CITY SAFETY PLAN

FEBRUARY 2022

PREPARED FOR THE CITY OF BATTLE GROUND

PREPARED BY DKS ASSOCIATES

THE CITY OF Battle Ground WASHINGTON

Southwest Washington Regional Transportation Council

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Acknowledgements

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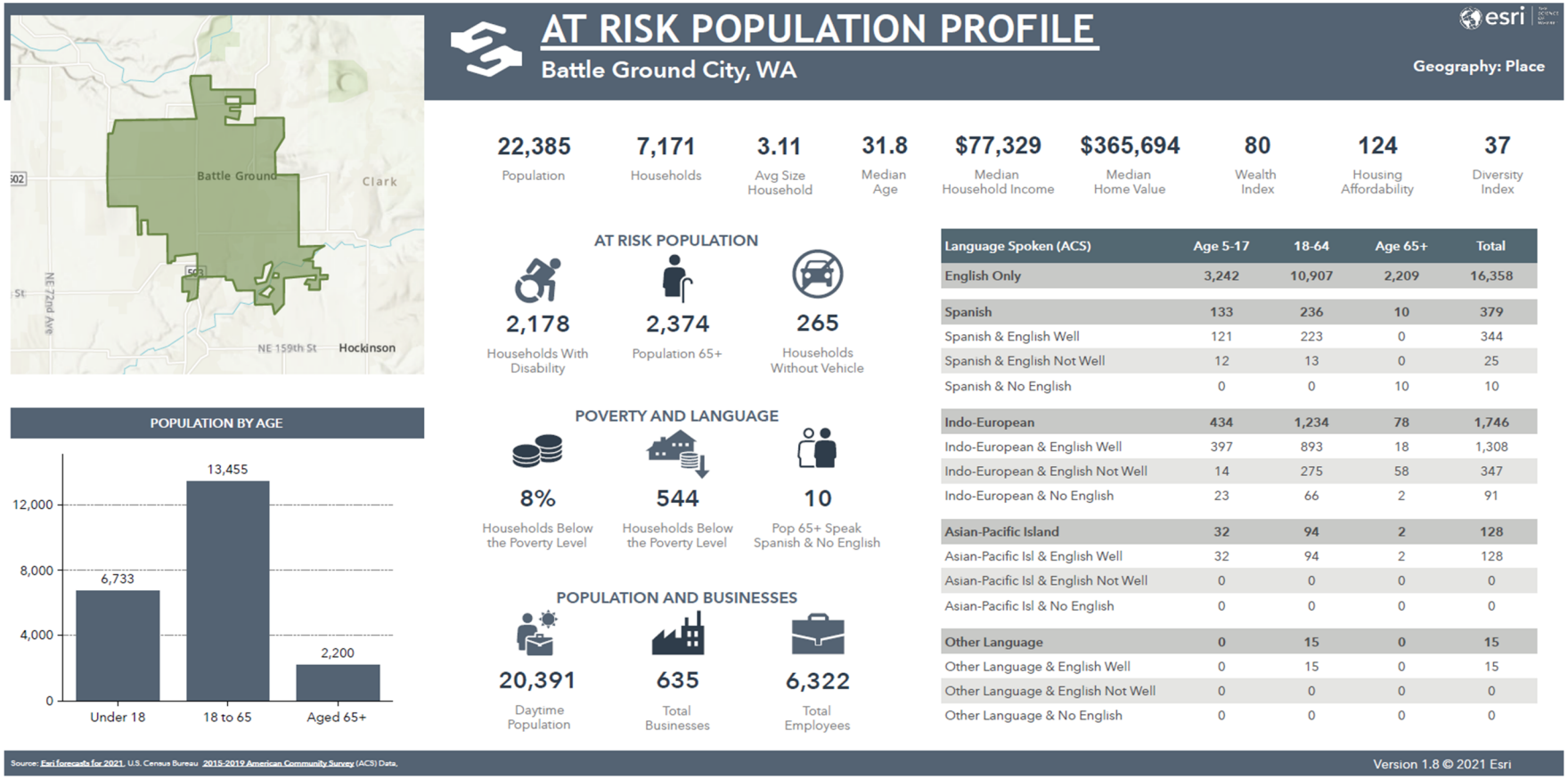
INTRODUCTION

The City of Battle Ground is located in the center of Clark County and is home to approximately 22,400 residents. The following 'At Risk Population Profile' provides key population and equity statistics based on 2021 data.[1]



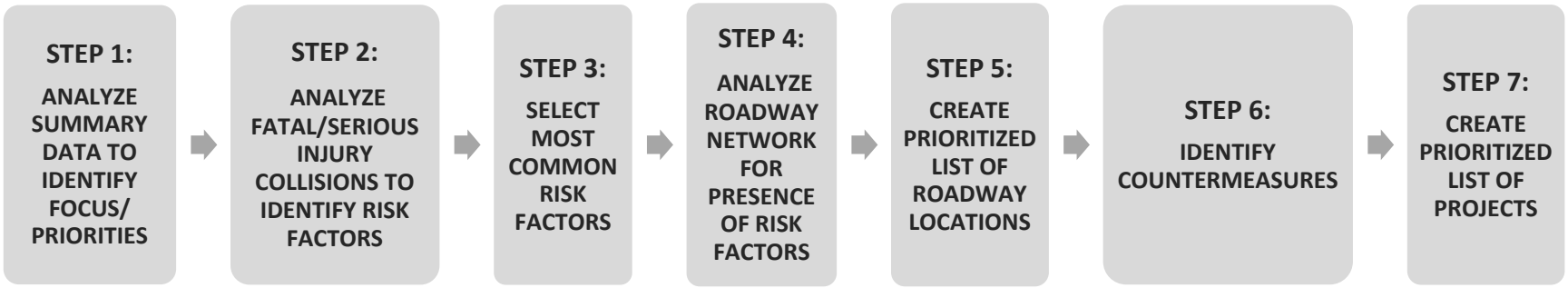
Language Spoken (ACS)	Age 5-17	18-64	Age 65+	Total
English Only	3,242	10,907	2,209	16,358
Spanish	133	236	10	379
Spanish & English Well	121	223	0	344
Spanish & English Not Well	12	13	0	25
Spanish & No English	0	0	10	10
Indo-European	434	1,234	78	1,746
Indo-European & English Well	397	893	18	1,308
Indo-European & English Not Well	14	275	58	347
Indo-European & No English	23	66	2	91
Asian-Pacific Island	32	94	2	128
Asian-Pacific Isl & English Well	32	94	2	128
Asian-Pacific Isl & English Not Well	0	0	0	0
Asian-Pacific Isl & No English	0	0	0	0
Other Language	0	15	0	15
Other Language & English Well	0	15	0	15
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 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 Battle Ground, 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

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 Battle Ground, Southwest Washington Regional Transportation Council (RTC), and WSDOT Transportation Data to acquire the following data sets.

- WSDOT database of all collisions on City of Battle Ground streets, Jan 2016 - Dec 2020 (provided by WSDOT Transportation Data)
- City of Battle Ground Citizen Feedback (provided by Mark Herceg, City of Battle Ground)

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.

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

DATA ANALYSIS OVERVIEW

As illustrated in Figure 1, over the past five years, there were a total of 13 fatal and serious injury collisions on city streets. During the five-year study period, there was one fatal collision that occurred on September 7th, 2020, around 9pm in dark, foggy conditions near the intersection of NE 196th St and NE 112th Ave. The driver departed the roadway, the vehicle overturned, and the driver was ejected.

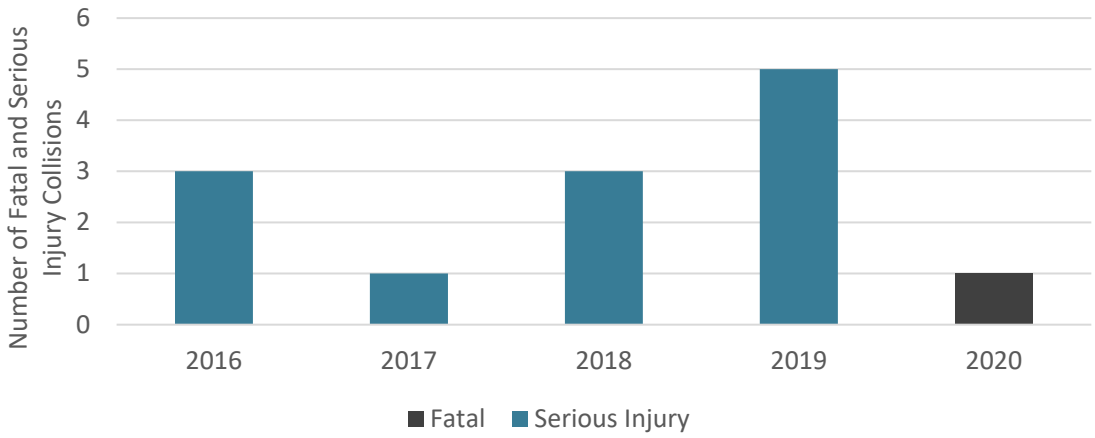


Figure 1. Fatal and Serious Injury Collisions in Battle Ground, 2016-2020.

The number of all reported collisions (regardless of severity) has ranged between 89 and 133, as shown in Figure 2. In the most recent year of data available, 2020, the city experienced 89 reported crashes (a 21% 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.

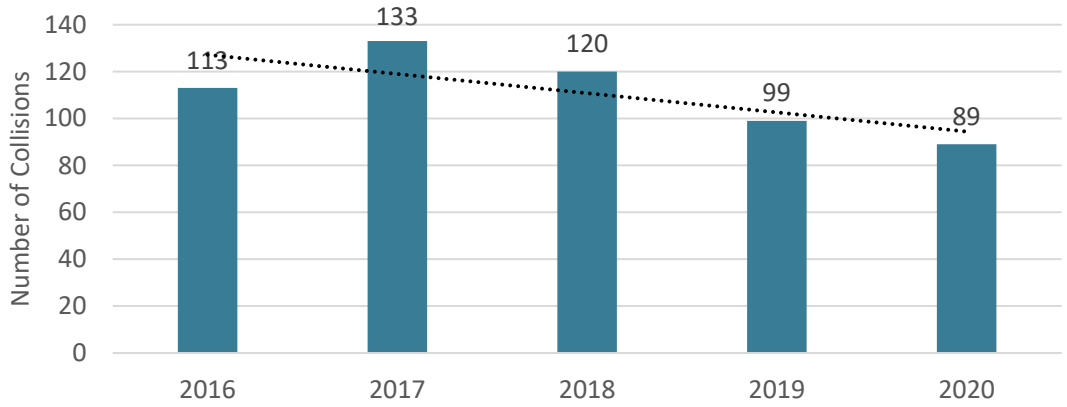


Figure 2. All Reported Collisions in Battle Ground, 2016-2020.

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 Battle Ground during the study period

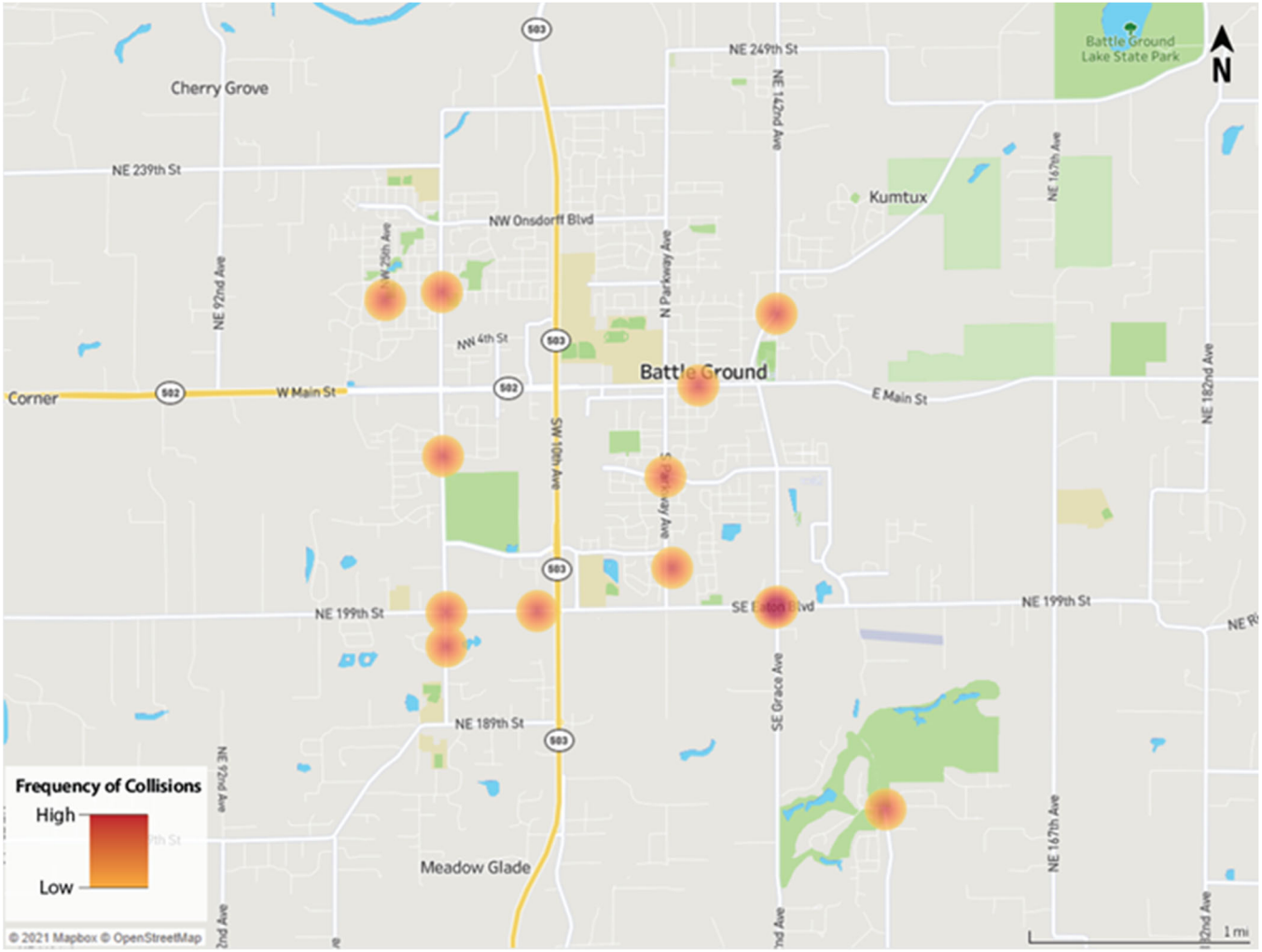


Figure 3. Heat Map of Fatal and Serious Injury Collisions in Battle Ground, 2016-2020.

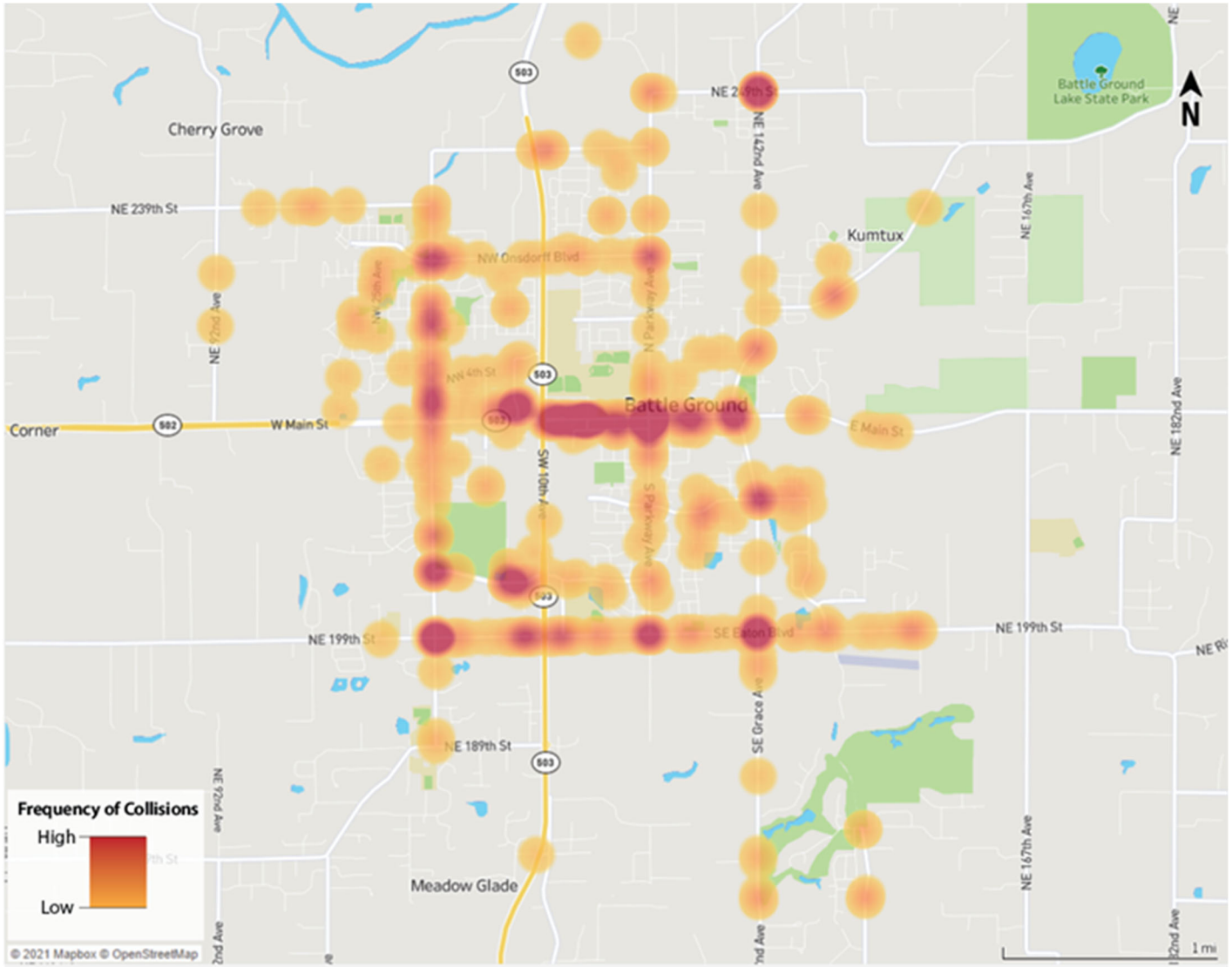


Figure 4. Heat Map of All Reported Collisions in Battle Ground, 2016-2020.

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 Battle Ground provided a history of transportation safety-related citizen requests made over the past few years. Of the two citizen requests and 107 survey responses reviewed, most focused on the following topics:

Pedestrian Safety

- Students walking to and from school, including safety on roads adjacent to the schools during drop-off and pick-up.
- Request for sidewalk infill along roads that currently do not have pedestrian facilities
- Request for new bike lanes on roads that currently do not have them and to fill gaps to connect existing bike routes.
- Request for enhanced pedestrian crossings.
- Request for improved pedestrian and bicycle facilities near schools, neighborhoods, and trails.-

High Vehicle Speeds

- Request for change to posted speed limit, speed humps, and speed limit enforcement.

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

Intersections:

- W Main Street & 10th Avenue
- W Main Street & 20th Avenue
- Main Street & Parkway Avenue
- SW Scotton Way & SW 13th Avenue
- E Main Street & Grace Avenue

Corridors:

- SW 20th Avenue
- Onsdorff Boulevard
- Main Street
- SW Scotton Way
- Grace Avenue
- N Parkway Avenue
- NE 10th Street

Sight Distance

- Visual restrictions due to on-premise vegetation near intersections.
- Request for improvements at intersections with limited sight distance.

Roundabouts

- Request for roundabouts to be implemented at the NE Onsdorff Blvd and NE 132nd Ave/N Parkway Ave intersection.

Geometry

- Request for road widening on narrow roads, especially those that allow parking on the sides of the road.
- Request to fix intersection geometry at NW 1st St and NW 12th Ave intersection where drivers are confused about right of way.
- Remove excess grocery store driveways near intersection approaches (W Main St and N Parkway Ave intersection).
- Request for turn lanes at specific intersections.
- Request to install signalized intersection at SW Scotton Way and SW 13th Ave intersection.
- Request for red-light cameras and enforcement for red light running.

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

The City studied each risk factor (collision attribute) to determine those most likely to contribute to future serious injury collisions in Battle Ground. Table 1 shows some of the most common attributes present in collisions that occur on City-owned streets. Collision attributes with a notably higher percentage of serious injury collisions versus all-severity collisions have an increased likelihood of contributing to serious injury crashes.

TABLE 1. COLLISION ATTRIBUTES, 2016-2020

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Battle Ground Collisions with this Attribute (1)	Percent of F&SI Battle Ground Collisions with this Attribute (2)
Citywide	*Any*	554	1	12		
Collision Type	Roadway Departure	108	1	3	19%	31%
	Head-On	5	0	1	1%	8%
	Entering at Angle	155	0	4	28%	31%
Contributing Circumstance (For at least one vehicle)	Exceeding Reasonable Safe Speed or Exceeding Stated Speed Limit	26	0	2	5%	15%
	Alcohol-Impaired (3)	30	0	1	5%	8%
	Drug-Impaired (3)	2	0	0	0%	0%
	Inattention / Distraction	170	1	4	31%	38%
Motor Type Involved	Motorcycle	6	0	1	1%	8%
	Heavy Vehicle	129	0	1	23%	8%

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Battle Ground Collisions with this Attribute (1)	Percent of F&SI Battle Ground Collisions with this Attribute (2)
Lighting Condition	Dark/Dusk/Dawn	59	1	4	11%	38%
Intersection	At Intersection or Intersection Related	302	1	9	55%	77%
	Signalized Intersection	72	0	1	13%	8%
	Unsignalized Intersection	230	0	6	42%	46%
Road User	Pedestrian Involved	16	0	3	3%	23%
	Cyclist Involved	14	0	1	3%	8%
Roadway Surface	Wet	172	0	2	31%	15%
	Ice	12	0	0	2%	0%
Age	Driver Age 16 to 25 Involved	303	0	7	55%	54%
	Driver Over Age 65 Involved	104	0	0	19%	0%
Restraint (Seat Belt) Usage	No Restraints Used	9	0	1	2%	8%

(1) For example, in Battle Ground 19% of all collisions involved roadway departure.
(2) For example, in Battle Ground 31% of all fatal and serious injury collisions involved roadway departure.
(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 (302 of 554; 55%) and the most common fatal and serious injury location type (10 of 13; 77%).
- Entering at Angle is the most common collision type (28% of all collisions, and 31% of fatal and serious injury collisions).
- Young drivers (age 16 to 25) were involved in more than half of all collisions (55%).

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. Dusk/Dark/Dawn Lighting Conditions
3. Wet Road Surface Conditions
4. Inattention/ Distraction
5. Vulnerable Users Involved [Pedestrians and Bicyclists]
6. Entering at Angle
7. At Intersection or Intersection Related

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 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 identify 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	Dusk/Dark/ Dawn Lighting	Wet Road Surface	Distracted/ Inattention	Ped/Bike	Entering at Angle	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
NE 199th St/SW Eaton Blvd and SW 20th Ave/ NE 112th Ave	✓	✓	✓	✓	-	✓	✓	✓	**7**
E Main St and NE Grace Ave	-	✓	✓	✓	✓	✓	✓	✓	**7**
W Main St and N Parkway Ave	✓	✓	✓	✓	-	✓	-	✓	**6**
NE 249th St and NE Dublin Rd	✓	✓	✓	✓	-	✓	-	-	**5**
NW 1st St and NW 12th Ave	✓	-	✓	✓	-	✓	-	✓	**5**
NW Onsdorff Blvd and NW 20th Ave	✓	-	✓	✓	-	✓	-	✓	**5**
NE 181st St and NE 152nd Ave	✓	✓	✓	✓	-	-	✓	-	**5**
W Main St and SW 3rd Ave	-	✓	✓	✓	✓	✓	-	-	**5**

Intersection	Roadway Departure	Dusk/Dark/ Dawn Lighting	Wet Road Surface	Distracted/ Inattention	Ped/Bike	Entering at Angle	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
W Main St and NW 5th Ave	-	✓	✓	✓	✓	✓	-	-	**5**
SW Scotton Way and SW 20th Ave	✓	-	✓	✓	-	✓	-	✓	**5**
SW Scotton Way and SW 13th Ave	✓	-	✓	✓	-	✓	-	✓	**5**
SE Rasmussen Blvd and SE Grace Ave	✓	-	✓	✓	-	✓	-	✓	**5**
SW Rasmussen Blvd and S Parkway Ave	-	✓	✓	-	✓	✓	✓	-	**5**
NE Grace Ave and NE Fairgrounds Ave	✓	✓	✓	-	-	-	✓	-	**4**
SE Eaton Blvd and SE Grace Ave	-	-	✓	✓	-	✓	✓	-	**4**
NW Onsdorff Blvd and NW 18th Ave	✓	-	✓	✓	-	-	-	✓	**4**
NE 142nd Ave and NE 249th St	-	✓	✓	✓	-	✓	-	-	**4**
NW 20th Ave and NW 9th St	-	-	✓	-	✓	✓	✓	-	**4**
NE 196th St and NE 112th Ave	✓	✓	-	✓	-	-	✓	-	**4**

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

Segment	Roadway Departure	Dusk/Dark/ Dawn Lighting	Wet Road Surface	Distracted /Inattention	Ped/Bike	Entering at Angle	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
W Main St from SE 10th Ave to NE Grace Ave	✓	✓	✓	✓	✓	✓	-	✓	**7**
SW Eaton Blvd from 112th Ave/SW 20th Ave to SE Grace Ave	✓	✓	✓	✓	-	✓	✓	-	**6**
NW 20th Ave from W Main St (SR 502) to NE 239th St	✓	-	✓	✓	✓	✓	-	-	**5**
NW 1st St from NW 15th Ave to SW 12th Ave	✓	-	✓	✓	-	✓	-	✓	**5**
S Parkway Ave from SE Eaton Blvd to E Main St	✓	-	✓	✓	✓	✓	-	-	**5**
SW Scotton Way from SW 20th Ave to S Parkway Ave	✓	✓	✓	-	-	-	-	✓	**4**
SE Grace Ave from E Main St to SE Eaton Blvd	✓	✓	✓	-	-	-	-	✓	**4**

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	Dusk/Dark/ Dawn Lighting	Wet Road Surface	Distracted/ Inattention	Ped/Bike	Entering at Angle	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
1. Intersection: W Main St and N Parkway Ave	✓	✓	✓	✓	-	✓	-	✓	6
2. Intersection: NE 249th St and NE Dublin Rd	✓	✓	✓	✓	-	✓	-	-	5
3. Intersection: NE 181st St and NE 152nd Ave	✓	✓	✓	✓	-	-	✓	-	5
4. Intersection: W Main St and NW 5th Ave	-	✓	✓	✓	✓	✓	-	-	5
5. Intersection: NW 20th Ave and NW 9th St	-	-	✓	-	✓	✓	✓	-	4
6. Segment: Main St from SE 10th Ave to NE Grace Ave	✓	✓	✓	✓	✓	✓	-	✓	7
7. Segment: SW 20th Ave from W Main St (SR 502) to SW Eaton Blvd	✓	-	✓	✓	✓	✓	-	-	5

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. SAFETY PROJECTS TO PURSUE

Prioritized Location or Systemic Collision Type	Safety Project	Next Step
1. Systemic Signalized Intersections	Signal visibility upgrades; left-turn signal phasing modifications; pedestrian crossing enhancements	Apply for 2022 WSDOT City Safety Program grant funding
2. NW 20th Avenue and NW 9th Street Intersection	Rectangular Rapid Flashing Beacon pedestrian crossing; other pedestrian enhancements; compact roundabout	Apply for 2022 WSDOT City Safety Program grant funding
3. Systemic Stop-controlled Intersections	Intersection sign upgrades; speed feedback signs; intersection lighting	Apply for future grant funding
4. SW 20th Ave from W Main Street (SR 502) to SW Eaton Boulevard	Multi-use path; ped crossing improvements; sign upgrades	Apply for a Pedestrian/Bicycle grant or Safe Routes to School grant

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.

PRIORITY 1. SYSTEMIC SIGNALIZED INTERSECTIONS

In Battle Ground, intersection and intersection-related collisions are the most common types to occur for all collision severities. 77% of fatal and serious injury collisions occurred at intersections or were intersection-related, and 55% of all collisions occurred at intersections or were intersection-related. The City is responsible for the operations and maintenance of five signalized intersections.

- W 8th Avenue (Safeway) and W Main Street
- W 5th Avenue and W Main Street
- Parkway Avenue and Main Street
- S Parkway Avenue and S Eaton Boulevard
- SE Grace Avenue and SE Eaton Boulevard

Potential Safety Treatments. Low-cost systemic safety countermeasures at signalized intersections consist primarily of signal hardware upgrades and timing changes. To address the safety risks at intersections and due to the low cost of the recommended treatments, the City will consider a combination of these countermeasures at all City-maintained and operated signalized intersections. Treatments include the following:

- ***Signal Visibility Upgrades.*** Improving the visibility of signal heads (larger lenses, reflectorized backplates, supplemental signal heads) improves driver compliance with signal indications.
- ***Left-turn Signal Upgrades.*** Includes conversion to flashing yellow arrow (FYA) for permissive left-turns and providing permissive-protected or protected-only left-turn phasing where practical. FYA is shown to improve driver understanding and compliance (yielding), which reduces vehicle-vehicle and vehicle-pedestrian conflicts.

- ***Signalized Pedestrian Crossing Enhancements.*** Install pedestrian countdown timers, disallow permissive left-turns with conflicting pedestrian WALK phase, and provide leading pedestrian intervals (gives pedestrians a 3-7 second head start before the associated vehicle phase) to reduce vehicle-pedestrian conflicts.

Battle Ground Systemic Signalized Intersection Treatments

Project Description

Provide signal visibility upgrades, left-turn signal phasing changes, and pedestrian crossing enhancements at all City-owned signalized intersections.

Cost Estimate

$972,000

Benefit / Cost Ratio

5.04

Time Frame

Medium-term

Crash Reduction

~48%

Combined reduction in signalized intersection collisions at the identified locations.

History: 58 intersection collisions from 2016-2020.

Expected Benefit: 5.6 fewer crashes per year.

Sample Signalized Intersections

W Main Street and N Parkway Avenue. This intersection has an old span wire signal with permissive left turns (green ball indication) on all approaches. It is located in the center of town adjacent to Battle Ground High School and commercial/retail land uses, and all four crosswalks are marked as school crossings. Collision history indicates 64% of collisions involved left turns and approximately half occurred in dark, dusk, or dawn conditions. One bicycle collision and one pedestrian collision occurred at the intersection, both involving a northbound left turning vehicle. The City has also received citizen complaints about this intersection.

Figure 5. S Parkway Avenue Northbound Approach at Main Street

W Main Street and NW 5th Avenue. This four-leg signalized intersection has dedicated left-turn lanes on all four approaches, permissive left turns (green ball indication) on the North-South approaches, and permissive-protected left turns (doghouse style signal heads) on the East-West approaches. It is located in the center of town near Battle Ground High School and commercial/retail land uses, and the crosswalks on the north and south legs are marked as school crossings. Collision history indicates nearly half of all crashes involved left-turning vehicles, including one crash involving a pedestrian. There were also three rear-end collisions and four angle crashes that did not involve left-turns, which indicates drivers may not be anticipating signal phase changes (due to poor signal progression or limited visibility of signal heads).

Figure 6. W Main Street Eastbound Approach at 5th Avenue

PRIORITY 2: NW 20TH AVENUE AND NW 9TH STREET INTERSECTION

Identified Safety Needs. This four-leg, two-way stop-controlled intersection is located in a residential neighborhood and is adjacent to Florence Park. All four approaches have marked crosswalks. The north-south approaches are uncontrolled and include pedestrian crossing warning signs. Five collisions occurred at this intersection, including one rear-end, two angle, and two bicycle crashes. Both bicycle collisions involved northbound vehicles striking bicyclists that were in the marked crosswalk, and one resulted in a serious injury. All collisions occurred during daylight conditions. The City has also received citizen complaints about this location.

Figure 9. NW 20th Avenue Northbound Approach to NW 9th Street

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

- ***Rectangular Rapid Flashing Beacon (RRFB).*** Install RRFB at the south or north crosswalk to improve driver yielding to pedestrians and bicyclists in the crosswalk. RRFBs can be supplemented with flashing beacons at the advanced warning signs, curb extensions, and advanced stop or yield lines.
- **Compact Roundabout**. Roundabouts provide enhanced safety compared to two-way stop controlled intersections and improved operations over an all-way stop intersection. The footprint of a compact roundabout—designed for urban and neighborhood installations—is smaller than a traditional modern roundabout, which can reduce the cost of right-of-way acquisition and construction.

PRIORITY 3. SYSTEMIC STOP-CONTROLLED INTERSECTIONS

In Battle Ground, intersection and intersection-related collisions are the most common types to occur for all collision severities. 77% of fatal and serious injury collisions occurred at intersections or were intersection-related, and 55% of all collisions occurred at intersections or were intersection-related.

Potential Safety Treatments. Low-cost systemic safety countermeasures at unsignalized intersections consist primarily of signing and pavement marking. Treatments include doubled-up signs, additional pavement marking, double-wide stop bars, fluorescent yellow sign sheeting, advance warning signs, oversize signs, and a between-lanes curbing on the side street.

- ***Intersection Sign Upgrades.*** A double-wide stop bar on the northbound approach and high visibility sheeting on the stop sign and arrow board can make the stop condition more conspicuous for approaching motorists. Retroreflective sign posts can also add conspicuity to the signs.
- ***Speed Feedback Sign.*** Installing a speed feedback sign on the existing curve warning signs will reinforce the warning for drivers to slow down as they approach the curve.
- ***Intersection Lighting.*** Installing intersection lighting will increase visibility of the unique roadway geometry and traffic control at night.

To address the safety risks at intersections and due to the low cost of the recommended treatments, the City will consider a combination of these countermeasures at the following stop-controlled intersections:

- NE 181st Street and NE 152nd Avenue
- NE 249th Street and NE 132nd Avenue/NE Dublin Road
- SW 20th Avenue and SW Eaton Boulevard
- SW 20th Avenue and SW Scotton Way
- SE Grace Avenue and SE Rasmussen Boulevard
- SW Scotton Way and SW 13th Avenue
- NW 1st Street and NW 12th Avenue
- SW 1st Street and S Parkway Avenue

Sample Unsignalized Intersections

NE 181st Street and NE 152nd Avenue. This unsignalized T-intersection is on the outskirts of town and has signed yield control for the northbound approach. It is adjacent to an at-grade rail crossing. Two collisions occurred at this intersection, both involving roadway departure. One involved a northbound right-turning vehicle that lost control, and the other involved a westbound (through) driver that was distracted, ran off the road, overcorrected, and crashed into a sign post. The second collision resulted in a serious injury.

Figure 7. NE 181st Avenue Northbound Approach to NE 152nd Avenue

NE 249th Street and NE 132nd Avenue/NE Dublin Road. This unsignalized intersection is on the outskirts of town and has atypical traffic control. The predominant movements are northbound-right and westbound-left, with both the north and west legs leading to dead-ends. The southbound and eastbound approaches are stop controlled, and the northbound approach is stop controlled except for right turns; however, there is no painted stop bar. The westbound approach has no traffic control (free movement).

Three roadway departure collisions occurred at this intersection, all involving northbound vehicles (one through vehicle, two right turn vehicles), and two occurred in the dark. While the traffic control is atypical, the collision patterns indicate that the horizontal curve is also problematic for drivers to navigate.

Figure 8. NE 132nd Avenue Northbound Approach to NE Dublin Road

PRIORITY 4. SW 20TH AVENUE FROM W MAIN STREET (SR 502) TO SW EATON BOULEVARD/NE 199TH STREET

City staff requested that this corridor be evaluated for sidewalk infill. North of SW 6th Street, the surrounding land use is residential and there are sidewalks on both sides of the street. South of SW 6th Street, sidewalks are provided sporadically, and the land use is much less dense. Just north of SW Scotton Way, the Remy Wetland Trail connects to a commercial shopping center that includes Walmart and several restaurants; however, the trail dead-ends on the east side of SW 20th Avenue where the sidewalk ends. Along the corridor, there were eight rear-end collisions, five roadway departure collisions, five angle collisions (one serious injury), three pedestrian collisions (one serious injury) and one bicycle collision. Over half of all collisions occurred in dark conditions. All pedestrian and bicycle collisions involved the pedestrian or cyclists crossing the street, either midblock or at unsignalized intersections. Several collisions, including a serious injury pedestrian crash, occurred at the intersection of SW 20th Avenue and SW 6th Street. This intersection has a marked pedestrian crossing on the north leg; however, the single street light at this intersection is on the south leg.

Figure 10. SW 20th Avenue, looking south toward SW 6th Street

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

- ***Multi-Use Path.*** Construct a sidewalk or multi-use path on the east side of SW 20th Avenue between SW 6th Street and SW Scotton Way, with a connection to the Remy Wetland Trail.
- ***Unsignalized Pedestrian Crossing Enhancements.*** Includes installing new mid-block or intersection crossings and enhancing existing crossings with striped crosswalks, advanced warning signs, and improved lighting. Consider installing an RRFB at one or two locations with the highest pedestrian crossing activity.
- ***Sign Upgrades.*** Stop Ahead warning sign, oversized Stop sign, doubled-up Stop signs, and retroreflective post sleeves can make the stop condition more conspicuous for approaching motorists and reduce the likelihood of angle crashes.

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

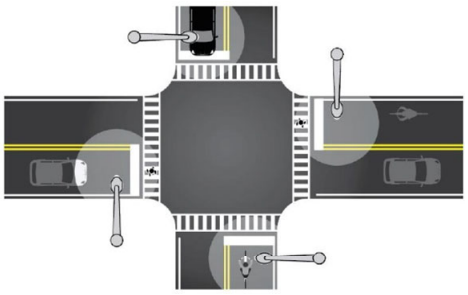
» Estimated $75,000

» 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).

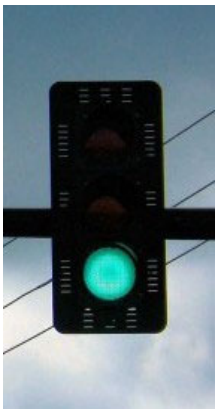
» 10 years of expected life

» 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

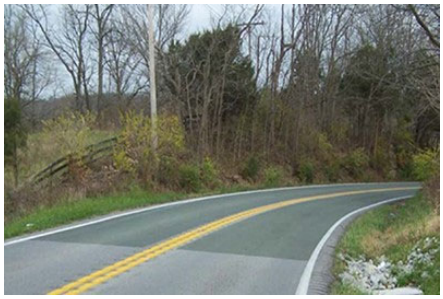
» Estimated $5,000 per intersection for materials and equipment

» 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

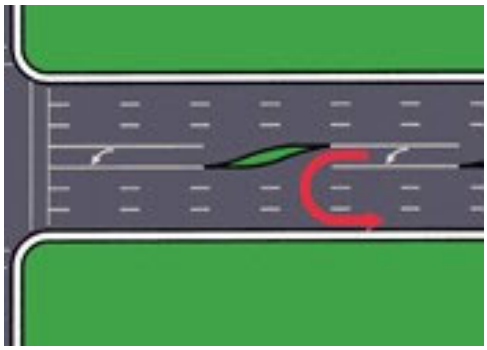
Install medians to reduce crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. This treatment only applies to crashes occurring in the intersection/influence area of the new directional openings.

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.

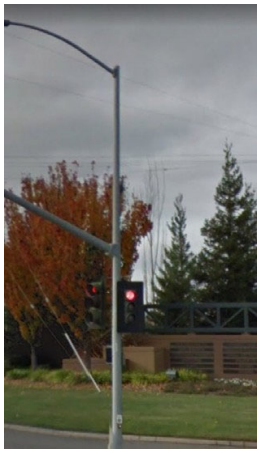
IMPLEMENTATION

Sources: CA-Local Roadway Safety Manual

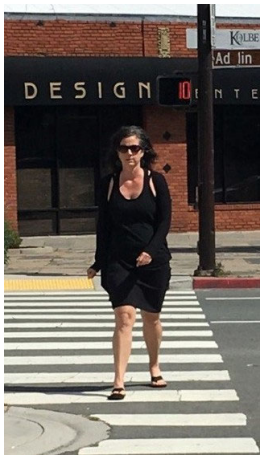
S9. Install Pedestrian Countdown Signal Heads

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

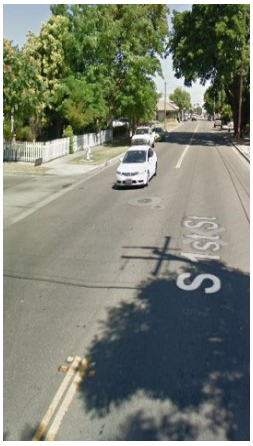
IMPLEMENTATION

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).

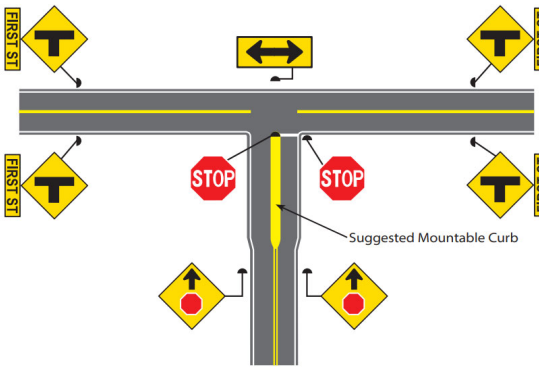
» 10 years of expected life.

» 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.

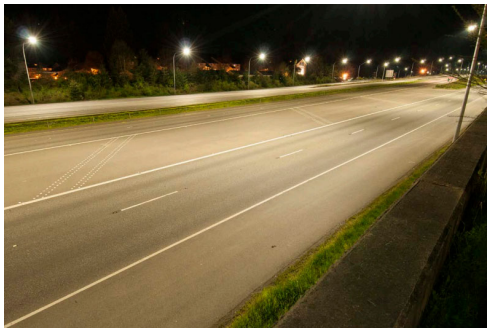
Benefit-Cost

- 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 C7 illustrate the locations of crashes with these attributes.

Figure C1 illustrates that roadway departure collisions are most common along SW Eaton Boulevard and SW Main Street.

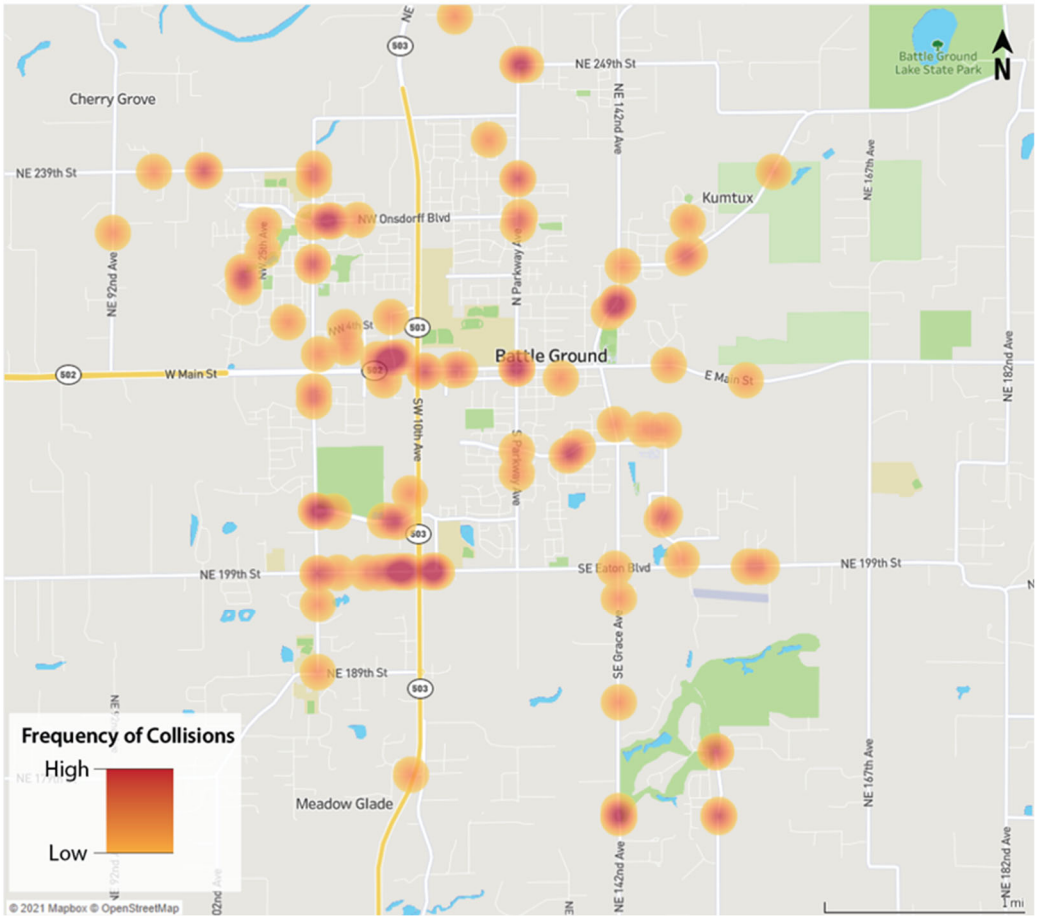


Figure C1. Roadway Departure Collisions, Battle Ground, 2016-2020.

Figure C2 shows three main streets where dark/dusk/dawn collisions occurred:

- E Main Street
- SE Eaton Boulevard
- NE 249th Street

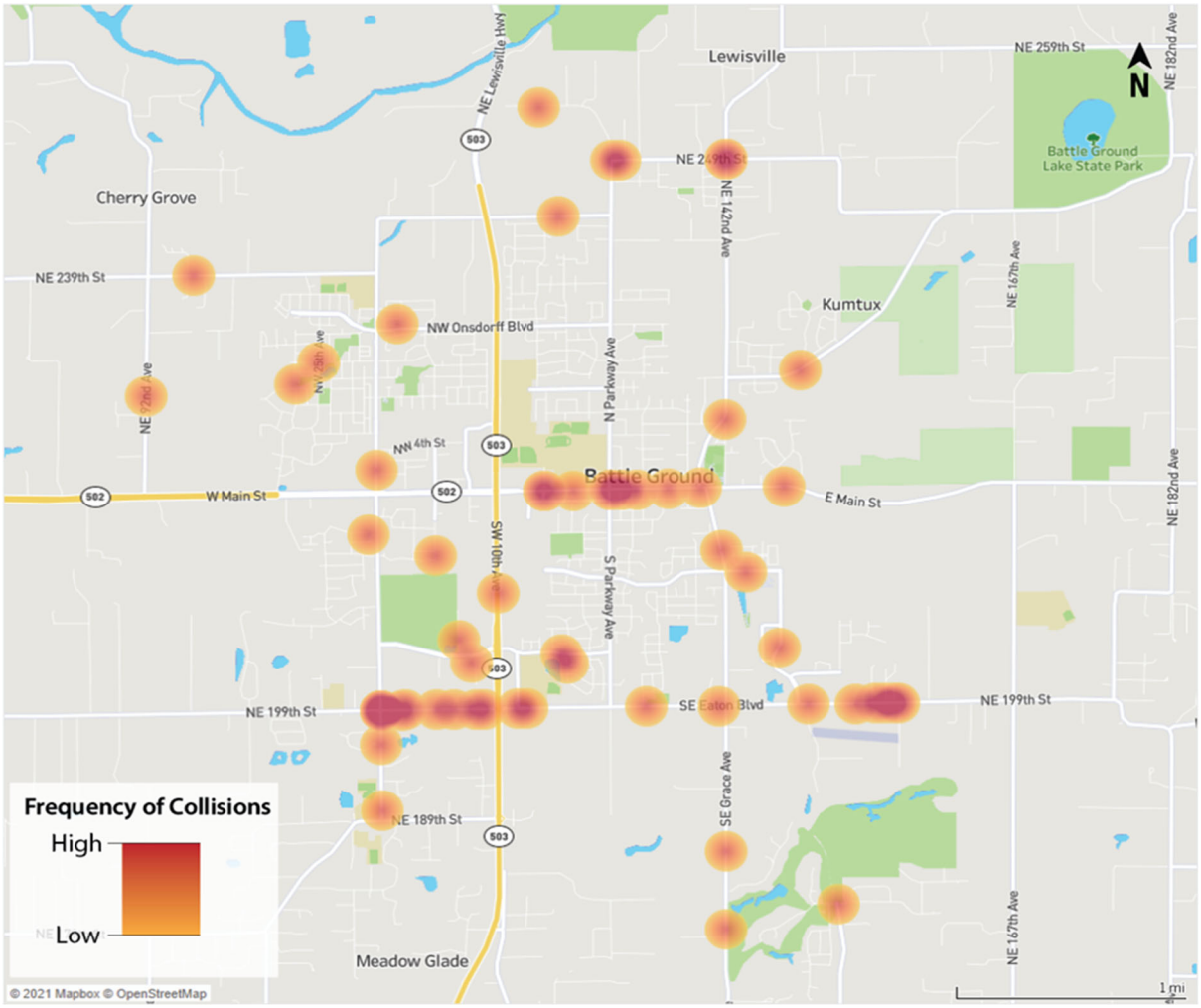


Figure C2. Dark/Dusk/Dawn Collisions, Battle Ground, 2016-2020.

Figure C3 shows the areas in Battle Ground where collisions occurred on wet roads.

Several locations show clusters of wet-road collisions.

- Along E Main Street
- Along SE Eaton Boulevard
- Along NW 20th Avenue
- NE 142nd Avenue and NE 249th Street intersection

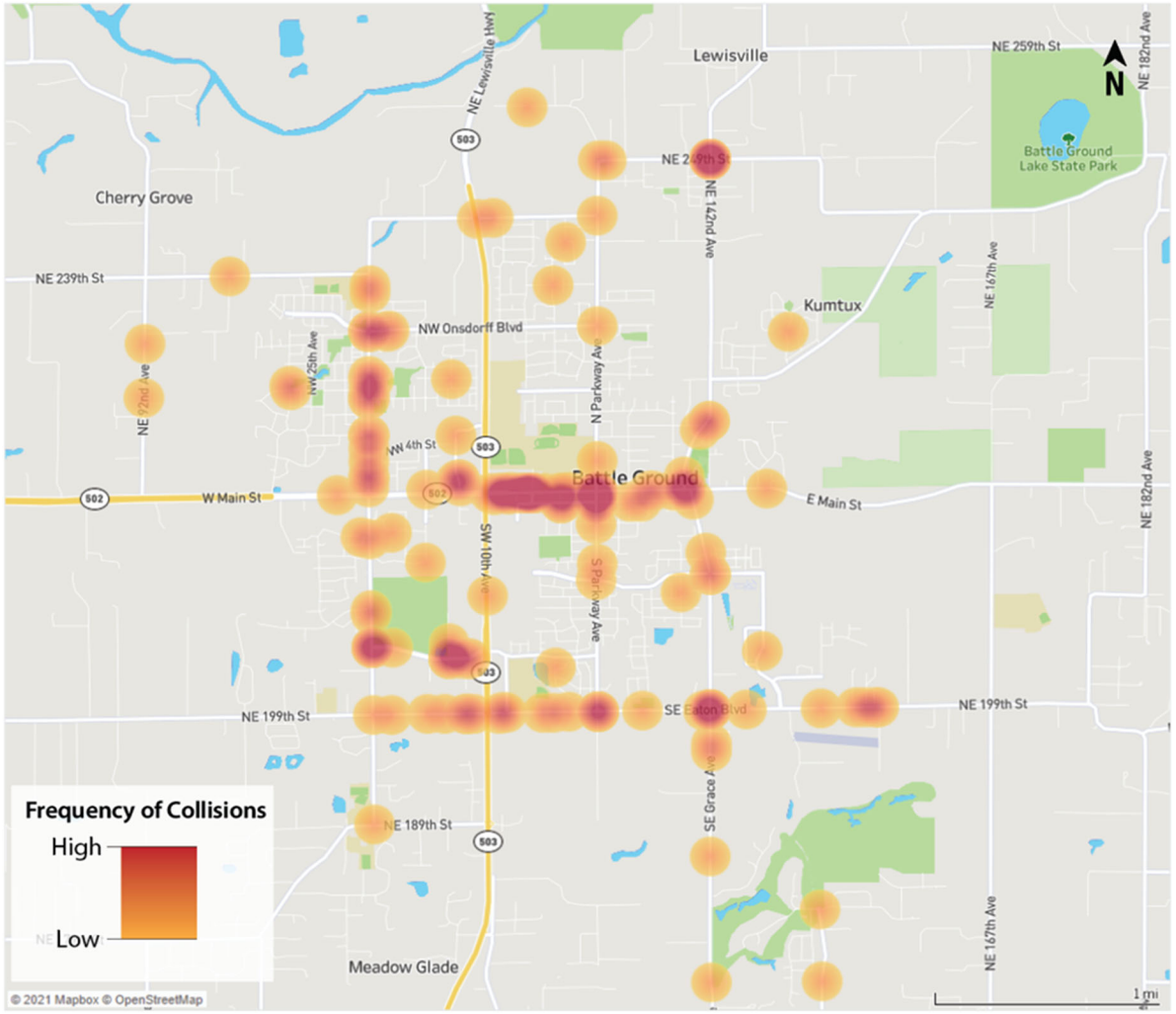


Figure C3. Collisions on Wet Roads, Battle Ground, 2016-2020.

Figure C4 presents the heat map of all the collisions that involved inattention or distraction of the driver. Similar to the previous figure, there was a high concentration of inattention/distraction related collisions along E Main Street, NE 199th Street, and NW 20th Avenue.

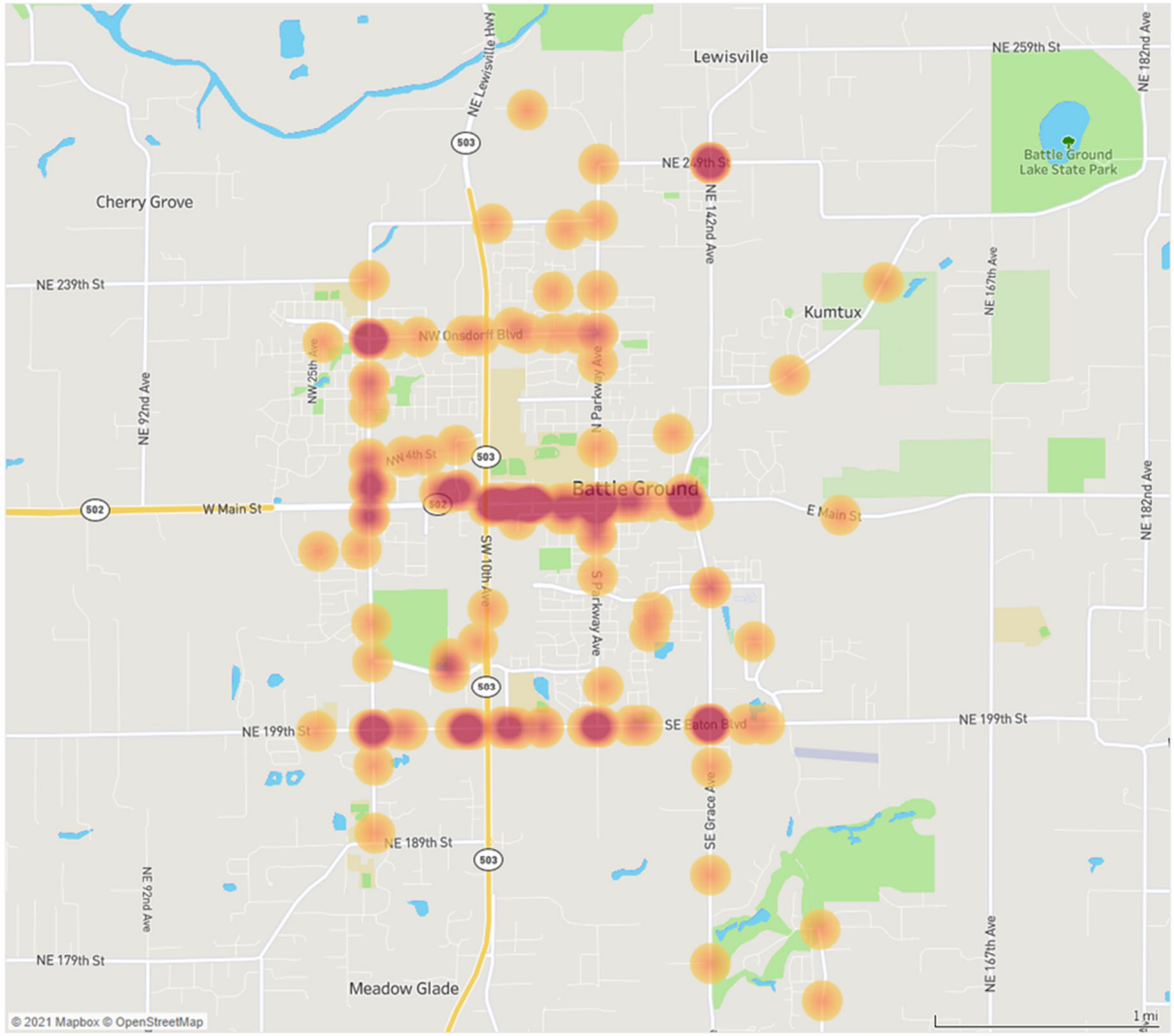


Figure C4. Inattention/Distraction, Battle Ground, 2016-2020

There were 16 pedestrian involved collisions and 14 bicyclist-involved collisions during the study period. Figure C5 displays a heat map of all the pedestrian and bicyclist collisions. Although there are a number of collisions that occurred on residential streets, there is a high concentration of collisions along W Main Street near Battle Ground High School.

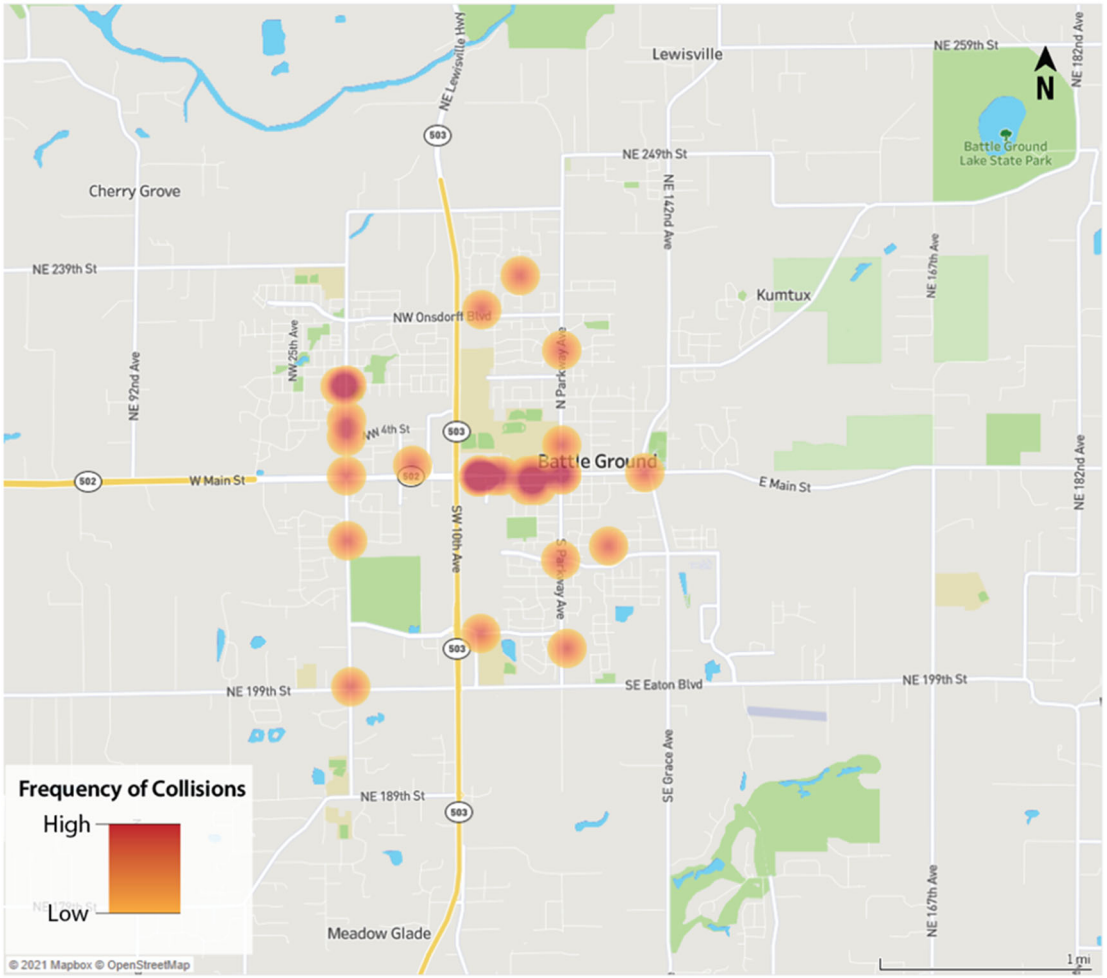


Figure C5. Collisions Involving Bicyclists or Pedestrians, Battle Ground, 2016-2020.

There are several clusters of collisions that occurred due to vehicles entering at an angle, as shows in Figure C6. Examples include:

- NE 249th Street and NE 142nd Avenue
- NE 199th Street and SW 20th Avenue
- SE Eaton Boulevard and SE Grace Avenue
- W Main Street and SW 5th Avenue
- SW 1st Street and S Parkway Avenue

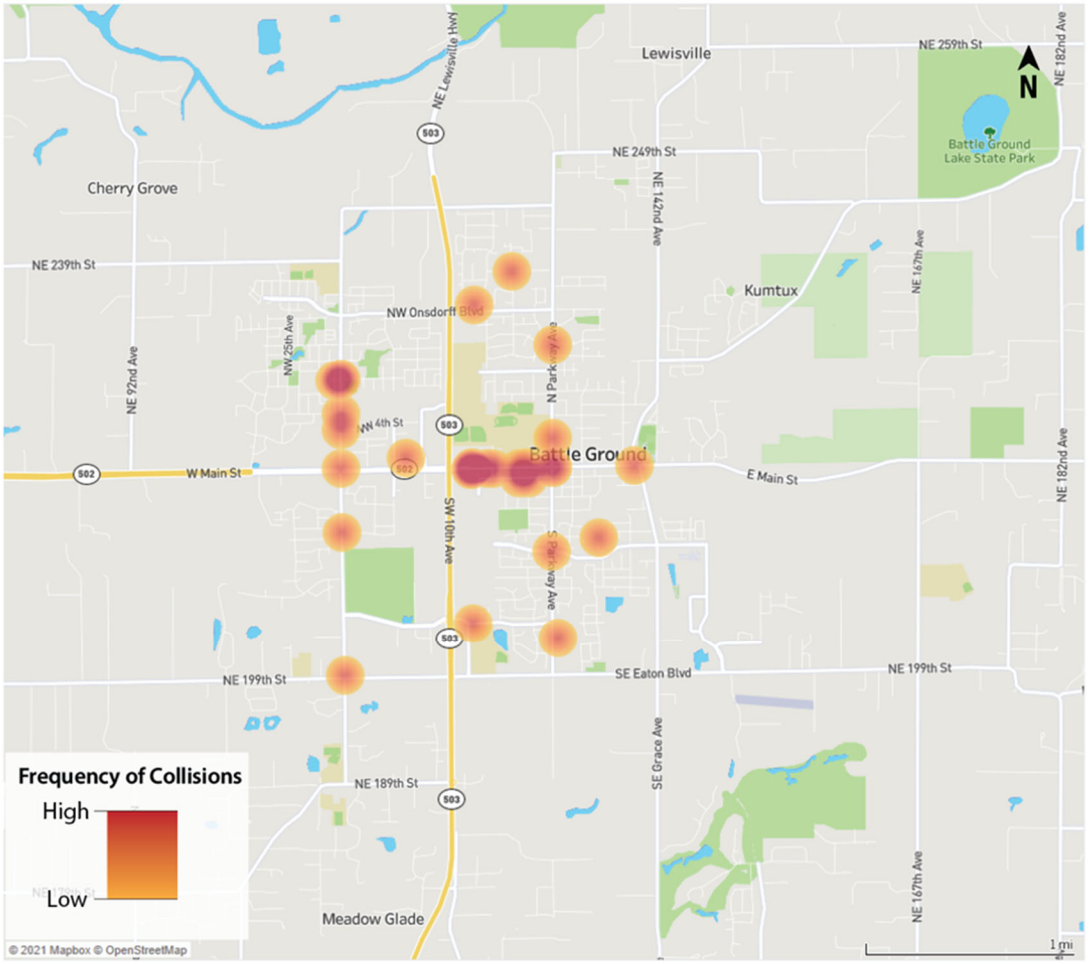


Figure 6. Entering at Angle Collisions, Battle Ground, 2016-2020.

There are several clusters of collisions that occurred at intersections or intersection-related, as shown in Figure C7. Examples include:

- NE 249th Street and NE 142nd Avenue
- NE 199th Street/SW Eaton Boulevard and NE 112th Avenue
- SE Eaton Boulevard and SE Grace Avenue
- E Main Street and S Parkway Avenue
- E Main Street and NW 5th Avenue

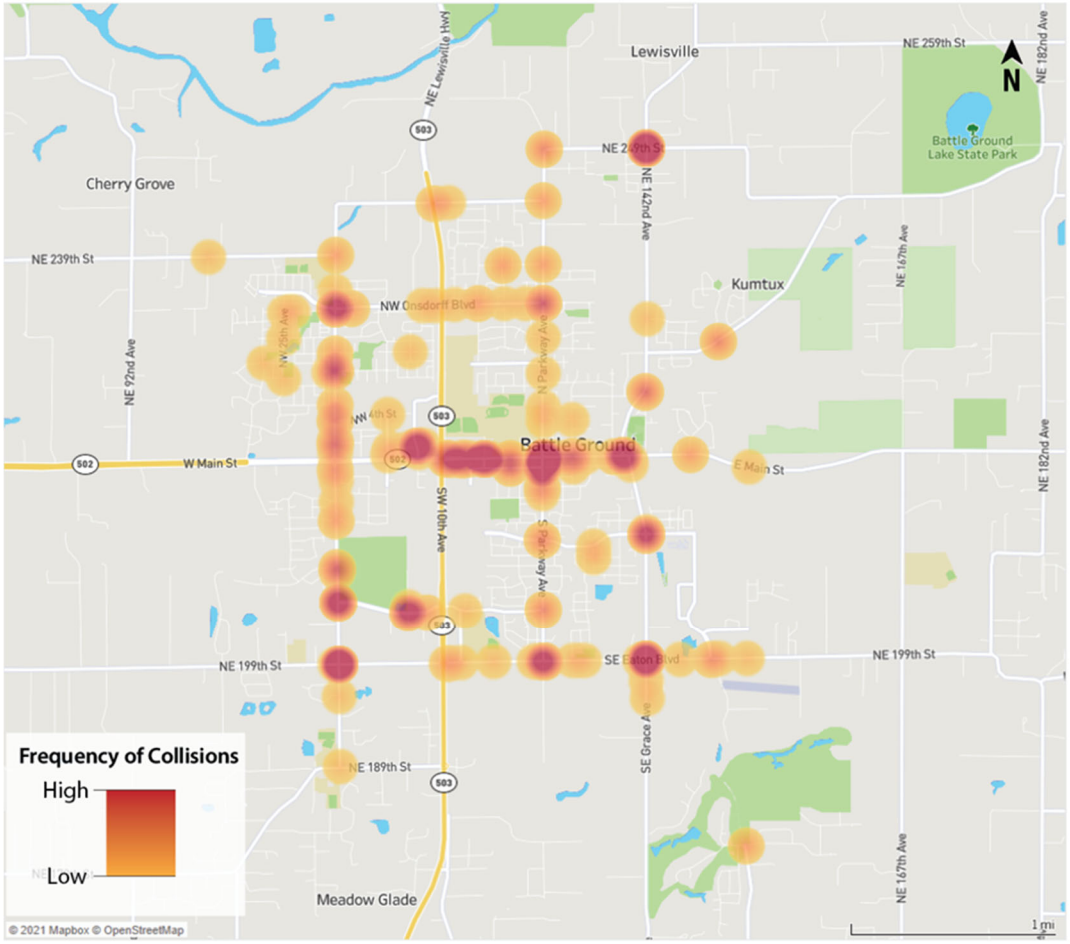


Figure C7. At Intersection or Intersection Related Collisions, Battle Ground, 2016-2020.

Attachment B
Cost Estimate

NW 20TH AVENUE/NW 9TH STREET INTERSECTION IMPROVEMENT - COST ESTIMATE

Preliminary Engineering				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
PE.1	Design Consultant	1	LS	$70,000.00	$70,000.00
PE.2	City Staff	100	HRS	$55.00	$5,500.00
			Preliminary Engineering Total		**$75,500.00**

Right-Of-Way				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
RW.1	Consultant	1	LS	$5,000.00	$5,000.00
RW.2	Land Costs	1	LS	$10,000.00	$10,000.00
RW.3	City Staff	25	HRS	$55.00	$1,375.00
			Right-Of-Way Total		**$16,375.00**

Construction - Division 1 - General Requirements				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
1-1	Minor Change	1	CALC	$1,000.00	$1,000.00
1-2	Roadway Surveying	1	LS	$1,000.00	$1,000.00
1-3	SPCC Plan	1	LS	$500.00	$500.00
1-4	Type B Progress Schedule	1	LS	$1,000.00	$1,000.00
1-5	Mobilization	1	LS	$30,000.00	$30,000.00
1-6	Project Temporary Traffic Control	1	LS	$5,000.00	$5,000.00
			CN - Division 1 Total		**$38,500.00**

Construction - Division 2 - Earthwork				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
2-1	Clearing and Grubbing	1	LS	$2,000.00	$2,000.00
2-2	Removal of Structure and Obstruction	1	LS	$10,000.00	$10,000.00
			CN - Division 2 Total		**$12,000.00**

NW 20TH AVENUE/NW 9TH STREET INTERSECTION IMPROVEMENT - COST ESTIMATE

Construction - Division 8 - Miscellaneous Construction				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
8-1	Erosion Control	1	LS	$1,000.00	$1,000.00
8-2	ADA Ramp	8	EA	$6,000.00	$48,000.00
8-3	Roundabout	1	LS	$50,000.00	$50,000.00
8-4	Medians	2	EA	$60,000.00	$120,000.00
8-5	Rapid Rectangular Flashing Beacons	4	EA	$10,000.00	$40,000.00
8-6	Permanent Signing	1	LS	$5,000.00	$5,000.00
8-7	Plastic Marking	1	LS	$10,000.00	$10,000.00
8-8	Street Lighting	1	LS	$15,000.00	$15,000.00
			CN - Division 8 Total		**$289,000.00**

Construction Subtotal	**$339,500.00**
Sales Tax - 8.4%	**$28,518.00**
Contingency - 10%	**$33,950.00**
Construction Total	**$401,968.00**

Construction Engineering				Engineer's Estimate	
Item Number	Item	Quantity	Unit	Unit Cost	Total Cost
CN.1	Bidding & Advertising	1	LS	$1,500.00	$1,500.00
CN.2	Materials Testing	1	LS	$10,000.00	$10,000.00
CN.3	Engineering - City Staff	50	HRS	$55.00	$2,750.00
			Const. Engineering Total		**$14,250.00**

Preliminary Engineering	**$75,500.00**
Right-Of-Way	**$16,375.00**
Construction	**$401,968.00**
Construction Engineering	**$14,250.00**
Project Total	**$508,093.00**

PE - Grant (90%)	**$67,950.00**
PE - City (10%)	**$7,550.00**
ROW - Grant (90%)	**$14,737.50**
ROW - City (10%)	**$1,637.50**
CN - Grant (100%)	**$416,218.00**

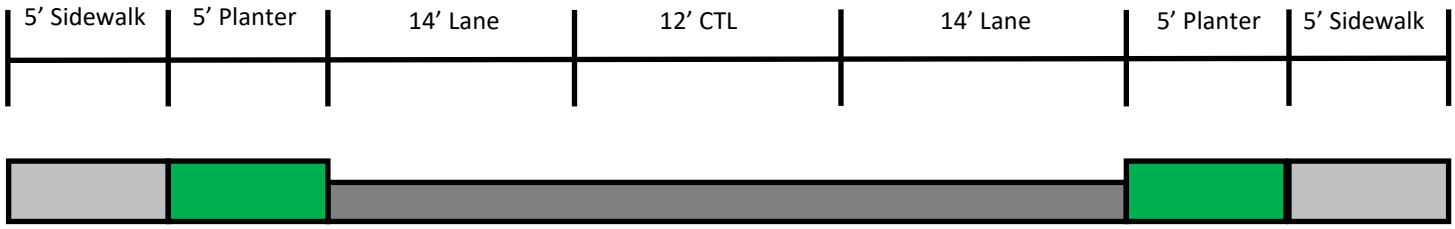
Attachment C
Concept Plan

NW 20th Avenue/NW 9th Street Intersection Improvement
Conceptual Plan

Attachment D
Cross-Section

NW 20th Avenue/NW 9th Street Intersection Improvement
Cross-Sections

Before Project



After Project