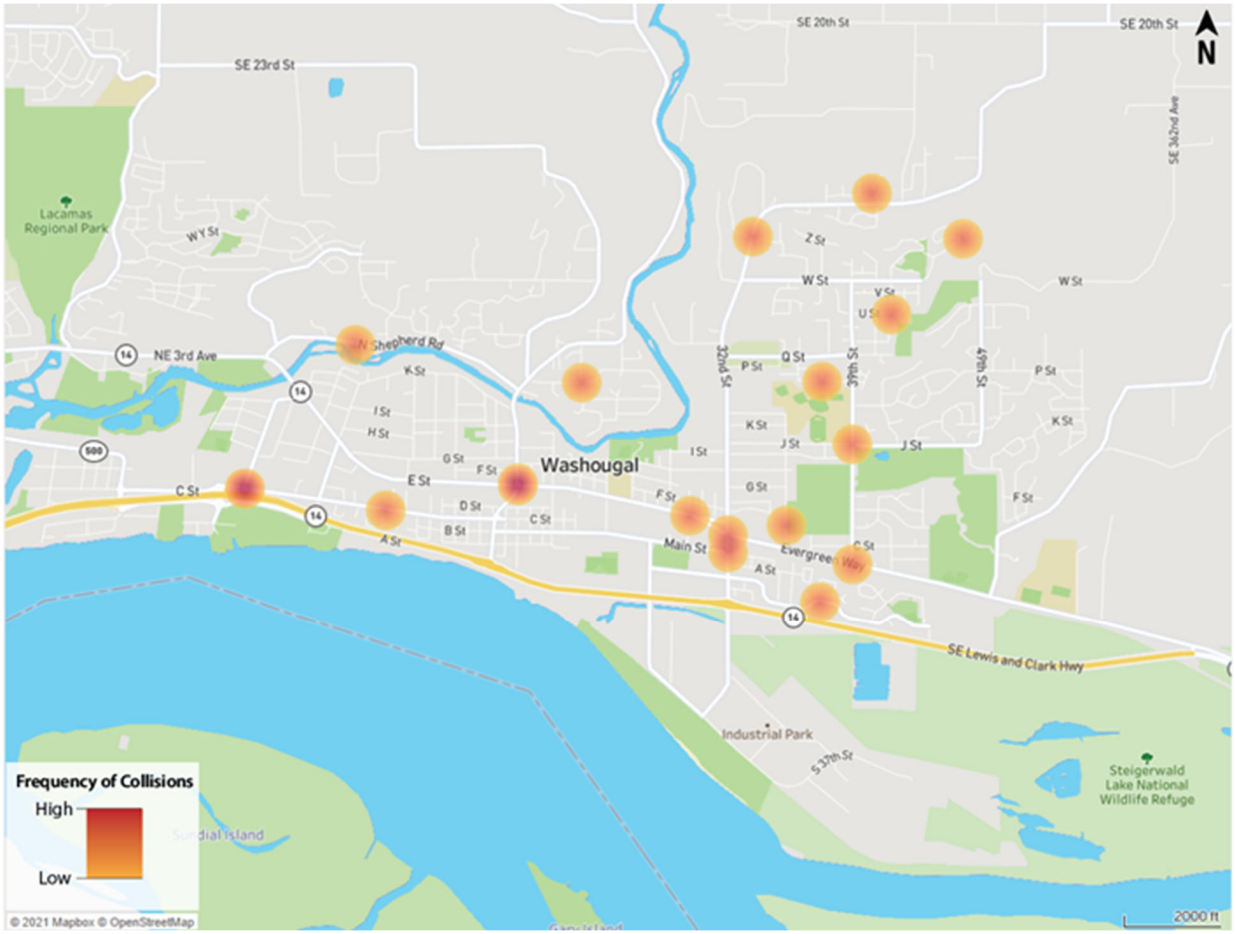


Figure C4. Collisions Involving Bicyclists or Pedestrians, Washougal, 2016-2020

There are several clusters of collisions that occurred due to distraction or inattention, as shows in Figure C5. Examples include intersection around and including E Street (SR 14) and Washougal River Road, as well as 32nd Street from Evergreen Way to Addy Street.

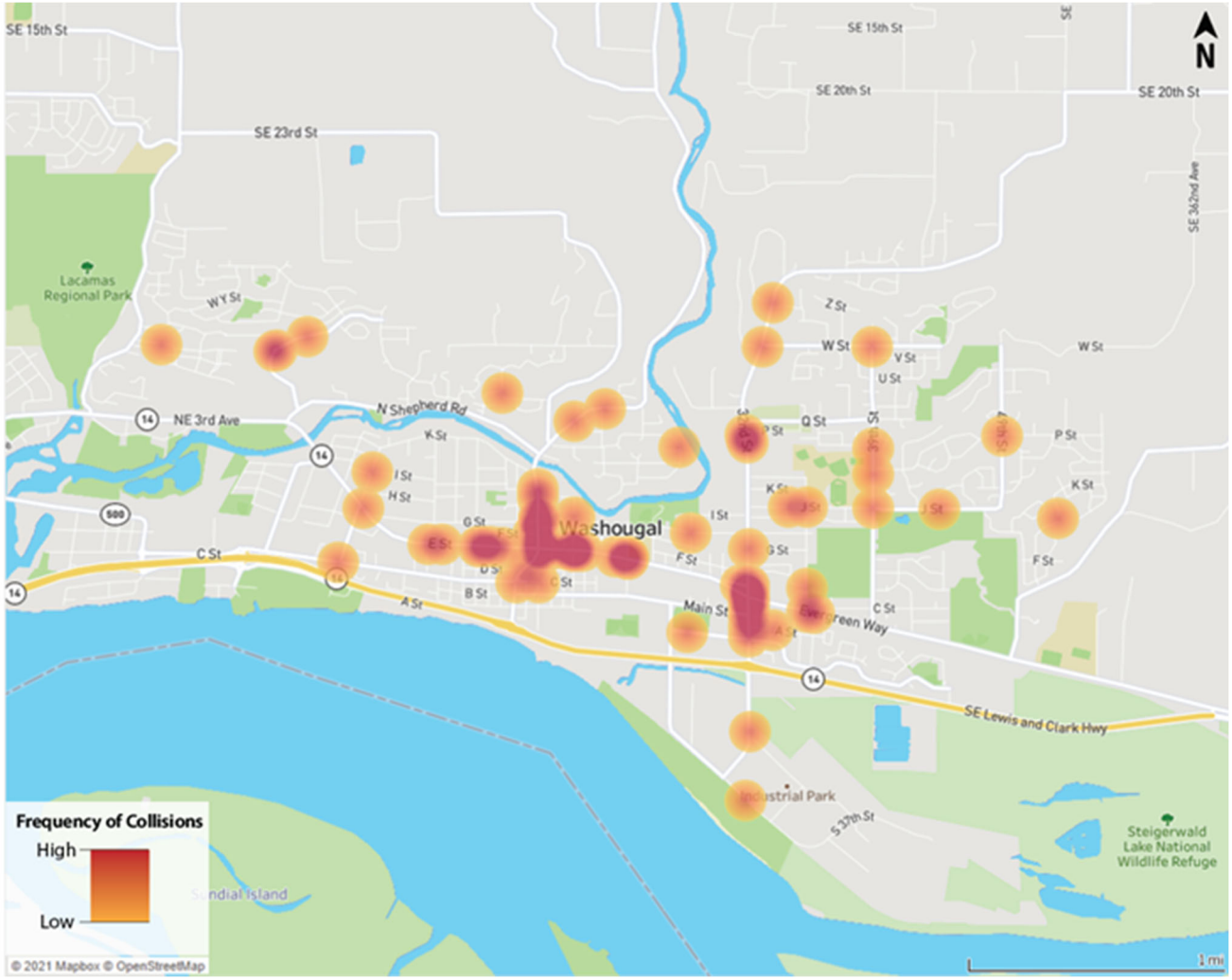


Figure C5. Distraction/Inattention Collisions, Washougal, 2016-2020.

Figure C6 shows that speeding related collisions are scattered throughout the city. Some areas of note include along 32nd Street, E Street (SR14), and 12th Street.

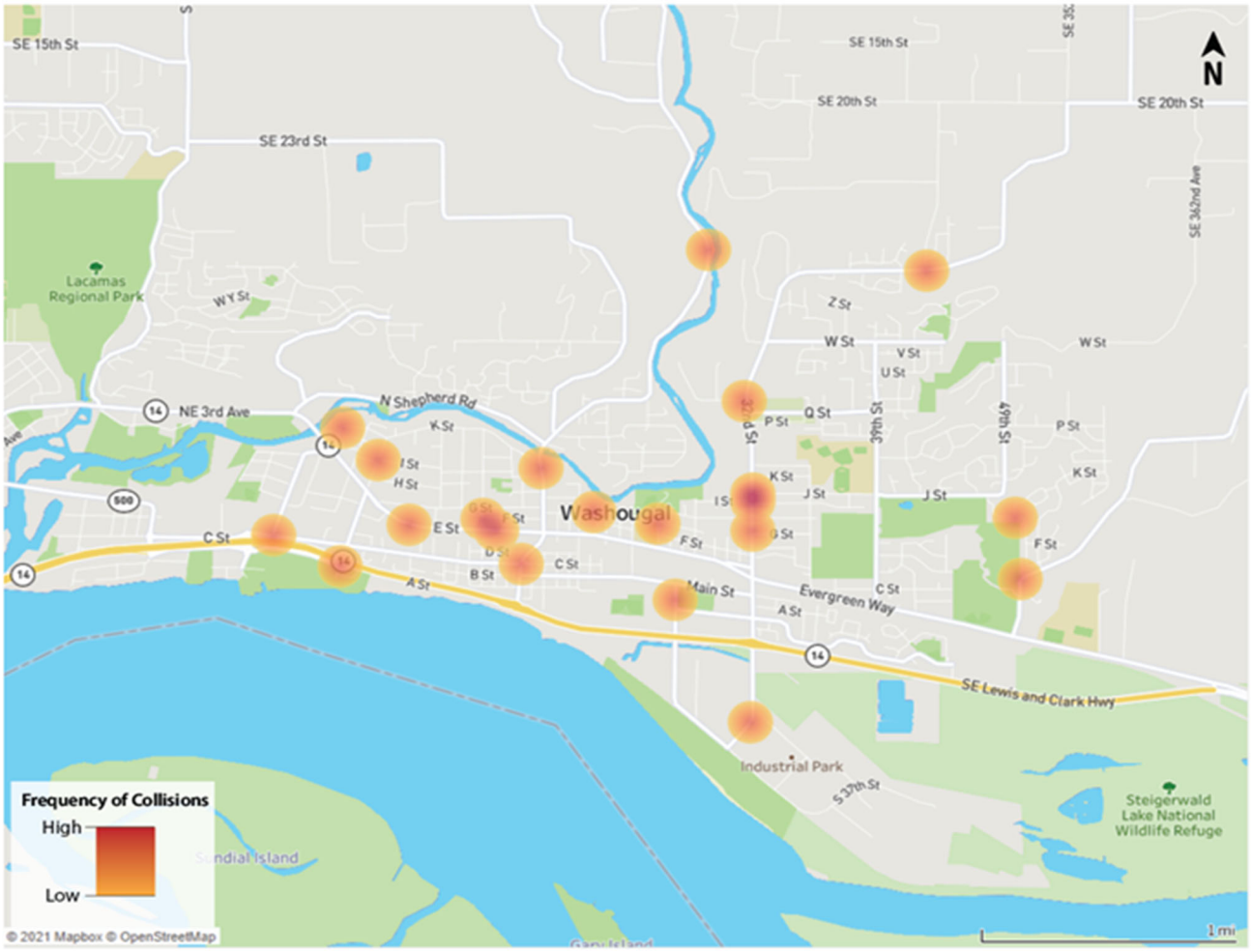


Figure C6. Speeding Related Collisions, Washougal, 2016-2020.