Deschutes County
(including the cities of La Pine,
Redmond, & Sisters)

DESCHUTES COUNTY TRANSPORTATION SAFETY ACTION PLAN

September 30, 2019

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SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1 INTRODUCTION

Between 2012 and 2016, there were 174 reported crashes within unincorporated Deschutes County that resulted in fatal or incapacitating (potentially life-changing) injuries. As shown in Figure 1, the County has experienced a general increasing trend in crash frequency between 2012 and 2016. These statistics emphasize the need for a comprehensive, multidisciplinary action plan to reduce crashes within the County.

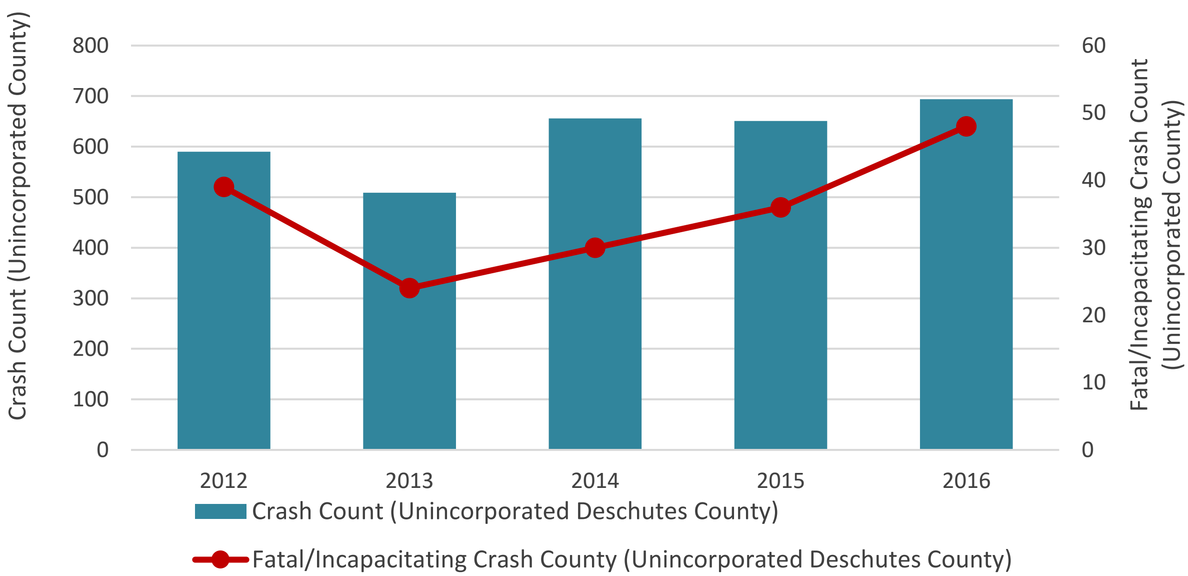
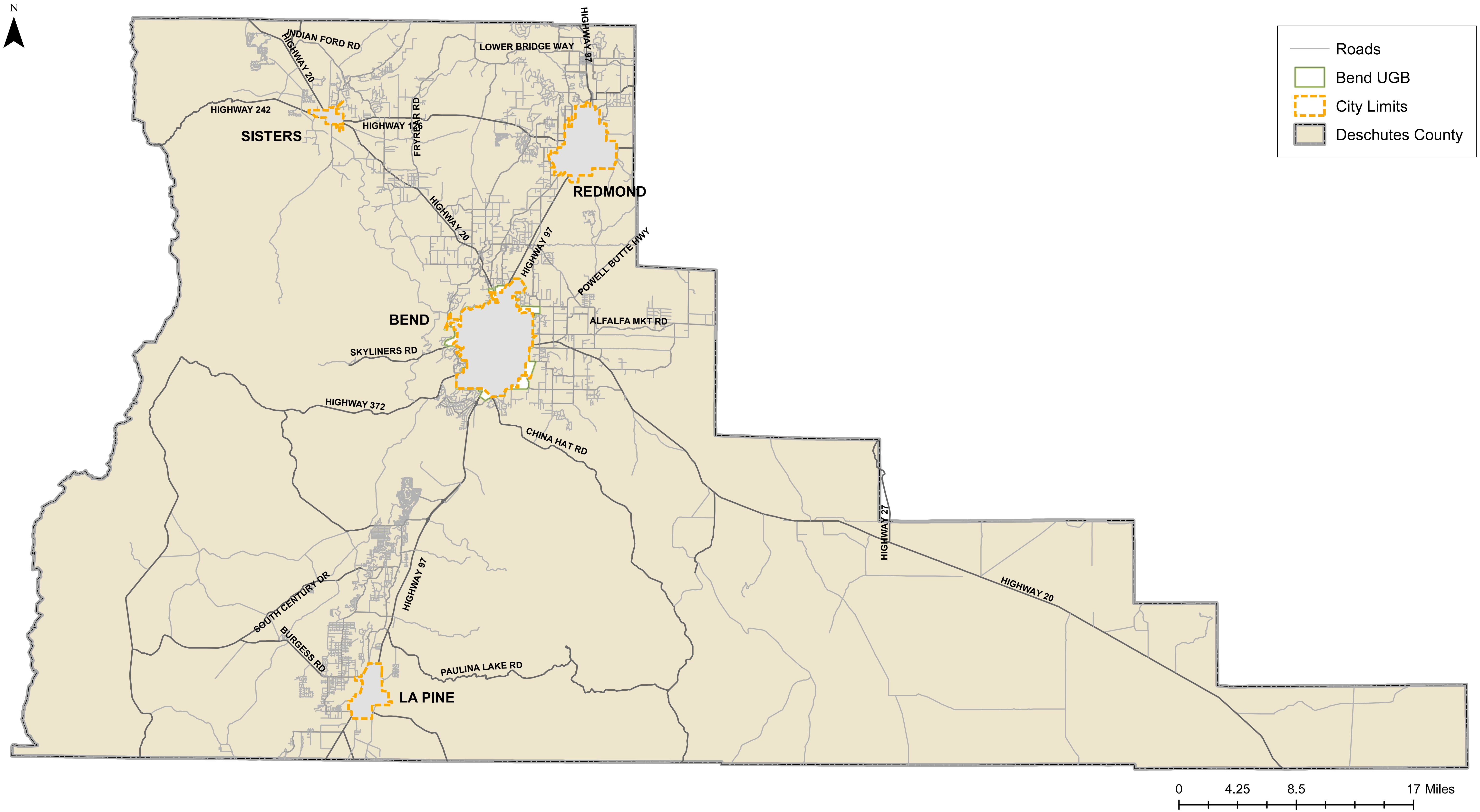


Figure 1. Number of Reported Crashes per Year

The state of Oregon has developed a statewide Transportation Safety Action Plan (TSAP) and set a goal of zero fatal and incapacitating injuries on Oregon's transportation system by 2035. The Deschutes County TSAP is Deschutes County's specific action plan developed to help the County work towards the state's goal by identifying and addressing safety issues specific to Deschutes County. This Deschutes County TSAP evaluates crash trends and issues based on current data and identifies a broad range of treatments including projects, policies, and programs, to address identified issues.

1.1.1 Study Area

The Deschutes County TSAP focuses on the rural areas of the County and the cities of La Pine, Redmond, and Sister area outside the Bend Urban Growth Boundary (UGB), including the area within the Bend Metropolitan Planning Organization (MPO), as well as the cities of La Pine, Redmond, and Sisters, as shown by the study area in Figure 2. The City of Bend concurrently developed its own TSAP for the area within the Bend UGB. The simultaneous development of the County and City/MPO TSAPs allowed for coordination between the two jurisdictions and an understanding of County-specific safety performance. The Framework Memorandum, provided as Appendix 1, summarizes how the two Plans were coordinated.



Study Area
Deschutes County Boundaries

Figure
2

1.2 PLAN DEVELOPMENT PROCESS

A comprehensive approach to transportation safety acknowledges that policy, planning, programming, and projects are multidisciplinary and involve "the 7Es" of safety. The seventh "E" represents a dedication to transportation safety through a commitment to evaluate progress and continue to adapt future safety plans to meet identified future needs.:

- Engineering;
- Emergency Medical Services (EMS);
- Enforcement;
- Education;
- Encouragement;
- Equity; and
- Evaluation.

By including elements from the 7Es that complement each other, the TSAP provides a multidisciplinary approach that could support policy, programs, and project recommendations to achieve a vision of zero transportation fatalities or serious injuries on roads within Deschutes County. This would be consistent with the Oregon statewide vision zero objectives. To achieve this multidisciplinary plan, input was obtained from a variety of stakeholders throughout the project.

- Project Management Team (PMT) – The PMT included key staff from Deschutes County and the Oregon Department of Transportation (ODOT) who met regularly throughout the project to provide technical input at key steps throughout the project.
- Project Advisory Committee (PAC) – The PAC included stakeholders representing a wide range of interests (including the County road department, health department, sheriff's office, planning department, Bicycle and Pedestrian Advisory Committee, Emergency Medical Services, District Attorney's office, and cities located within the County). The PAC met three times throughout the project to provide input on the project framework and goals; the existing conditions analysis and emphasis areas; and the TSAP's policy, program, and project recommendations.

1.3 HOW TO USE THE TSAP

The TSAP is organized into seven sections. The following overview summarizes the content of each section and how it is intended to be used.

- **Section 1: Introduction** – This section provides an overview of the Plan's purpose and development and the study area. This section should orient the user to the Plan document.
- **Section 2: Crash Data Summary** – This section provides an overview of the key findings from the crash analysis and the identified emphasis areas for Deschutes County, La Pine, Redmond, and Sisters.
- **Section 3: Systemic Solutions –** This section is a toolbox of systemic solutions, summarizing the solutions, planning level cost estimates, and effectiveness at reducing crashes. This toolbox is meant to be referenced to identify appropriate solutions to address various safety issues throughout the County and cities. These treatments can often be incorporated into regular maintenance practices.

- **Section 4: Speed Management Toolbox –** This section provides a toolbox of treatments that can be implemented to help reduce travel speeds.
- **Section 5: Location Specific Applications –** This section summarizes the specific locations identified for safety treatments during the TSAP development. Section 5.1 identifies the intersections with the highest crash frequency and severity in the County and cities; Section 5.2 identifies locations where specific recommendations were produced; and Section 5.3 provides summarizes the locations where specific risk factors were identified. Section 5.3 helps guide the implementation of systemic solutions presented in Section 3.
- **Section 6: Non-Infrastructure Recommendations –** This section summarizes the educational, enforcement, programmatic, and policy action items developed to support the engineering recommendations of the TSAP.
- **Section 7: Performance Measures –** This section summarizes performance measures for County to use in tracking progress towards implementing the TSAP.

1.4 UPDATING THE TSAP

Implementing the TSAP actions in concert with other safety, land use, and transportation plans should result in measured decreases in fatal and severe crashes for the corresponding emphasis areas. Measuring safety benefits will require reassessing crash data to consider the TSAP effectiveness and then generate revised programs to meet future identified safety performance needs. Kittelson recommends this TSAP be assessed in approximately 5 to 7 years as new crash data is available and sufficient time has passed to measure the effectiveness of the various safety, land use, and transportation plans.

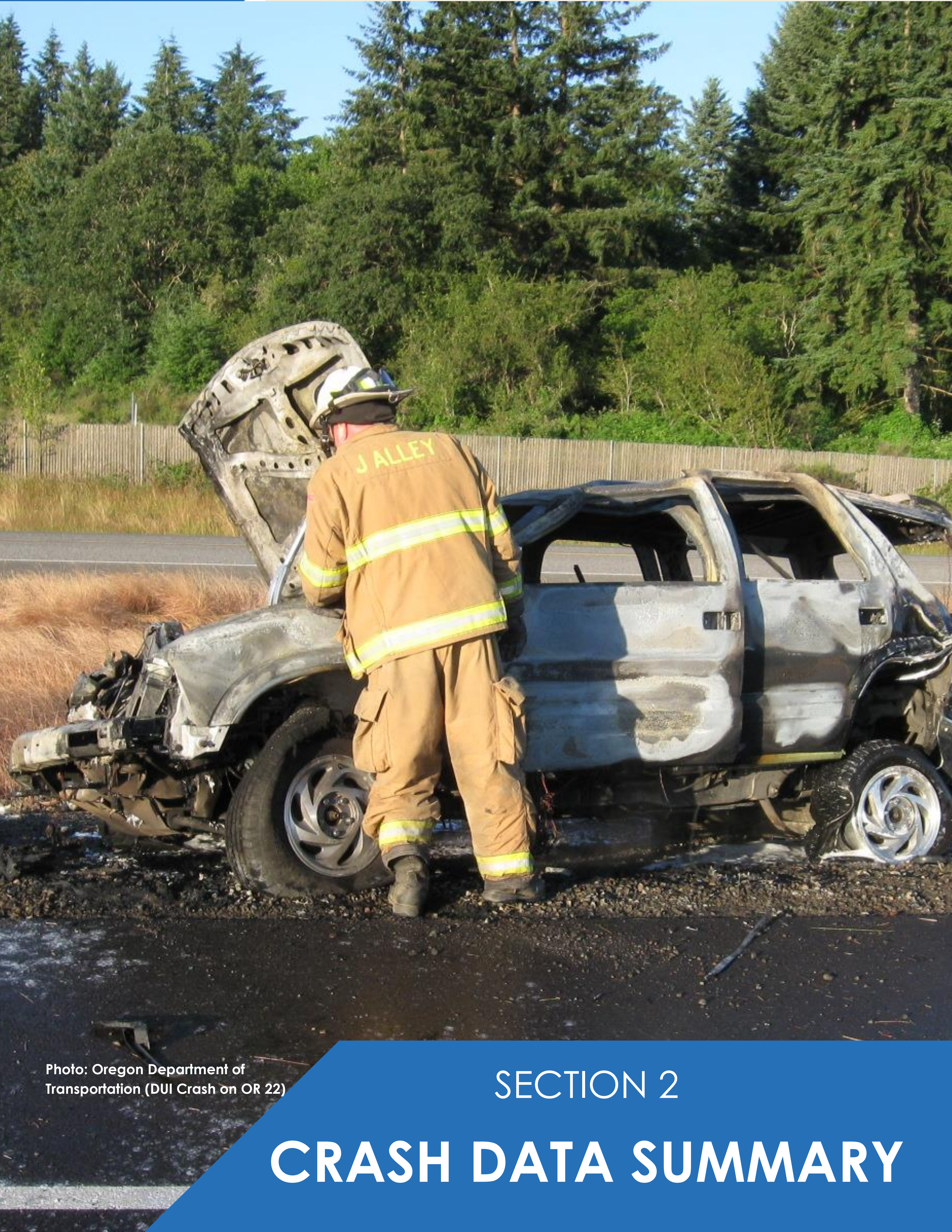


Photo: Oregon Department of Transportation (DUI Crash on OR 22)

SECTION 2

CRASH DATA SUMMARY

2. CRASH DATA SUMMARY

Kittelson obtained roadway, traffic, and crash data from the Oregon Department of Transportation (ODOT), Deschutes County, and the Bend MPO. Reported crash data for unincorporated Deschutes County was from ODOT's database for January 1, 2012 through December 31, 2016. Reported crashes include those resulting in an injury or fatality, as well as those resulting in over $1,500 of property damage.[1] ODOT's crash database provides reported crash characteristics such as date, time, crash type, light conditions, roadway conditions, etc. that Kittelson used to analyze and document factors associated with crashes. Additional roadway characteristics, such as number of lanes and intersection control type, were assigned to the crash data based on the GIS information received from the Bend MPO or Deschutes County.

Crashes are assigned one of five severity levels based on the most severe injury associated with that crash:

- Fatal;
- Incapacitating injury (Injury A);
- Moderate Injury (Injury B);
- Possible Injury (Injury C); or
- Property damage only (PDO).

More extensive discussion of analysis and findings is included in the *Executive Summary of the Crash Analysis* (Appendix 2) and the *Existing Conditions Summary* memorandum (Appendix 3).

2.1 UNINCORPORATED DESCHUTES COUNTY

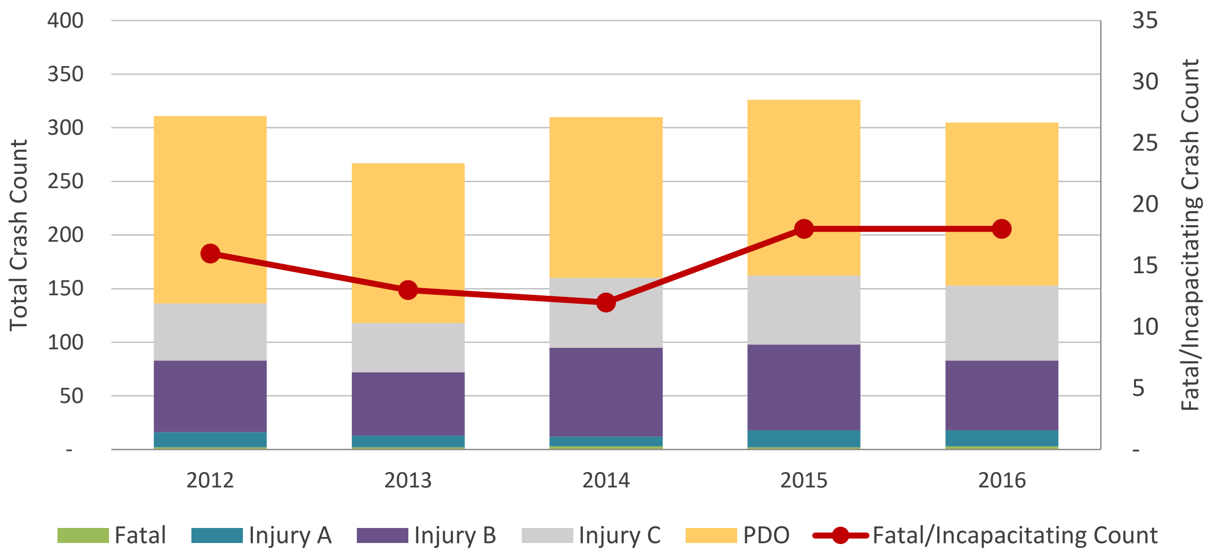
A total of 3,009 crashes were reported in unincorporated Deschutes County between 2012 and 2016. These crashes were relatively split between County and state facilities, with approximately half (1,519 crashes) of the crashes on county roads and half (1,490 crashes) on state highways.

Figure 3 presents the year-over-year crash frequency on county facilities in unincorporated Deschutes County including the number of crashes resulting in fatality or incapacitating injury. The annual number of reported crashes increased by 14 percent from 2013 to 2016.

Table 1 presents crashes that occurred on county facilities by severity. Among the1,519 crashes nearly half (48 percent) resulted in some level of injury. Five percent were fatal or incapacitating injury crashes.

A crash classified as injury "A" describes severe injuries including skull fractures, internal injuries, broken or distorted limbs, unconsciousness, severe lacerations, severe burns. The crash victim is unable to leave the scene without assistance.

[1] ODOT increased the property damage threshold for reporting crashes from $1,500 to $2,500 as of January 1, 2018. However, the data reflected in this analysis corresponds to a reporting threshold of $1,500 of damage. (Source: https://content.govdelivery.com/accounts/ORDOT/bulletins/1cbed84)



Source: ODOT

Figure 3: County Facility Crashes by Year, Deschutes County (Unincorporated), 2012-2016

Table 1: County Facility Crashes by Severity, Deschutes County (Unincorporated), 2012-2016

	Fatal	Injury A	Injury B	Injury C	PDO	Total
Count	12	65	354	298	790	**1,519**
Share	<1%	4%	23%	20%	52%	**100%**

Source: ODOT

Kittelson analyzed crashes by location (intersection or segment crashes) and by mode (including motor vehicle, bicyclist, or pedestrian crashes). Crashes within 250 feet of an intersection were considered *intersection crashes* and constituted approximately half the crashes on county facilities within unincorporated Deschutes County (52 percent), as shown in Table 2. For state facilities, 45 percent of reported crashes occurred at intersections. Non-intersection (segment) crashes were more likely to result in fatality or incapacitating injury compared to intersection crashes for both facilities.

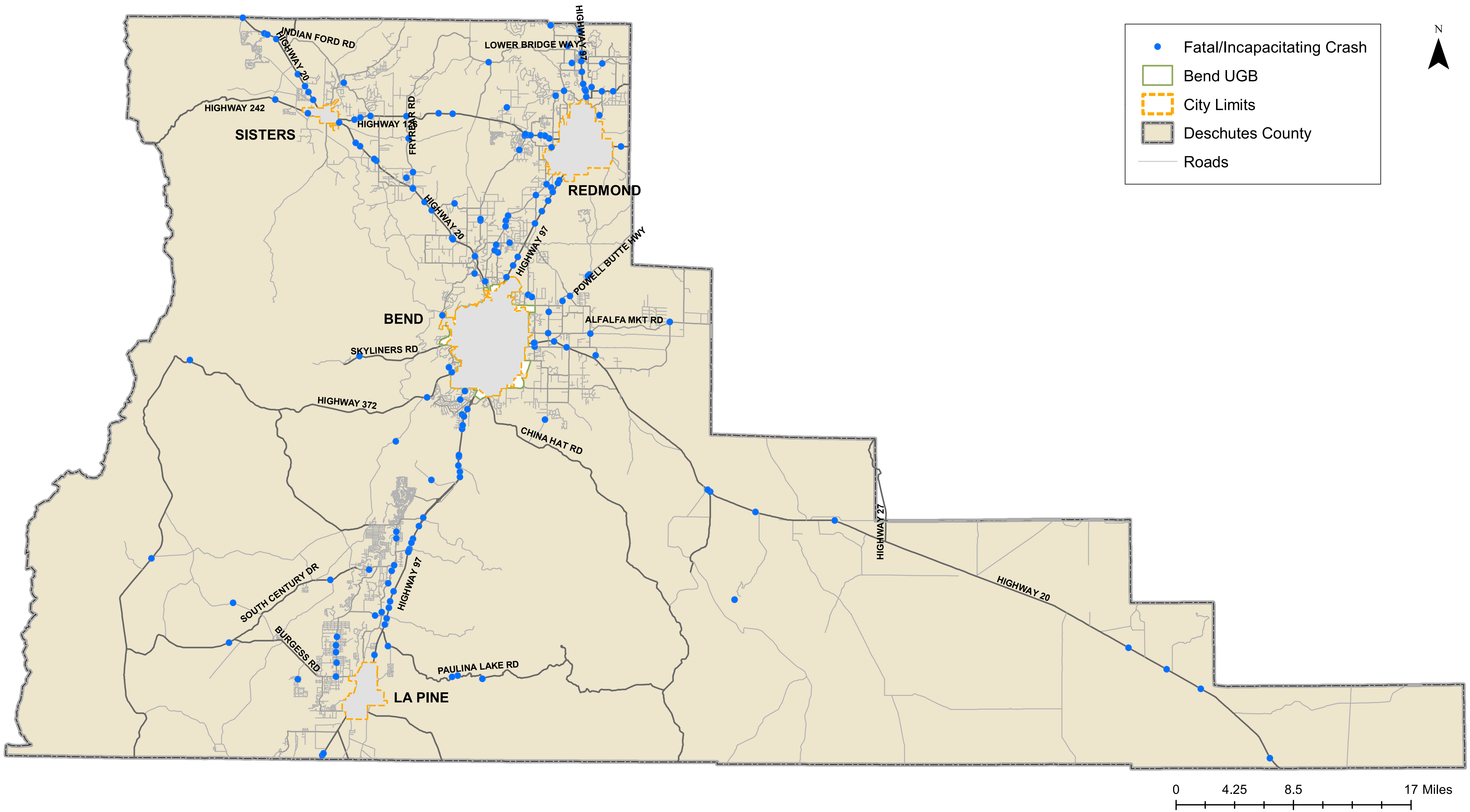
Figure 4 illustrates the location of the fatal and incapacitating crashes in unincorporated Deschutes County between 2012 and 2016.

The next section describes the major emphasis areas for unincorporated Deschutes County based on the analysis provided in Appendix 2.

Table 2: Crashes by Location (Intersection and Non-Intersection), Deschutes County (Unincorporated), 2012-2016

	Fatal	Injury A	Injury B	Injury C	PDO	Total (% Share)	Fatal/Incapacitating Total Count
State Facility							
Intersection	3	23	96	101	242	465 (31%)	26
Non-Intersection	28	43	173	205	576	1,025 (69%)	71
County Facility							
Intersection	3	26	171	170	418	788 (52%)	29
Non-Intersection	9	39	183	128	372	731(48%)	48

Source: ODOT



Reported Fatal and Incapacitating Crashes
Deschutes County, 2012 - 2016

Figure 4

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl

2.1.1 EMPHASIS AREAS – UNINCORPORATED DESCHUTES COUNTY

Based on the crash analysis using 2012-2016 data, Kittelson identified several emphasis areas for the unincorporated Deschutes County. These emphasis areas reflect the crash characteristics, such as crash type, behavior, or infrastructure, that were associated with fatal and incapacitating injury crashes. By addressing these emphasis areas, the County has the greatest potential to reduce fatal and incapacitating crashes. The following sections summarize these emphasize areas with focus on county facilities, unless otherwise stated.

Roadway Segments

Key trends include:

- **Crash severity**. 48 percent of reported crashes on County roads occurred on roadway segments, and 62 percent of fatal/incapacitating crashes on County roads occurred on roadway segments, further than 250 feet from an intersection.
- **Segment collision types**. Fixed object, overturn, animal, sideswipe, and head-on collisions accounted for 69 percent of reported crashes on County roads and 82 percent of fatal/incapacitating crashes.
    - Head-on collisions and non-collision (rollover) crashes were most likely to result in fatality or incapacitating injury when occurred.
- **Collectors and Arterials**. 74 percent of fatal/incapacitating crashes occurred on collectors or arterials.

Intersections

Key trends include:

- **Crash location**. Over half (52 percent) of reported crashes occurred within 250 feet of an intersection. 38 percent of fatal/incapacitating crashes occurred within 250 feet of an intersection.
- **Intersection collision types**. Of the reported crashes, 29 percent were intersection-related collision types (turning movement, angle, or rear-end crashes). Of the fatal/incapacitating crashes, 18 were intersection-related collision types.

Road User Behavior

Key trends include:

- **Excessive speeds.** 42 percent of fatal/incapacitating crashes involved excessive speeds.
- **Impaired driving.** Alcohol/drug involvement was reported in 12 percent of collisions and in 26 percent of fatal/incapacitating collisions.

Roadway Conditions

Key trends include:

- **Dark conditions.** 36 percent of reported crashes on County roads occurred in dark, dawn, or dusk conditions. 27 percent of fatal/incapacitating crashes on County roads occurred in dark, dawn, or dusk conditions.

  - On state facilities, 40 percent of fatal/incapacitating crashes occurred in dark, dawn, or dusk conditions.

- **Road surface conditions (snow/ice):** 23 percent of reported crashes on County roads occurred on snow or ice. Seven percent of fatal/incapacitating crashes on County roads occurred on snow or ice.
  - On state facilities, 22 percent of fatal/incapacitating crashes occurred on snow or ice.

Vulnerable Users

Key trends include:

- **Motorcyclists (severity).** Motorcycle-involved crashes accounted for 4 percent of reported crashes in the County and 26 percent of fatal/incapacitating crashes.
- **Pedestrians (severity).** Four pedestrian-involved crashes were reported on County roads. Each of these four crashes resulted in a moderate injury.
- **Bicyclists (severity).** Fifteen bicyclist-involved crashes were reported on County roads, and each of these 15 crashes resulted in some level of injury, including four incapacitating injury crashes.

2.2 CITY OF LA PINE

Between 2012 and 2016, 177 crashes were reported in La Pine. Of these, 47 percent resulted in some level of injury, and six percent (12 crashes) of reported crashes resulted in a fatality or incapacitating injury, as shown in Figure 5. Figure 6 illustrates the location of fatal/incapacitating crashes within the City.

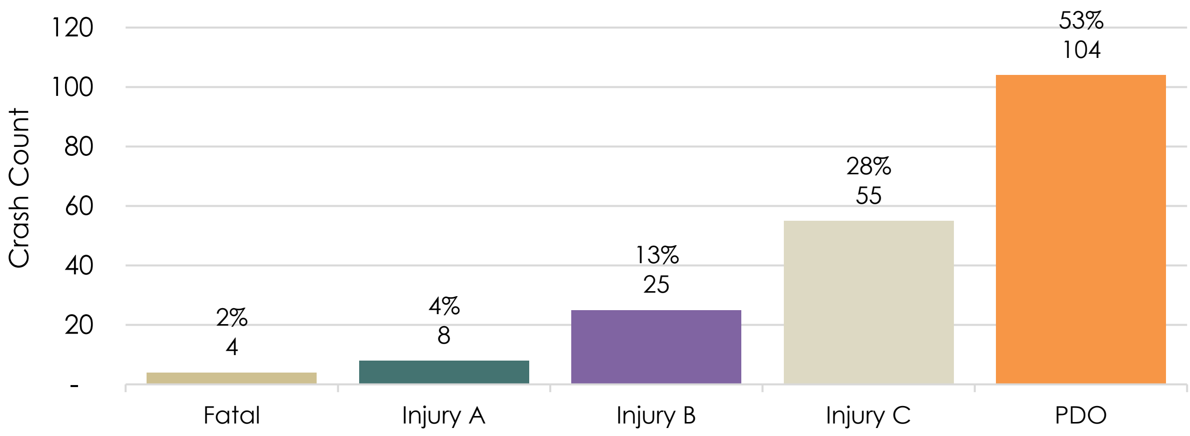
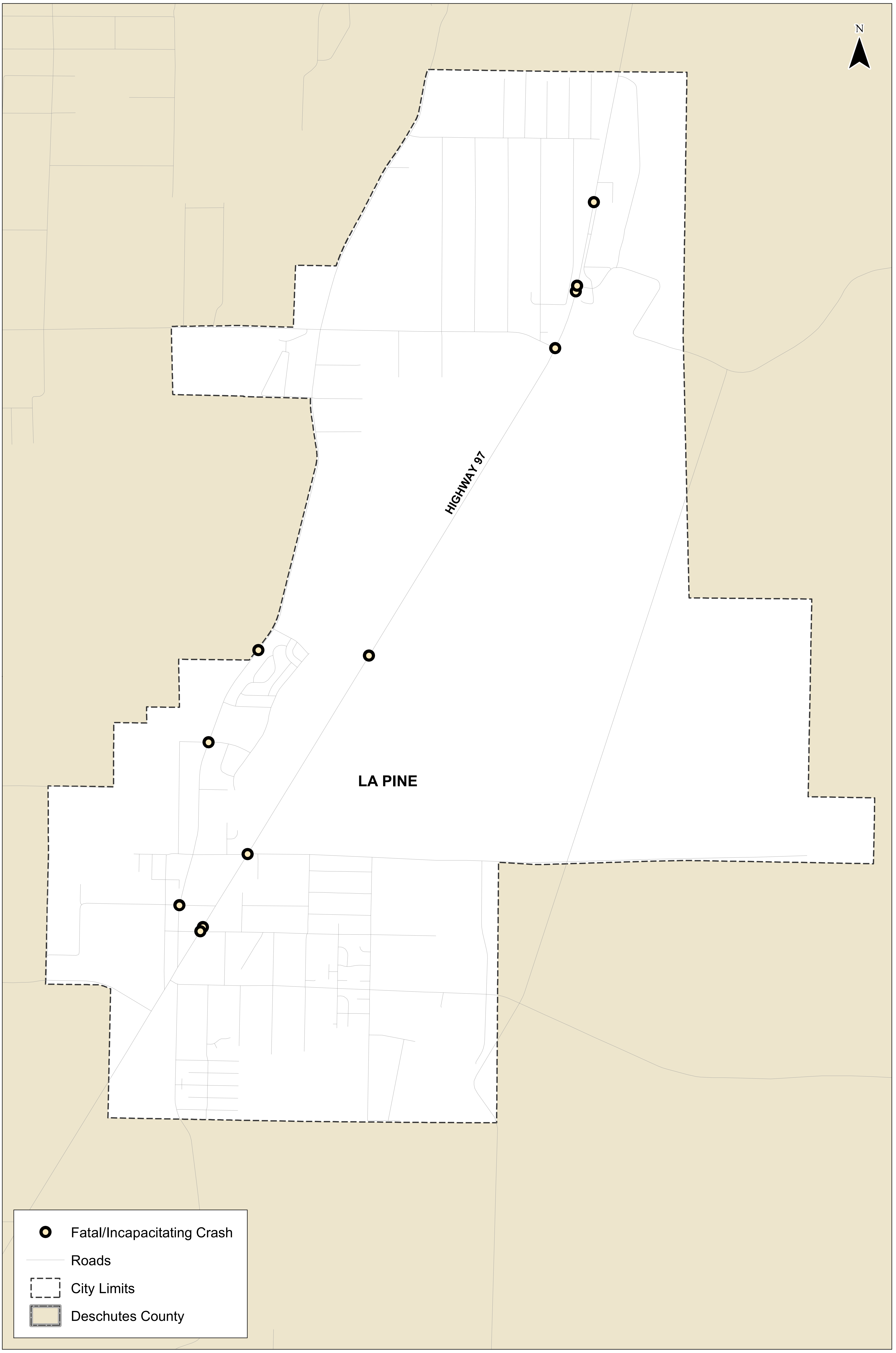


Figure 5. Reported Crashes by Severity, La Pine, 2012-2016



Fatal and Incapacitating Injury Crashes
La Pine, Deschutes County, 2012 - 2016

Figure 6

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Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

2.2.1 EMPHASIS AREAS – CITY OF LA PINE

Based on the crash analysis using 2012-2016 data, Kittelson identified several emphasis areas for the City of La Pine. These emphasis areas reflect the crash characteristics, such as crash type, behavior, or infrastructure, that were associated with fatal and incapacitating injury crashes. By addressing these emphasis areas, the City has the greatest potential to reduce fatal and incapacitating crashes.

Intersections

Key trends include:

- **Intersection collision types:** Turning movement, angle, and rear-end crashes accounted for 64 percent of reported crashes in La Pine and 58 percent of fatal/incapacitating crashes in La Pine.

Roadway Departure Crashes

Key trends include:

- **Collision types:** Roadway departure crashes account for 23 percent of reported crashes in La Pine and 16 percent (two crashes) of fatal/incapacitating crashes.

Road User Behavior

Key trends include:

- **Impaired driving:** Alcohol or drugs were involved in 25 percent of fatal/incapacitating crashes.
    - 30 percent of alcohol/drug involved crashes resulted in fatal/incapacitating injuries.
- **Excessive speeds.** 13 percent of reported crashes in La Pine involved excessive speed.
    - 54 percent of crashes involving excessive speed resulted in some level of injury.

Roadway Conditions & Characteristics

Key trends include:

- **Dark, dawn, or dusk conditions:** 33 percent (four crashes) of fatal/incapacitating crashes occurred in dark, dawn, or dusk conditions.
- **Crashes on US 97**. Over half of fatal/incapacitating crashes occurred on US 97.

Vulnerable Users

Key trends include:

- **Pedestrian crashes.** Three of the four reported pedestrian crashes resulted in fatalities.
- **Bicycle crashes.** The three reported bicycle crashes resulted in minor or moderate injuries.
- **Motorcycle crashes.** The two reported motorcycle crashes both resulted in minor or moderate injuries.
- **Drivers over age 65.** 19 percent (24 crashes) of reported crashes involved drivers age 65 and over. Two fatal/incapacitating crashes involved drivers age 65 and over.

2.3 CITY OF REDMOND

Between 2012 and 2016, 1,380 crashes were reported in Redmond. Of these, 49 percent resulted in some level of injury, and two percent (37 crashes) of reported crashes resulted in a fatality or incapacitating injury, as shown in Figure 7. Figure 8 illustrates the location of fatal/incapacitating crashes within the City.

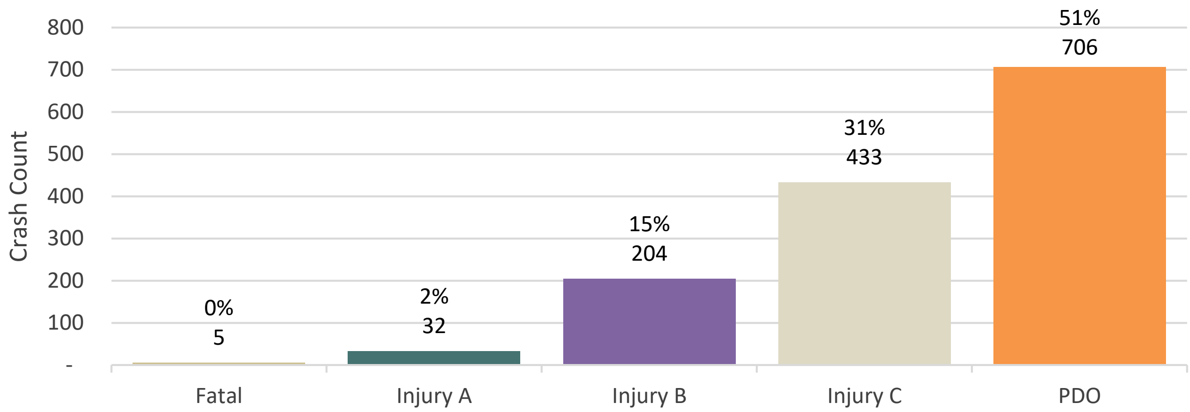
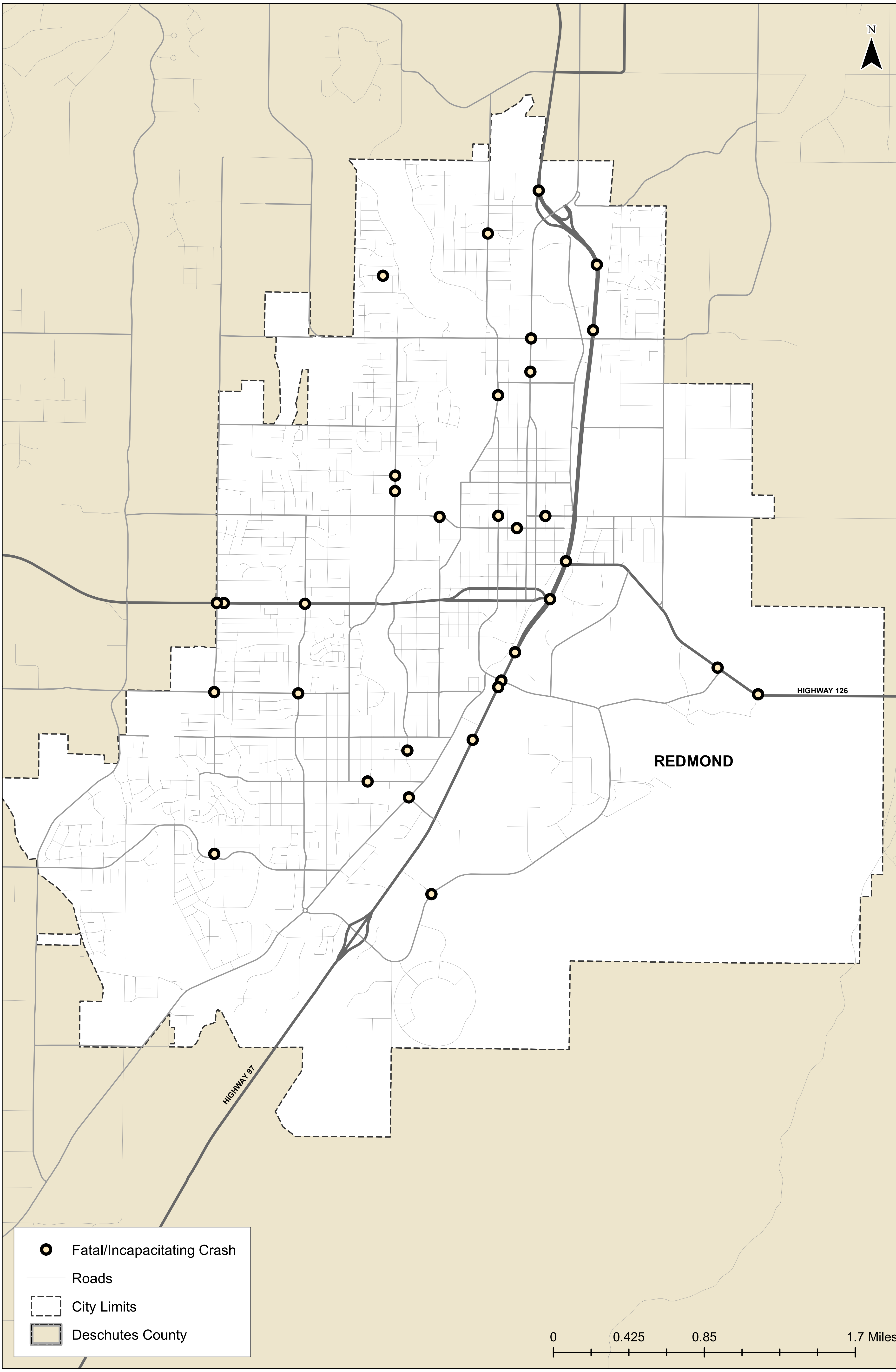


Figure 7. Reported Crashes by Severity, Redmond, 2012-2016



Fatal and Incapacitating Injury Crashes
Redmond, Deschutes County, 2012 - 2016

Figure 8

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Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

KITTELSON & ASSOCIATES

2.3.1 EMPHASIS AREAS – CITY OF REDMOND

Based on the crash analysis using 2012-2016 data, Kittelson identified several emphasis areas for the City of Redmond. These emphasis areas reflect the crash characteristics, such as crash type, behavior, or infrastructure, that were associated with fatal and incapacitating injury crashes. By addressing these emphasis areas, the City has the greatest potential to reduce fatal and incapacitating crashes.

Intersections

Key trends include:

- **Intersection related collision types**. Turning movement, angle, and rear-end crashes accounted for 79 percent of reported crashes and 68 percent of fatal/incapacitating crashes.

Roadway Departure Crashes

Key trends include:

- **Collision types (severity)**. Roadway departure crashes accounted for 17 percent of reported crashes in Redmond and 22 percent of fatal/incapacitating crashes.

Road User Behavior

Key trends include:

- **Excessive speeds**. Speed was involved in 27 percent of fatal/incapacitating crashes in Redmond.
- **Alcohol/drugs involved**. Alcohol/drugs were involved in 11 percent of fatal/incapacitating crashes.
- **Safety equipment usage**. 70 percent of crashes involving at least one participant not using safety equipment resulted in some level of injury.

Roadway Conditions

Key trends include:

- **Dark, dawn, or dusk conditions.** 43 percent (16 crashes) of fatal/incapacitating crashes occurred in dark, dawn, or dusk conditions.

Vulnerable Users

Key trends include:

- **Motorcycles**. Motorcycles were involved in 19 percent of fatal/incapacitating crashes in Redmond.
  - 100 percent of the 31 reported motorcycle crashes resulted in some level of injury.
- **Pedestrian crashes**. The 18 reported pedestrian crashes in Redmond resulted in some level of injury.
  - Three of these crashes resulted in fatal or incapacitating injury, accounting for eight percent of overall fatal/incapacitating crashes in the City.
- **Bicycle crashes**. 88 percent of the 16 reported bicycle crashes in Redmond resulted in some level of injury. Two crashes resulted in incapacitating injuries.

2.4 CITY OF SISTERS

Between 2012 and 2016, 146 crashes were reported in Sisters. Of these, 39 percent resulted in some level of injury, and three percent (five crashes) of reported crashes resulted in a fatality or incapacitating injury, as shown in Figure 9. Figure 10 illustrates the location of fatal/incapacitating crashes within the City.

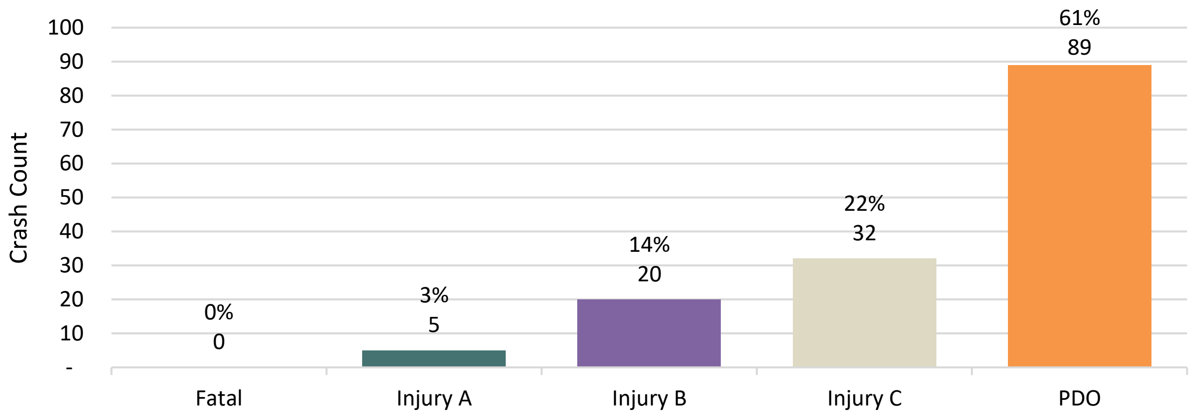
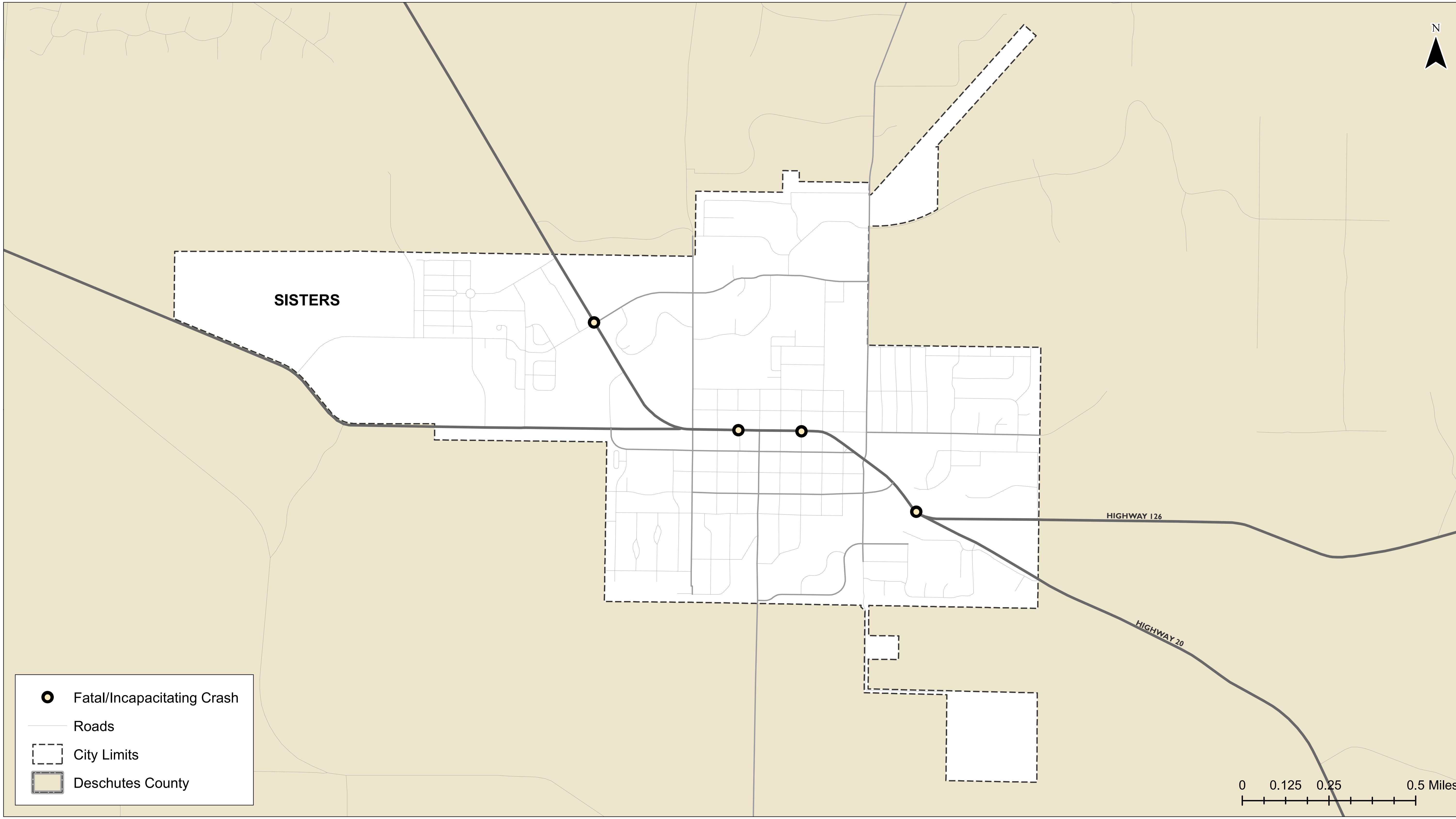


Figure 9. Reported Crashes by Severity, Sisters, 2012-2016



Fatal and Incapacitating Injury Crashes
Sisters, Deschutes County, 2012 - 2016

Figure 10

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KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

2.4.1 EMPHASIS AREAS – CITY OF SISTERS

Based on the crash analysis using 2012-2016 data, Kittelson identified several emphasis areas for the City of Sisters. These emphasis areas reflect the crash characteristics, such as crash type, behavior, or infrastructure, that were associated with fatal and incapacitating injury crashes. By addressing these emphasis areas, the City has the greatest potential to reduce fatal and incapacitating crashes.

Intersections

Key trends include:

- **Intersection related collision types**. Turning movement, angle, and rear-end crashes accounted for 74 percent of reported crashes and three of the five reported incapacitating crashes.
  - 41 percent of turning movement, angle, and rear-end crashes resulted in some level of injury.

Road User Behavior

Key trends include:

- **Alcohol/drugs involved (severity).** Three percent of crashes (four crashes) involved alcohol/drugs. Three of the four reported crashes involving alcohol/drugs resulted in an injury.
- **Safety equipment usage (severity).** Four crashes were reported with at least one participant not using safety equipment; each of these four crashes resulted in injury.

Roadway Conditions & Characteristics

Key trends include:

- **Crashes on Highway 20**. The reported incapacitating crashes occurred on Highway 20.
- **Crashes in dark, dawn, or dusk light conditions**. 53 percent of crashes in these light conditions resulted in injury, compared to daylight conditions which resulted in injury 37 percent of the time.

Vulnerable Users

Key trends include:

- **Pedestrian crashes.** Both pedestrian crashes in Sisters resulted in injury, including one incapacitating injury.
- **Bicycle crashes.** The four reported bicycle crashes in Sisters resulted in injuries.
- **Older drivers.** 19 percent (21 crashes) of reported crashes involved drivers age 65 or over.

Photo: Kittelson & Associates, Inc.

SECTION 3

SYSTEMIC SOLUTIONS

3. SYSTEMIC SOLUTIONS

This section presents recommended systemic engineering countermeasures. Systemic solutions can often be applied on a wide-scale for relatively low-cost. Many of these may be incorporated into ongoing maintenance activities to maximize cost-effectiveness. We have presented the countermeasures in two general groups and summarized the documented effectiveness at reducing crashes through the Crash Reduction Factor (CRF), when available:

- **Roadway Segments and Curves Countermeasures,** which are treatments to reduce the crashes most commonly observed along roadway segments, including lane departure and run-off-the-road crashes. **Pedestrian and bicycle countermeasures** are also included in this section;
- **Systemic Intersection Countermeasures**, which may be applied in a systemic fashion and for relatively low cost at intersections in the County or cities;

Table 3 and Table 4 and summarizes the solutions that are presented in the following sections for segments and intersections, respectively, and provides the documented effectiveness of each treatment at reducing crashes through the Crash Reduction Factor (CRF), when available. Section 5.3 of the TSAP provides maps summarizing locations where specific characteristics, such as light conditions or crash types, were most common. This section should be used to help focus priorities for implementation of the systemic recommendations.

Table 3. Systemic Treatments for Roadway Segments and Curves

Countermeasure	Applicable Crash Types	Crash Reduction Factor (CRF)	Planning-Level Cost*
Rural Roadway Segments & Curves (Signing, Striping, Clear Zone, and Delineation)			
Install Shoulder Rumble Strips	Run off the road	16-42%[1,3]	$3,000 per mile (both sides)
Install Centerline Rumble Strips	All injury crashes	9-45%[1,3]	$2,000 per mile
Widen Paved Shoulder	All crashes	3-18%[1,3]	Varies
Install Chevron Signs on Horizontal Curves	Run off the road injury crashes	4-25%	$300 per sign
Install Dynamic Feedback Signs on Curves	All crashes	5%[1,3]	$10,000 per sign
Install Dynamic Speed Feedback Signs	All crash types	41%[1,3]	$10,000 per sign
Increase Pavement Friction	Crashes on wet roads	20-68%[1,3]	$30 per sq yd
Install/Widen Edge-Line (8") or Centerline Markings	Run off Road	11 – 13%[1,3]	$0.20 per ft (paint); $0.80 per ft (thermoplastic); $2.00 per ft (MMA)
Install Raised or Recessed Pavement Markers	Night-time crashes	15%[1,5]	Raised: $4.20 each; Recessed: $10.00 each
Install Post-Mounted Delineators (Curve Application)	Night-time crashes	0-30%[1]	$38.00 each
Remove, Relocate, or Protect Fixed Objects Adjacent to Road	All crashes	38%[3]	Varies
Corridor Access Management			
Close, Consolidate, or Relocate Driveways (Access Management)	All injury crashes	Varies based on driveway density	Varies
Pedestrians & Bicyclists			
Install Pedestrian Refuge Island	Pedestrian crashes	26-31%[1,4]	$25,000
Curb Extensions	Pedestrian Crashes	37%	$20,000
Install Rectangular Rapid Flashing Beacon	Pedestrian crashes	10-56%[1]	$20,000 - $50,000
Install Pedestrian-Scale Lighting	Night-time pedestrian and bicycle crashes	42%[1,2]	$8,500 per pole
Install or buffer bicycle lanes	Bicycle	Varies	$20,000 - $30,000 per mile (striping only)
Bicycle Signage and Beacons at Pinch Points	Bicycle	N/A	$10,000

*Planning-level cost estimates were obtained from ODOT's list of approved CRFs, unless marked with an asterisk (*).
Crash Reduction Factor Sources:
[1] ODOT ARTS
[2] Highway Safety Manual
[3] CMF Clearinghouse
[4] NCHRP Report 841
[5] Caltrans / Intersection Implementation Plan / ODOT

Table 4. Systemic Treatments for Intersections

Countermeasure	Applicable Crash Types	Crash Reduction Factor (CRF)	Planning-Level Cost*
Rural Two-Way Stop-Controlled Intersections (Signing, Striping, Illumination)			
Increase Intersection Warning with Signing and Striping (FHWA low-cost systemic intersection recommendations)	All	11 – 55%[1,4]	Varies ($400 per new sign; $700 per oversized sign; $1,000 per Stop Ahead legend)
Install Raised Divider on Stop Approach (Splitter Island)	All crashes	15%[1]	$7.55 per sq ft
Transverse Rumble Strips on Stop-controlled Approaches	Fatal and incapacitating crashes	25%[1, 3]	$500 each
Provide "Stop Ahead" Pavement Markings	All crash types	31%[3]	$1,000 each
Provide Flashing Beacons at Stop-Controlled Intersections	Angle crashes	5-58%[1,2]	$5,000 per mount
Install intersection lighting	Nighttime	31 – 38%[1,2]	$8,500 per pole
Intersection Geometry			
Install a Roundabout	All crash types	19-82%[1,2]	$2.5M-3M*
Reduce Intersection Skew	All crash types	Varies by skew angle[3]	Varies
Increase Sight Distance	All injury crashes	11-56%[1,3]	Varies
Install Left-Turn Lanes on Major Roads at Stop-Controlled Intersections	All crash types	33-58%[1,2]	Varies
Install Rural Median Acceleration Lane	All injury crashes	20-79%[3]	Varies

*Planning-level cost estimates were obtained from ODOT's list of approved CRFs, unless marked with an asterisk (*).
Crash Reduction Factor Sources:
[1] ODOT ARTS
[2] Highway Safety Manual
[3] CMF Clearinghouse
[4] Caltrans / Intersection Implementation Plan / ODOT

3.1 ROADWAY SEGMENTS & CURVES COUNTERMEASURES

This category of countermeasures includes treatments to reduce the crashes most commonly observed along roadway segments, including lane departure and run-off-the-road crashes. Pedestrian and bicycle countermeasures are also included in this section.

Install Shoulder Rumble Strips

Install Shoulder Rumble Strips		
Shoulder rumble strips provide auditory and tactile feedback to motorists when they begin to exit the outside of the travel lane. Shoulder rumble strips can help reduce run-off-the-road crashes by alerting drivers that they are traveling beyond the designated lane. Consideration should be given to bicycle traffic when determining where to place rumble strips and how to accommodate bicyclists on the shoulder.		
Intersection or Segment	*Segment*	 Source: FHWA Proven Safety Countermeasures
Applicable Collision Types	*Run off the road collisions*	
Potential Collision Reduction	*16-42%*	
Planning-Level Cost	*$3,000 per mile (both sides)*	

Install Centerline Rumble Strips

Install Centerline Rumble Strips	
Centerline rumble strips provide auditory and tactile feedback to motorists when they have begun to cross over the centerline of the roadway. Centerline rumble strips can reduce head-on and other crossover crash types on horizontal curves of undivided roadway segments by alerting drivers they are crossing over the centerline into the opposing direction of traffic.	
Intersection or Segment	*Segment*
Applicable Collision Types	*All injury collisions*
Potential Collision Reduction	*9-45%*
Planning-Level Cost	*$2,000 per mile*


Source: FHWA

** Persaud, B. N., Retting, R. A., and Lyon, C., "Crash Reduction Following Installation of Centerline Rumble Strips on Rural Two-Lane Roads." Arlington, Va., Insurance Institute for Highway Safety, (2003)*

Widen Paved Shoulder

Widen Paved Shoulder	
Widen the paved shoulder adjacent to travel lanes. Paved shoulders may increase safety performance when navigating horizontal curves by providing a paved recovery area for motorists who have left the travel lane. The shoulder can help a driver maintain control and correct the vehicle path. Widening the outside shoulder of a curve provides the greatest benefit on roads where existing space is limited. This treatment also benefits bicyclists by providing more dedicated space for the bicyclists separate from motor vehicle traffic.	
Intersection or Segment	*Segment*
Applicable Collision Types	*All collisions*
Potential Collision Reduction	*3-18%*
Planning-Level Cost	*Varies*


Source: FHWA

Install Chevron Signs on Horizontal Curves

Install Chevron Signs on Horizontal Curves	
Chevron signs along horizontal curves provide a visual que to alert and guide motorists through an approaching curve. Chevron signs alert drivers to reduce speeds and prepare to enter a curve. Chevron placement also helps guide drivers through the curve by providing a visual cue to the approaching curve's radius.	
Intersection or Segment	*Segment*
Applicable Collision Types	*Run off the road injury collisions*
Potential Collision Reduction	*4-25%*
Planning-Level Cost	*$300 per sign*

Source: FHWA

Install Dynamic Feedback Sign on Curves

Install Dynamic Feedback Sign on Curves	
Dynamic speed warning signs alert drivers of their speed into the approach of a curve when their speed is above the curve design speed. Dynamic speed warning signs can reduce curve-related crashes by providing visual feedback to the driver that speeds should be reduced when approaching a curve.	
Intersection or Segment	*Segment*
Applicable Collision Types	*All collisions*
Potential Collision Reduction	*5%*
Planning-Level Cost	*Varies*

Source: FHWA

Install Changeable Speed Warning Signs

Install Dynamic Speed Feedback Signs		
Dynamic speed feedback signs display the speed of approaching vehicles. Dynamic signs can display other information or signage that is triggered by an approaching vehicle.		
Intersection or Segment	*Segment*	 Source: FHWA
Applicable Collision Types	*All collisions*	
Potential Collision Reduction	*41%*	
Planning-Level Cost	*$10,000*	

Increase Pavement Friction

Increase Pavement Friction		
High friction surface treatments apply aggregate to the pavement to increase or maintain the pavement friction at a site. Increasing or maintaining appropriate pavement friction through a curve can reduce the potential for motorists to lose control of their vehicle or skid when navigating a curve. Increased pavement friction has been shown to reduce crash frequency during wet conditions and in locations with high friction demand caused by vehicle speeds or roadway geometrics.		
Intersection or Segment	*Segment*	 Source: FHWA
Applicable Collision Types	*Collisions on wet roads*	
Potential Collision Reduction	*20-68%*	
Planning-Level Cost	*$30 per sq yd*	

Install or Widen Edge-lines

Install or Widen Edge-lines (8")

Restripe edge-lines to increase their width to improve visibility for drivers. Wider edge-lines more clearly define the edge of the roadway. This increased visibility of the edge of roadway can reduce the incidence of vehicles leaving the roadway.

Intersection or Segment	*Segment*
Applicable Collision Types	*Run off the road collisions*
Potential Collision Reduction	*11-13%*
Planning-Level Cost	*$0.20 per ft (paint); $0.80 per ft (thermoplastic); $2.00 per ft (MMA)*

Source: Texas A&M Transportation Institute

Install Raised or Recessed Pavement Markers

Install Raised or Recessed Pavement Markers

Raised or recessed pavement markers are installed along the edge and centerline of the roadway to increase reflectivity and visibility during night-time conditions.

Intersection or Segment	*Segment*
Applicable Collision Types	*Nighttime crashes*
Potential Collision Reduction	*15%*
Planning-Level Cost	*Raised: $4.20 each; Recessed: $10.00 each*

Source: FHWA

Install Post-Mounted Delineators (Curve Application)

Install Posted-Mounted Delineators

Post mounted delineators can be installed outside the roadway to provide better delineation for drivers to see where the roadway is, particularly during low-visibility conditions.

Intersection or Segment	*Segment*
Applicable Collision Types	*Nighttime crashes*
Potential Collision Reduction	*0-30%*
Planning-Level Cost	*$38.00 each*

Source: FHWA

Remove, Relocate, or Protect Fixed Objects Adjacent to Road

Remove, Relocate, or Protect Fixed Objects Adjacent to Road

Remove or relocate fixed objects adjacent to the roadway to increase the unpaved shoulder clear zone. Clearing or moving fixed-objects away from the roadway can reduce fixed-object crashes by providing a clear zone that gives drivers more space and time to correct their path should they leave the road.

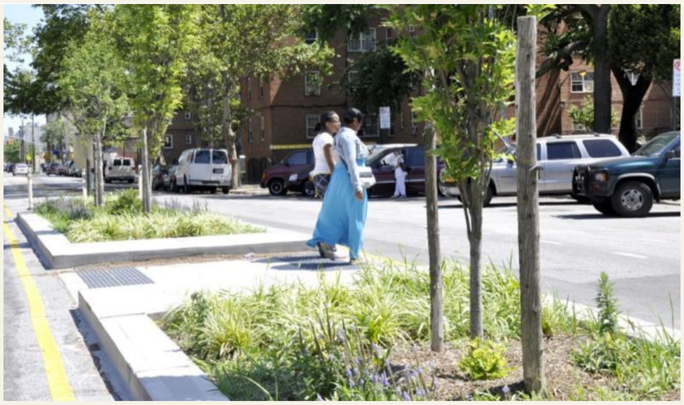
Intersection or Segment	*Segment*
Applicable Collision Types	*All collisions*
Potential Collision Reduction	*38%*
Planning-Level Cost	*Varies*

Source: Florida Vegetation Management Association

Close, Consolidate, or Relocate Driveways (Access Management)

Close, Consolidate, or Relocate Driveways (Access Management)		
Access management refers to the control of entry and exit points along a roadway. Access management treatments can include closing, consolidating, or relocating driveways or restricting certain movements in and out of driveways. This treatment can enhance safety for all modes, facilitate walking and biking, reduce trip delay and congestion, and decrease vehicle conflicts.		
Intersection or Segment	*Segment*	 A raised median reduces conflict points along this roadway. Source: FHWA
Applicable Collision Types	*All injury crashes*	
Potential Collision Reduction	*Varies based on driveway density*	
Planning-Level Cost	*Varies*	

Pedestrian Refuge Island

Pedestrian Refuge Island		
Median refuge islands are physical crossing enhancements that allow for two-stage crossings (where people only need to cross one direction of travel at a time). This effectively shortens the crossing distance and reduces exposure to vehicles. Median refuge islands are most suitable for locations where pedestrians must cross three or more vehicle travel lanes (but may also be considered in other locations, space permitting). Medians may also support speed management on high-speed roadways at uncontrolled or midblock crossing locations.		
Intersection or Segment	*Intersection/Segment*	 *Source: New York City DOT*
Applicable Collision Types	*26 – 31%*	
Potential Collision Reduction	*37%*	
Planning-Level Cost	*$25,000*	

Curb Extensions

Curb Extensions

Curb extensions visually and physically narrow the roadway at pedestrian crossing locations and provide additional space to wait at street corners while reducing crossing distances for pedestrians. Curb extensions increase visibility of pedestrians by bringing the crossing further into the roadway. This is especially beneficial with the presence of on-street parking at the approach to the crossing. Curb extensions can also serve as transit stop locations to support bus priority in not leaving the traffic stream.

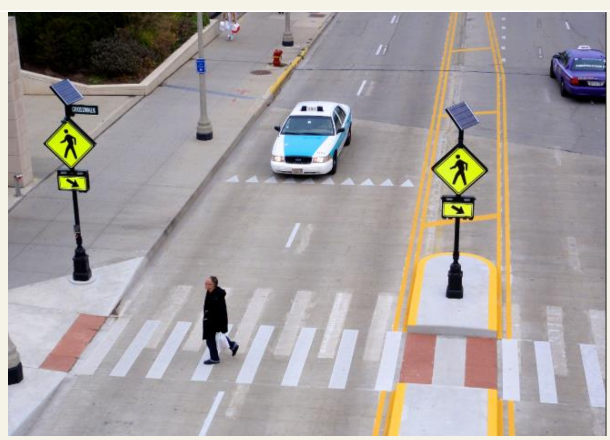
Intersection or Segment	*Intersection/Segment*
Applicable Collision Types	*Pedestrian Collisions*
Potential Collision Reduction	*37%*
Planning-Level Cost	*$20,000*

Rectangular Rapid Flashing Beacon (RRFB)

Rectangular Rapid Flashing Beacon

Rectangular rapid-flashing beacons (RRFBs) are pedestrian-actuated warning signs supplemented with high-visibility LED lights. When activated, RRFBs flash a high-visibility strobe-like light warning drivers when pedestrians are crossing. RRFBs have shown to reduce pedestrian collisions by up to 47%. RRFBs should be used in locations with high pedestrian safety issues as over-use may diminish their effectiveness. Installing median pedestrian islands with RRFBs can also reduce crashes at pedestrian crossings with more than two lanes.

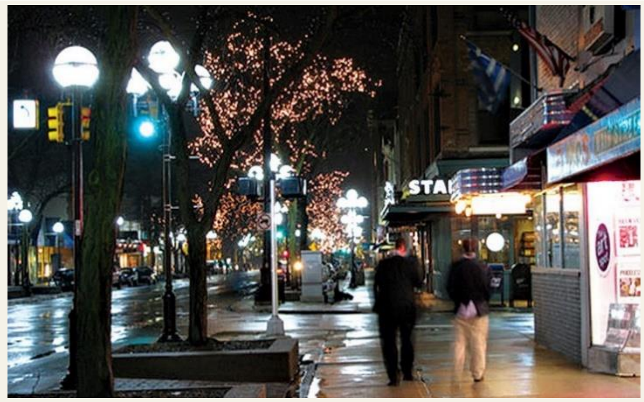
Intersection or Segment	*Segment*
Applicable Collision Types	*Pedestrian Collisions*
Potential Collision Reduction	*10 – 56%*
Planning-Level Cost	*$20,000 - $50,000*



Source: FHWA

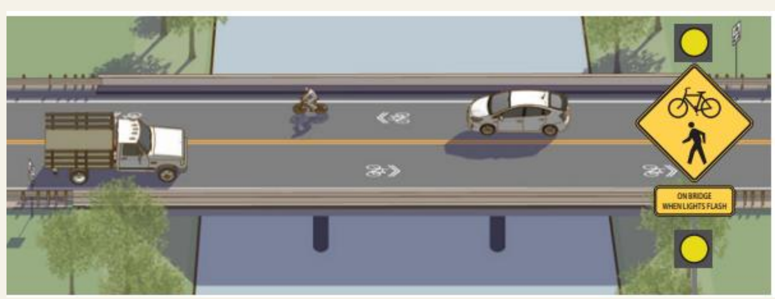
Pedestrian-Scale Lighting

Pedestrian Scale Lighting	
Pedestrian-scale lighting is lower to the ground and more closely spaced than street or intersection lighting. Pedestrian-scale lighting illuminates sidewalks, increases perception of personal security and comfort for pedestrians, and increase driver awareness and visibility of pedestrians.	
Intersection or Segment	*Intersection/segment*
Applicable Collision Types	*Nighttime Pedestrian and Bicycle Collisions*
Potential Collision Reduction	*42%*
Planning-Level Cost	*$8,500 per pole*



Install Bicycle Signage and Beacons at Pinch Points

Install Bicycle Signage and Beacons at Pinch Points	
At locations with physical constraints, such as bridges and tunnels, active warning beacons, signage, and pavement markings may be used to alert drivers that bicyclists are on the roadway. It may be appropriate to reduce vehicle speeds through reduced posted or advisory speed limits and traffic calming measures to increase bicyclist comfort.	
Intersection or Segment	*Segment*
Applicable Collision Types	*Bicycle Collisions*
Potential Collision Reduction	*Not available*
Planning-Level Cost	*$10,000*



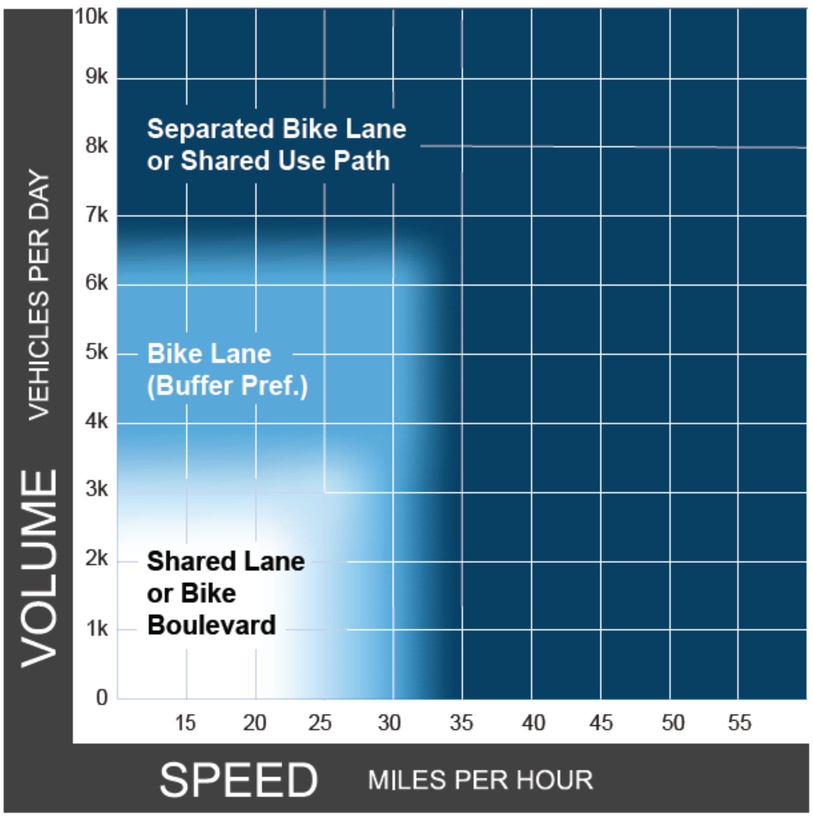
Source: FHWA Small Town and Rural Multimodal Networks

Bicycle Lanes

Bicycle facilities, which may include bicycle lanes, separated paths, or shared lanes, may be applicable at some locations in the County or cities. The context of each location should be considered to determine whether a treatment is applicable at that location. The FHWA *Bikeway Selection Guide* makes recommendations for the type of bikeway appropriate given the level of motor vehicle volume and prevailing speeds on a given roadway (see Figure 11.) The County and cities may consider this guidance when determining if a bicycle facility is applicable for specific roads.

The County has many miles of roadway, often higher speeds, which would require widening to accommodate separated bicycle lanes or shared use paths. These treatments would not be considered low-cost systemic treatments; widening or installing shared use paths is a relatively high cost treatment. This section is meant to provide tools but does not set the expectation these facilities would be applicable on all County roads. The County will use engineering judgment and their long-range planning efforts to determine if any County roads should include these facilities. These treatments may be more easily applied in urban areas where speeds may be lower on some roads and existing pavement width may be wider.

In general, the varying levels of bikeway treatments provide similar benefits of dedicating roadway space for bicyclists. A detailed description of bikeway treatments is provided below.



Notes

1 Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.
2 Advisory bike lanes may be an option where traffic volume is <3K ADT.
3 See page 32 for a discussion of alternatives if the preferred bikeway type is not feasible.

Figure 11. Bicycle Facility Selection for Urban or Suburban Areas (Figure 9 from Bikeway Selection Guide)

Class I: Bike Path / Shared-Use Path

Class I Bike Path / Shared-Use Path

Bike paths provide a separated facility for exclusive bicyclist and pedestrian use. They have minimal or no conflicting motor vehicle traffic. Generally, bike paths serve corridors not served by streets (e.g., river paths or converted rail rights-of-way) or may be parallel to roadways where right-of-way is available (sidepaths). Bike paths provide recreational and commute routes for bicyclists. Shared-use paths are typically installed along independent rights-of-way (for example, along greenways or abandoned rail trails). Path crossings may be designed with yield, signal, or stop control depending on path volume and traffic volume on the crossing street. Refer to MUTCD 9C.04 for more information.

Intersection or Segment	*Segment*
Applicable Collision Types	*Bicycle Collisions*
Potential Collision Reduction	*N/A*
Planning-Level Cost	*Varies, approximately $300/linear foot*

Class II: Bike Lanes / Buffered Bike Lanes

Class II Bike Lanes / Buffered Bike Lanes

Bike lanes are on-street facilities. This facility type includes bike lanes with a painted buffer (stripe) but no physical (horizontal and vertical) separation between vehicle travel lanes and bicycle travel lanes. The class II designation includes buffered bike lanes, which provide extra lateral separation visually but without vertical elements. In general, a buffer is preferred where possible. When bicycle lanes are installed on roads with on-street parking, the buffer should be wide enough to prevent "dooring" bicycle crashes.

Intersection or Segment	*Segment*
Applicable Collision Types	*Bicycle Collisions*
Potential Collision Reduction	*0 – 53%*
Planning-Level Cost	*$20,000-$30,000 per mile (striping only)*

Class III: Bike Routes / Bicycle Boulevards

Class III Bike Routes / Bicycle Boulevards / Urban Greenways		
Bike routes (which may be designated as "bicycle boulevards" or "urban greenways") provide shared use of right-of-way among bicyclists and motorists, as designated by signs or permanent markings along a route. Roadways designated as Class III bike routes should have enough width to accommodate motorists and bicyclists together. Shared-lane markings ("sharrows") can be used to alert users of the shared roadway environment. Because the right-of-way is shared, speed management on Class III bikeways is essential (see the *Speed Management Toolbox* later in this Plan).		
Intersection or Segment	*Segment*	 *Source: NACTO*
Applicable Collision Types	*Bicycle Collisions*	
Potential Collision Reduction	*N/A*	
Planning-Level Cost	*$20,000 per mile (striping)*	

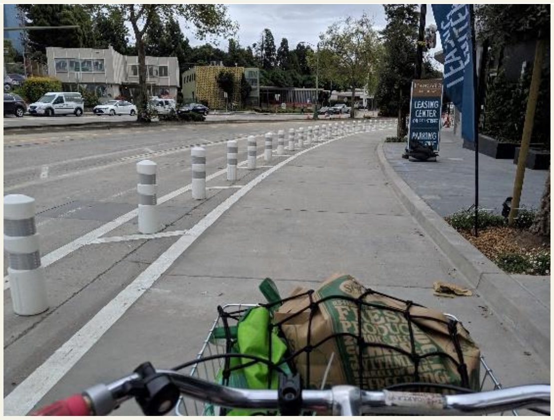
Class IV: Separated Bikeways

Class IV Separated Bikeways

Separated bikeways provide a physical separation from vehicular traffic. This separation may include grade separation (slightly elevated bike lane), flexible posts, planters or other inflexible physical barriers, or on-street parking. These bikeways provide bicyclists a greater sense of comfort and security, especially in the context of high-speed roadways. Separated facilities can provide one-way or two-way travel and may be located on either side of a one-way roadway.

Separated bikeways are appropriate at speeds and volumes where bike lanes or buffered bike lanes do not adequately address the comfort needs of a majority of the candidate biking population (see Figure 11). These facilities are more appropriate than shared-use paths if pedestrian and bicyclist volumes are expected to be relatively high (i.e., separation of bicyclists and pedestrians is encouraged).

Intersection or Segment	*Segment*
Applicable Collision Types	*Bicycle Collisions*
Potential Collision Reduction	*N/A*
Planning-Level Cost	*$20,000-$30,000 per mile (striping only)*



3.2 SYSTEMIC INTERSECTION COUNTERMEASURES

This section summarizes the countermeasures that are applicable at intersections. Many of these can be applied in a systemic fashion for relatively low cost at intersections in the County or cities.

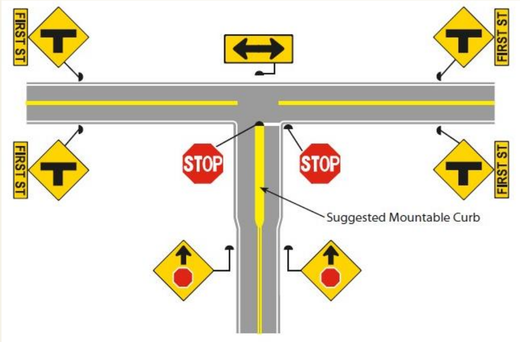
Increase Intersection Warning with Signing and Striping

Increase Intersection Warning with Signing and Striping

Implementing a package of low-cost treatments can be used to increase intersection warning and improve safety performance at unsignalized intersections. The improvements may include:

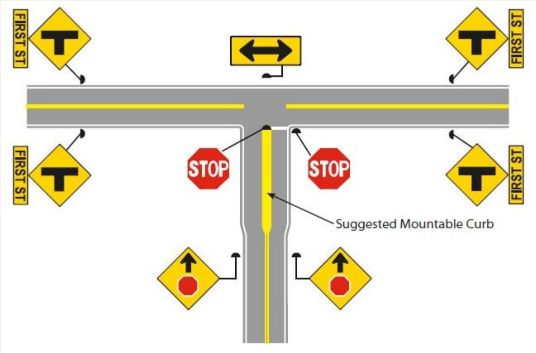
- doubled (left and right) oversize warning signs,
- doubled STOP signs,
- a raised splitter island on the stop approach (if feasible),
- street name signs,
- stop bars,
- removing any limitations to sight distance, and
- double warning arrow at the stem of T-Intersections.

This set of enhancements combines multiple treatments to make the approach of two-way stop-controlled intersections more visible to the driver and increase awareness and visibility of potential conflicts. These treatments can help slow approaching vehicles and increase stop compliance on the controlled approaches. The County and cities should determine which treatments are appropriate at the individual locations where they are applied; some of the treatment options may not be applicable at every location.

Intersection or Segment	*Intersection (Unsignalized)*	 Source: FHWA
Applicable Collision Types	*All collisions*	
Potential Collision Reduction	*11-55%*	
Planning-Level Cost	*Varies: $400 per new sign; $700 per oversized sign; $1,000 per Stop Ahead legend*	

** FHWA, "Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections," (2014)*

Install Raised Divider on Stop Approach (Splitter Island)

Install Raised Divider on Stop Approach (Splitter Island)		
Installing a raised divider (with mountable curb) on a stop-controlled approach to an intersection can increase intersection visibility by adding a left-side stop sign and better delineate vehicle paths at the intersection. Where possible, a minimum width of 6-feet should be used for the splitter island.		
Intersection or Segment	*Intersection (Unsignalized)*	 Source: FHWA
Applicable Collision Types	*All collisions*	
Potential Collision Reduction	*15%*	
Planning-Level Cost	*$7.55 per sq ft*	

* *FHWA, "Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections," (2014)*

Transverse Rumble Strips on Stop-Controlled Approaches

Install Transverse Rumble Strips on Stop-Controlled Approaches		
Transverse rumble strips create an audible warning to attract the attention of a driver and alert them to a possible change of conditions, such as an upcoming stop control or curve. Transverse rumble strips should be used in conjunction with advance signing to warn of the intersection ahead. Care should be taken to avoid installing transverse rumble strips near residences and businesses due to the noise generated by the vehicles when driving over the strips. In locations with bicycle lanes or wide paved shoulders, these should not extend into the bicyclists area.		
Intersection or Segment	*Intersection (Unsignalized)*	 Source: FHWA
Applicable Collision Types	*Fatal & incapacitating collisions*	
Potential Collision Reduction	*25%*	
Planning-Level Cost	*$500 each*	

* *FHWA, "Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections," (2014)*

Provide "Stop Ahead" Pavement Markings

Install "Stop Ahead" Pavement Markings		
Stop ahead pavement markings are used to alert drivers of the presence of an intersection and that stopping is required. These markings provide a supplementary message and should be used in conjunction with additional regulatory warning and stops signs.		
Intersection or Segment	*Intersection (Unsignalized)*	 Source: FHWA
Applicable Collision Types	*All collisions*	
Potential Collision Reduction	*31%*	
Planning-Level Cost	*$1,000 each*	

Provide Flashing Beacons at Stop-Controlled Intersections

Provide Flashing Beacons at Stop-Controlled Intersections		
Flashing beacons can be placed above stop-signs, as well as above stop-ahead warning signs, to raise intersection visibility and awareness. Flashing beacons may flash continuously or be actuated when a vehicle approaches the intersection. This treatment may help reduce angle collisions at intersections where driver awareness of the approaching intersection is a challenge.		
Intersection or Segment	*Intersection (Unsignalized)*	 Source: FHWA
Applicable Collision Types	*Angle collisions*	
Potential Collision Reduction	*5-58%*	
Planning-Level Cost	*$5,000 per mount*	

** FHWA, "Safety Evaluation of Flashing Beacons at Stop-Controlled Intersections," (2008) https://www.fhwa.dot.gov/publications/research/safety/08048/index.cfm*

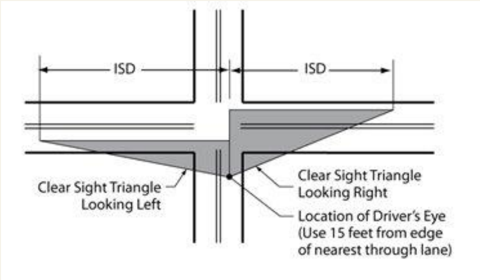
Intersection Lighting

Intersection Lighting		
Adding intersection lighting for signalized and non-signalized intersections helps improve the visibility of the intersection and potential conflicts. Intersection illumination, including pedestrian crossings, helps illuminate crossing pedestrians for approaching motorists and assists pedestrians in navigating the crossing.		
Intersection or Segment	*Intersection*	
Applicable Collision Types	*Nighttime*	
Potential Collision Reduction	*31 – 38%*	
Planning-Level Cost	*$8,500 per pole*	

Roundabouts

Roundabouts		
Roundabouts feature channelized approaches and a central island to move traffic through an intersection. At roundabouts, entering traffic yields to vehicles already circulating, leading to improved operational performance. Single-lane roundabouts are typically designed so that drivers must approach the intersection at speeds below 25 miles per hour. The approach speed can reduce the severity of crashes when compared to other intersection forms. Roundabouts can be used in place of a two-way and all-way stop controlled intersection, and potentially traffic signals depending on volume. Replacing a rural two-way stop-controlled intersection with a single-lane roundabout has been shown to reduce injury crashes as much as 87 percent.		
Intersection or Segment	*Intersection*	
Applicable Collision Types	*All*	
Potential Collision Reduction	*19 – 82%*	
Planning-Level Cost	*$2.5M - $3M*	Source: FHWA

Increase Sight Distance

Increase Sight Distance		
Increasing intersection sight distance may involve a variety of actions to increase the line of sight including clearing vegetation and embankments, relocating objects, implementing parking restrictions. By increasing intersection sight distance, drivers are provided with a greater distance to see potential conflicts and complete maneuvers to avoid potential collisions.		
Intersection or Segment	*Intersection (Signal and Unsignalized)*	
Applicable Collision Types	*All injury collisions*	
Potential Collision Reduction	*11-56%*	
Planning-Level Cost	*Varies*	Source: FHWA

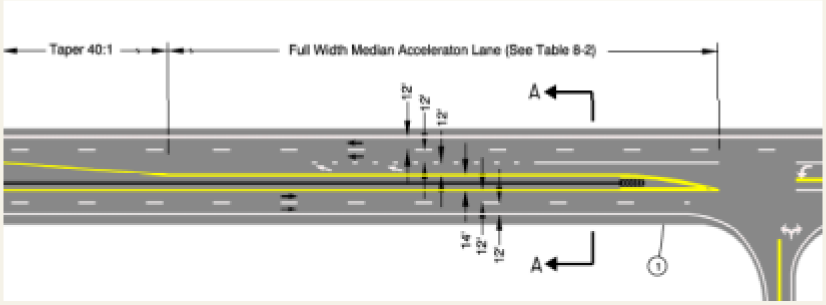
* *FHWA, "Intersection Safety: A Manual for Local Rural Road Owners,"*
https://www.fhwa.dot.gov/publications/research/safety/08048/index.cfm

Install Left-Turn Lanes on Major Roads at Stop Controlled Intersections

Install Left-Turn Lanes on Major Roads at Stop-Controlled Intersections		
Left-turn lanes provide physical separation between turning vehicles and through traveling vehicles, thus separating the slowing vehicles from the rest of traffic and reducing the risk for rear-end crashes. Left-turn lanes allow drives to continue through the intersection without having to stop for traffic making left turns.		
Intersection or Segment	*Intersection (Signal and Unsignalized)*	
Applicable Collision Types	*All collisions*	
Potential Collision Reduction	*33-58%*	
Planning-Level Cost	*Varies*	Example of left-turn lanes. Source: FHWA

Install Rural Median Acceleration Lane

Install Rural Median Acceleration Lane	
Rural median acceleration lanes allow vehicles turning from the side street onto the major street to complete a two-stage left-turn. Vehicles must wait for a gap in one direction of traffic before turning into the acceleration lane, where they are able to accelerate and merge into the travel lane at full speed.	
Intersection or Segment	*Intersection (Signal and Unsignalized)*
Applicable Collision Types	*All injury collisions*
Potential Collision Reduction	*20-79%*
Planning-Level Cost	*Varies*



Source: ODOT APM

Photo: Kittelson & Associates, Inc.

SECTION 4

SPEED MANAGEMENT TOOLBOX

4. SPEED MANAGEMENT TOOLBOX

Kittelson identified speeding as an emphasis area for the County. Excessive speed can exacerbate risks when a crash occurs, especially for bicyclists and pedestrians. As such, managing speeds is an area of continued interest for the County. Kittelson developed a secondary set of treatments for managing speeds, either by reducing the frequency of unsafe speeds by motorists and/or by clearly indicating to drivers when speeds need to be reduced to prepare for a change in roadway conditions, such as a stop-controlled intersection or curve. Kittelson focused on low-cost treatments that may be implemented in a systemic manner.

The types of treatments and other strategies presented in the Speed Management Toolbox are organized into the following three categories:

- Pavement markings;
- Physical roadway improvements; and,
- Signage.

For each treatment, a description is provided as well as guidance on typical application.

4.1 PAVEMENT MARKINGS

This section describes speed management treatments that use pavement to provide visual cues and messaging.

Transverse Lane Marking

Description: Transverse lane markings are horizontal markings placed on the roadway. There are many types of transverse lane markings including optical bars and chevron marking. They may extend partially into a lane or be placed fully across the lane.

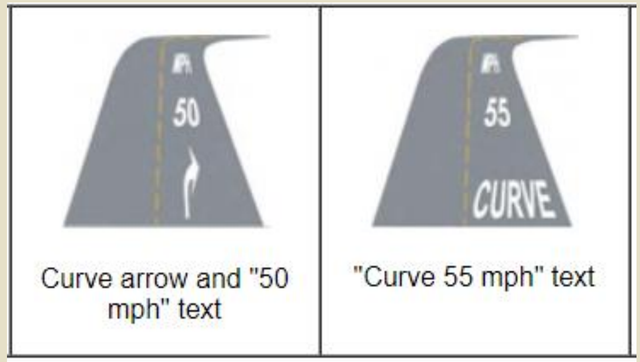
Application Guidance: Transverse markings are especially useful for transition zones and can be used in locations where there is an approaching change in roadway character such as an intersection or curve. Markings may be spaced increasingly closer on the approach to an intersection to give the appearance so a driver is more aware of their speed. Transverse lane markings support decreased speeds on intersection approaches or other roadway transition. Optical speed bars are an additional type of transverse marking. MUTCD Section 3B.22 provides guidance on placement of optical speed bars.

Source: FHWA

Speed Advisory Markings in Lane (“Slow”, “Curve”, or “Speed Limit XX”)

Description: Advisory markings provide information before curves and other advisory zones. Markings may include the speed limit or a warning of an approaching curve.

Application Guidance: NCHRP Report 600: *Human Factors Guidelines for Road Systems* contains guidelines for effective markings. The report found that usage of speed advisory markings may lower speeds by up to 4 MPH and showed an 11% reduction in vehicles exceeding the speed limit. Speed advisory markings can supplement other signage such as curve advisory signs. MUTCD Section 3B.20 provides design and placement criteria for pavement advisory markings.



Source: FHWA

Colored Pavement Advisory Markings

Description: Adding color to advisory pavement markings may make the markings more visible to the driver.

Application Guidance: Colored pavement markings are typically used in transition zones but may be appropriate for rural roadways in general or where there is a change in roadway character, such as an approaching curve. Studies have study found colored pavement markings reduced mean speeds between 2.3 and 7.4 MPH.

Source: Iowa State University, Speed Management Toolbox for Rural Communities

Shoulder Widening to Narrow Travel Lanes

Description: Shoulders in rural areas can be widened to visually narrow the roadway. The example figure shows an example of shoulders with transverse striping. Shoulders can be colored to further define the roadway edge and further the appearance of lane narrowing.

Application Guidance: This treatment is most applicable in areas where there is the right-of-way available to widen the shoulder. Narrowing lanes can reduce excessive speeding, but lanes that are too narrow for larger vehicles may increase crashes.

Source: Iowa State University, Speed Management Toolbox for Rural Communities

Wider Edge-Lines

Description: Edge-lines are a visual pavement marking that guide drivers when navigating a roadway. Wider edge-lines further delineate the roadway path, make the roadway appear narrower, and can increase driver perception of speed.

Application Guidance: Edge-lines can be placed along roadways with curves or long straight segments. Although the specific effect of wider edge-lines on speed is not available, studies have shown that widening edge-lines has reduced crashes on rural roadway segments. Wide edge-lines can only be installed on roadways where there is sufficient right-of-way. See the countermeasure treatment toolbox for more information on wider edge-lines.

Source: Texas Transportation Institute

4.2 PHYSICAL ROADWAY IMPROVEMENTS

This section describes speed management treatments that alter the physical roadway. The treatments range from relatively low-cost treatments, like vertical centerline posts to more expensive construction projects, such as installing a roundabout.

Splitter Islands at Intersections

Description: Splitter islands are a treatment for stop-controlled intersections that may be located on the approach to an intersection to increase the intersection visibility and allow space to add a left-side stop sign. They can also be used to provide deflection on the intersection approach to support speed reduction. They help channelize and guide turning vehicles from the major roadway.

Application Guidance: Splitter islands have been shown to be effective at decreasing traffic speed and reducing intersections crashes. Splitter islands can be combined with doubled-up stop signs for increased visibility. NCHRP Report 279 covers splitter island design and placement.

Source: FHWA

Horizontal Deflections

Description: Horizontal deflections are a type of physical roadway or curb enhancement to narrow or otherwise break up a roadway's straight design character. A horizontal deflection requires the motorist to navigate a curvilinear alignment stay on the roadway path.

Application Guidance: Horizontal deflections can provide a visual endpoint for the roadway along curves. Lateral shifts, chicanes, and roundabouts are examples of horizontal deflections. Horizontal deflections are more common in populated areas and can be integrated as a part of other roadway infrastructure such as medians, pedestrian islands, or curb extensions. Center islands are an additional type of horizontal defection that provides separation from traffic and can reduce the risk of a head-on collision occurring.

Source: City and County of San Francisco

Vertical Centerline Posts

Description: Vertical centerline posts are a type of vertical treatment that delineates the centerline. This treatment is also known as a longitudinal channelizer.

Application Guidance: Vertical delineators can be used for lane narrowing. Delineators may be between 18-36 inches tall and spaced 32 inches apart. Posts should only be applied where there is enough room in the roadway to accommodate larger vehicles. This treatment can help reduce speed along long straight roadways. Centerline vertical delineators placed on rural roads have been shown to reduce average speed by as much as 3 MPH. Delineators also have the benefit of separating oncoming traffic and potentially reducing the risk of head-on collisions.

Source: Iowa State University, Speed Management Toolbox for Rural Communities

Sinusoidal Transverse Rumble Strips

Description: Rumble strips provide an auditory warning to drivers of an approaching change in roadway character. Sinusoidal rumble strips are a type of rumble strip that has a sine wave milled into the pavement. This design reduces the amount exterior noise of the rumble strips and vibration while still providing interior noise and rumble.

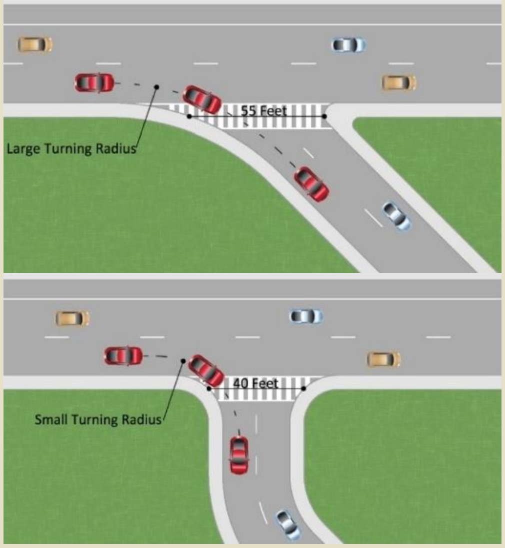
Application Guidance: Sinusoidal rumble strips can be applied in the same way that transverse rumble strips are installed. The grooves of transverse rumble strips are installed perpendicular to the roadway travel lane. Transverse rumble strips are most effective at locations before an intersection, transition zone, or other change in roadway character. The sinusoidal design allows the speed management benefits of transverse rumble strips without the noise.

Source: Caltrans

Intersection Realignment

Description: Realigning a skewed intersection to meet at a right angle can improve safety performance and decrease speed in the approach to the intersection by making the intersection more visible.

Application Guidance: In an intersection realignment, the straight-through movement should become the top of the 'T' and approaches should be as perpendicular as possible, given site conditions. Intersection realignment also improves sight distance for drivers approaching the intersection.



Source: FHWA, Pedestrian Safety Guide and Countermeasure Selection System

Speed Tables

Description: Speed tables are flat-top mounds that cover the full width of the roadway to create vertical deflection. Speed tables are similar in design to speed humps with an elongated top that covers the wheelbase of a passenger car.

Application Guidance: Speed tables can target speeds as high 45 MPH. Speed tables are most effective in transition zones or community-focused streets. Consideration should be given to accommodate trucks, emergency responders, or other larger vehicles.

Source: FHWA

4.3 SIGNAGE

This section describes treatments that manage speed through improved communications with drivers. The treatments are generally targeted at locations, such as prior to a curve, where changing roadway conditions reduce the appropriate roadway speed.

Dynamic Speed Displays and Vehicle-Actuated Signs / Speed Trailers

Description: Dynamic speed feedback signs display the speed of approaching vehicles. Dynamic signs can display other information or signage that is triggered by an approaching vehicle.

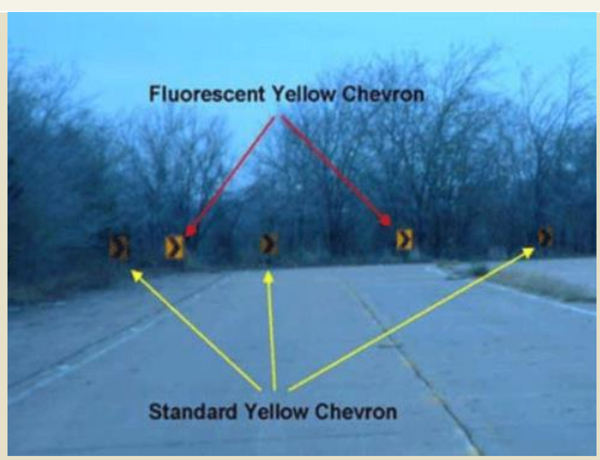
Application Guidance: Dynamic speed feedback signs on rural roadways may reduce 85th percentile speeds by 2 – 7 MPH. Typical applications include paring a dynamic speed feedback sign with a speed limit sign or curve advisory sign.

Source: FHWA

Enhanced Signing

Description: A number of enhanced signing techniques can be applied to rural roadways, including oversized and fluorescent signage. Other techniques include placing retroflected strips on existing signage, such as chevrons or curve advisory signs.

Application Guidance: Fluorescent or retroreflective sheeting on signage makes signage more visible, especially in low-light conditions. Retroreflective strips on signage may help reduce the number of vehicles exceeding the speed limit and a reduction in overall mean speed.



Source: Texas Transportation Institute

Curve Warning Sign with Flashing Beacon

Description: Flashing beacons supplement curve warning signs at the approach to a horizontal curve by attracting driver attention to the curve.

Application Guidance: The 2009 MUTCD contains guidance on curve warning signs and the use of flashing beacons. Studies of speed-activated beacons have shown an average speed reduction of 1 – 8 MPH. Beacons can also be placed overhead the roadway to improve visibility.

Source: Michigan Department of Transportation

LEDs in Pavement Markings or Signs

Description: LEDs can be embedded in delineators or any warning or regulatory sign. MUTCD Section 2A.08 contains guidance on the installation of signage with embedded LEDs.

Application Guidance: LEDs can draw driver attention and improve comprehension of signage on curves. This treatment has also been applied LEDs experimentally by placing LEDs in the roadway serving the function of roadway advisory pavement markings. LEDs may also be embedded in speed limit signs. LEDs on speed limit signs have been shown to reduce the number of vehicles that were traveling over the speed limit.

Source: Marc Hutchins and Nick Hutchins

Community Gateway Signage

Description: Gateways are a type of sign or other visual cue that indicates that the motorist is entering a community or more urbanized area.

Application Guidance: Gateways may be placed overhead and completely span roadway or may simply be placed to the right of the road. Gateways are most effective when placed at transition zones into urban areas. Gateways have shown effectiveness at reducing speed in studies performed outside of the United States.

Source: Iowa State University, Speed Management Toolbox for Rural Communities


Photo: Kittelson & Associates, Inc.

SECTION 5

LOCATION SPECIFIC APPLICATIONS

5. LOCATION SPECIFIC APPLICATIONS

After identifying emphasis areas based on reported crashes in Deschutes County, Kittelson implemented a network screening approach to identify priority locations for recommendations. *Network screening* refers to a process to review a roadway network for the purpose of identifying and ranking locations that would benefit from safety countermeasures. Kittelson used two network screening performance measures to identify locations, as described below. The performance measures identified locations with high collision frequency and severity (equivalent property damage only, or EPDO, screening) and locations with a high concentration of particular collision types (excess proportions of specific crash types screening).

5.1 EQUIVALENT PROPERTY DAMAGE ONLY (EPDO) SCREENING

The EPDO performance measure assigns weighting factors to collisions by severity. The weighting factors generally reflect an order of magnitude difference between societal costs of fatal and incapacitating collisions versus less severe injury collisions. The weighting factors, shown below, are based on the Oregon Safety Priority Index System (SPIS) scoring method, which assign scores of 100 to fatal and incapacitating collisions, 10 to Injury B and C collisions, and one to property damage only (PDO) collisions:

- Fatal and Injury A Collisions: 100 points
- Injury B and Injury C Collisions: 10 points
- PDO collisions: 1 point

Kittelson used EPDO as the primary performance measure to prioritize site-specific recommendations because it captures the overall frequency and severity of collisions.[2] We identified the intersections with the top 10 percent of EPDO scores in the County, shown in Table 5 and Figure 12 through Figure 15. Based on input from County and City staff, 24 locations were identified for further crash analysis, including 16 locations in unincorporated Deschutes County, two locations in La Pine, three locations in Redmond, and three locations in Sisters. Kittelson prepared crash diagrams and concepts illustrating potential improvements for these intersections. Although additional intersections were identified in the EPDO screening, further analysis was not completed at every location for several reasons: some locations were located on state facilities outside of the County's jurisdiction, and many locations have had recent improvements completed or have improvements planned. The focus was intended to be on locations with the greatest potential for implementation by the County or cities.

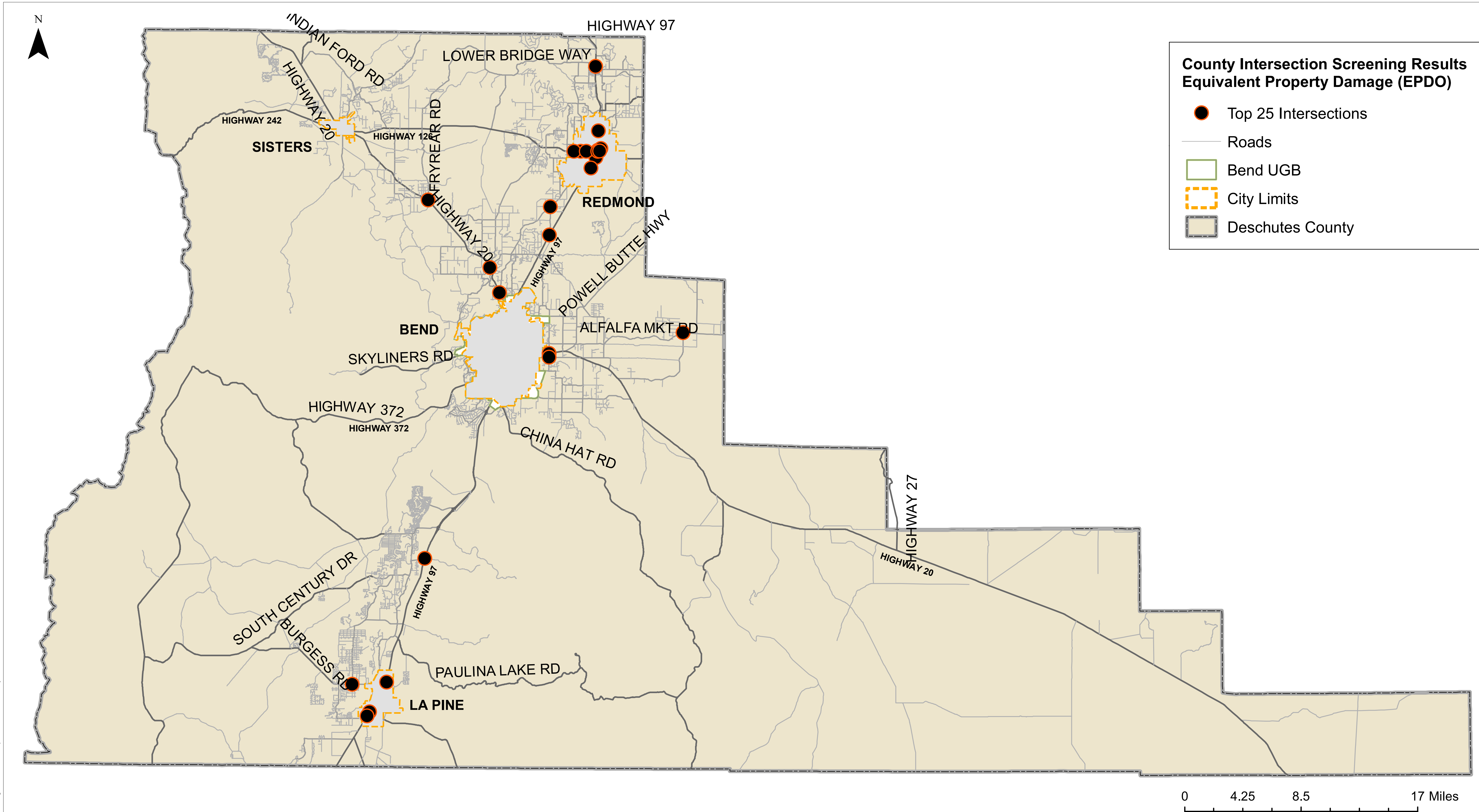
[2] This score is based on reported crashes. Some locations may not experience high frequency of reported crashes because users may avoid these locations due to perceived safety concerns. The EPDO score does not capture these locations.

Table 5: Top Sites for Safety Improvement, Identified with EPDO Performance Measure

Intersection Location*	Intersection Involves an ODOT Facility?	Concept Developed?	Number of Reported Crashes, 2012-2016	Annualized EPDO Score
Unincorporated County				
US20/Ward Road/Hamby Road	Yes		22	111
US97/Vandevert Road	Yes		17	56
US20/Fryrear Road	Yes	Yes	14	50
Burgess Road/Day Road/Pine Forest Drive	No		20	45
Bear Creek Road/Ward Road	No	Yes	14	41
Alfalfa Market Road/Dodds Road	No	Yes	2	40
US20/Old Bend Redmond Highway	Yes		17	38
US20/O.B. Riley Road/Cook Avenue	Yes		15	37
US97/61st Street	Yes		13	35
US97/11th Street/Lower Bridge Way	Yes		13	33
61st Street/Quarry Ave/Canal Blvd	No		17	32
Northwest Way/Coyner Ave	No	Yes	9	31
Alfalfa Market Road/Walker Road	No	Yes	7	28
US97/Smith Rock Way/B Ave	Yes		13	28
Deschutes Market Road/Hamehook Road	No	Yes	10	27
US97/Burgess Road	Yes		7	27
US20/Hawks Beard (Black Butte Ranch)	No		5	26
El Camino Lane/Helmholtz Way	No		4	26
Canal Blvd/Helmholtz Way	No		7	25
Dickey Road/Nelson Road	No	Yes	3	24
US97/Galloway Ave	Yes		3	24
Butler Market Road & Powell Butte Highway*	No	Yes	9	7
Butler Market Road & Hamby*	No	Yes	9	7
Butler Market Road & Hamehook*	No	Yes	5	6
Baker Road & Cinder Butte*	No	Yes	5	5
S Century and Huntington*	No	Yes	5	5
Cline Falls Rd/Coopers Hawk Drive/ Falcon Crest Drive*	No	Yes	2	2
Lower Bridge Way/19th*	No	Yes	1	2
Lower Bridge Way/31st*	No	Yes	3	2

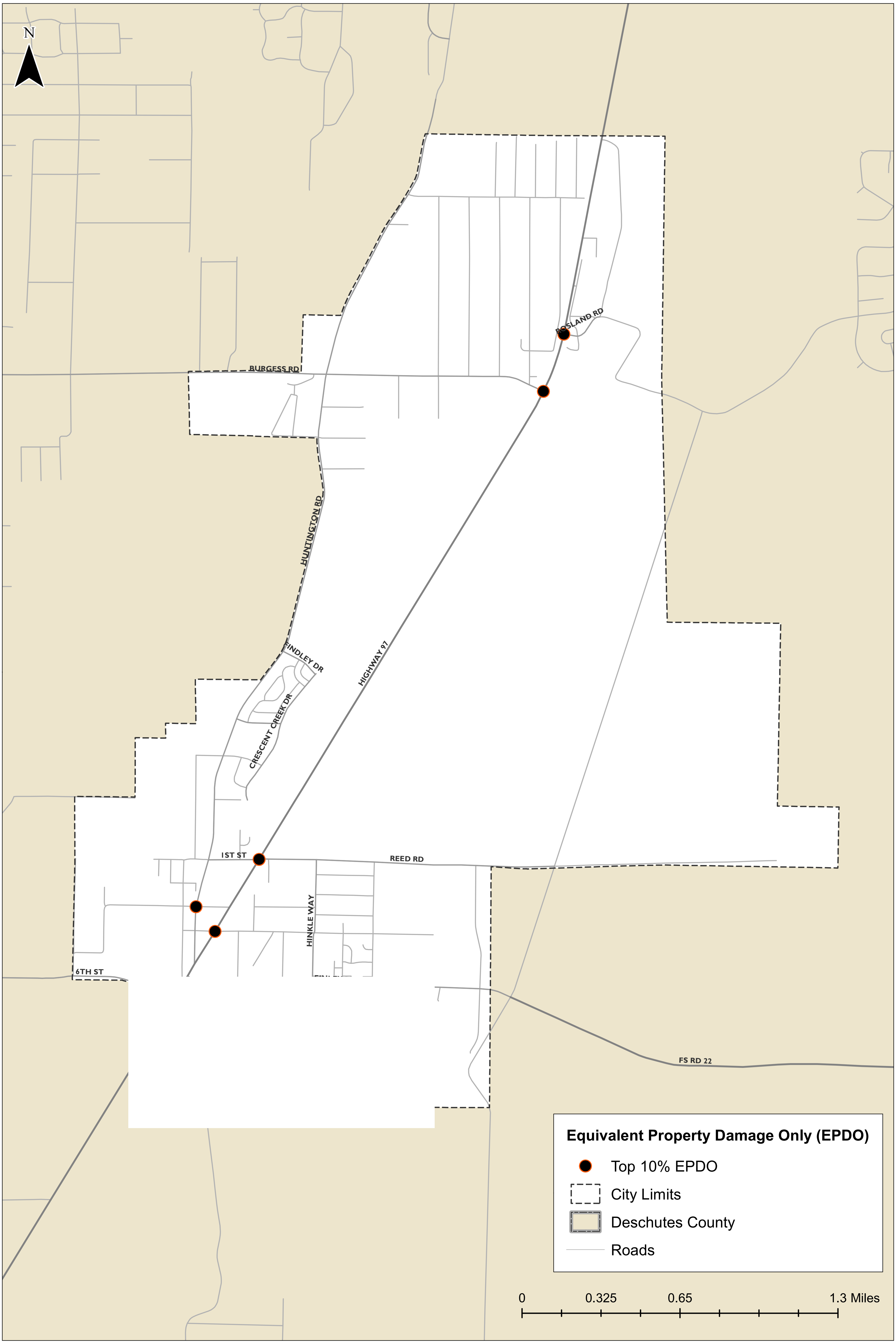
Intersection Location*	Intersection Involves an ODOT Facility?	Concept Developed?	Number of Reported Crashes, 2012-2016	Annualized EPDO Score
Lower Bridge Way/43rd*	No	Yes	3	2
City of La Pine				
US97/Rosland Road	Yes		13	71
US97/4th Street/William Foss Road	Yes		7	43
US97/1st Street/Reed Road	Yes		26	39
Huntington Road/3rd Street	No	Yes	6	26
Day Road/Sunrise Blvd	No	Yes	5	26
City of Redmond				
US97 & Veterans Way	Yes		54	180
SW Highland Ave (OR 126)/35th Street	Yes		27	95
US97/Hwy 126 (SW Highland Ave)	Yes		42	70
OR126 (Evergreen Ave)/US97	Yes		33	64
Maple Street/6th Street	No		32	57
SW Glacier Ave (Hwy 126)/SW 6th Street	Yes	Yes	28	40
SW Highland Ave (Hwy 126)/27th Street	Yes		18	40
SW Highland Ave (Hwy 126)/Rimrock Way	Yes		31	39
US97/Odem Medo Way	Yes		38	35
SW Highland Ave (Hwy 126)/6th Street	Yes	Yes	33	32
Canal Blvd/Odem Medo Road	No		11	29
4th Street/Antler Avenue	No		6	26
SW Highland Ave (Hwy 126)/15th Street	Yes		24	26
7th Street/Black Butte Blvd	No	Yes	5	26
City of Sisters				
US20/Barclay Drive	Yes		16	57
US20/Hawks Beard (Black Butte Ranch)	Yes		5	26
US20/OR126	Yes	Yes	6	25
Locust Street/US20*	Yes	Yes	5	8.2
Locust Street/E. Cascade Avenue*	No	Yes	4	1

*Note: These intersections were added at the request of Deschutes County or City of Sisters staff; the intersections were not within the top 10 percent of the EPDO scores.



Equivalent Property Damage (EPDO) Only Scoring
Deschutes County, 2012 - 2016

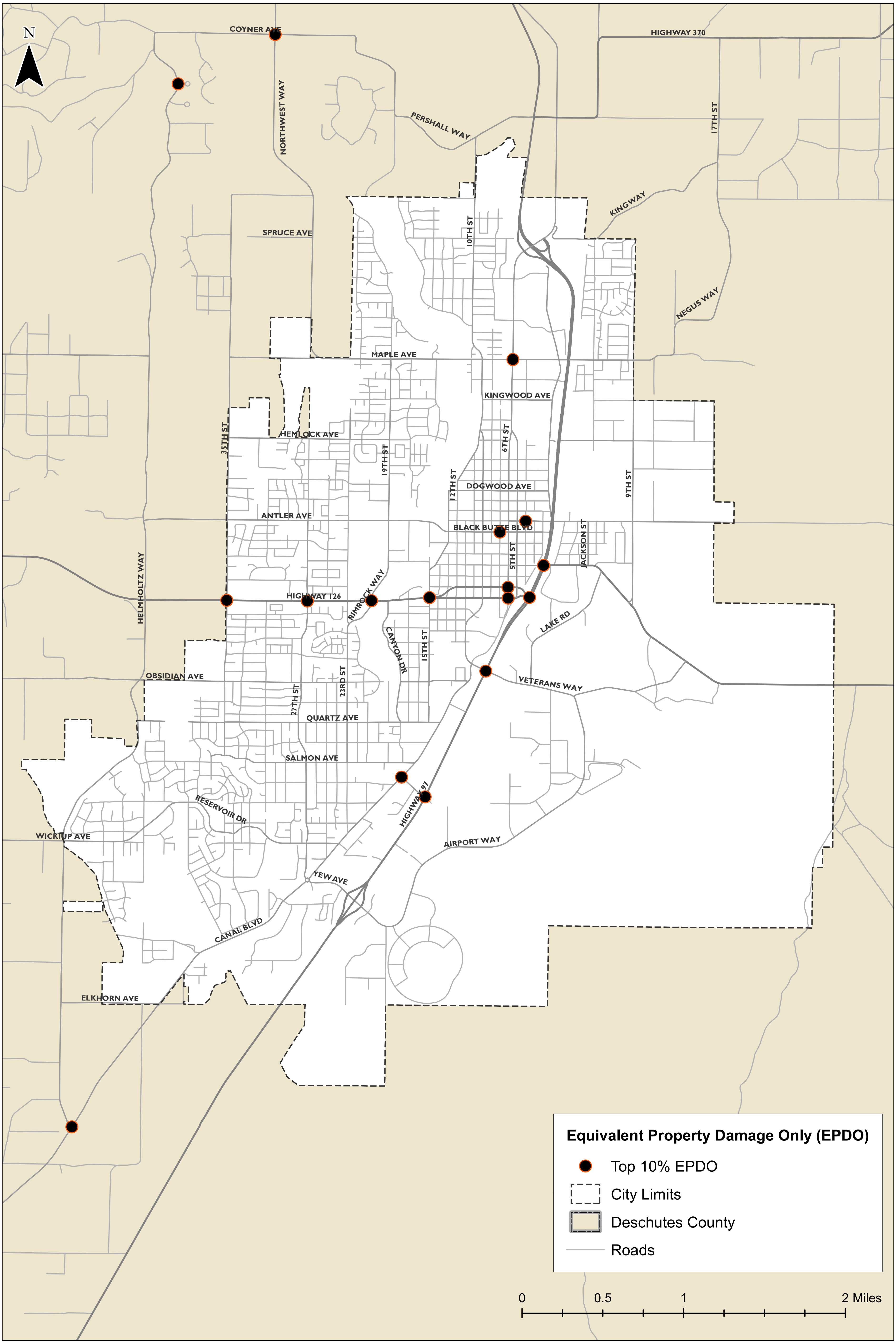
Figure
12



Intersection Screening Results
Top 10% Equivalent Property Damage Only Scoring
La Pine, Deschutes County, 2012 - 2016

Figure 13

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



Intersection Screening Results
Top 10% Equivalent Property Damage Only Scoring
Redmond, Deschutes County, 2012 - 2016

Figure 14

H:\21\21829 - Deschutes County TSAP\gis\location prioritization maps\cities\Redmond EPDO Intersections Top %.mxd - ahunter - 11:22 AM 7/3/2019

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl

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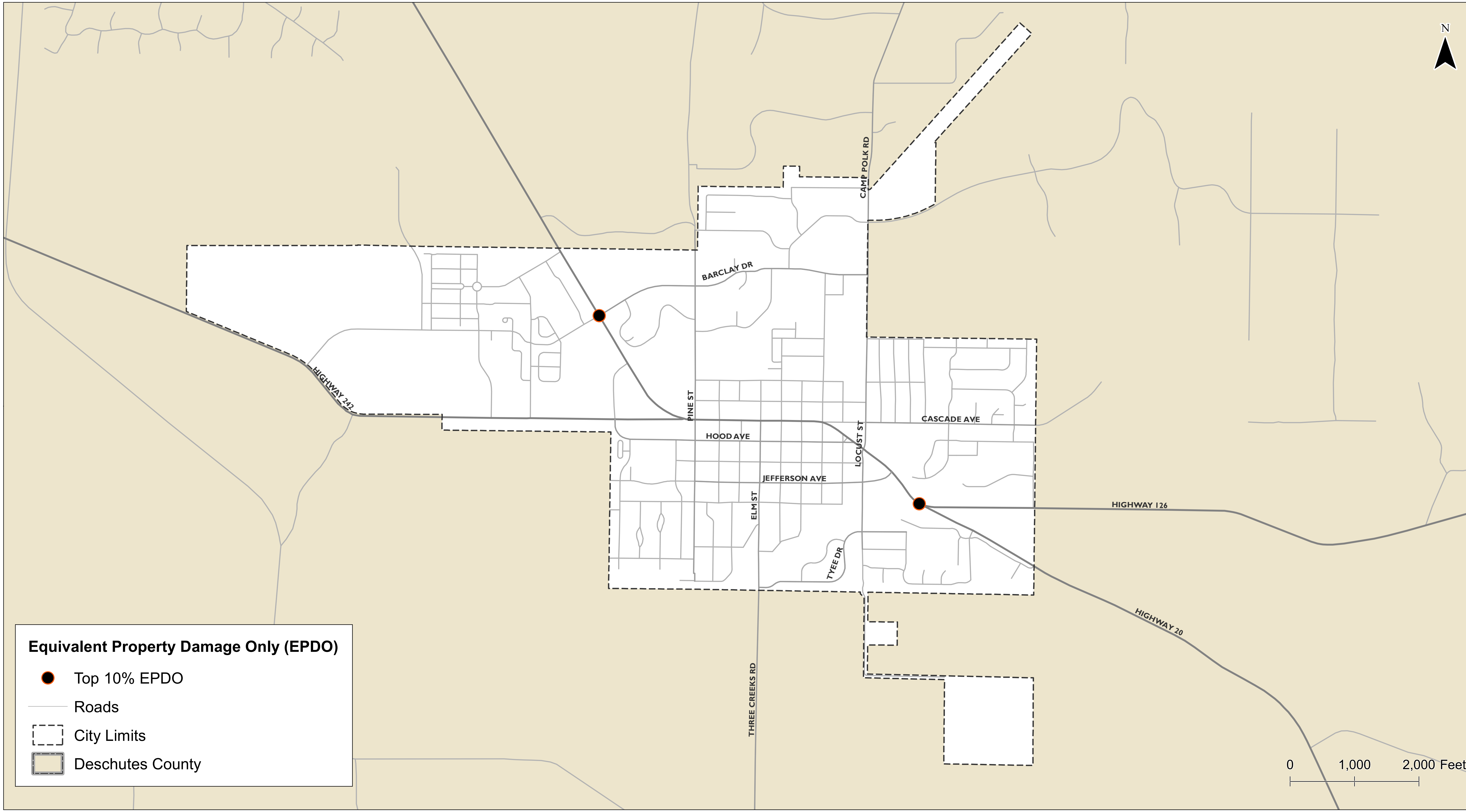


Intersection Screening Results
Top 10% Equivalent Property Damage Only Scoring
Sisters, Deschutes County, 2012 - 2016

Figure 15

5.2 SITE SPECIFIC EVALUATION

Kittelson developed high-level concepts for the 24 sites identified through the EPDO screening process with the County and cities' input. This section summarizes the site-specific characteristics, collision patterns, and concepts at these sites.

In some cases, near-term and long-term concepts are provided. Near-term concepts are typically low cost, easy to implement solutions and often include elements from the Systemic Toolbox. Long-term concepts are typically higher-cost and need additional project development to further refine. Long-term concepts could integrate elements from the Systemic Toolbox.

Many crash countermeasures at the County intersections rely heavily on treatments in the Systemic Toolbox. Although the concepts focus on the identified study intersections, the treatments are often applicable at other nearby locations along the corridor. Many intersections along County roads share similar characteristics and may benefit from the systemic treatments that increase intersection awareness and visibility. The County could consider ways to package a grouping of similar treatments that address documented crash locations and modify locations that exhibit similar crash risk characteristics.

5.2.1 US 20 & Fryrear Road

US 20/Fryrear Road is a stop-controlled intersection along a two-lane highway. Fryrear Road is a minor collector that provides a north-south connection between US 20 and OR 126. US 20 is a state highway that runs east and west between the City of Bend and the City of Sisters. There is an existing right-turn deceleration lane on US 20 in the northwest bound direction; no other turn lanes exist at this intersection.

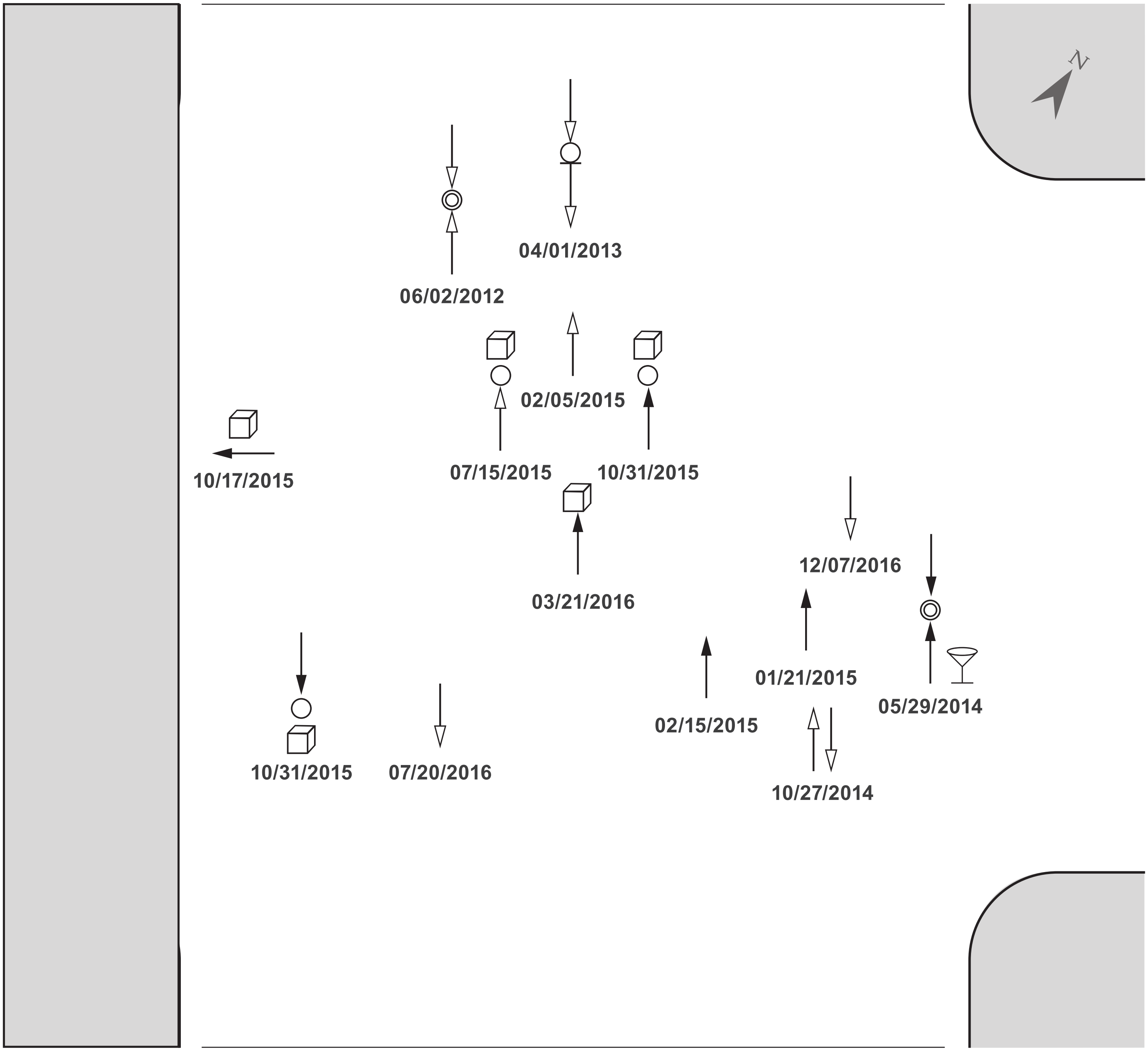
As shown in the crash diagram in Figure 16, over a third (36%) of the reported crashes at US 20 & Fryrear Road were fixed-object or other-object crashes. Half of the reported crashes occurred in dark, dusk, or dawn lighting conditions. Countermeasures that increase intersection awareness such as installing illumination and additional oversize advanced intersection warning signs are potential near-term treatments, as summarized in Figure 17. Longer-term concepts, illustrated in Figure 18, include intersection geometry changes such as installing a roundabout and/or using curb and gutter to provide raised channelization, further increasing intersection awareness. The intersection modifications could include widening for an eastbound left-turn lane to provide a refuge for stopped vehicles waiting to turn. Project development and alternatives evaluation would need to be coordinated with ODOT since the intersection is located on a state highway. Actual treatments would be determined during project development.

East-West Street **Fryrear Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Highway 20**

Date Prepared: **04/05/2019**



Number of Collisions

8	**Property Damage Only**
4	**Non-incapacitating Injury Collisions**
2	**Fatal and Incapacitating Injury Collisions**
14	**Total Collisions**

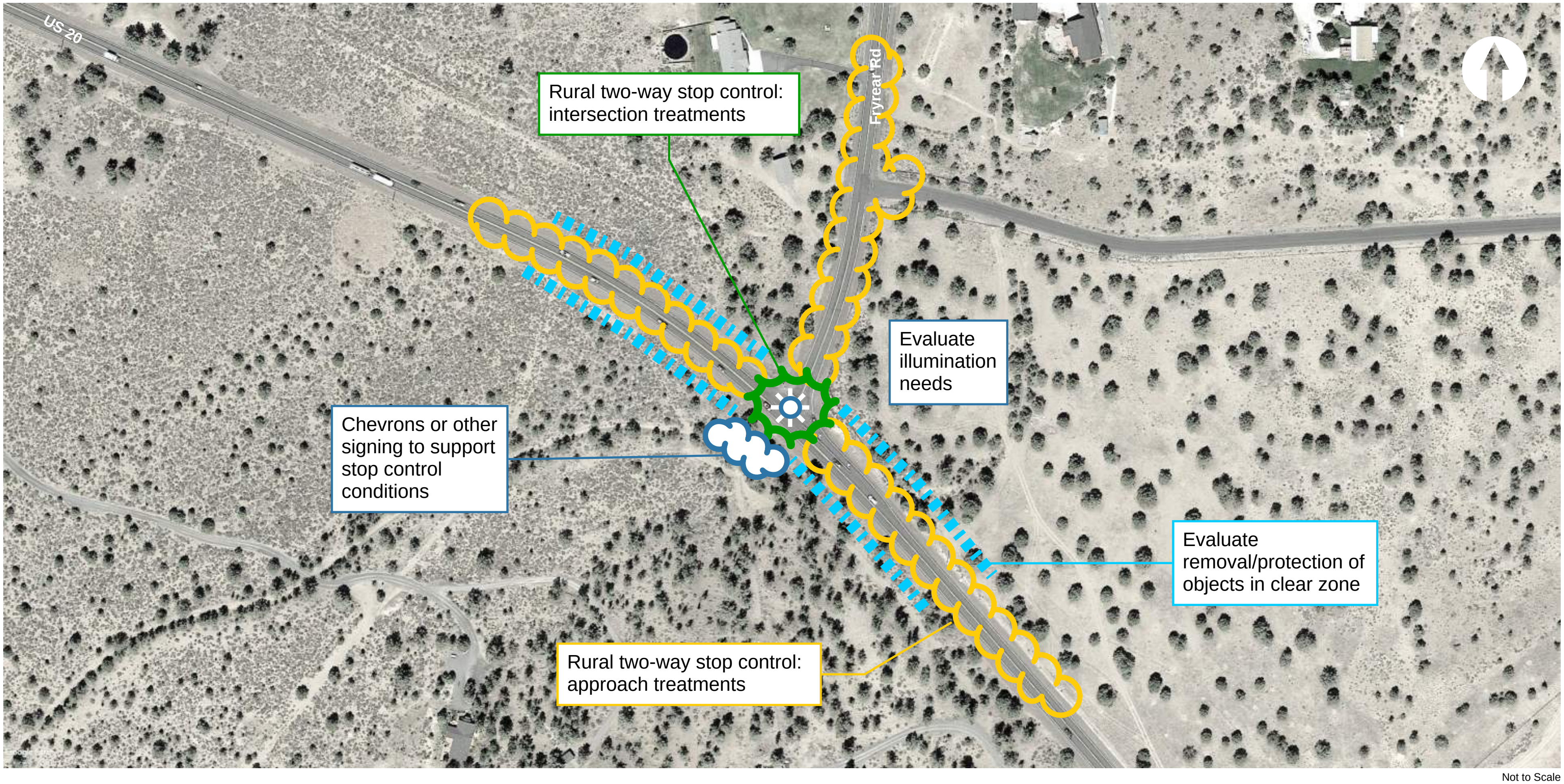
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 16
Crash Diagram



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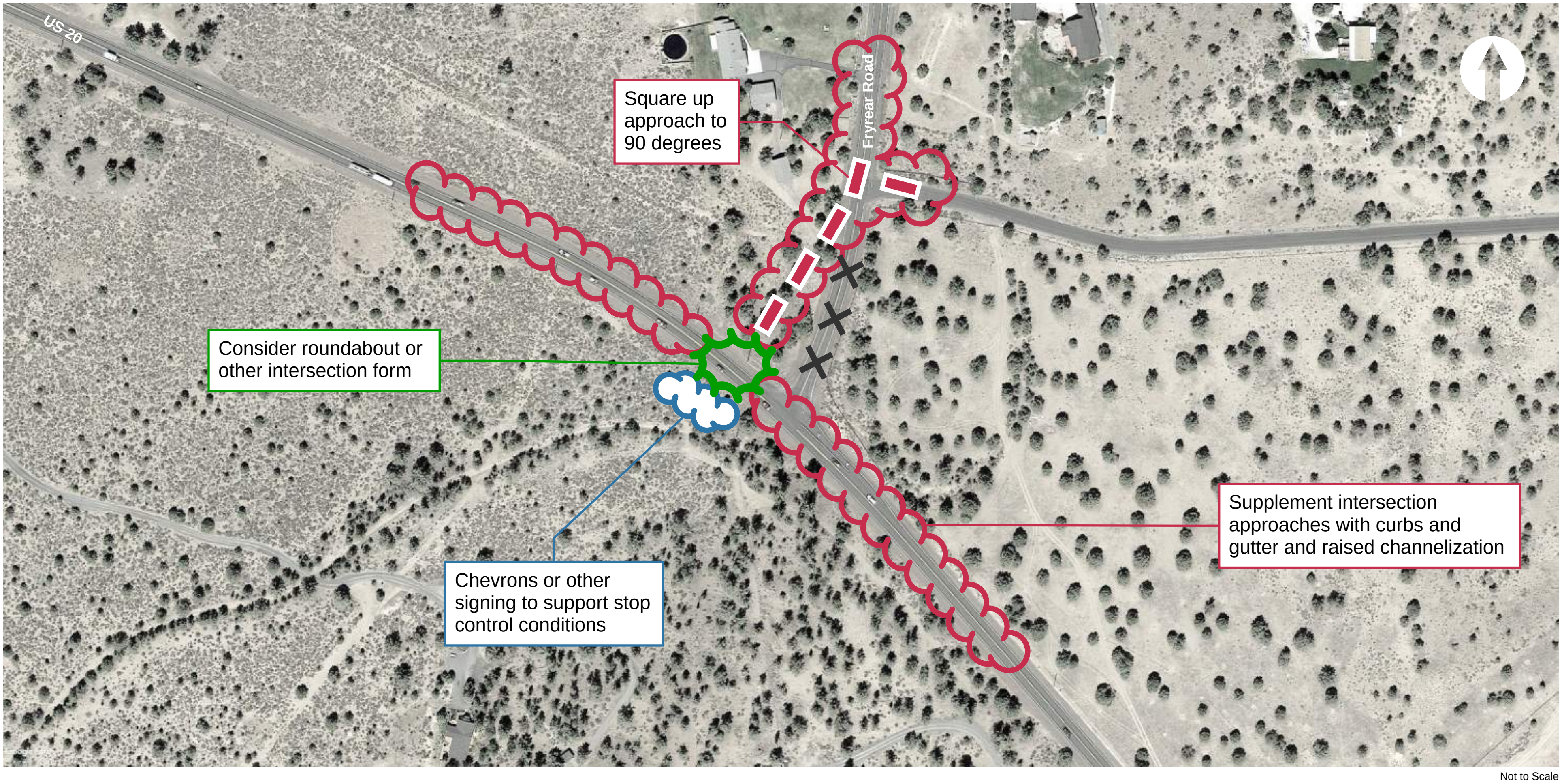
Location-Specific Concepts
US 20 & Fryrear Road
Short Term

Figure 17



US 20
Fryrear Road
Square up approach to 90 degrees
Consider roundabout or other intersection form
Chevrons or other signing to support stop control conditions
Supplement intersection approaches with curbs and gutter and raised channelization
Not to Scale

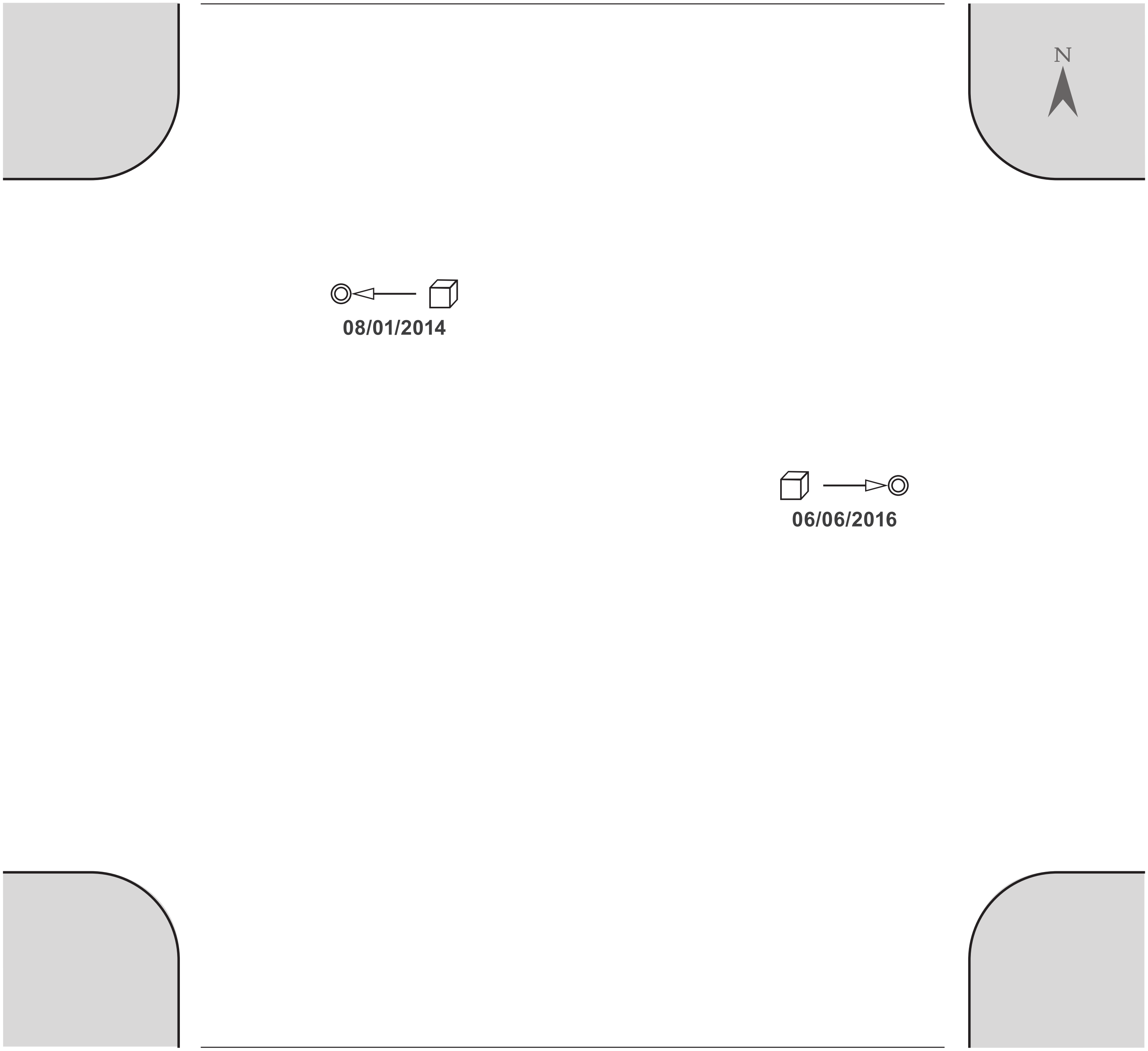
5.2.2 Alfalfa Market Road & Dodds Road

Alfalfa Market Road & Dodds Road is a stop-controlled intersection of a major collector (Alfalfa Market Road) and a minor collector (Dodds Road). The east, south, and west legs of the intersection are paved, and the north leg is a gravel road. Northbound traffic is stop controlled. The intersection is located immediately east of a horizontal curve, which may restrict intersection sight distance. Approximately eight miles southwest of the intersection, Dodds Road connects to US 20.

During the five years of reported intersection crash data there were two reported crashes. Both crashes involved a fixed object or other-object resulted in fatalities or incapacitating injuries, as shown in the crash diagram in Figure 19. The low-cost treatment of removing, relocating, or protecting fixed objects adjacent to road is included in the concept, as shown in Figure 20, along with other systemic treatments to improve intersection awareness. Actual treatments would be determined during project development.

East-West Street **Alfalfa Market Road** From: **01/01/2012** To: **12/31/2016**

North-South Street: **Dodds Road** Date Prepared: **04/04/2019**



Number of Collisions

0	**Property Damage Only**
0	**Non-incapacitating Injury Collisions**
2	**Fatal and Incapacitating Injury Collisions**
2	**Total Collisions**

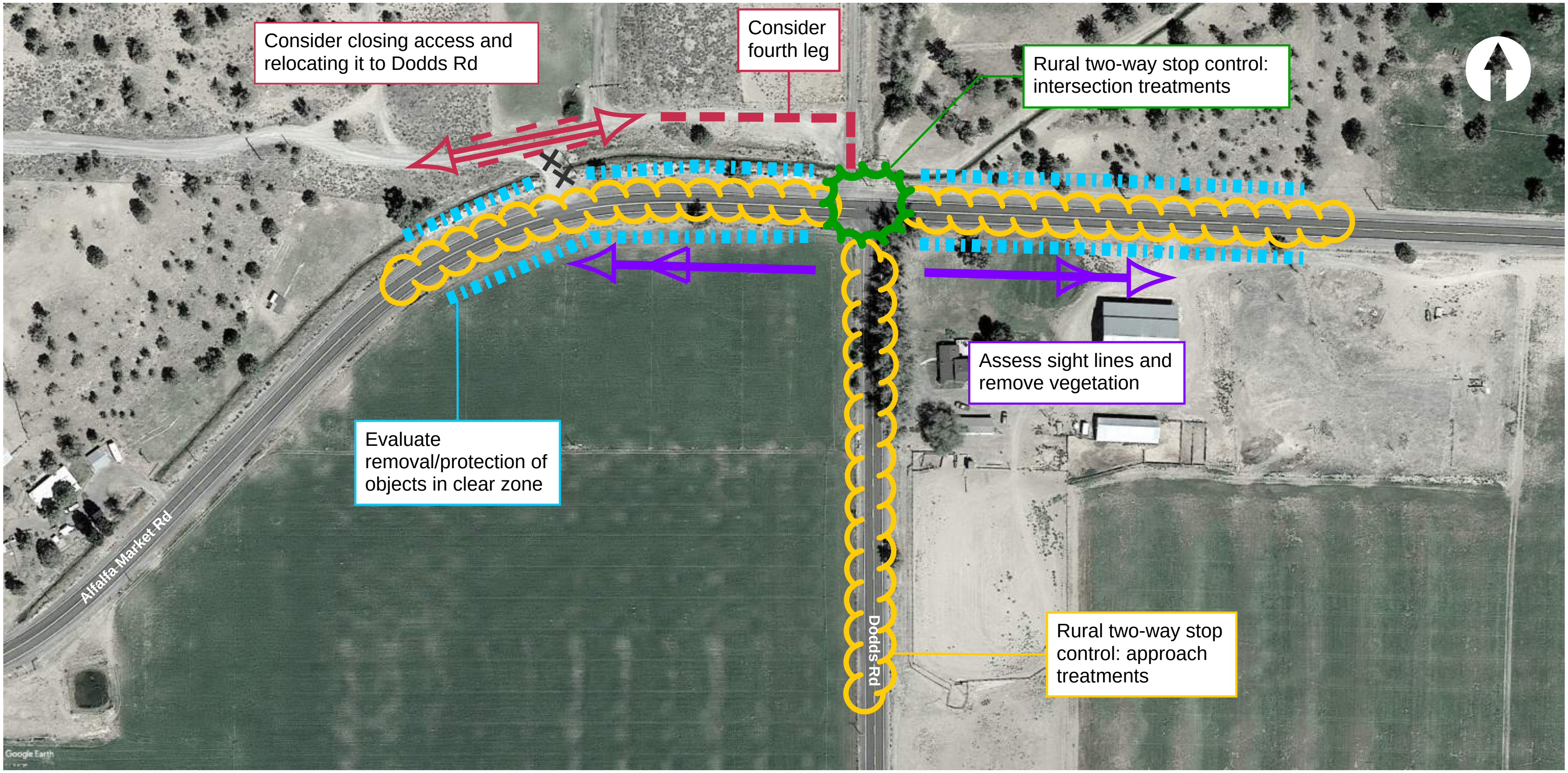
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 19
Crash Diagram



Consider closing access and relocating it to Dodds Rd
Consider fourth leg
Rural two-way stop control: intersection treatments
Assess sight lines and remove vegetation
Evaluate removal/protection of objects in clear zone
Rural two-way stop control: approach treatments
Alfalfa Market Rd
Dodds Rd
Google Earth

Not to Scale

5.2.3 Northwest Way & Coyner Avenue

Northwest Way & Coyner Avenue is a two-way, stop-controlled intersection location northwest of Redmond. Eastbound and westbound movements are stop controlled. Northwest Way & Coyner Avenue are classified as major collectors.

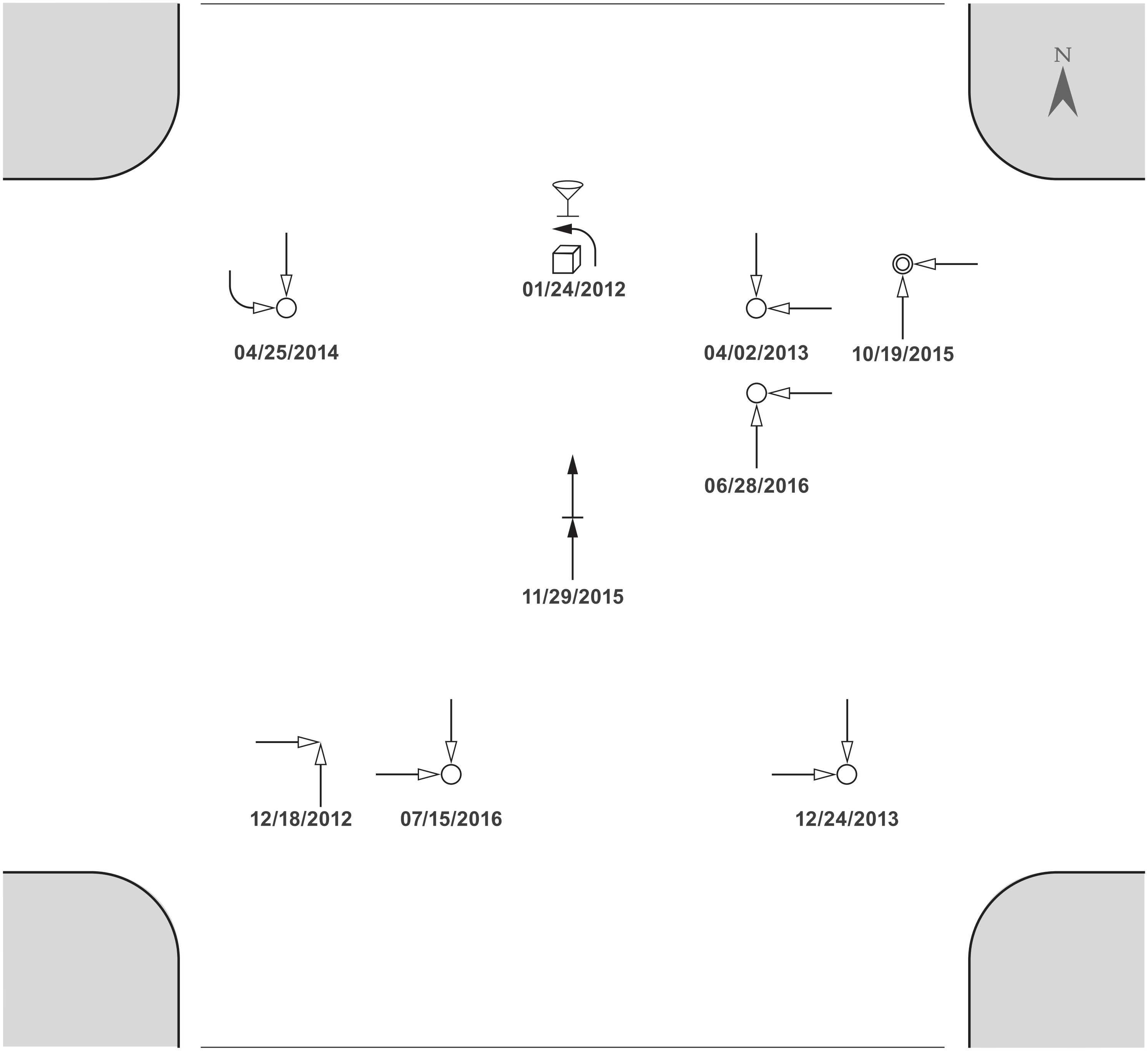
Nine crashes were reported at Northwest Way & Coyner Avenue. Approximately 89 percent of crashes at Northwest Way & Coyner Avenue were reported as angle (67 percent) or turning movement (22 percent) crashes, as shown in Figure 21. Two-thirds of the crashes resulted in an injury with one being fatal or incapacitating. Based on the crash types, the concept includes applying intersection awareness treatments, as shown in Figure 22. Specific intersection awareness treatments could include FHWA low-cost approach and intersection treatments such as enhanced delineation and signing, properly placed stop bars, and splitter islands on minor approaches. Actual treatments would be determined during project development.

East-West Street **Coyner Avenue**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Northwest Way**

Date Prepared: **04/05/2019**



Number of Collisions

3	**Property Damage Only**
5	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
9	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

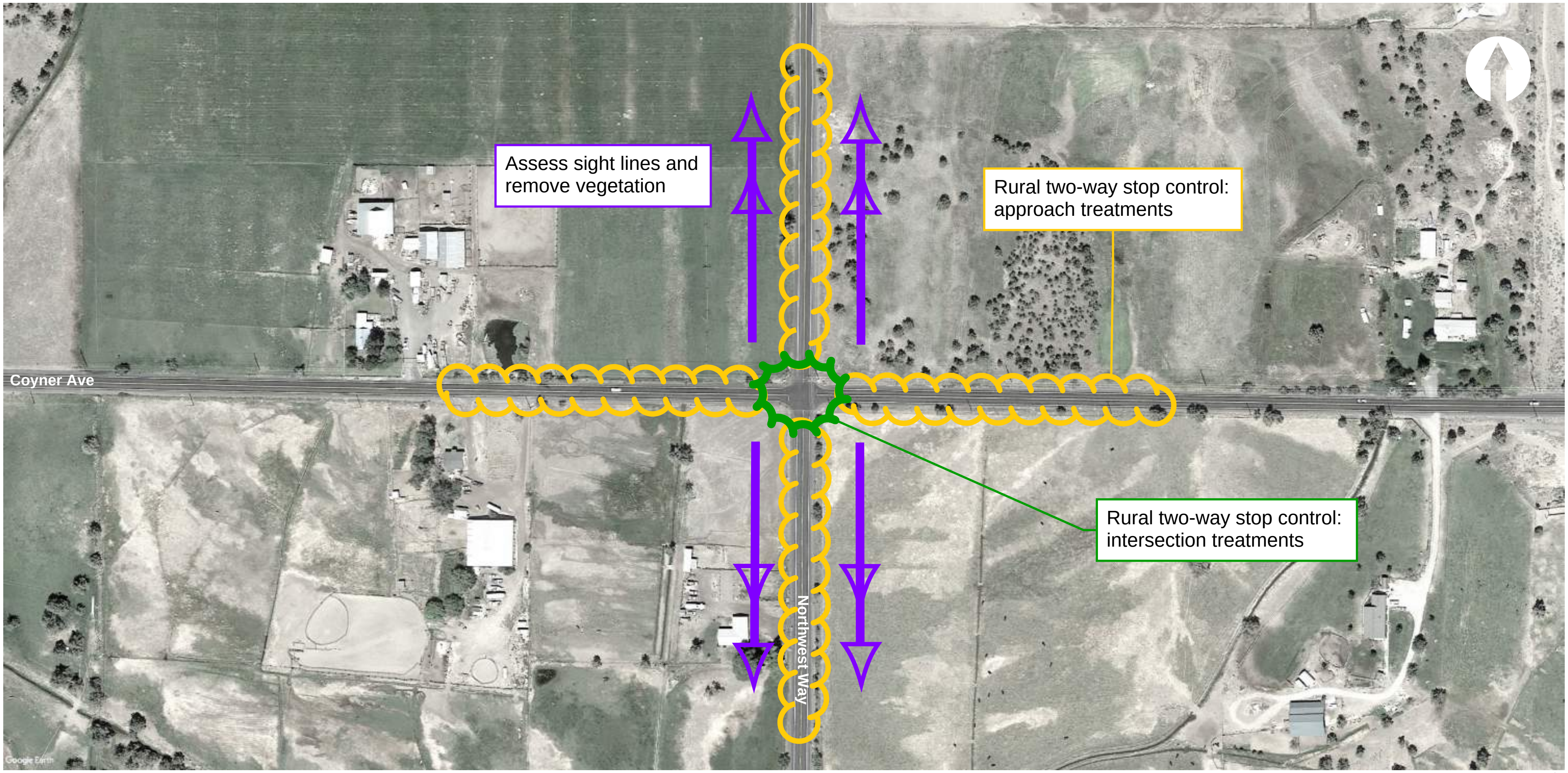
Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 21
Crash Diagram



Assess sight lines and remove vegetation
Rural two-way stop control: approach treatments
Coyner Ave
Northwest Way
Rural two-way stop control: intersection treatments

Not to Scale

5.2.4 Alfalfa Market Road & Walker Road

Alfalfa Market Road & Walker Road is a two-way stop-controlled intersection, with the northbound and southbound movements stop controlled. Alfalfa Market Road is a major collector roadway that provides an east-west connection between Powell Butte Highway and Millican Road. Walker Road is classified as a major collector north of Alfalfa Market Road and classified as a local roadway south of Alfalfa Market Road.

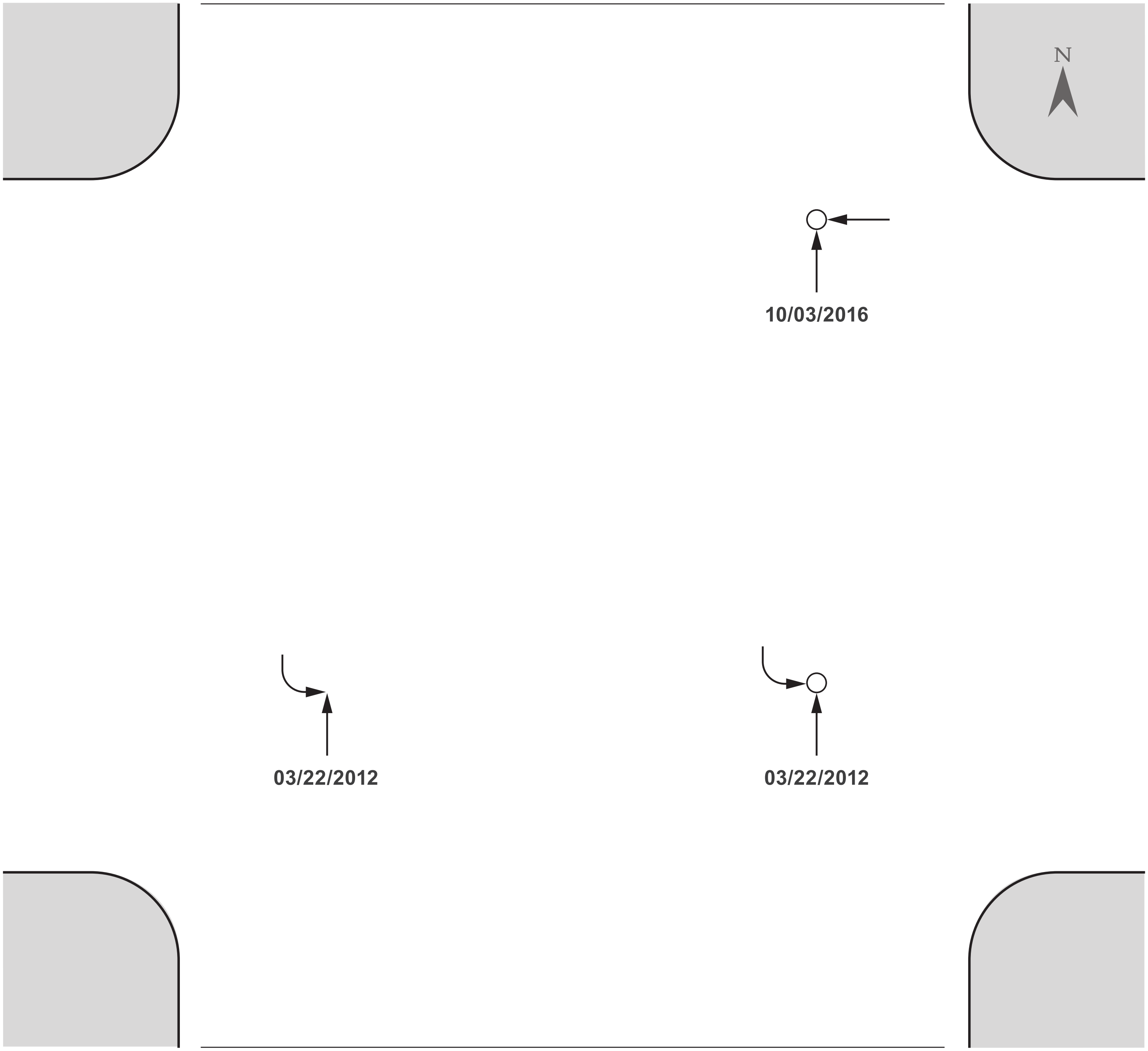
Three crashes were reported at Alfalfa Market Road & Walker Road between 2012 and 2016, including two turning movement crashes and one angle crash, as shown in Figure 23. The three crashes occurred in dark, dusk, or dawn lighting conditions. Two of the crashes resulted in non-incapacitating injuries. As shown in Figure 24, the recommended concepts include installing illumination and increasing intersection awareness to address the angle/turning movement crashes occurring at night. Specific intersection awareness treatments could include post-mounted reflective delineators, oversized and/or doubled up advanced intersection warning signs, and installing/widening edge-line and/or centerline markings. Actual treatments would be determined during project development.

East-West Street **Alfalfa Market Road/ Willard Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Johnson Ranch Road/ Walker Road**

Date Prepared: **04/05/2019**



Number of Collisions

1	**Property Damage Only**
2	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
3	**Total Collisions**

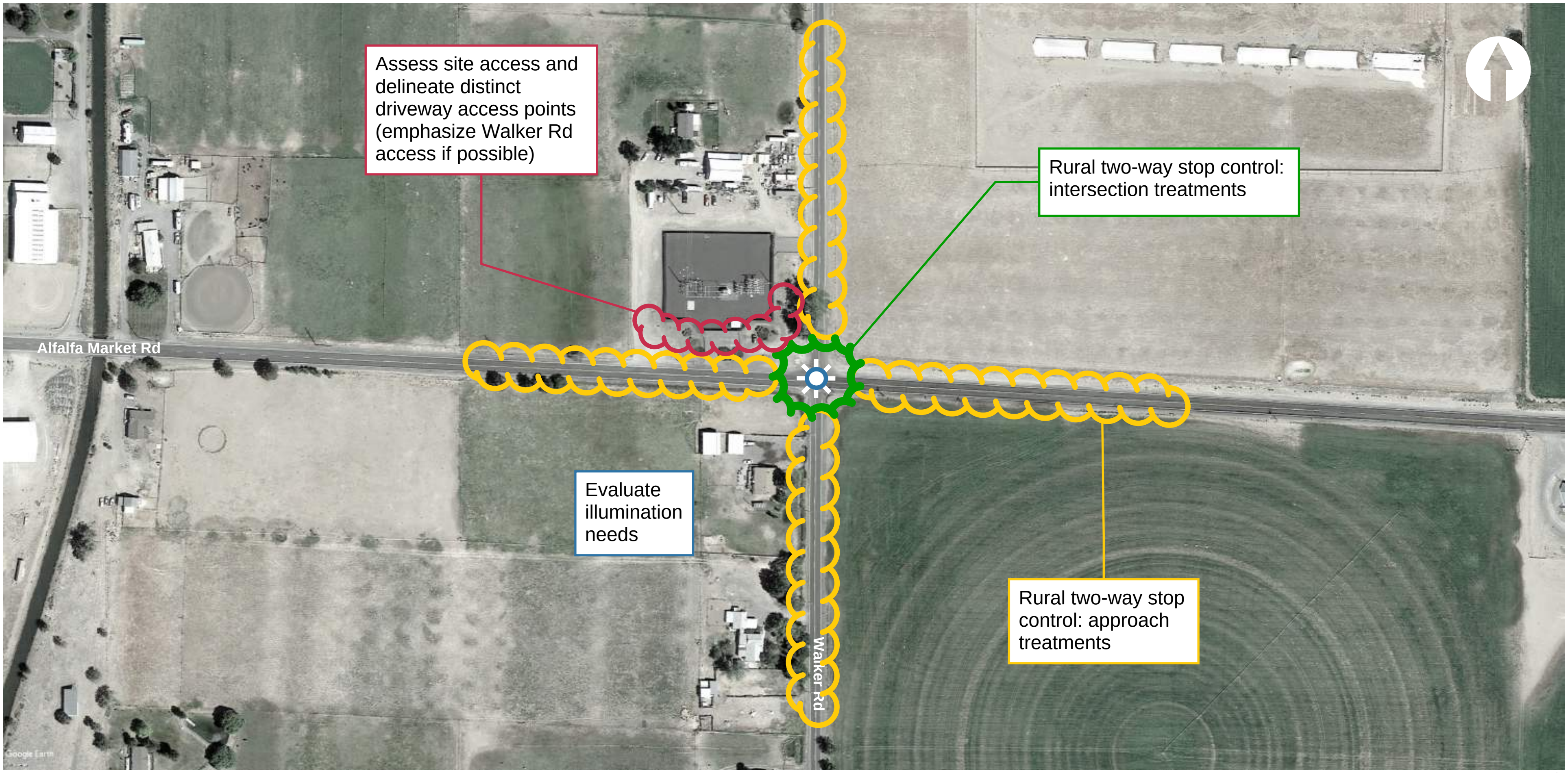
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 23
Crash Diagram



Assess site access and delineate distinct driveway access points (emphasize Walker Rd access if possible)
Rural two-way stop control: intersection treatments
Alfalfa Market Rd
Evaluate illumination needs
Rural two-way stop control: approach treatments
Walker Rd

Not to Scale

5.2.5 Hamehook Road & Deschutes Market Road

Hamehook Road & Deschutes Market Road is a stop-controlled T-intersection, with a stop-controlled southbound movement. Hamehook Road and Deschutes Market Road are classified as major collector roadways. There is a southbound right-turn (with deceleration lane) on Deschutes Market Road and an eastbound left-turn lane on Hamehook Road. Deschutes Market Road serves as a north south connection to/from Highway 97. The County's adopted five-year Capital Improvement Plan (CIP) identifies an improvement at this location.

Ten crashes were reported at Hamehook Road and Deschutes Market Road, including three crashes that resulted in non-incapacitating injuries and one crash that resulted in a fatality or incapacitating injury. As shown in Figure 25, 50 percent of reported crashes were rear-end crashes, with most of those in the southbound direction, and 40 percent were turning movement crashes. Four of the ten reported crashes for this intersection occurred in dark, dusk, or dawn lighting conditions, and half of those crashes involved a fixed object or other-object.

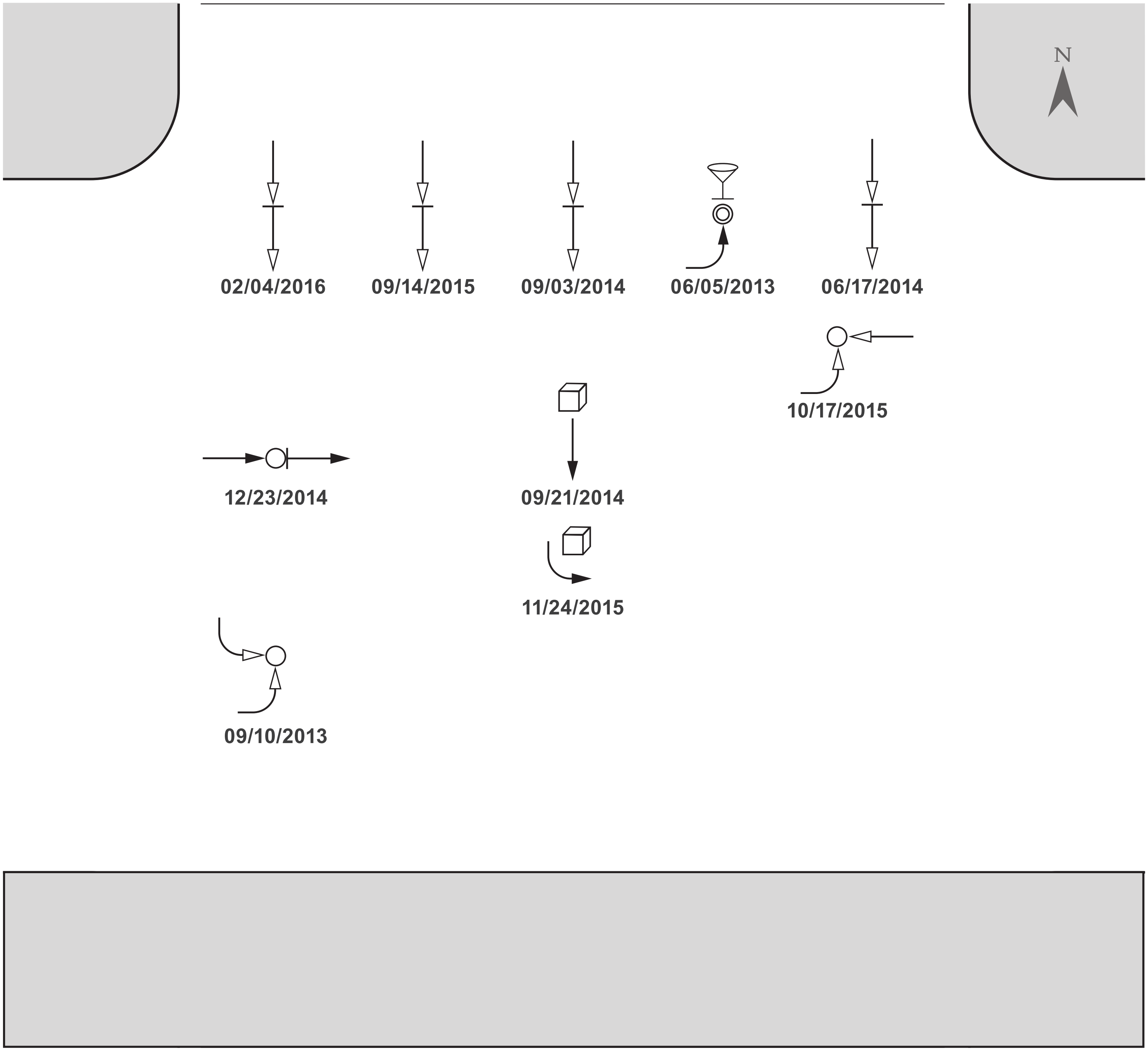
The concept, shown in Figure 26, includes installing stop-ahead pavement markings, modifying the right-turn lane to provide a clear deliberate decision point to enter the right-turn lane while maximizing the right turn storage. Treatments could alert drivers of the intersection by installing raised medians or channelized islands and additional signage. Installing illumination may also be considered to increase intersection visibility. Actual treatments would be determined during project development.

East-West Street **Deschutes Market Road/ Hamehook Road**

From: **01/01/2012** To: **12/31/2016**

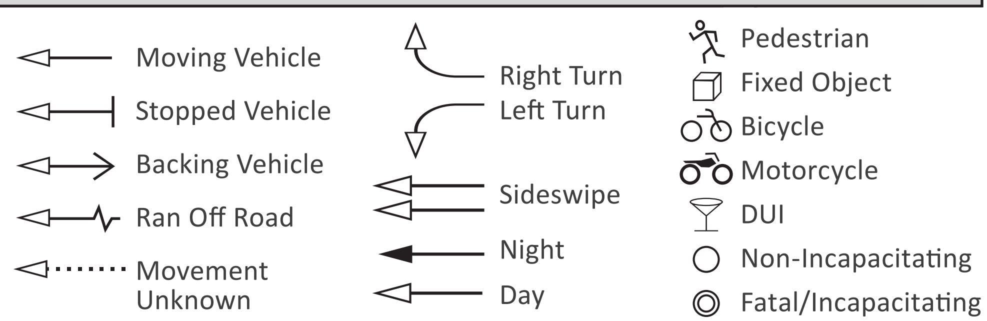
North-South Street: **Deschutes Market Road**

Date Prepared: **04/03/2019**



Number of Collisions

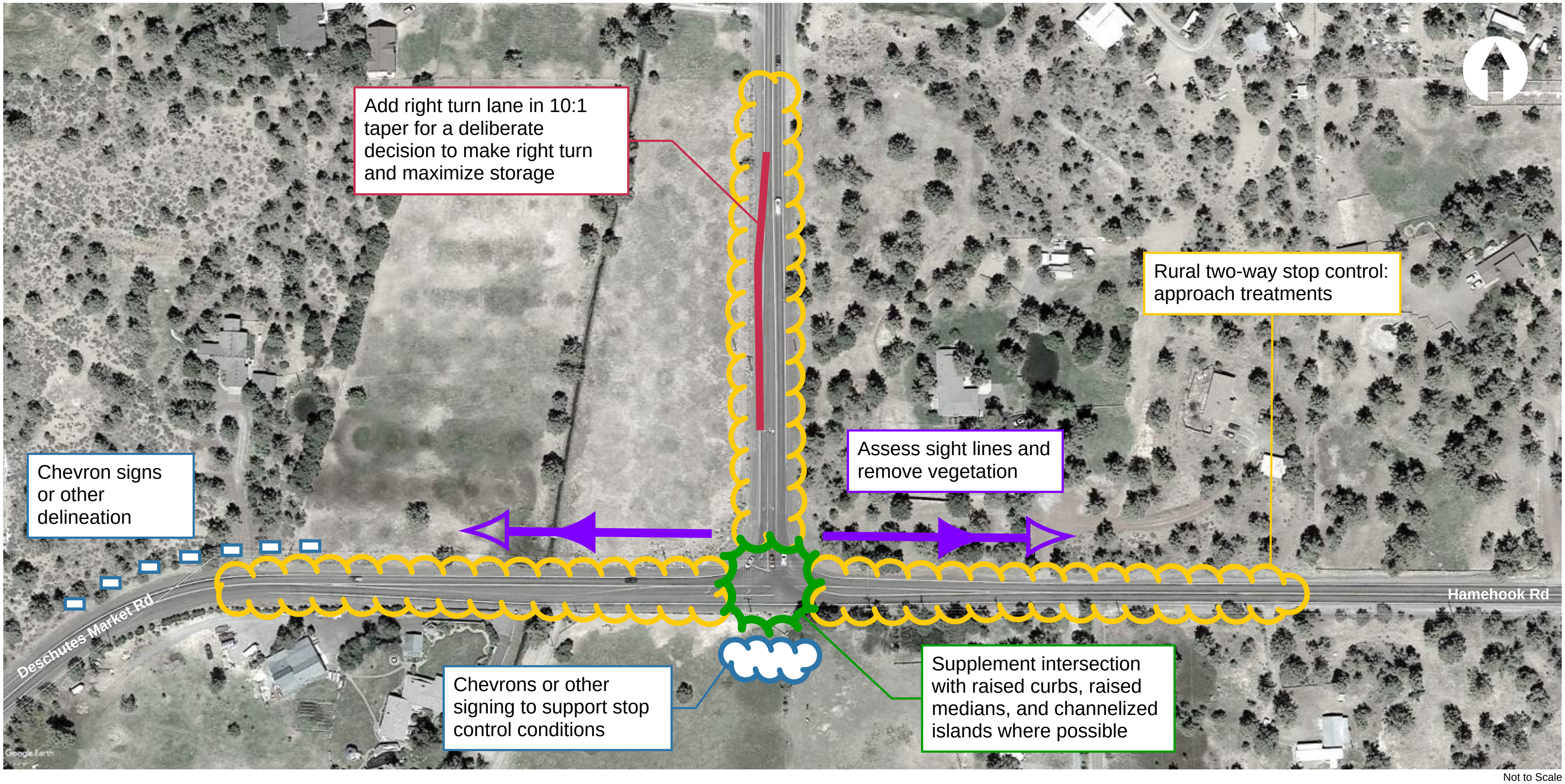
6	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
10	**Total Collisions**



Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 25
Crash Diagram


Add right turn lane in 10:1 taper for a deliberate decision to make right turn and maximize storage
Rural two-way stop control: approach treatments
Assess sight lines and remove vegetation
Chevron signs or other delineation
Hamehook Rd
Deschutes Market Rd
Chevrons or other signing to support stop control conditions
Supplement intersection with raised curbs, raised medians, and channelized islands where possible
Not to Scale

5.2.6 Bear Creek Road & Ward Road

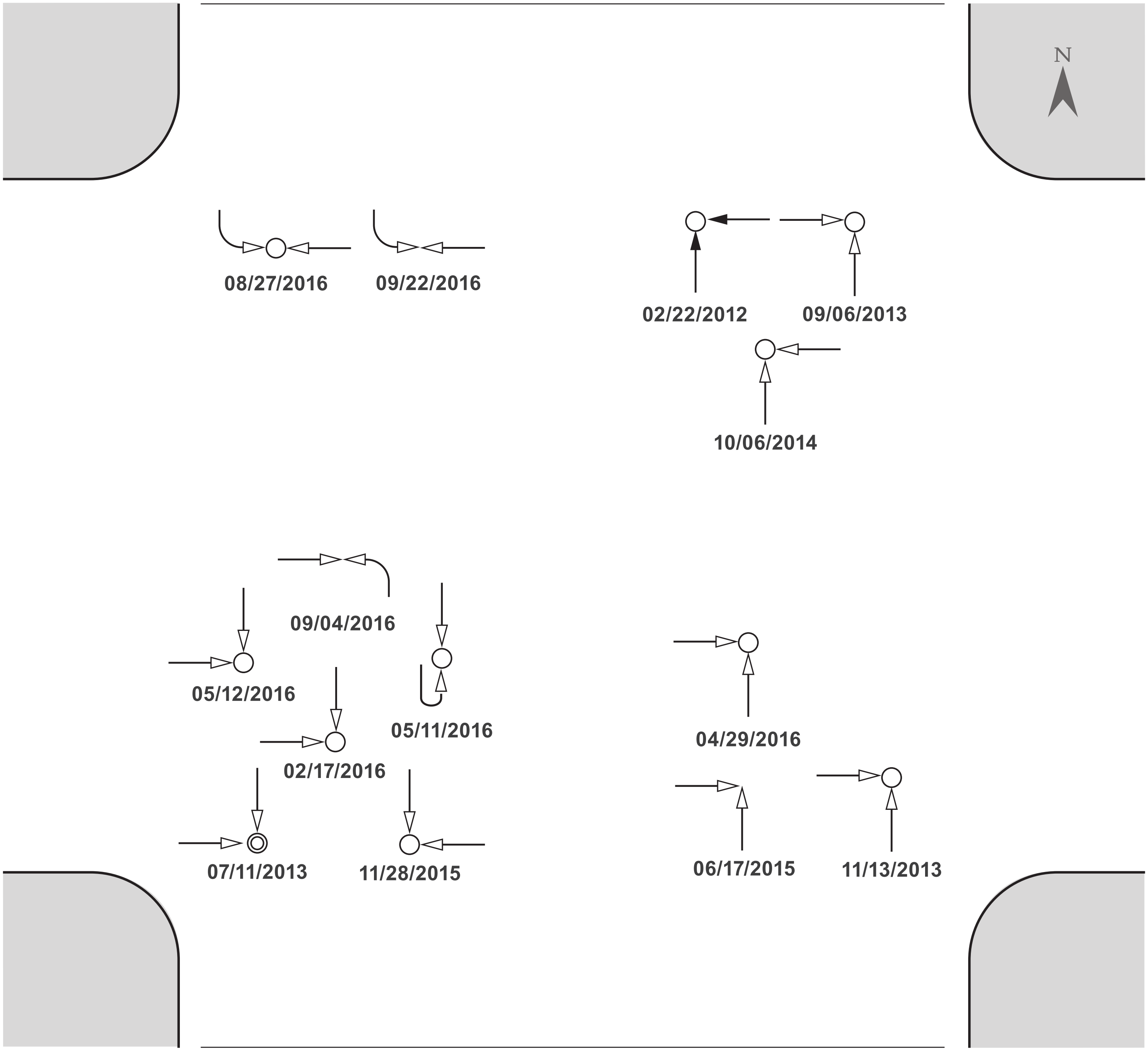
Bear Creek Road & Ward Road is a two-way stop-controlled intersection, with stop-controlled eastbound and westbound approaches. Bear Creek Road and Ward Road are two-lane major collector roadways. The intersection is located immediately east of the City of Bend.

As shown in Figure 27, 14 crashes were reported between 2012 and 2016, and approximately 80 percent of those crashes resulted in an injury with one being a fatal or incapacitating injury. Approximately 72 percent of reported crashes were angle crashes, and approximately 29 percent were turning movement crashes. Low-cost systemic intersection and approach treatments such as assessing sight lines and the location of stop bars are included in the concept for this location, as shown in Figure 28. Actual treatments would be determined during project development.

The County completed several signage improvements at this location in 2016, near the end of the study period. This included advanced warning signage, double signage, and oversize signage. Future evaluations of this site may reveal if these treatments have been successful in reducing crashes at this location.

East-West Street **Bear Creek Road** | From: **01/01/2012** | To: **12/31/2016**

North-South Street: **Ward Road** | Date Prepared: **04/05/2019**



Number of Collisions

3	**Property Damage Only**
10	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
14	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
U-turn

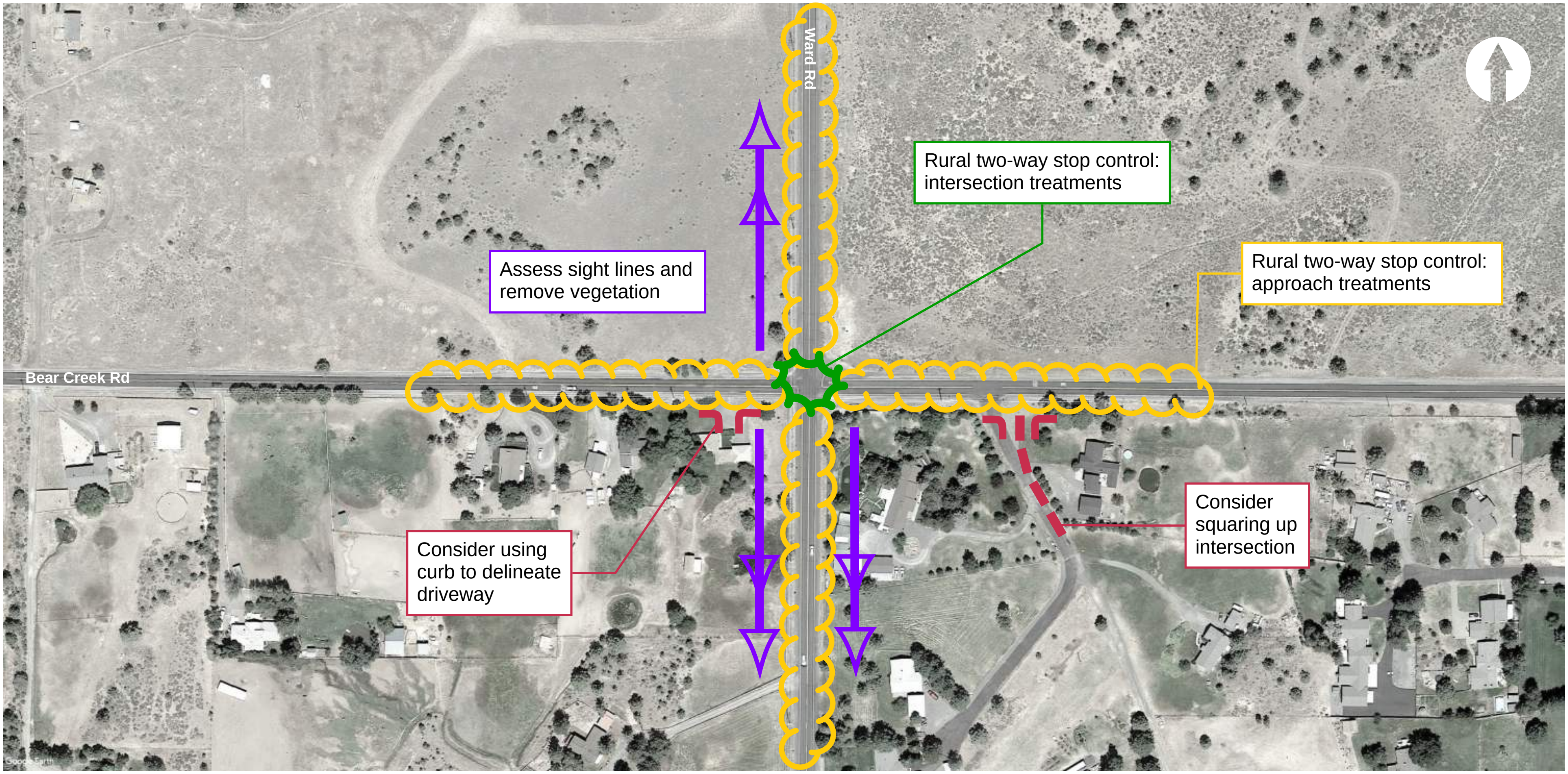
Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 27
Crash Diagram


Ward Rd
Bear Creek Rd
Rural two-way stop control: intersection treatments
Assess sight lines and remove vegetation
Rural two-way stop control: approach treatments
Consider using curb to delineate driveway
Consider squaring up intersection
Not to Scale

5.2.7 Nelson Road & Dickey Road

Nelson Road & Dickey Road is a stop-controlled intersection, with a stop-controlled westbound approach. Dickey Road is a two-lane minor collector, and Nelson Road is a two-lane local roadway.

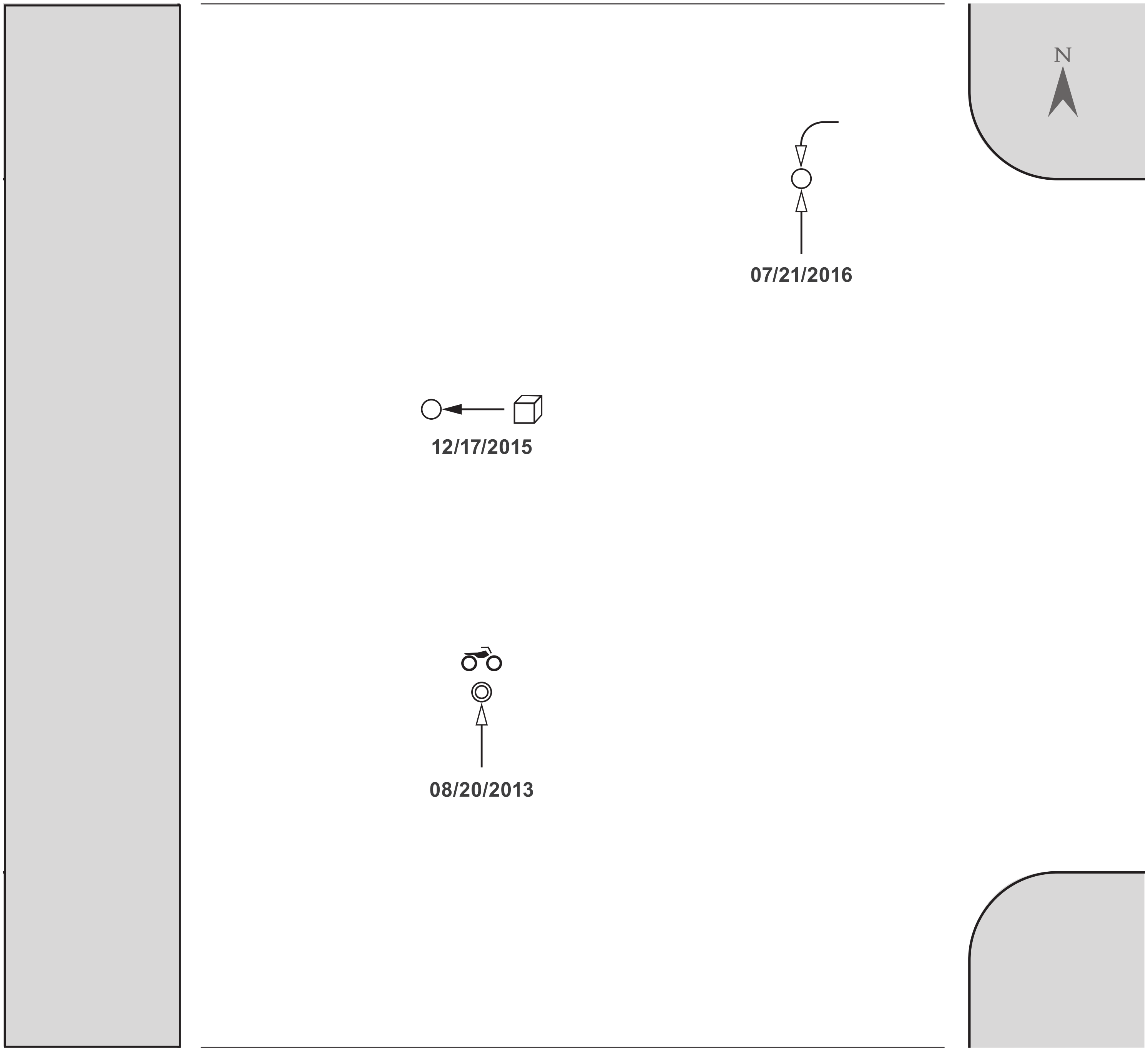
Between 2012 and 2016, three crashes were reported. The three crashes each resulted in some level on injury, as shown in Figure 29, including one fatal or incapacitating injury involving a motorcycle. Intersection awareness treatments are included in the concept, as shown in Figure 30. Specific treatments to consider include installing additional intersection ahead warning signs on the major approaches and assessing sight lines. Actual treatments would be determined during project development.

East-West Street **Nelson Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Dickey Road**

Date Prepared: **04/03/2019**



Number of Collisions

0	**Property Damage Only**
2	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
3	**Total Collisions**

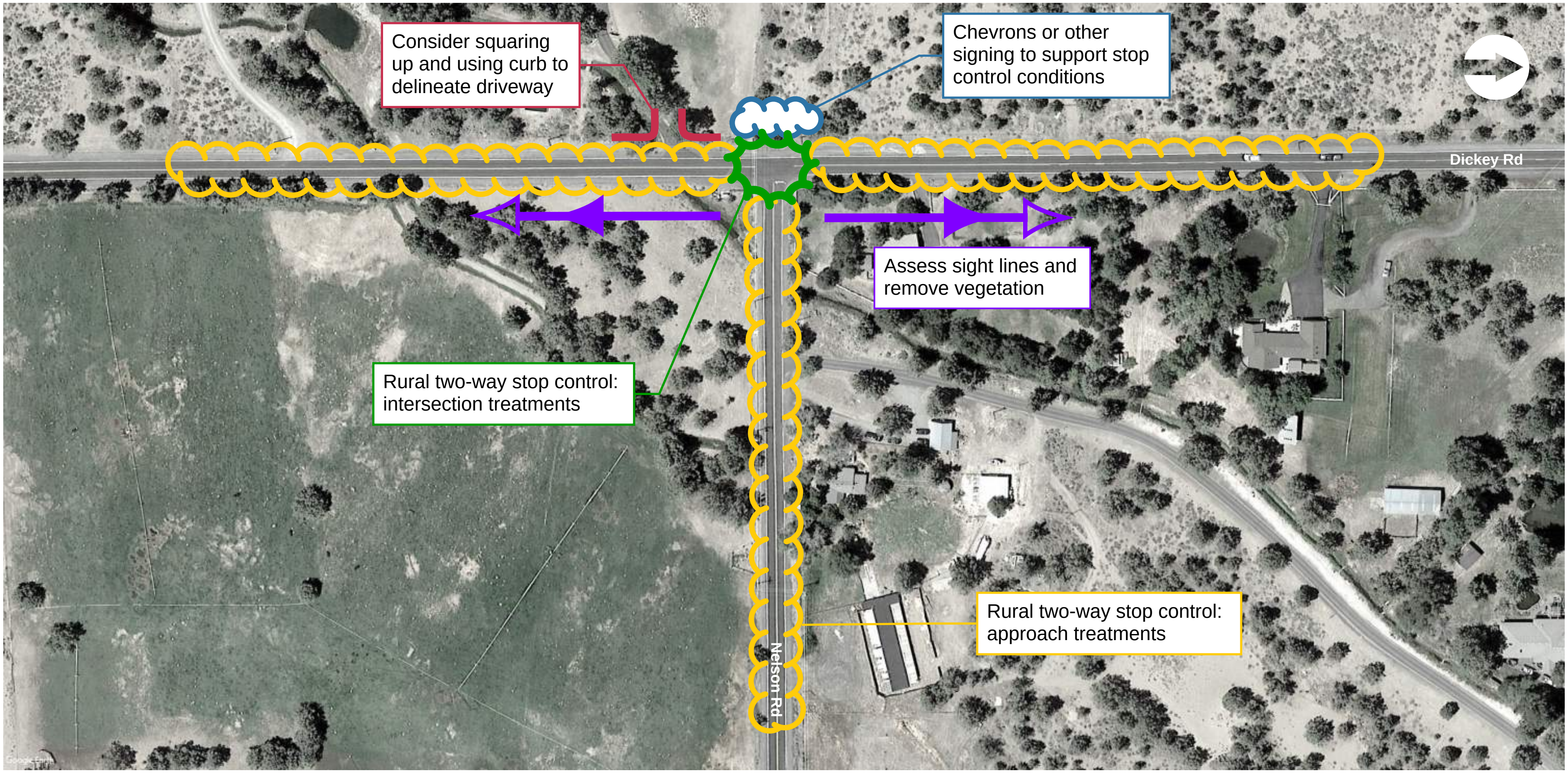
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 29
Crash Diagram



Consider squaring up and using curb to delineate driveway
Chevrons or other signing to support stop control conditions
Dickey Rd
Assess sight lines and remove vegetation
Rural two-way stop control: intersection treatments
Rural two-way stop control: approach treatments
Nelson Rd

Not to Scale

5.2.8 Butler Market Road & Powell Butte Highway

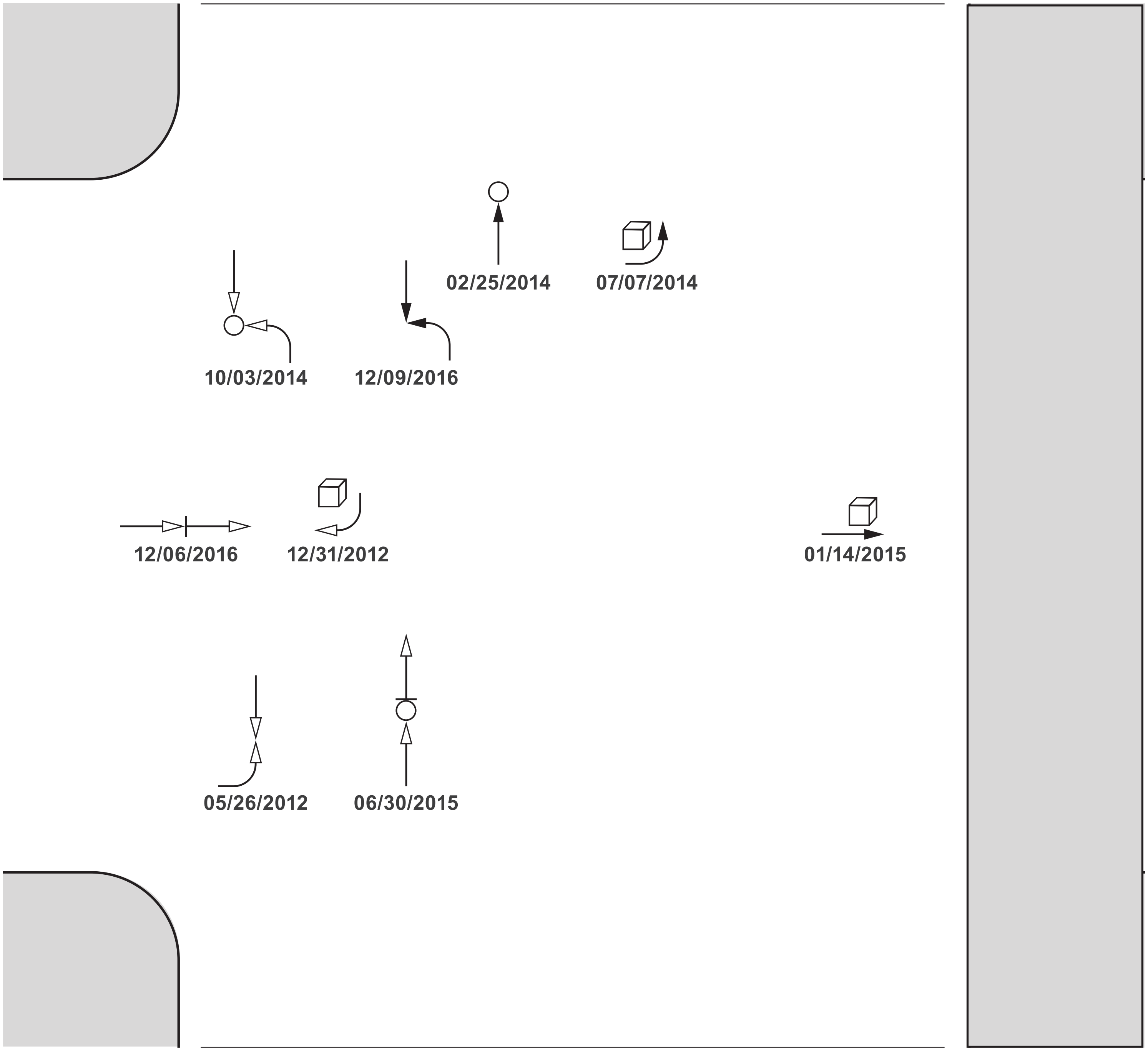
Butler Market Road & Powell Butte Highway is a stop-controlled T-intersection, with a stop-controlled eastbound approach. Butler Market Road and Powell Butte Highway are two-lane minor arterial roadways. There is a southbound channelized right- turn lane on Powell Butte Highway.

Illustrated in Figure 31, nine crashes were reported between 2012 and 2016, and three of those resulted in non-incapacitating injuries. Approximately 55 percent of reported crashes were turning movement crashes, 22 percent were rear-end crashes, and one-third involved fixed object or other objects. Approximately 44 percent of the reported crashes occurred in dark, dusk, or dawn lighting conditions.

The concept, shown in Figure 32, includes systemic treatments to increase intersection awareness. Low-cost approach treatments could include delineation such as widening edge-lines and/or centerlines, installing post-mounted reflective delineators, installing oversized and/or doubled up advanced intersection warning signs, installing chevrons or other signing to mark the stop-controlled approach, and improving the definition of the southbound right-turn lane with skip striping. In addition, the concept includes installing a raised island and tightening the southbound right-turn to slow vehicles and provide better sight distance where southbound right-turning vehicles merge back into traffic on Butler Market Road. A higher-cost option may include a more substantial intersection control change such as a roundabout to help reduce speeds, raise intersection visibility, and reduce conflict points. The County's TSP identifies a roundabout at the location. Actual treatments would be determined during project development.

East-West Street **Butler Market Road** From: **01/01/2012** To: **12/31/2016**

North-South Street: **Powell Butte Highway** Date Prepared: **04/03/2019**



Number of Collisions

6	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
9	**Total Collisions**

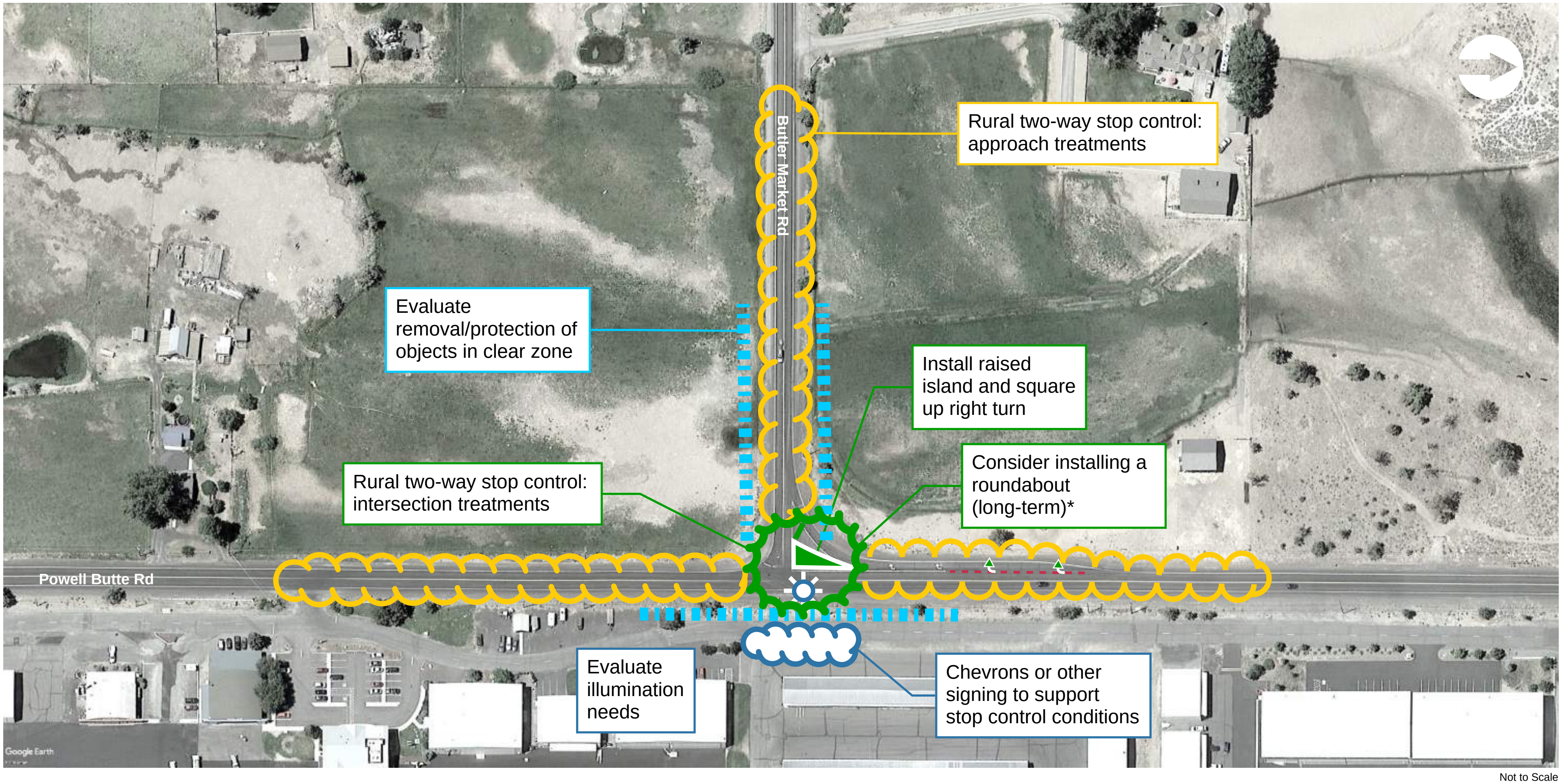
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 31
Crash Diagram



*Deschutes County Transportation System Plan (TSP) identifies roundabout at this location.

5.2.9 Butler Market Road & Hamby Road

Butler Market Road & Hamby Road is three-leg stop-controlled intersection located east of Bend. The northbound and eastbound approaches are stop-controlled, and the southbound approach is a free movement. Butler Market Road and Hamby Road are two-lane minor arterial roadways. Butler Market Road serves as an east-west connection between Highway 97, in Bend, and Powell Butte Highway. There is an overhead intersection warning beacon at Butler Market Road & Hamby Road and a southbound right-turn deceleration lane on Hamby Road. Bike lanes are provided on the north and south legs.

Between 2012 and 2016 nine crashes were reported at the intersection, including three non-incapacitating injury crashes. Approximately 44 percent of reported crashes were turning movement, and 22 percent were fixed object or other-object, as shown in Figure 33. Two of the nine reported crashes (22 percent) occurred in dark, dusk, or dawn lighting conditions.

As shown in Figure 34, the near-term concept includes delineating the nearby driveway with curb, installing a raised median island to better delineate the right-turn, and providing signage to support stop-controlled conditions. In addition to these near-term safety treatments, an operational analysis of the intersection may be completed to determine if there are treatments such as converting the intersection to all-way stop-control or a mini-roundabout that may improve safety performance and traffic operations of the intersection. Although the TSAP did not include an operational analysis of the site, the County has noted that the existing intersection control at this location may be failing.

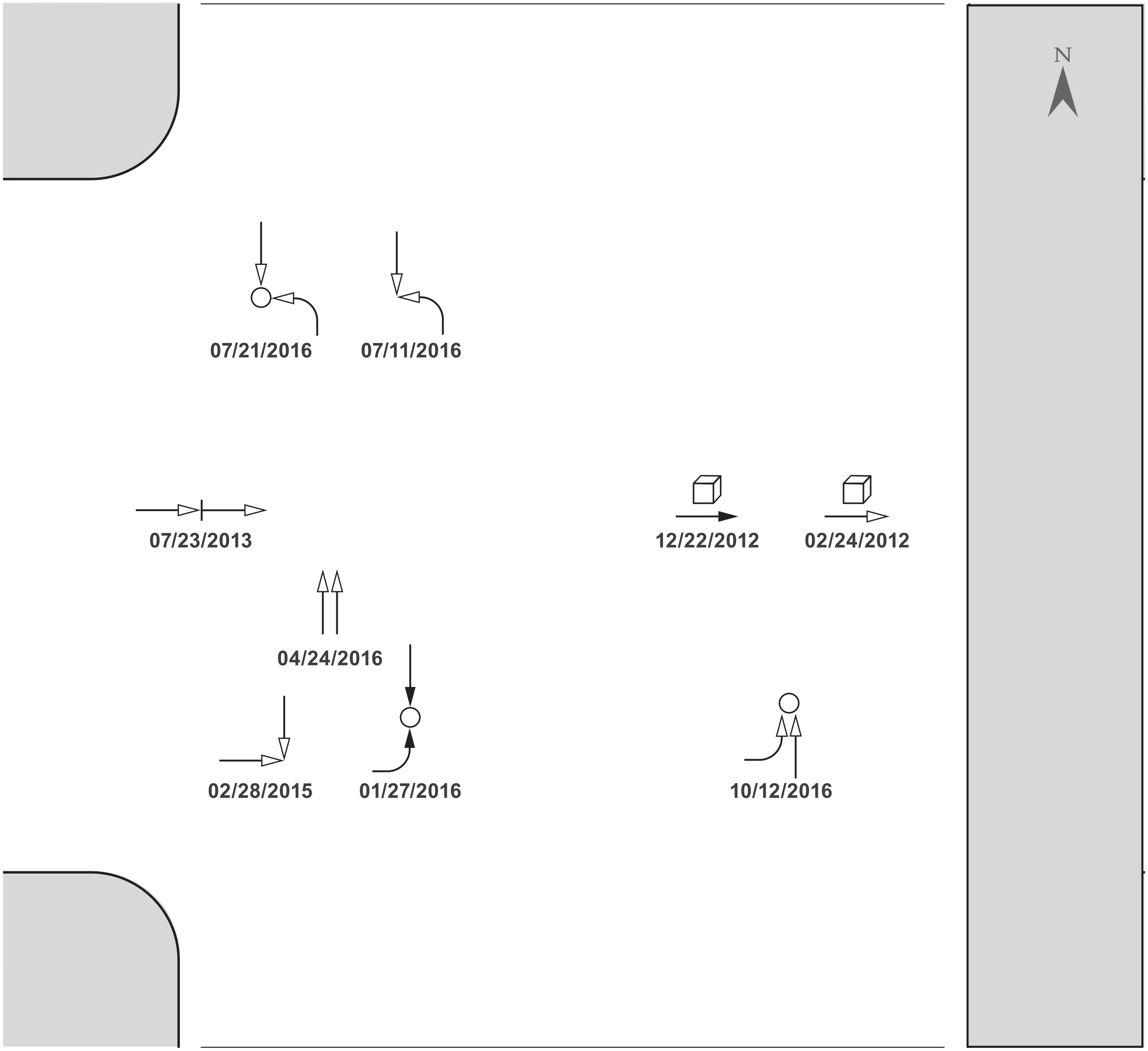
The longer-term concept, illustrated in Figure 35, includes a single lane roundabout and supplementing intersection approaches with curb and gutter and raised channelization to increase awareness. Actual treatments would be determined during project development.

East-West Street **Butler Market Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Hamby Road**

Date Prepared: **04/05/2019**



Number of Collisions

6	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
9	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

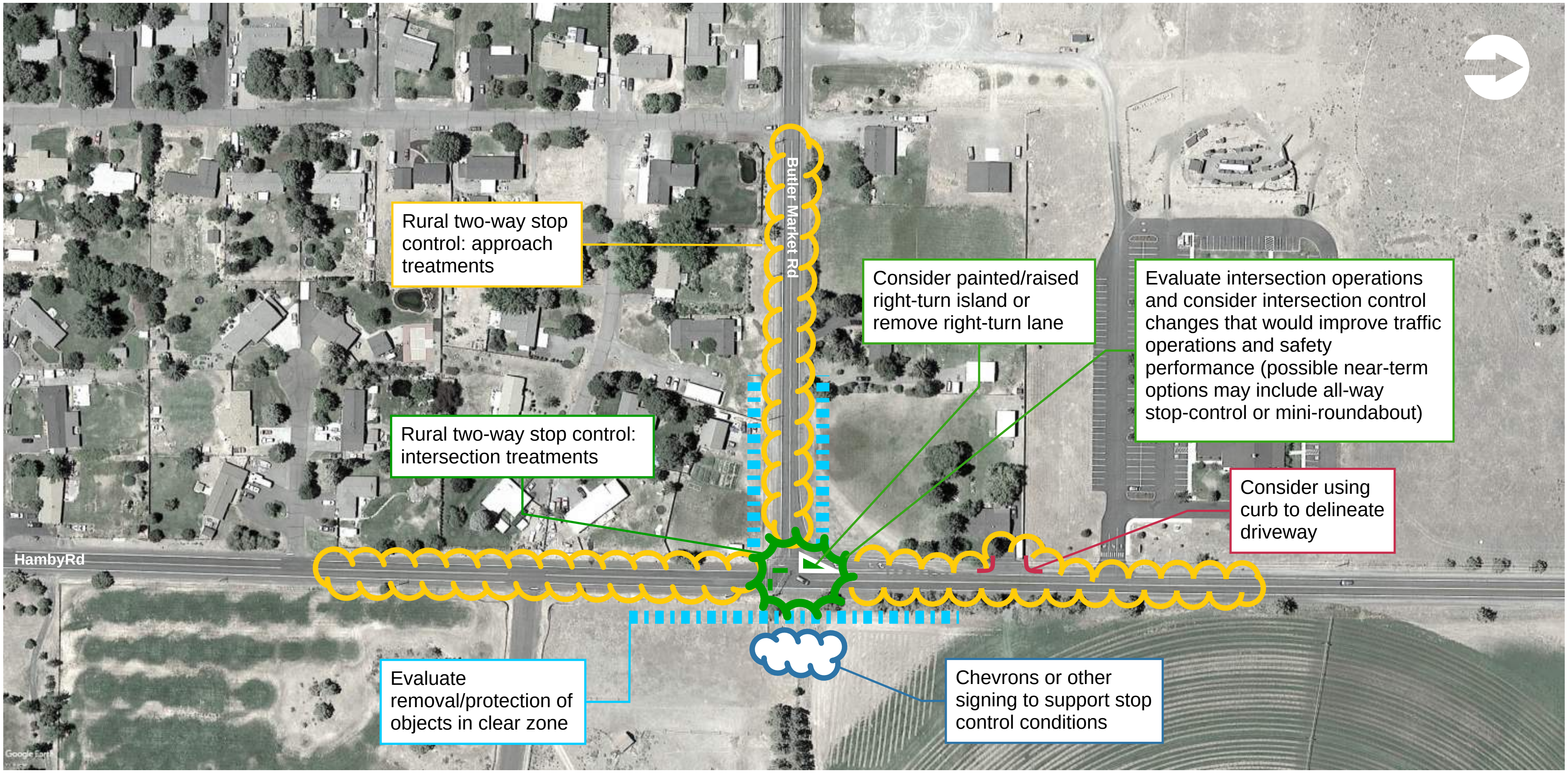
Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon

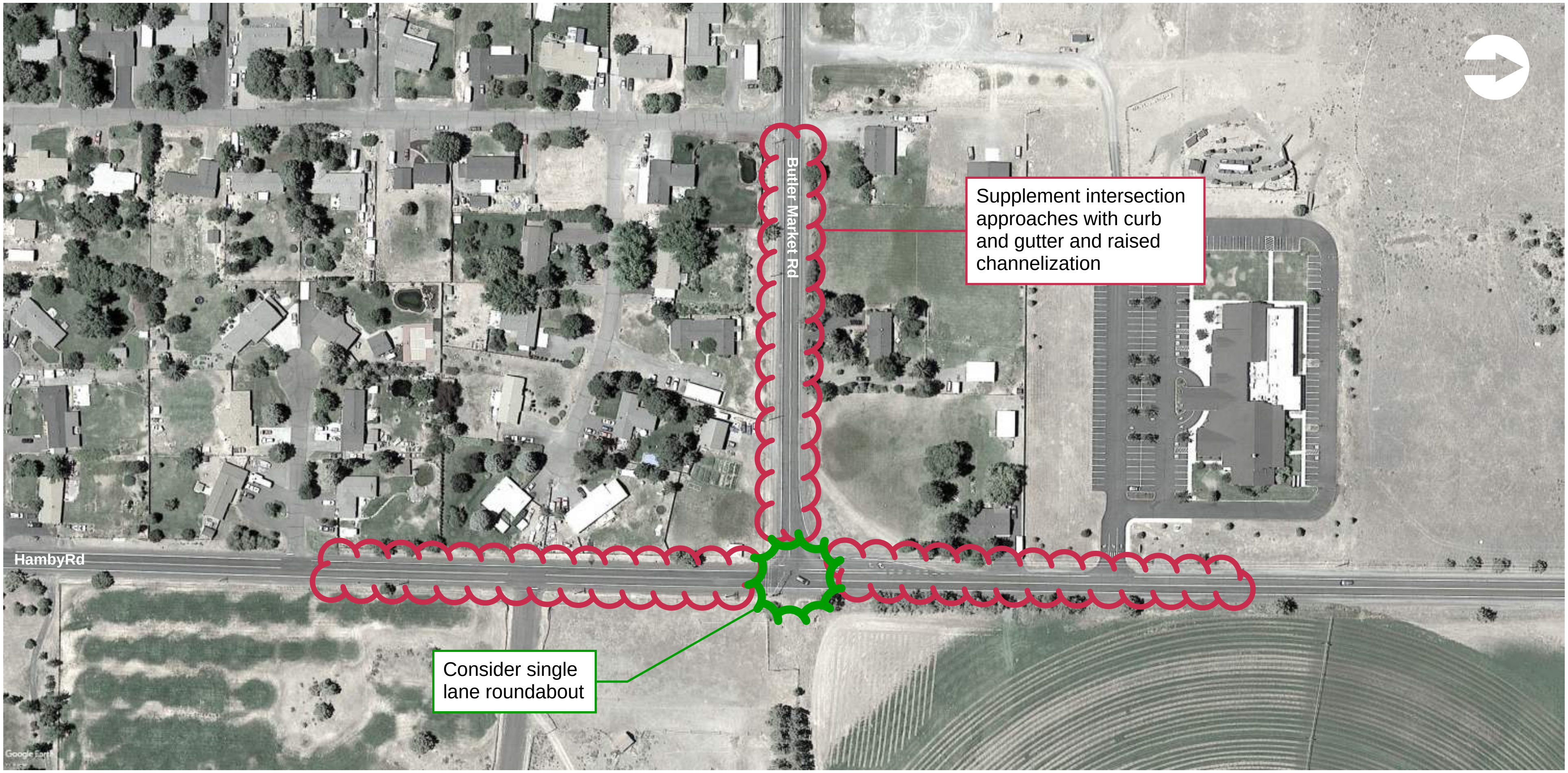
DUI represents a collision where alcohol and/or drugs were reported

Figure 33
Crash Diagram



Butler Market Rd
HambyRd
Rural two-way stop control: approach treatments
Consider painted/raised right-turn island or remove right-turn lane
Evaluate intersection operations and consider intersection control changes that would improve traffic operations and safety performance (possible near-term options may include all-way stop-control or mini-roundabout)
Rural two-way stop control: intersection treatments
Consider using curb to delineate driveway
Evaluate removal/protection of objects in clear zone
Chevrons or other signing to support stop control conditions

Not to Scale



Butler Market Rd
HambyRd
Supplement intersection approaches with curb and gutter and raised channelization
Consider single lane roundabout

Not to Scale

5.2.10 Butler Market Road & Hamehook Road

Butler Market Road & Hamehook Road is a three-leg stop-controlled intersection with stop-controlled westbound and southbound approaches. The northbound approach is a free movement. Butler Market Road is an east-west minor arterial roadway. Hamehook Road is a major collector roadway providing a north-south connection between Highway 97 and Highway 20. There is a right-turn deceleration lane on Hamehook Road in the northbound direction.

As shown in Figure 36, there were five reported crashes at Butler Market Road & Hamehook Road between 2012 and 2016, with 60 percent resulting in non-incapacitating injuries.

The near-term concept, shown in Figure 37, includes treatments that increase intersection awareness such as installing additional oversized advanced intersection warning signs. In addition to these near-term safety treatments, an operational analysis of the intersection may be completed to determine if there are treatments such as converting the intersection to all-way stop-control or a mini-roundabout that may improve safety performance and traffic operations of the intersection. Although the TSAP did not include an operational analysis of the site, the County has noted that the existing intersection control at this location may be failing.

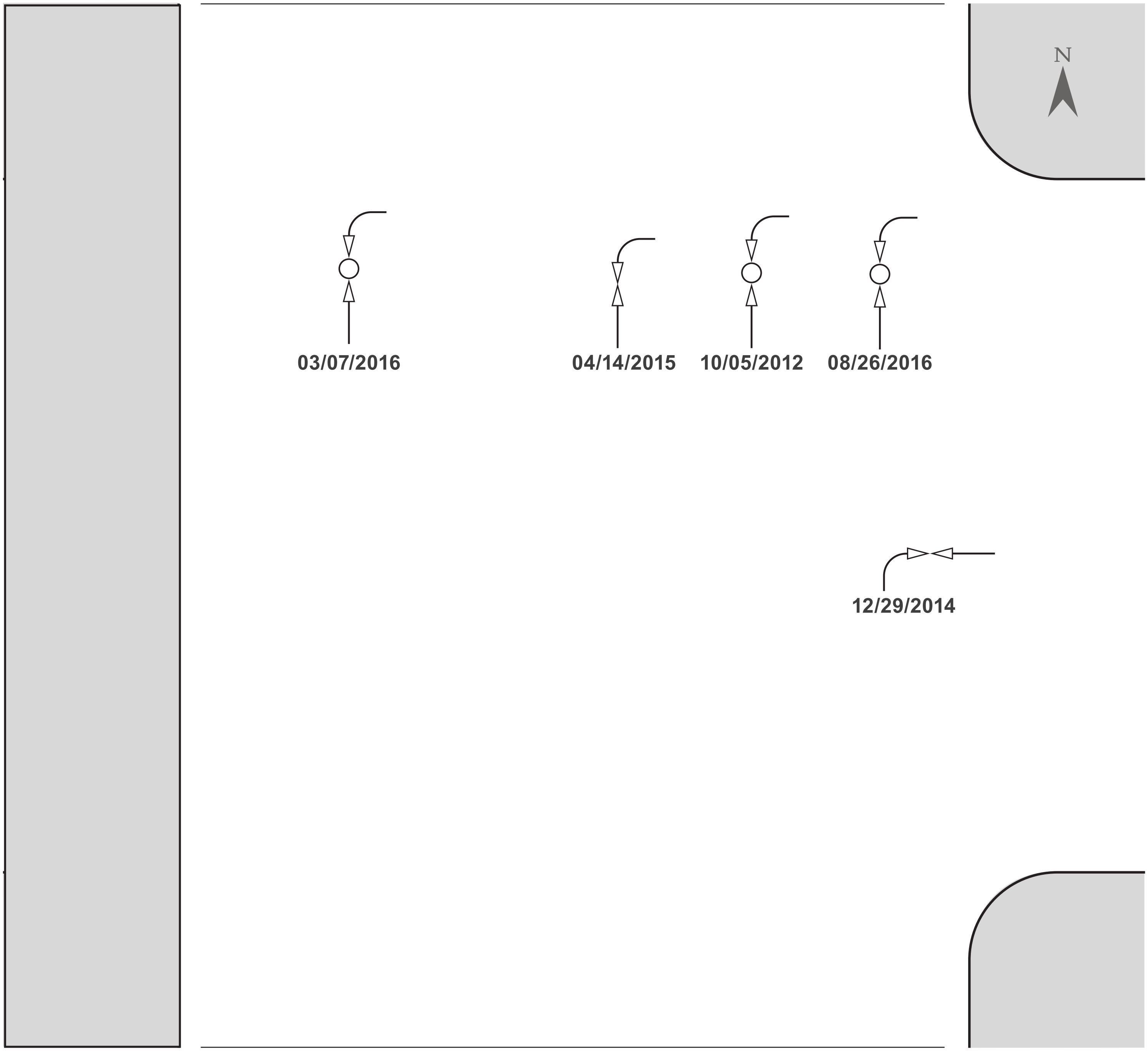
The longer-term concept, shown in Figure 38, incudes potential treatments such as a single lane roundabout and installing curb, gutter, and raised channelization (splitter islands) on the intersection approaches. Actual treatments would be determined during project development.

East-West Street **Butler Market Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Hamehook Road/Butler Market Road**

Date Prepared: **04/03/2019**



Number of Collisions

2	Property Damage Only
3	Non-incapacitating Injury Collisions
0	Fatal and Incapacitating Injury Collisions
5	Total Collisions

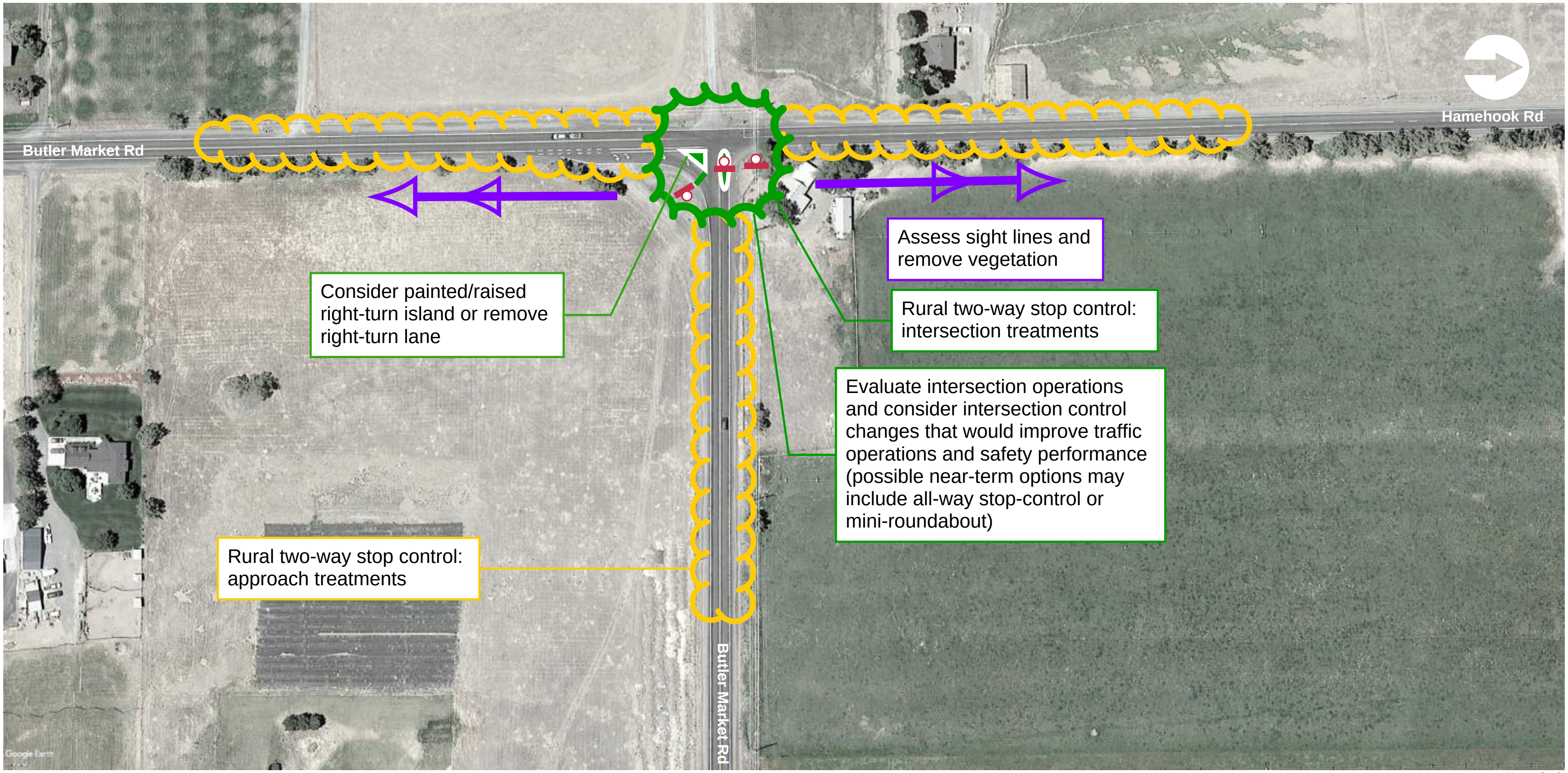
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

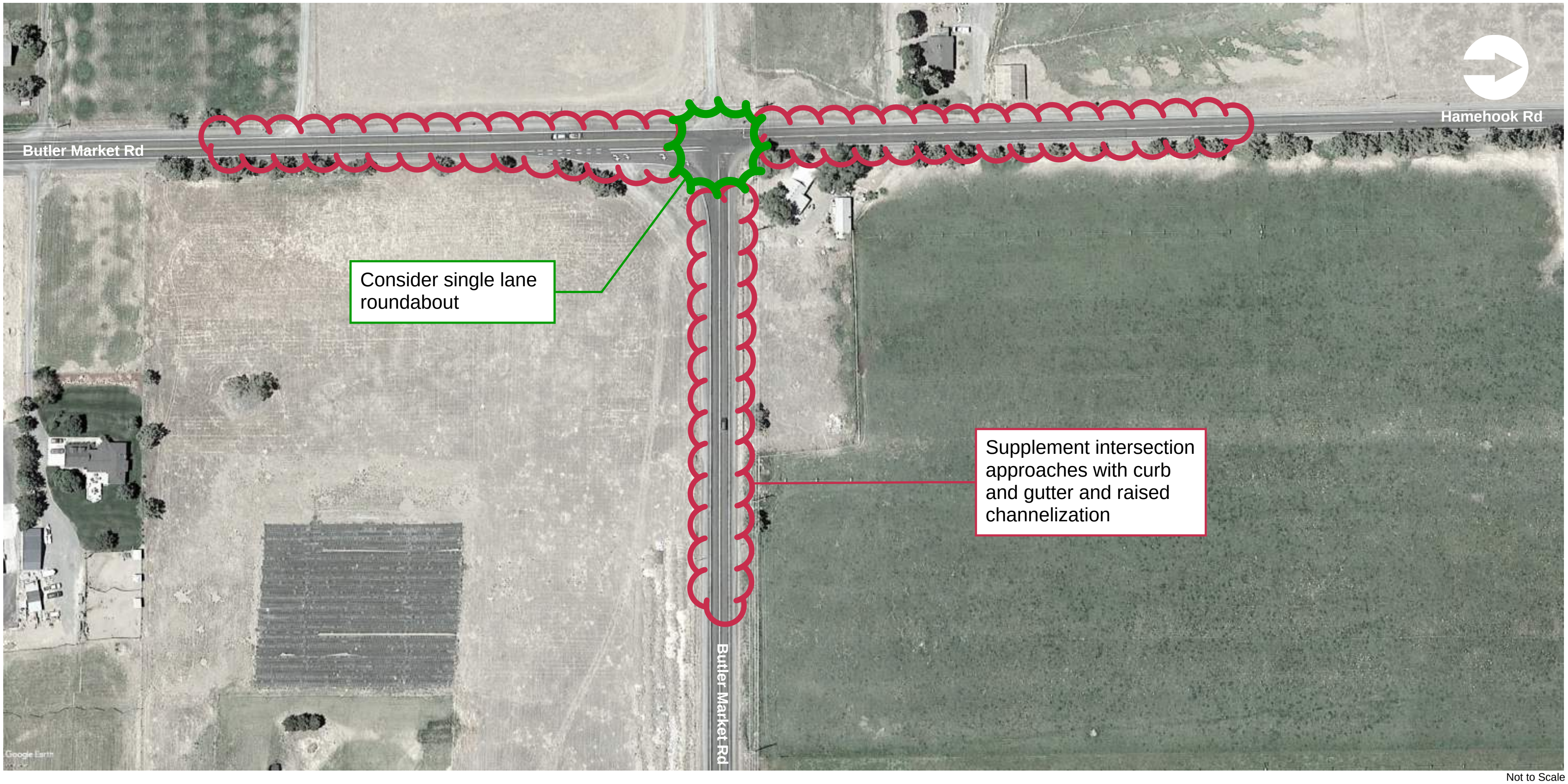
Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 36
Crash Diagram



Hamehook Rd
Butler Market Rd
Butler Market Rd
Assess sight lines and remove vegetation
Consider painted/raised right-turn island or remove right-turn lane
Rural two-way stop control: intersection treatments
Evaluate intersection operations and consider intersection control changes that would improve traffic operations and safety performance (possible near-term options may include all-way stop-control or mini-roundabout)
Rural two-way stop control: approach treatments
Google Earth

Not to Scale



KITTELSON & ASSOCIATES

Location-Specific Concepts
Butler Market Road & Hamehook Road
Long Term

Figure 38

5.2.11 Baker Road & Cinder Butte Road

Baker Road & Cinder Butte Road is a stop-controlled intersection. Baker Road is a two-lane minor arterial roadway running east-west. Cinder Butte Road is a two-lane major collector roadway and is stop-controlled. Railroad tracks and Highway 97 ramps are located immediately east of the intersection. Baker Road & Cinder Butte Road is a skewed intersection.

Between 2012 and 2016, there were 12 reported crashes. Half of the reported crashes (6) were rear-end crashes, and one-third (4) were turning movement crashes as summarized in Figure 39. Approximately 42 percent of crashes resulted in non-incapacitating injuries. One injury crash involved a bicyclist.

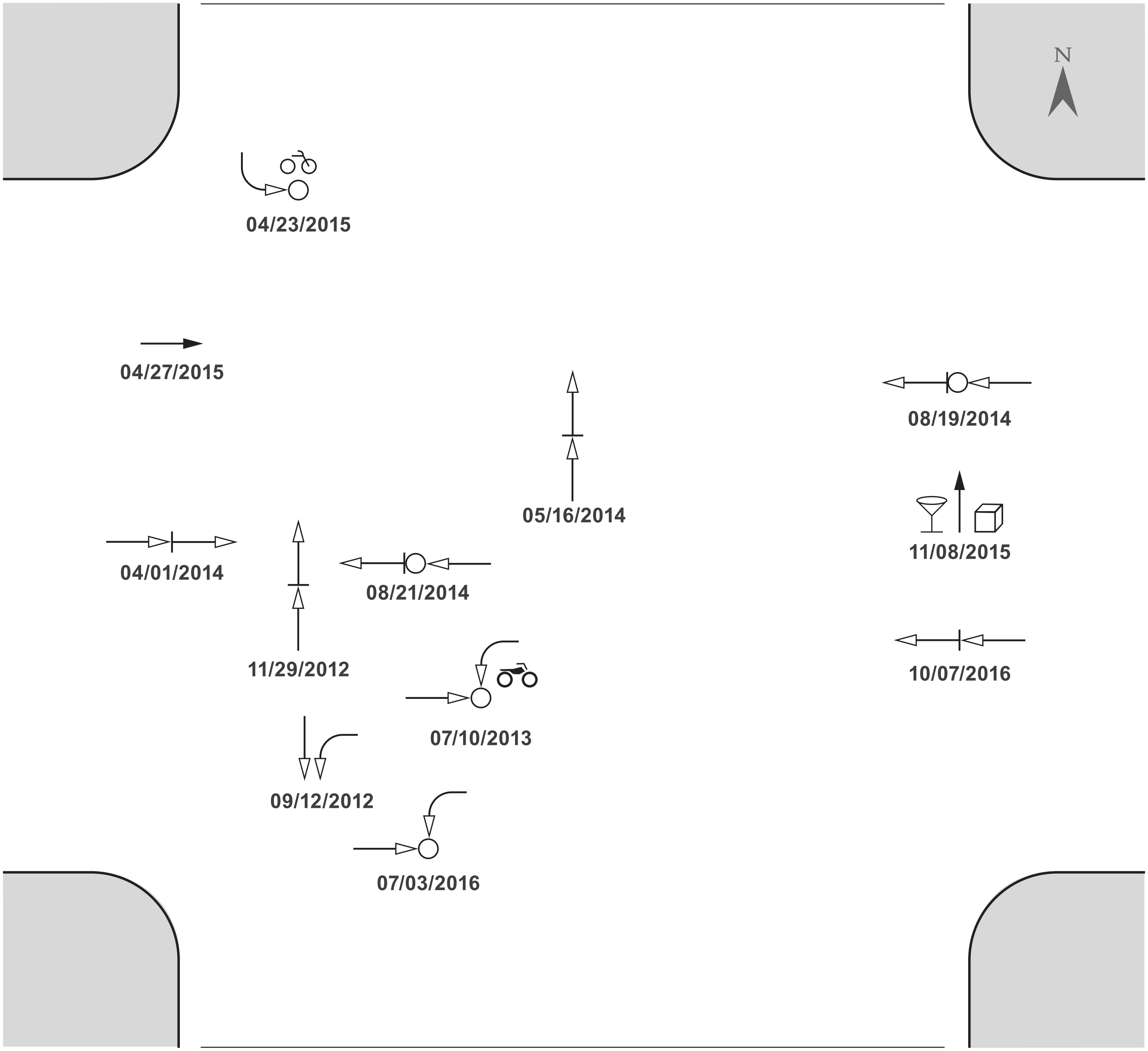
The near-term concept, shown in Figure 40, includes improving delineation and increasing intersection awareness through signing and striping. Sight lines should be assessed. The long-term concept, shown in Figure 41, includes intersection geometry changes such as squaring up the intersection and using raised channelization to further increase intersection awareness. Another longer-term consideration for this intersection is installing a roundabout per the 2012 Deschutes County Transportation System Plan (TSP). Actual treatments would be determined during project development.

East-West Street **Baker Road**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Cinder Butte Road/ Pocahontas Lane**

Date Prepared: **04/03/2019**



Number of Collisions

7	**Property Damage Only**
5	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
12	**Total Collisions**

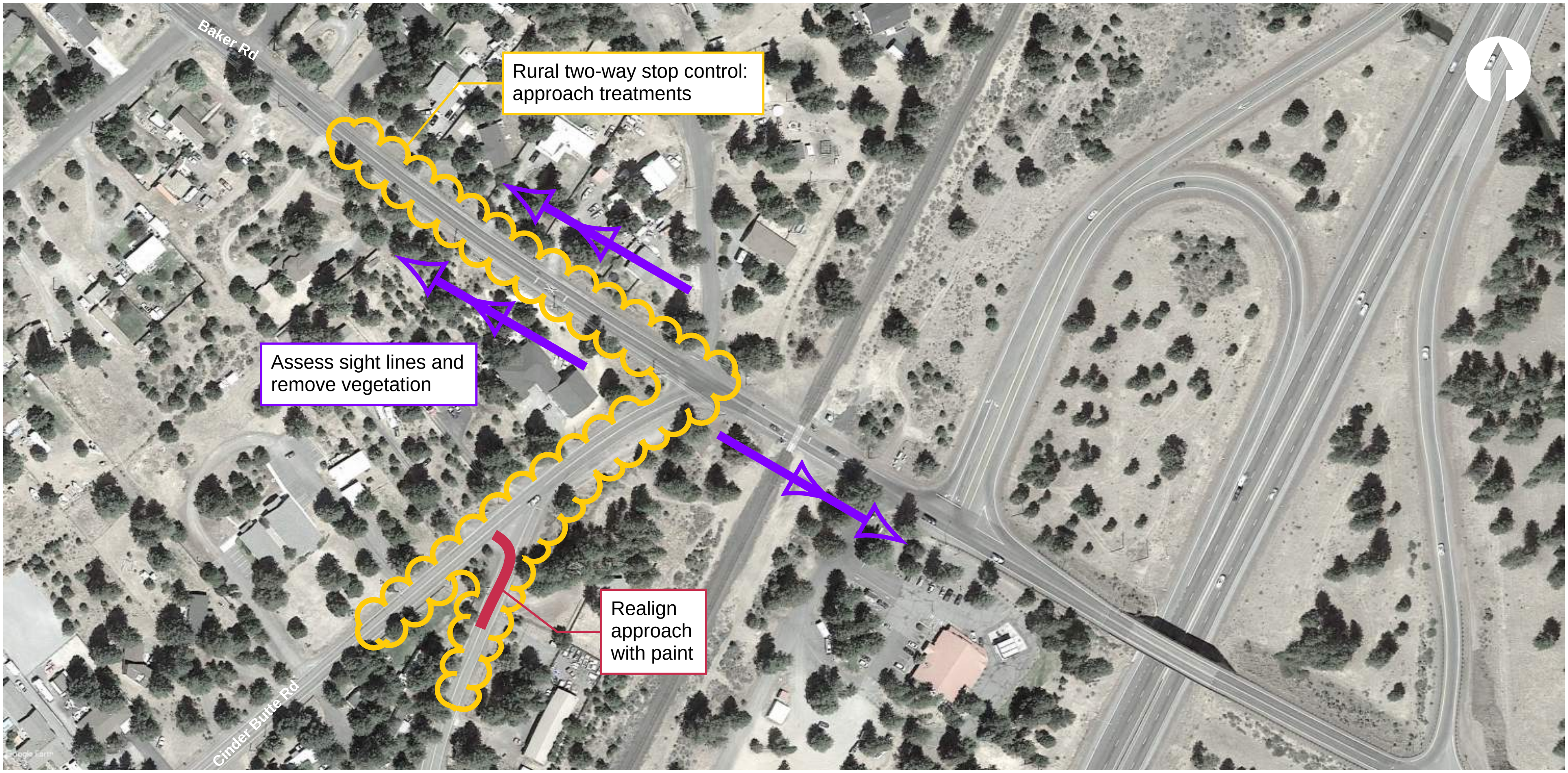
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

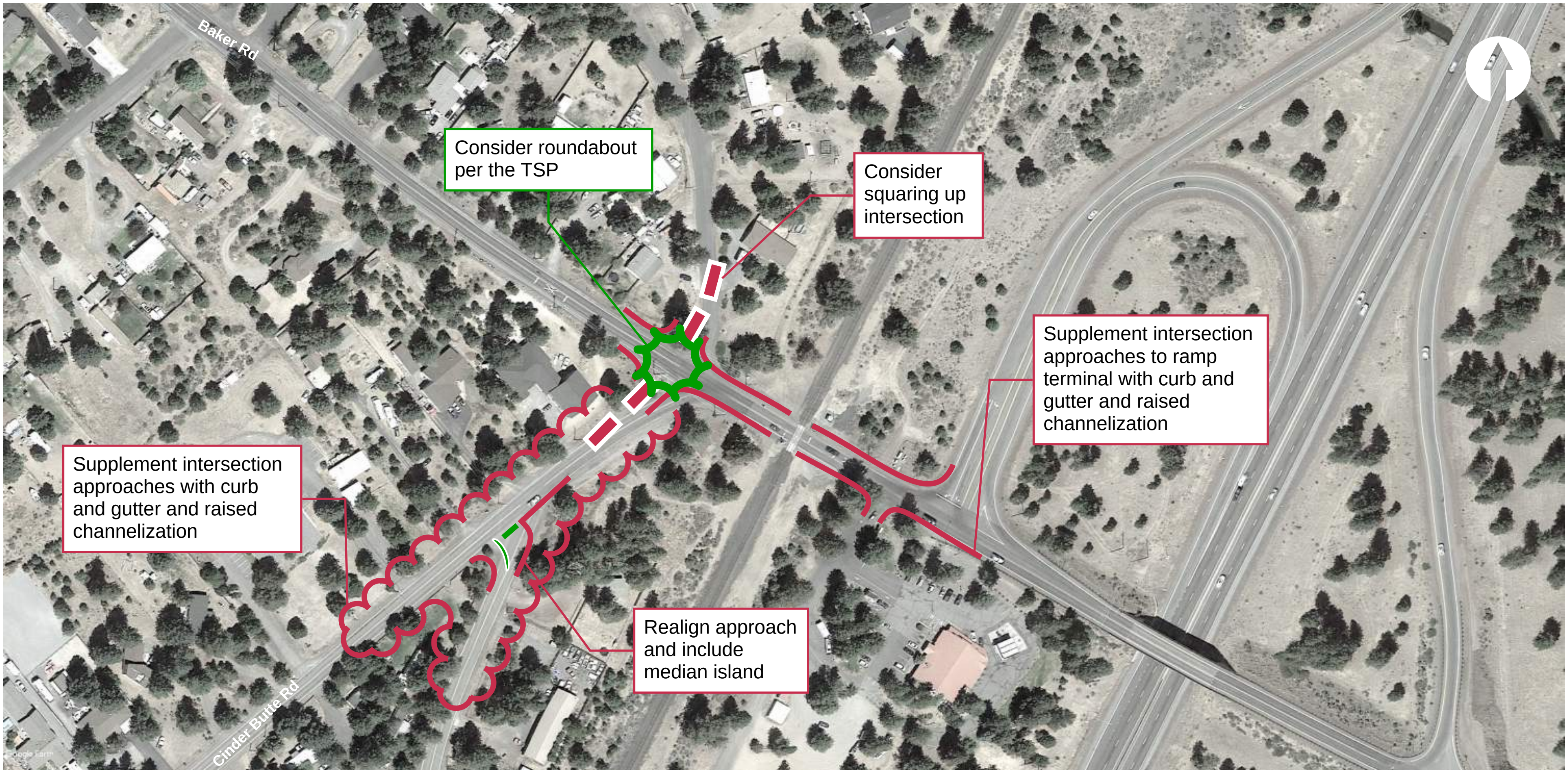
Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 39
Crash Diagram



Baker Rd
Rural two-way stop control: approach treatments
Assess sight lines and remove vegetation
Realign approach with paint
Cinder Butte Rd

Not to Scale



Not to Scale

KITTELSON & ASSOCIATES

Location-Specific Concepts
Baker Road & Cinder Butte Road
Long Term

Figure 41

5.2.12 S. Century Drive & Huntington Road

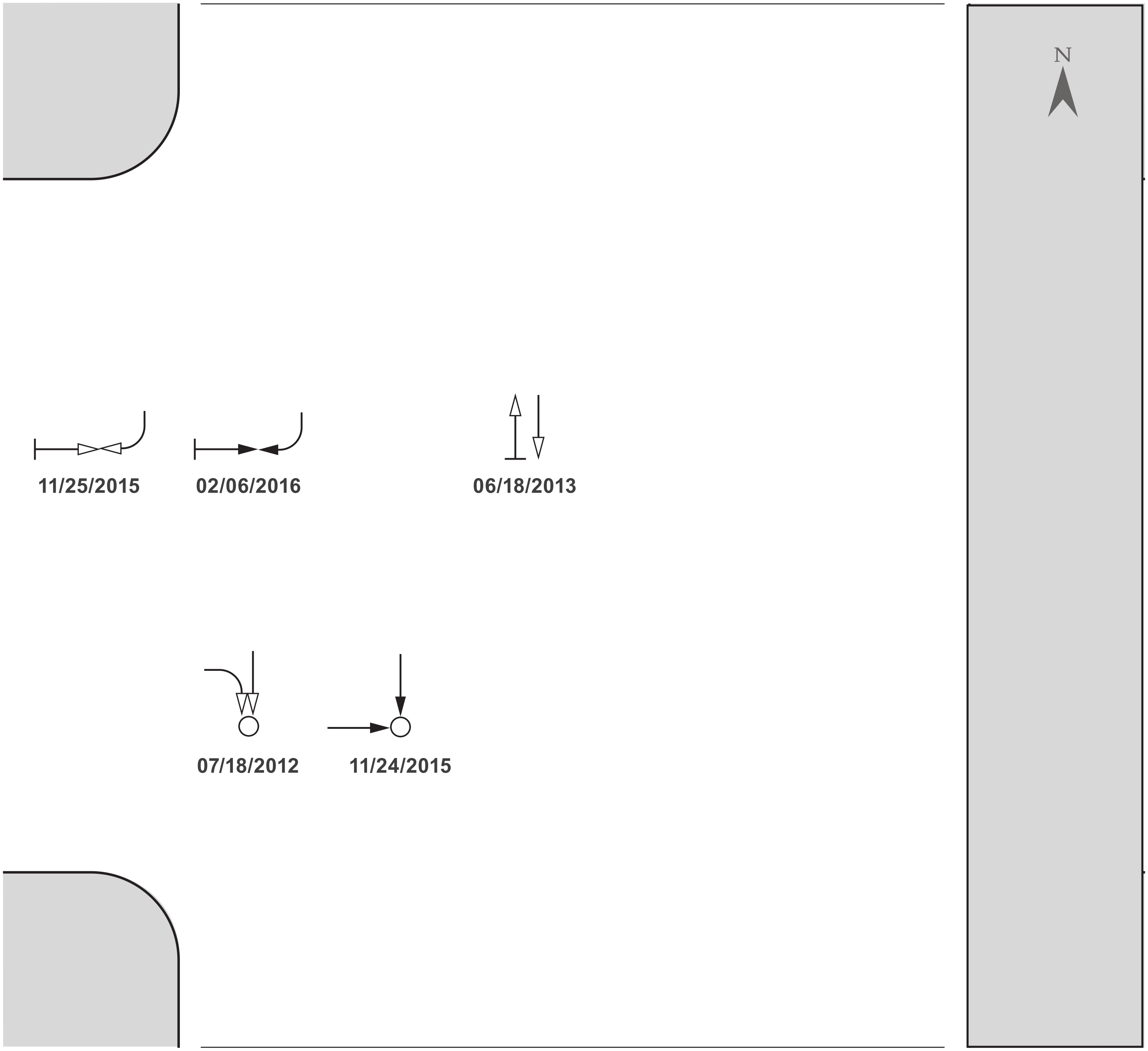
S. Century Drive & Huntington Road is a three-leg stop-controlled intersection with the northbound and eastbound movements stop-controlled. The southbound approach is a free movement. S. Century Drive & Huntington Road are two-lane major collector roadways. S. Century Drive provides an east-west connection between Cascade Lakes Highway and Highway 97.

Figure 42 shows five crashes were reported at S. Century Drive & Huntington Road between 2012 and 2016, including three turning movement crashes. Two crashes occurred in dark, dusk, or dawn lighting conditions, and two crashes resulted in non-incapacitating injuries. The five reported crashes involved a vehicle traveling southbound.

The near-term concept, shown in Figure 43, includes treatments that increase intersection awareness such as additional oversized advanced intersection warning signs, transverse rumble strips on the approaches, assessing sight lines, and assessing illumination needs. In addition, the existing intersection control may be evaluated to determine if converting to an all-way stop-control intersection would operate acceptably. The longer-term concept, shown in Figure 44, includes considering a single lane roundabout and squaring up the intersection to increase the curve radius for the southbound travel lanes. The County's TSP identifies a roundabout at this location. Actual treatments would be determined during project development.

East-West Street **Century Drive** From: **01/01/2012** To: **12/31/2016**

North-South Street: **Huntington Road** Date Prepared: **04/03/2019**



Number of Collisions

3	**Property Damage Only**
2	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
5	**Total Collisions**

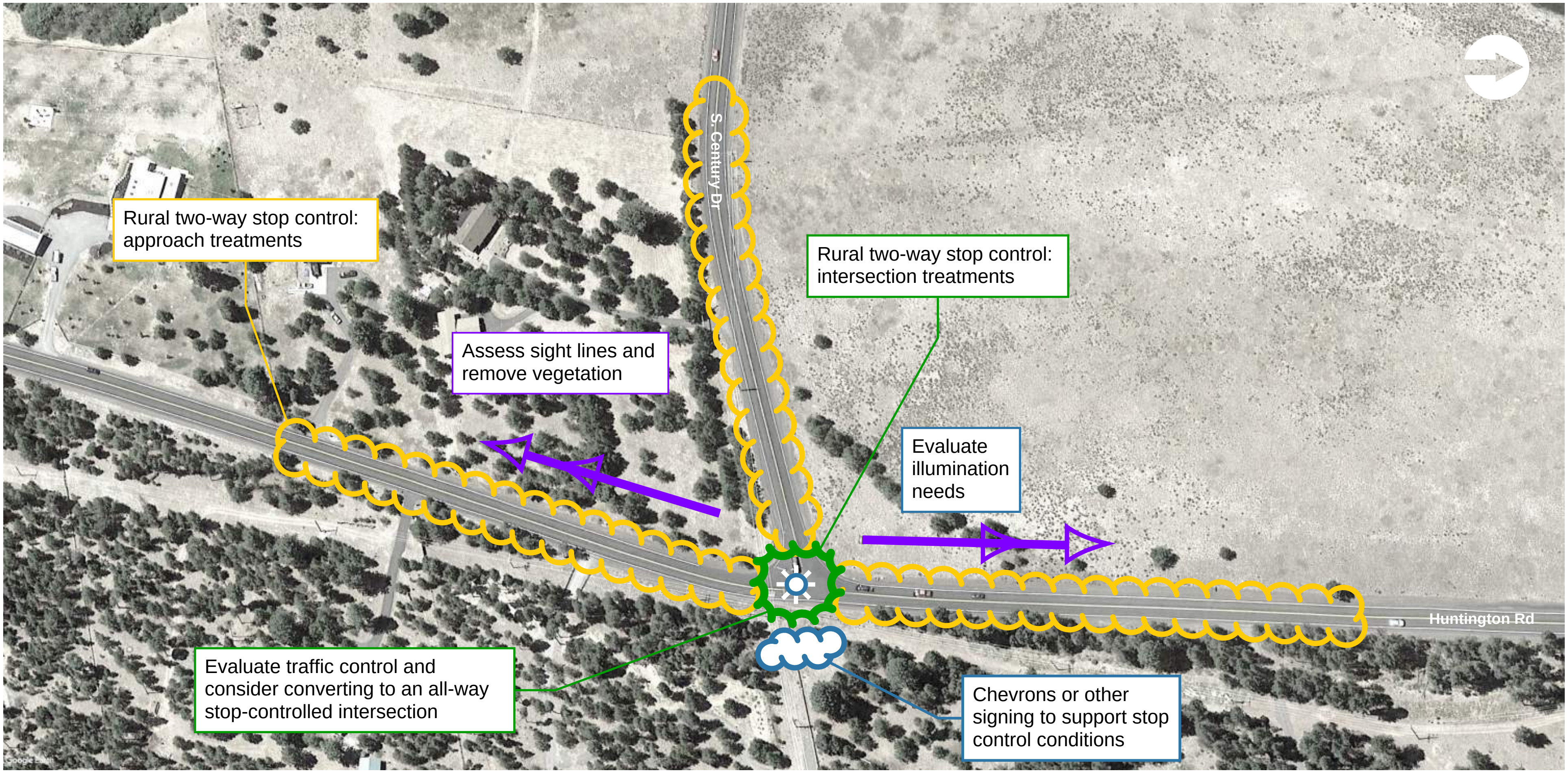
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

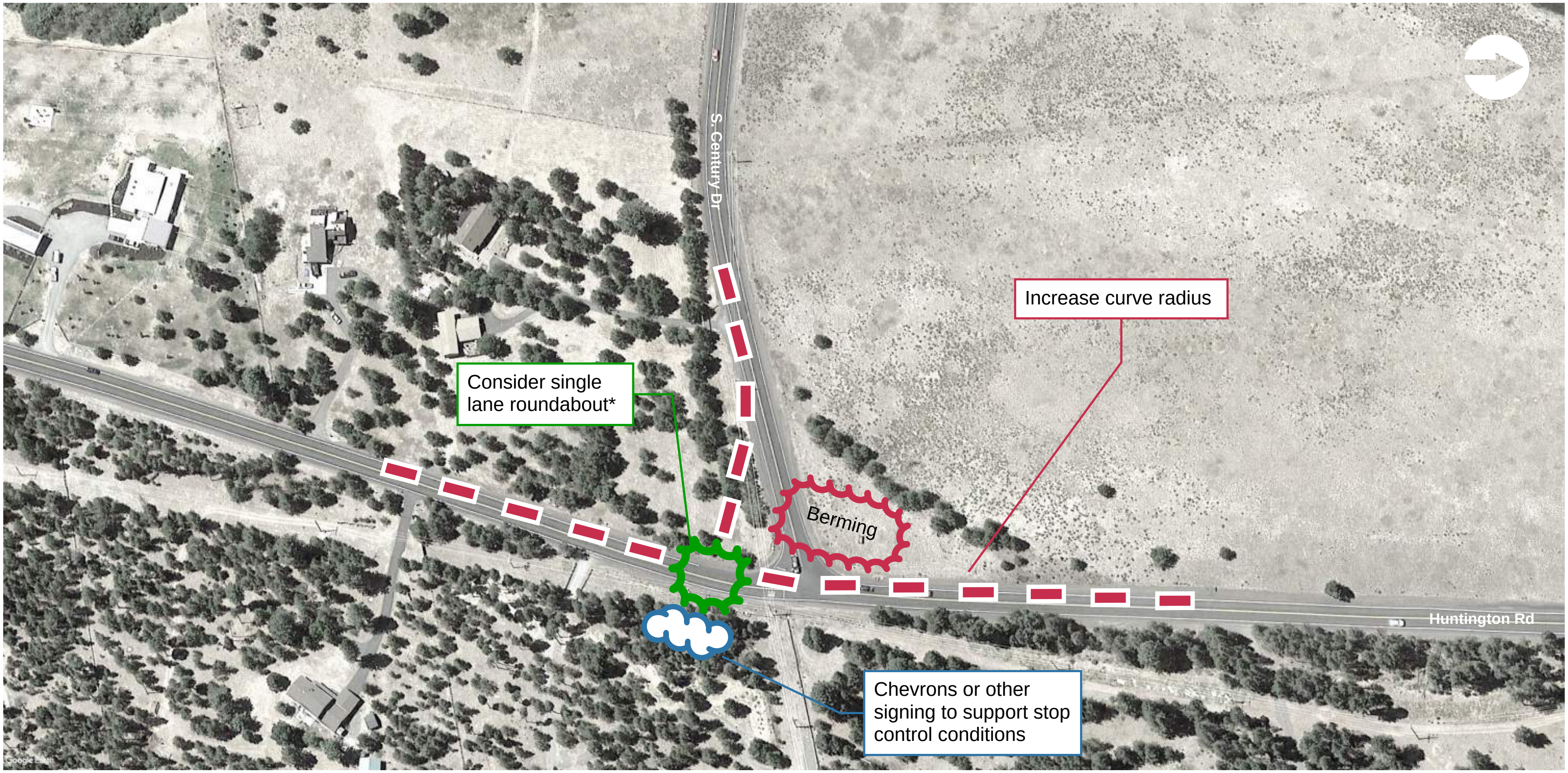
Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 42
Crash Diagram



S. Century Dr
Rural two-way stop control: approach treatments
Rural two-way stop control: intersection treatments
Assess sight lines and remove vegetation
Evaluate illumination needs
Huntington Rd
Evaluate traffic control and consider converting to an all-way stop-controlled intersection
Chevrons or other signing to support stop control conditions

Not to Scale



Not to Scale

*Deschutes County Transportation System Plan (TSP) identifies a roundabout.

5.2.13 Coopers Hawk Drive/Falcon Crest Drive & Cline Falls Road

Coopers Hawk Drive/Falcon Crest Drive & Cline Falls Road is a two-way, stop-controlled intersection that serves as access to Eagle Crest Resort. The eastbound and westbound approaches are stop-controlled. Cline Falls Road is a minor arterial providing a north-south connection between the City of Bend to Highway 126, west of Redmond. Cline Falls Road has dedicated northbound and southbound left-turn and right-turn lanes. Falcon Crest Drive has a shared left-turn and through movement lane and a dedicated right-turn lane. There is a bicycle crossing located south of the intersection on Cline Falls Road.

Two crashes were reported between 2012 and 2016, including one angle crash and one turning movement crash, as shown in Figure 45. One crash resulted in a non-incapacitating injury.

The concept for this site, illustrated in Figure 46, includes shifting stop bars on Coopers Hawk Drive/Falcon Crest Drive them towards Cline Falls Road. This can be done by installing painted right turn islands to channelize the right-turn movements from Cline Falls Road. As currently striped, there is no indication to drivers they must turn right and the stop bars are located as if the right turn lane allows a through movement.

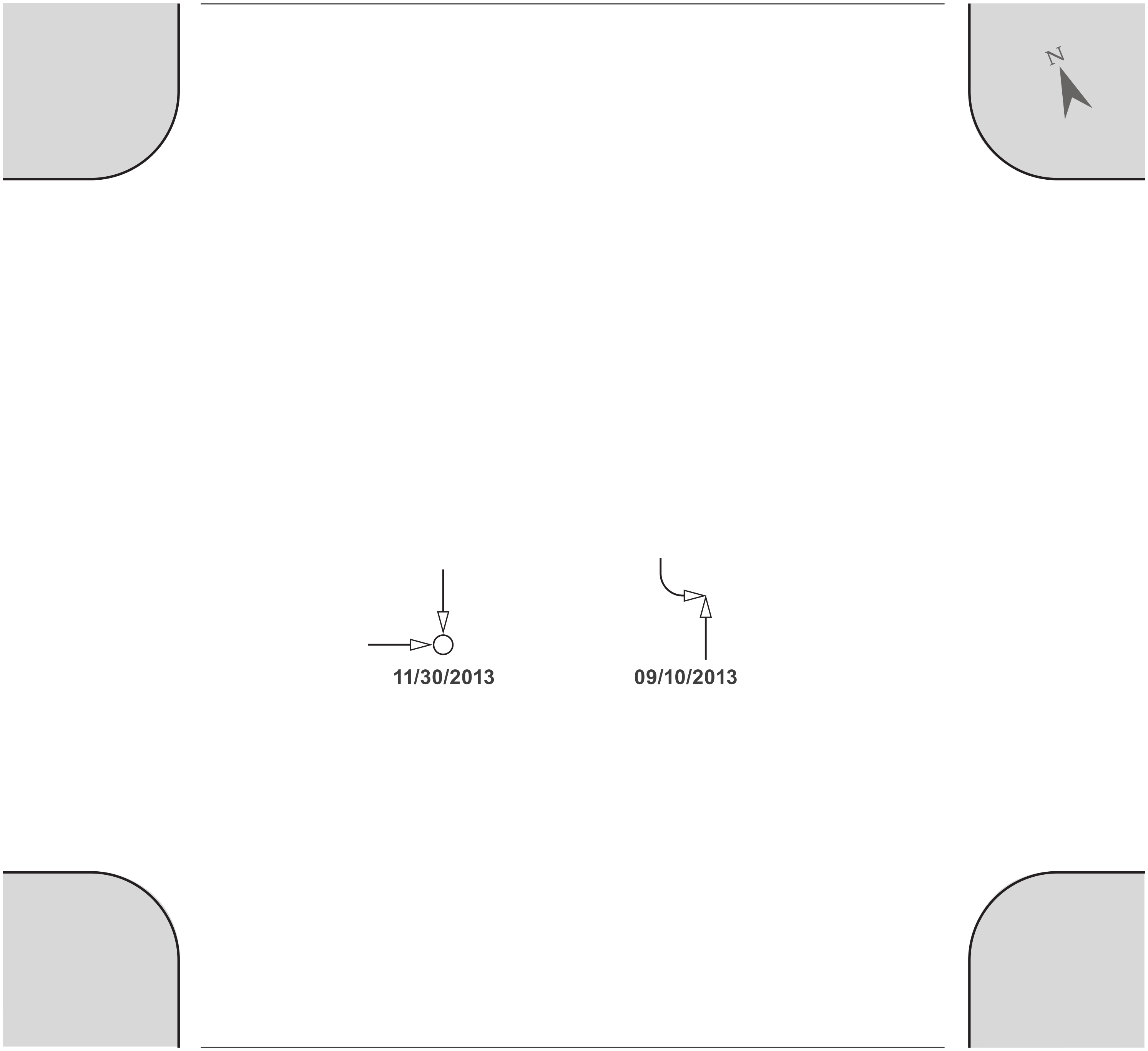
The concept shows realigning the Cline Falls Road bike crossing to be perpendicular to the road. Relocating the start of the northbound right-turn lane taper to begin after the realigned bike crossing eliminates the ambiguity of developing a right-turn lane at the location of the bike crossing. Making the bike crossing perpendicular to the roadway reduces overall travel distance and eliminates the bike crossing skew. This improves the sight lines for bicyclists to upstream traffic. Actual treatments would be determined during project development.

East-West Street **Cooper Hawks Drive/Falcon Crest Drive**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Cline Falls Road**

Date Prepared: **04/03/2019**



Number of Collisions

1	Property Damage Only
1	Non-incapacitating Injury Collisions
0	Fatal and Incapacitating Injury Collisions
2	Total Collisions

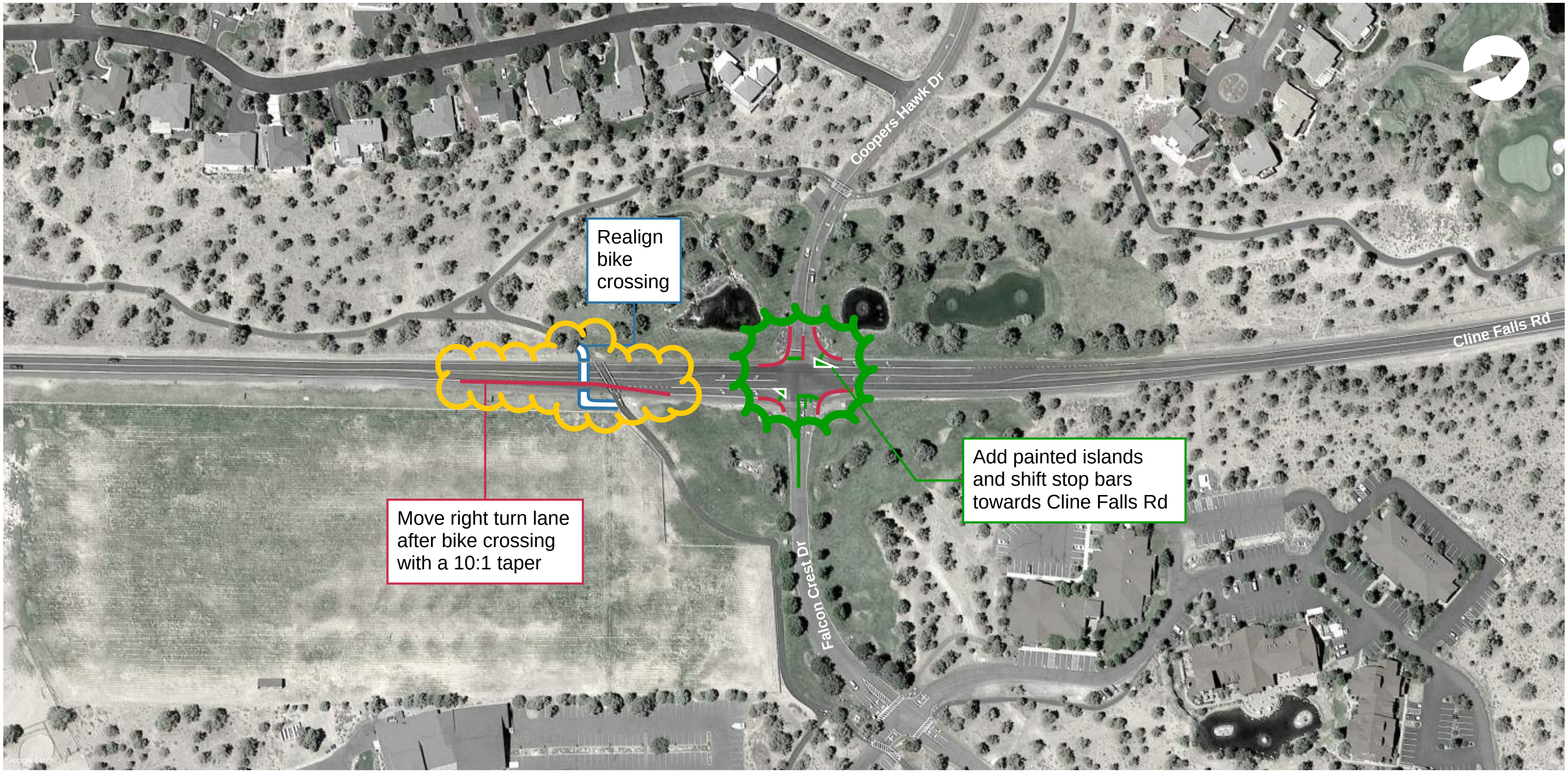
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 45
Crash Diagram



Coopers Hawk Dr
Realign bike crossing
Cline Falls Rd
Add painted islands and shift stop bars towards Cline Falls Rd
Move right turn lane after bike crossing with a 10:1 taper
Falcon Crest Dr

Not to Scale

5.2.14 Lower Bridge Way & 19th Street

Lower Bridge Way & 31st Street is a three-leg stop-controlled intersection, with a stop-controlled northbound approach. The intersection is located on a horizontal curve. Lower Bridge Way is a two-lane major collector roadway.

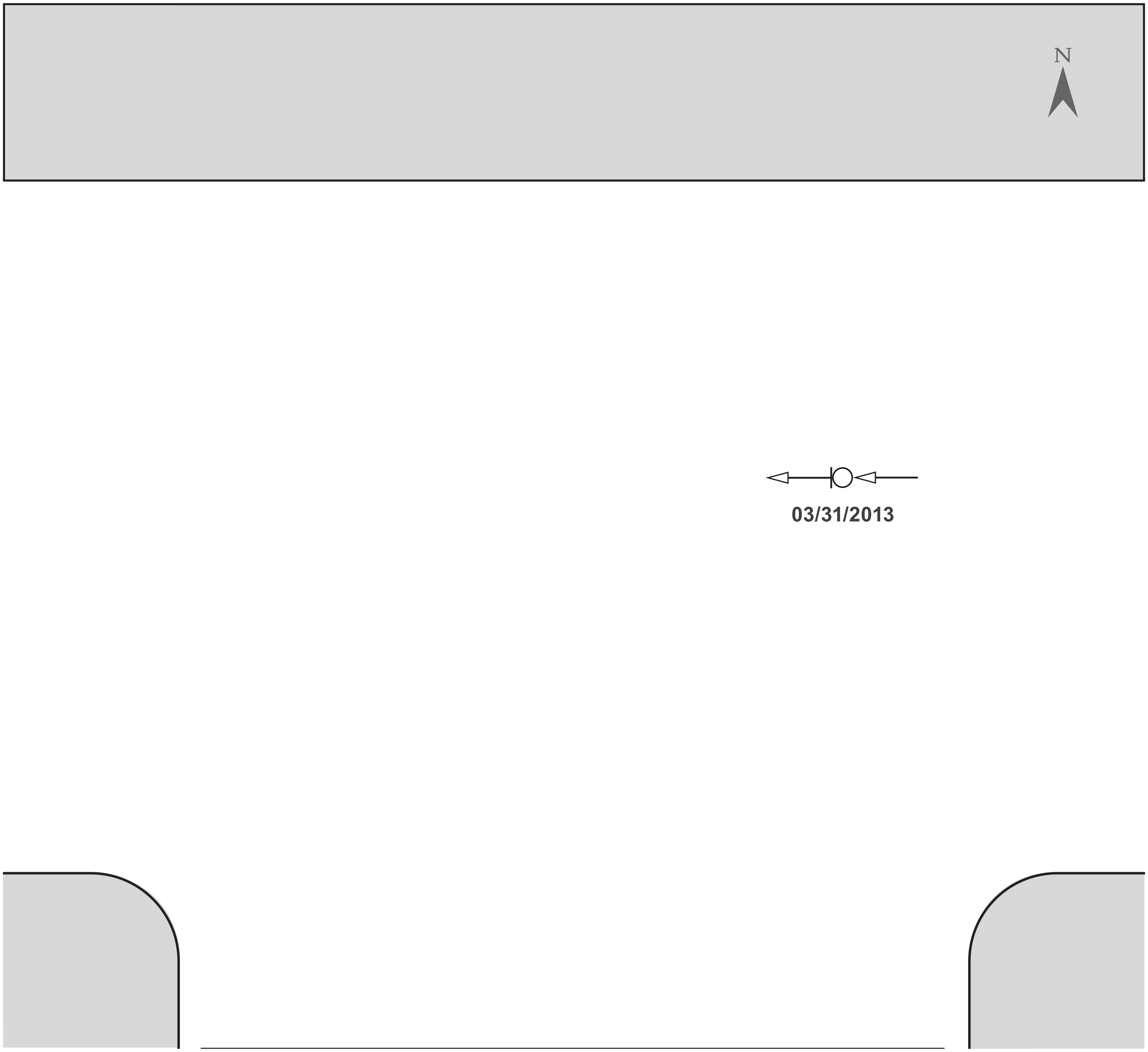
Between 2012 and 2016, one rear-end crash, resulting in a non-incapacitating injury, was reported at Lower Bridge Way & 19th Street, as shown in Figure 47. The concept, shown in Figure 48, includes installing chevron signs on the horizontal curve, installing signing to support the stop-control conditions, consolidating driveway access points, and delineating driveways with curb. In addition, vegetation should be maintained to provide adequate sight lines. Actual treatments would be determined during project development.

East-West Street **Lower Bridge Way**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **19th Street**

Date Prepared: **04/03/2019**



Number of Collisions

0	**Property Damage Only**
1	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
1	**Total Collisions**

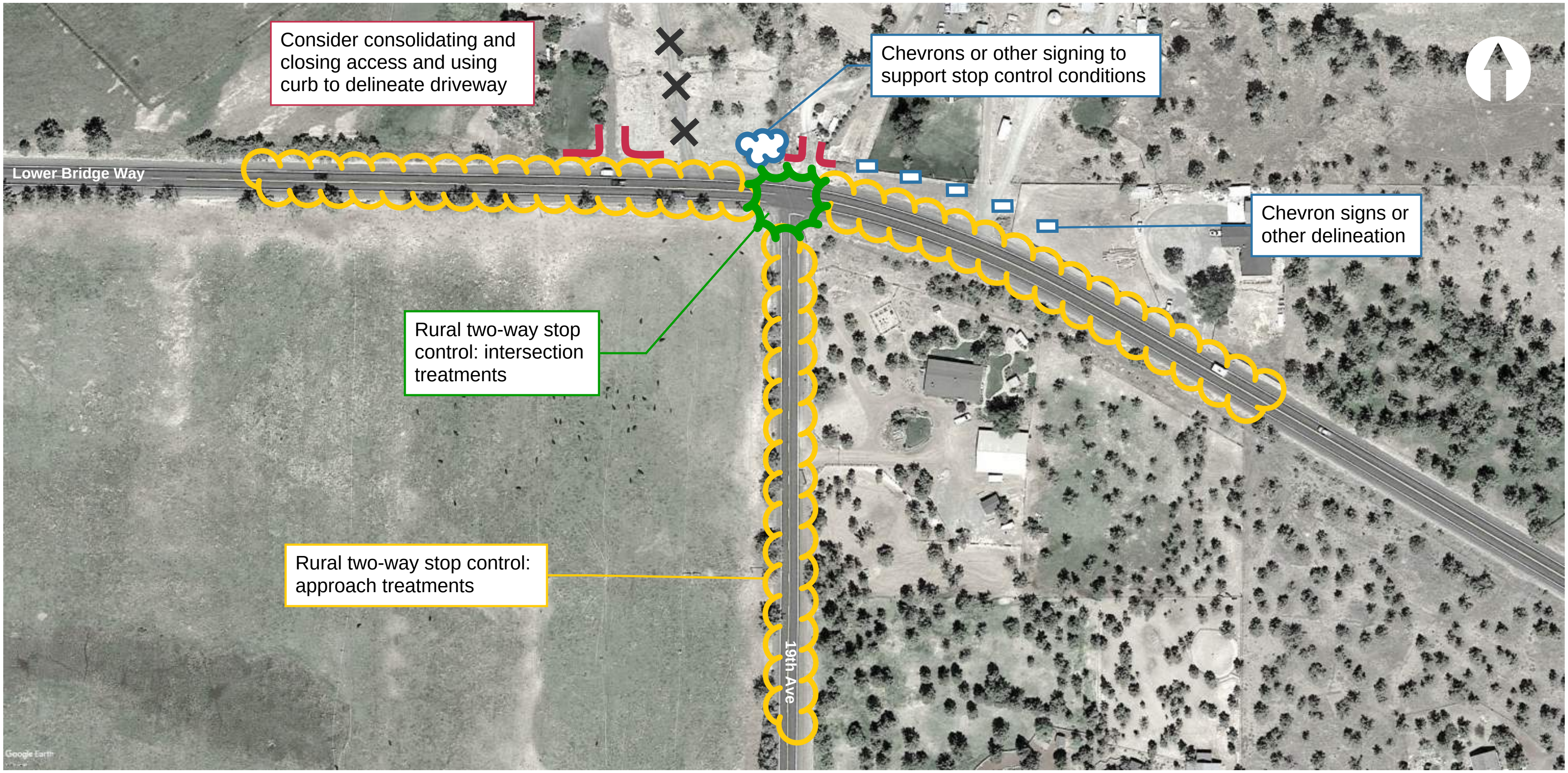
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 47
Crash Diagram


Consider consolidating and closing access and using curb to delineate driveway
Chevrons or other signing to support stop control conditions
Lower Bridge Way
Chevron signs or other delineation
Rural two-way stop control: intersection treatments
Rural two-way stop control: approach treatments
19th Ave

Not to Scale

5.2.15 Lower Bridge Way & 31st Street

Lower Bridge Way & 31st Street is a three-leg stop-controlled intersection, with a stop-controlled northbound approach. 31st Street is classified as a north-south minor collector road. Passing is permitted in both directions on Lower Bridge Way at the intersection.

Figure 49 shows the three reported crashes at the intersection between 2012 and 2016, including one crash that resulted in a non-incapacitating injury. One fixed object crash occurred in dark, dusk, or dawn lighting conditions at this intersection. The other two crashes included one rear-end crash and one turning movement crash.

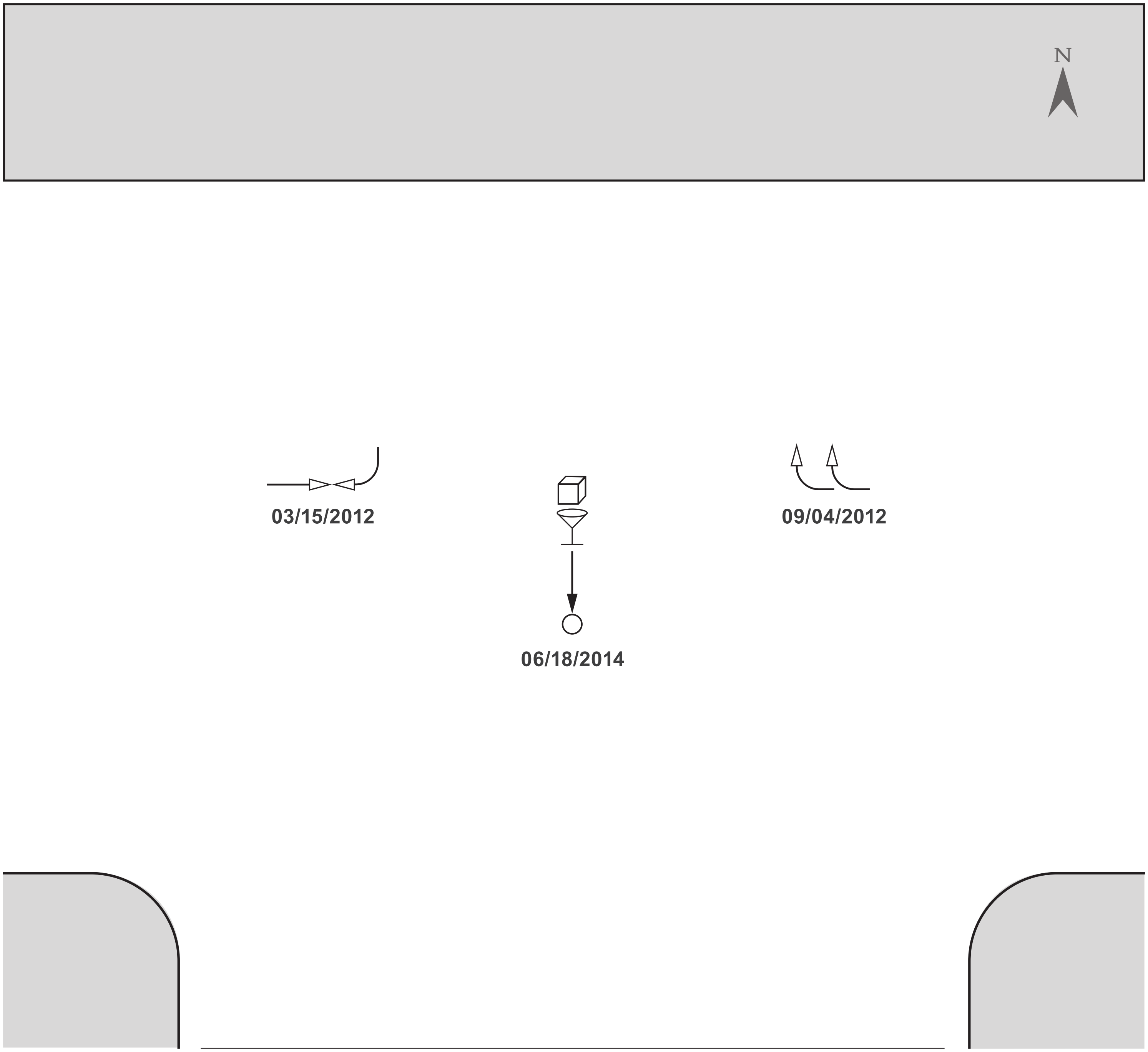
The concept for this location, shown in Figure 50, include systemic treatments to increase intersection awareness such as illumination, wider edgeline striping, post-mounted delineators, and enhanced signage. In addition, the concept includes assessing sight lines and considering the need to remove vegetation. Actual treatments would be determined during project development.

East-West Street **Lower Bridge Way**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **31st Street**

Date Prepared: **04/03/2019**



Number of Collisions

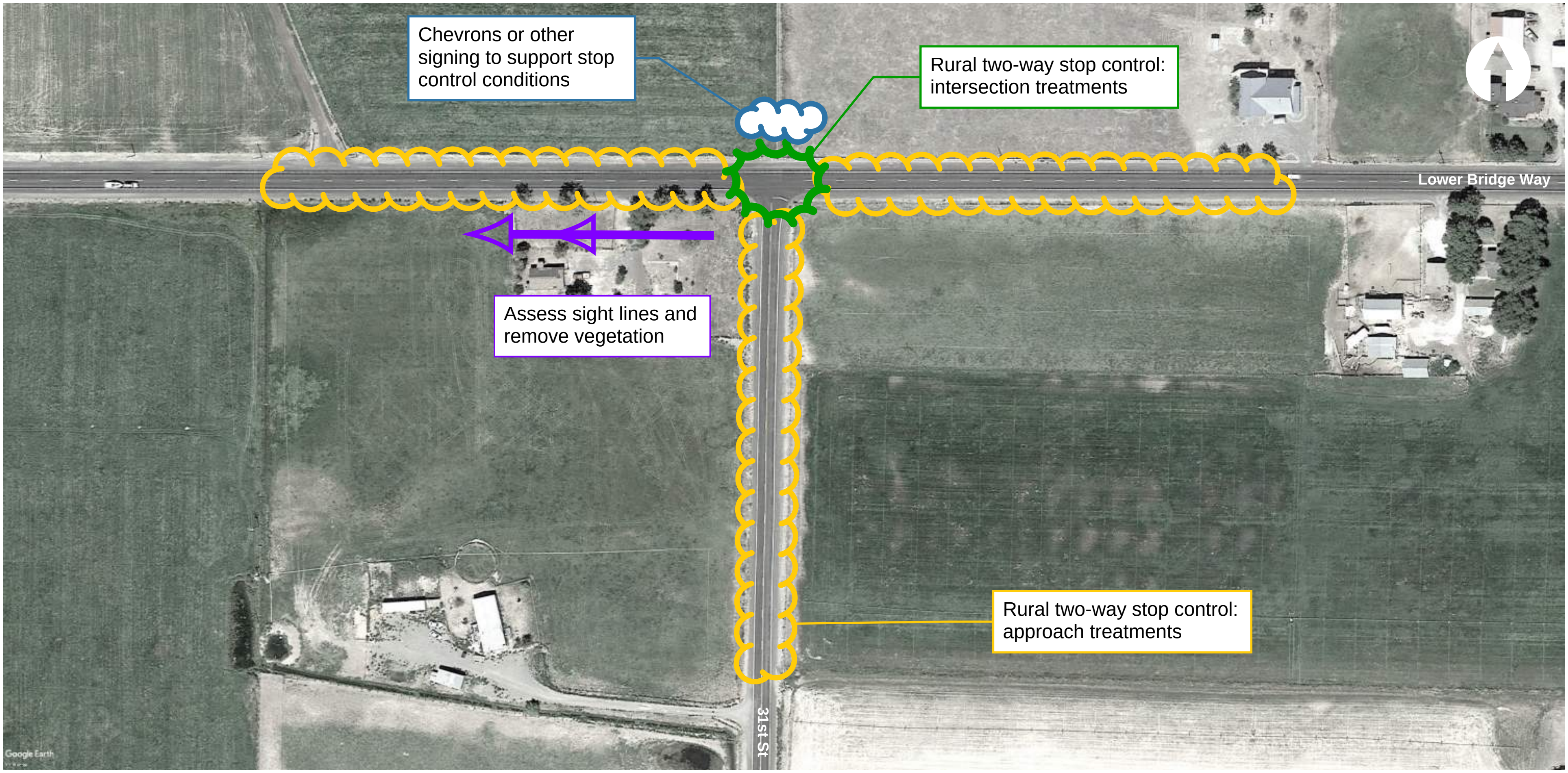
2	Property Damage Only
1	Non-incapacitating Injury Collisions
0	Fatal and Incapacitating Injury Collisions
3	Total Collisions

- Moving Vehicle
- Stopped Vehicle
- Backing Vehicle
- Ran Off Road
- Movement Unknown
- Right Turn
- Left Turn
- Sideswipe
- Night
- Day
- Pedestrian
- Fixed Object
- Bicycle
- Motorcycle
- DUI
- Non-Incapacitating
- Fatal/Incapacitating

Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 49
Crash Diagram


Chevrons or other signing to support stop control conditions
Rural two-way stop control: intersection treatments
Lower Bridge Way
Assess sight lines and remove vegetation
Rural two-way stop control: approach treatments
31st St

Not to Scale

5.2.16 Lower Bridge Way & 43rd Street

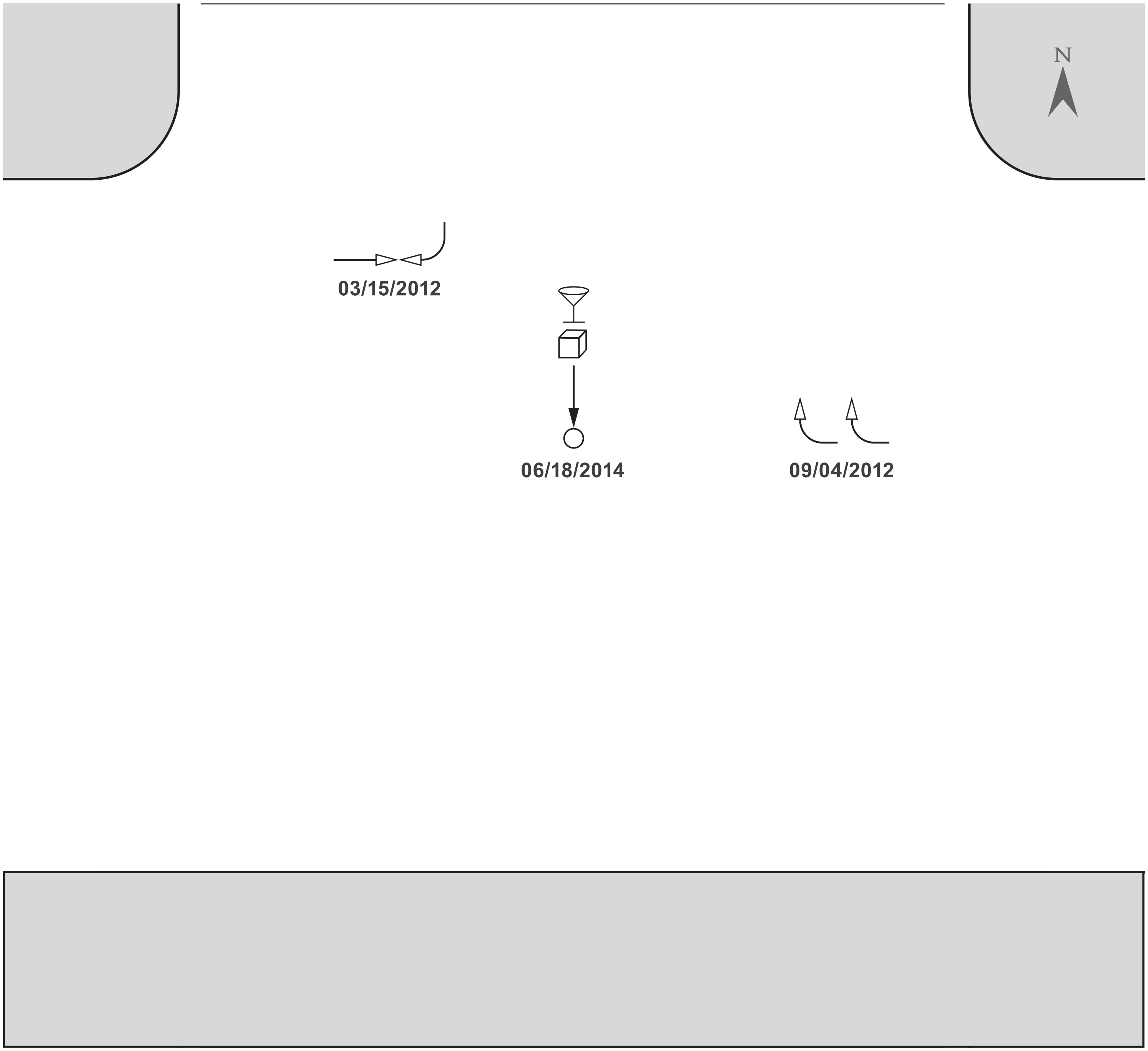
Lower Bridge Way & 43rd Street is a three-leg, stop-controlled intersection, with a stop-controlled southbound approach. Lower Bridge Way and 43rd Street are major collector roads. Lower Bridge Way provides a connection to Highway 97. There is an existing eastbound right-turn deceleration lane on Lower Bridge Way.

Three crashes were reported at Lower Bridge Way & 43rd Street between 2012 and 2016, including two turning movement crashes and one fixed object or other-object crash, as shown in the crash diagram in Figure 51. The fixed object crash occurred in dark, dusk, or dawn lighting conditions. One crash resulted in non-incapacitating injuries.

Near and long-term concepts could improve the overall intersection functionality and reduce crash risk. The near-term concept, illustrated in Figure 52, includes installing a splitter island on the southbound approach, evaluating removing the westbound right-turn lane, and installing chevron signs on the horizontal curve west of the intersection. The longer-term concept could include a single lane roundabout and installation of curb and gutter on the approaches, as illustrated in Figure 53 and Figure 54. Actual treatments would be determined during project development.

East-West Street **Lower Bridge Way** From: **01/01/2012** To: **12/31/2016**

North-South Street: **43rd Street** Date Prepared: **04/03/2019**



Number of Collisions

2	**Property Damage Only**
1	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
3	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

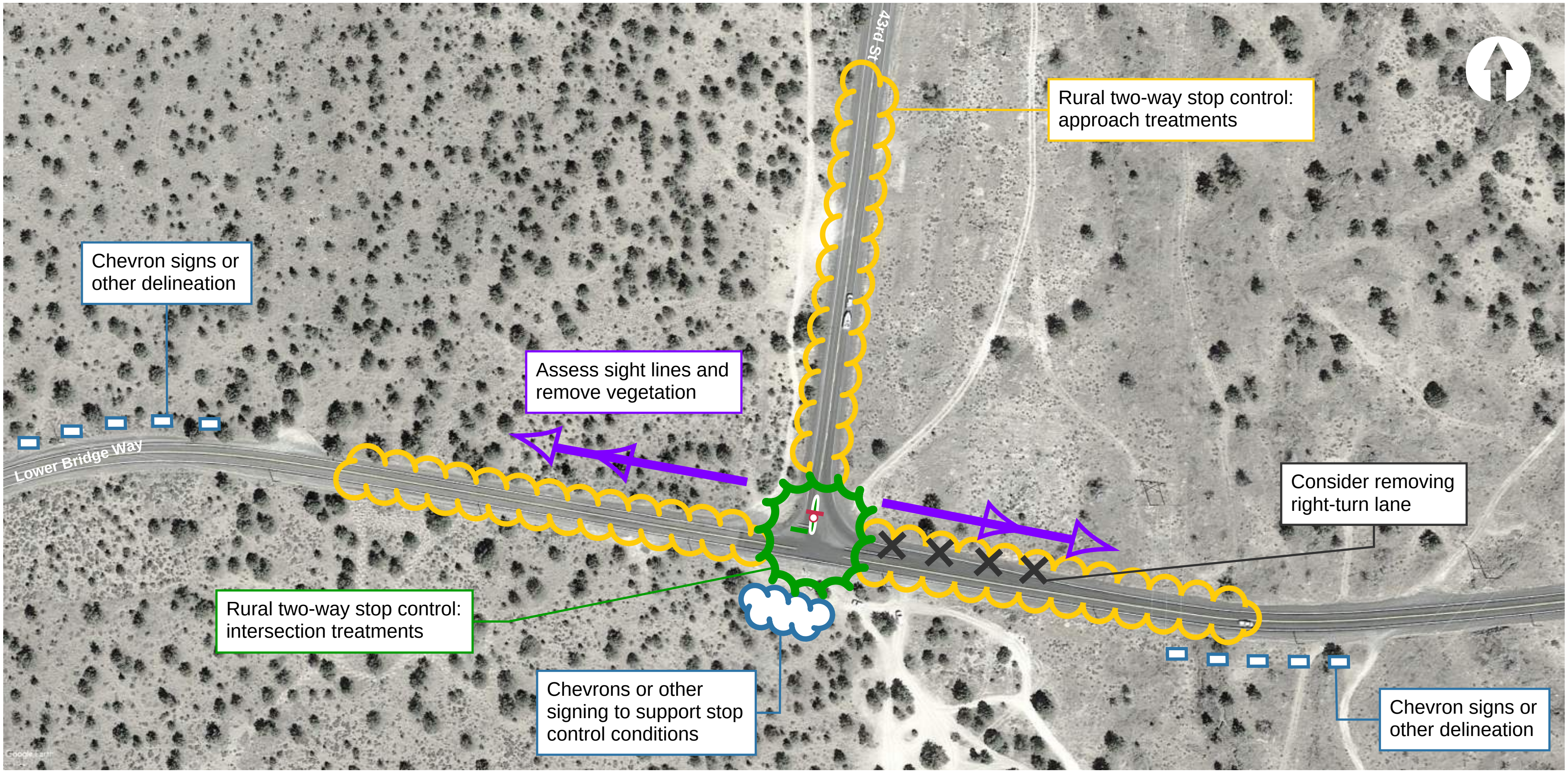
Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon

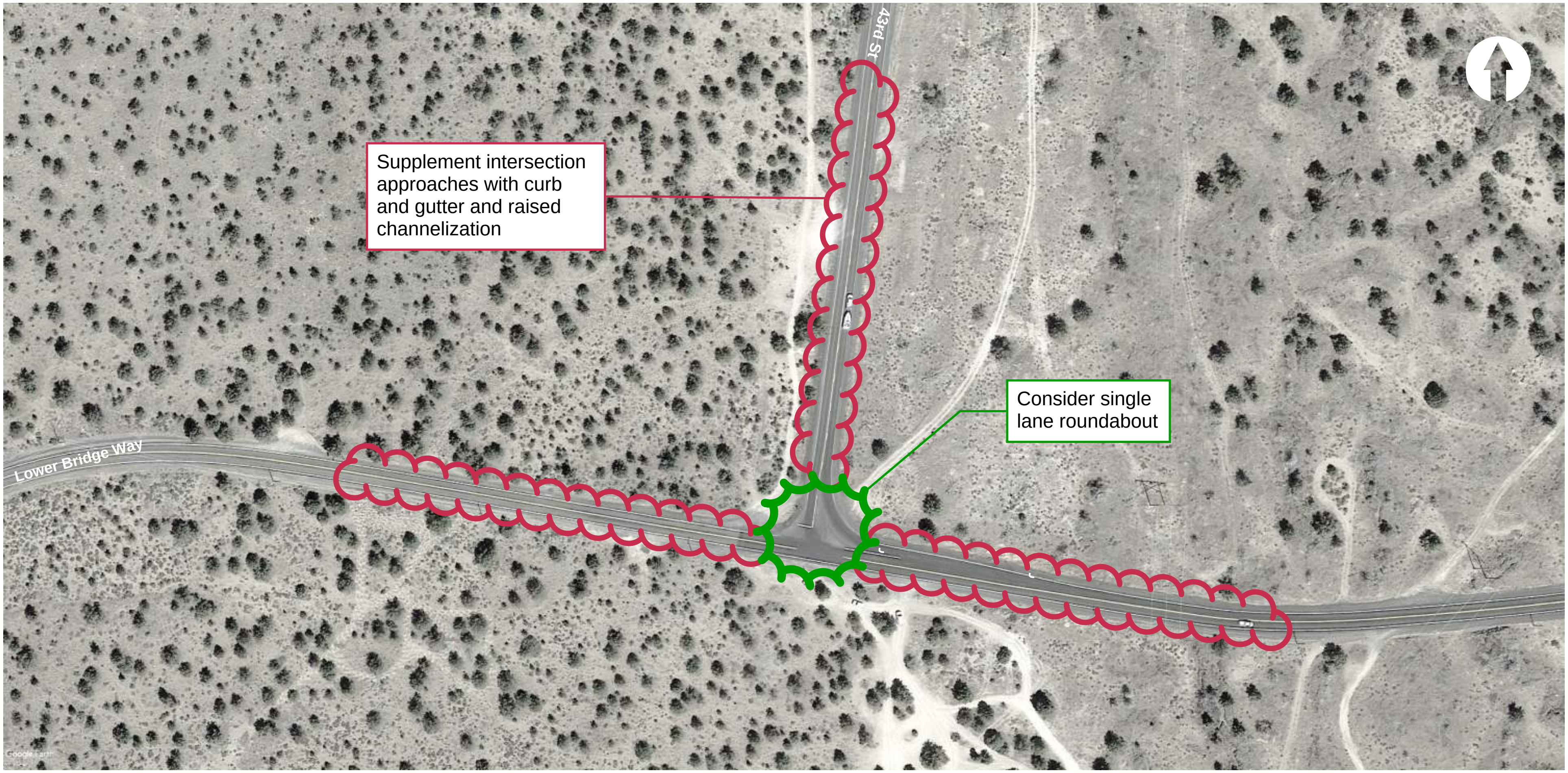
DUI represents a collision where alcohol and/or drugs were reported

Figure 51
Crash Diagram



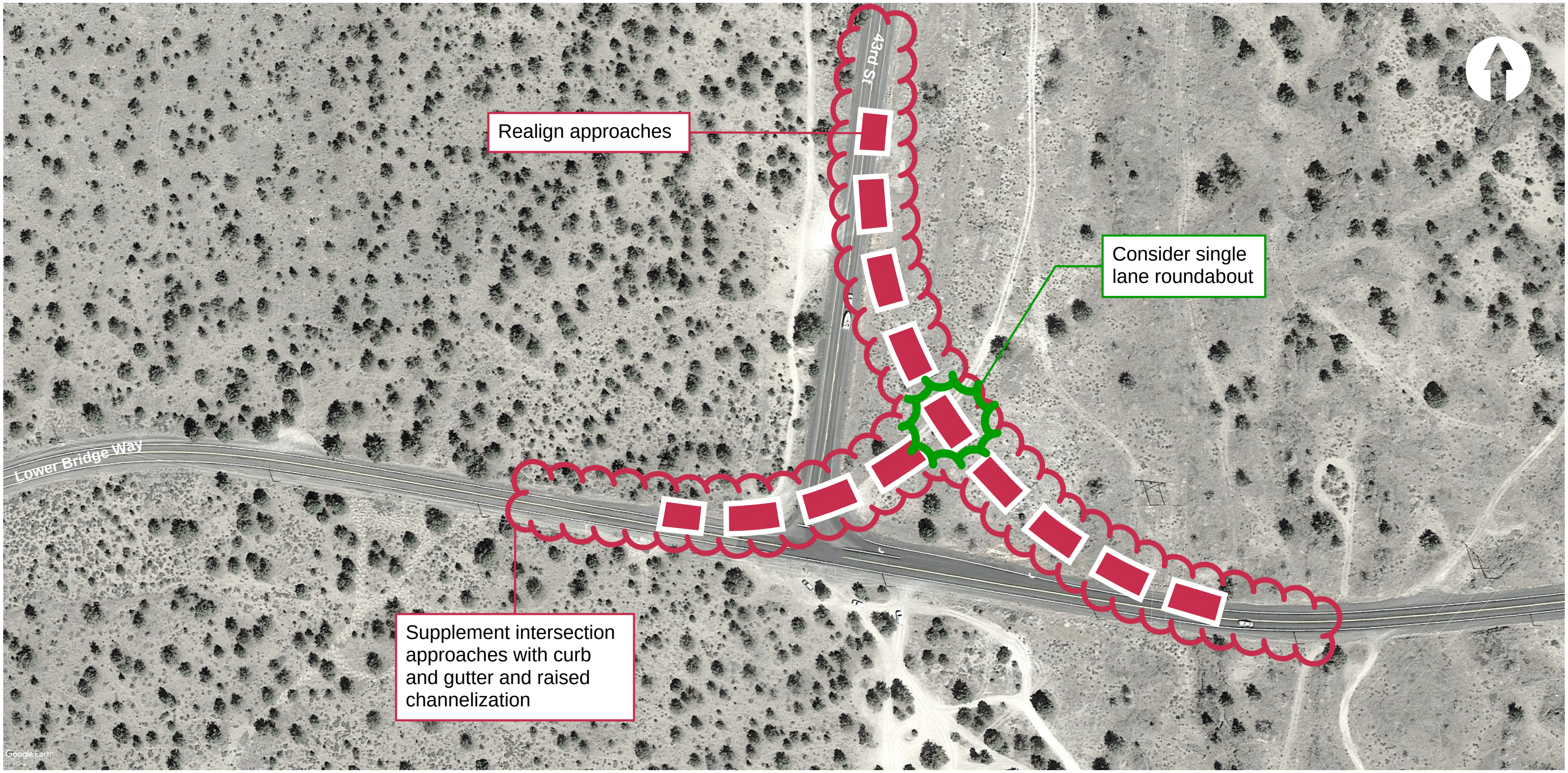
43rd St
Rural two-way stop control: approach treatments
Chevron signs or other delineation
Assess sight lines and remove vegetation
Lower Bridge Way
Consider removing right-turn lane
Rural two-way stop control: intersection treatments
Chevrons or other signing to support stop control conditions
Chevron signs or other delineation

Not to Scale



43rd St
Lower Bridge Way
Supplement intersection approaches with curb and gutter and raised channelization
Consider single lane roundabout

Not to Scale



43rd St
Lower Bridge Way
Realign approaches
Consider single lane roundabout
Supplement intersection approaches with curb and gutter and raised channelization

Not to Scale

5.2.17 Sunrise Boulevard & Day Road (La Pine)

Sunrise Boulevard and Day Road are two lane roadways in a residential area northwest of La Pine. Day Road is a major collector. Sunrise Boulevard is classified as a local roadway. The intersection is a stop-controlled T-intersection, with a stop-controlled eastbound movement. Five crashes were reported at Sunrise Boulevard & Day Road, including three rear-end, one angle, and one turning movement (involving a U-turn), as shown in Figure 55. Of those crashes, 80 percent (four crashes) resulted in an injury, with one being fatal or incapacitating, and two occurred in dark, dusk, or dawn light conditions.

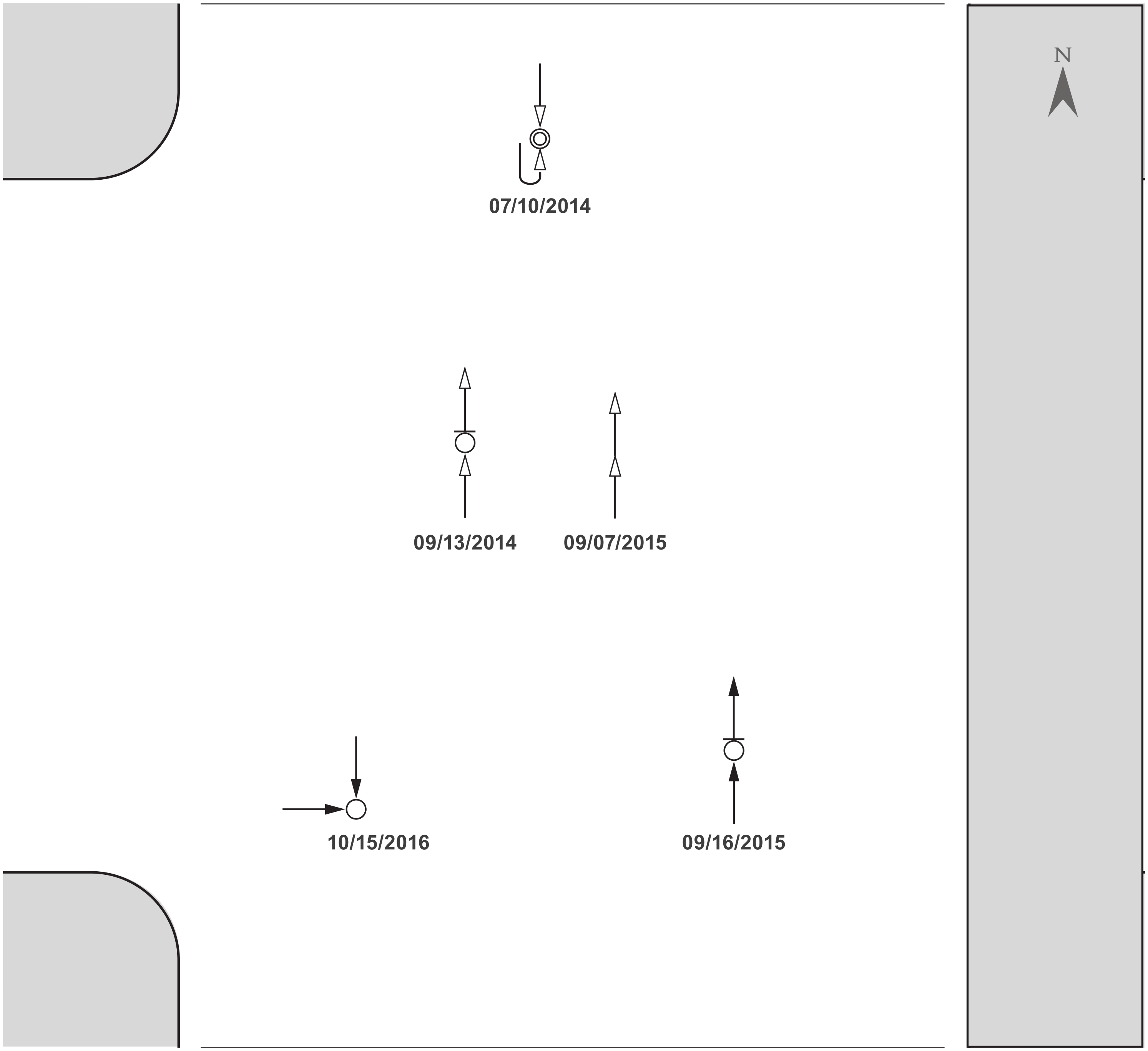
The proposed concept, shown in Figure 56, includes low-cost treatments such as enhanced signage and delineation to improve intersection awareness, particularly on Day Road. In addition, illumination levels should be assessed given the crash conditions, and a northbound left-turn lane should be considered on Day Road to reduce rear-end crashes. Actual treatments would be determined during project development.

East-West Street **Sunrise Boulevard**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Day Road**

Date Prepared: **04/04/2019**



Number of Collisions

1	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
5	**Total Collisions**

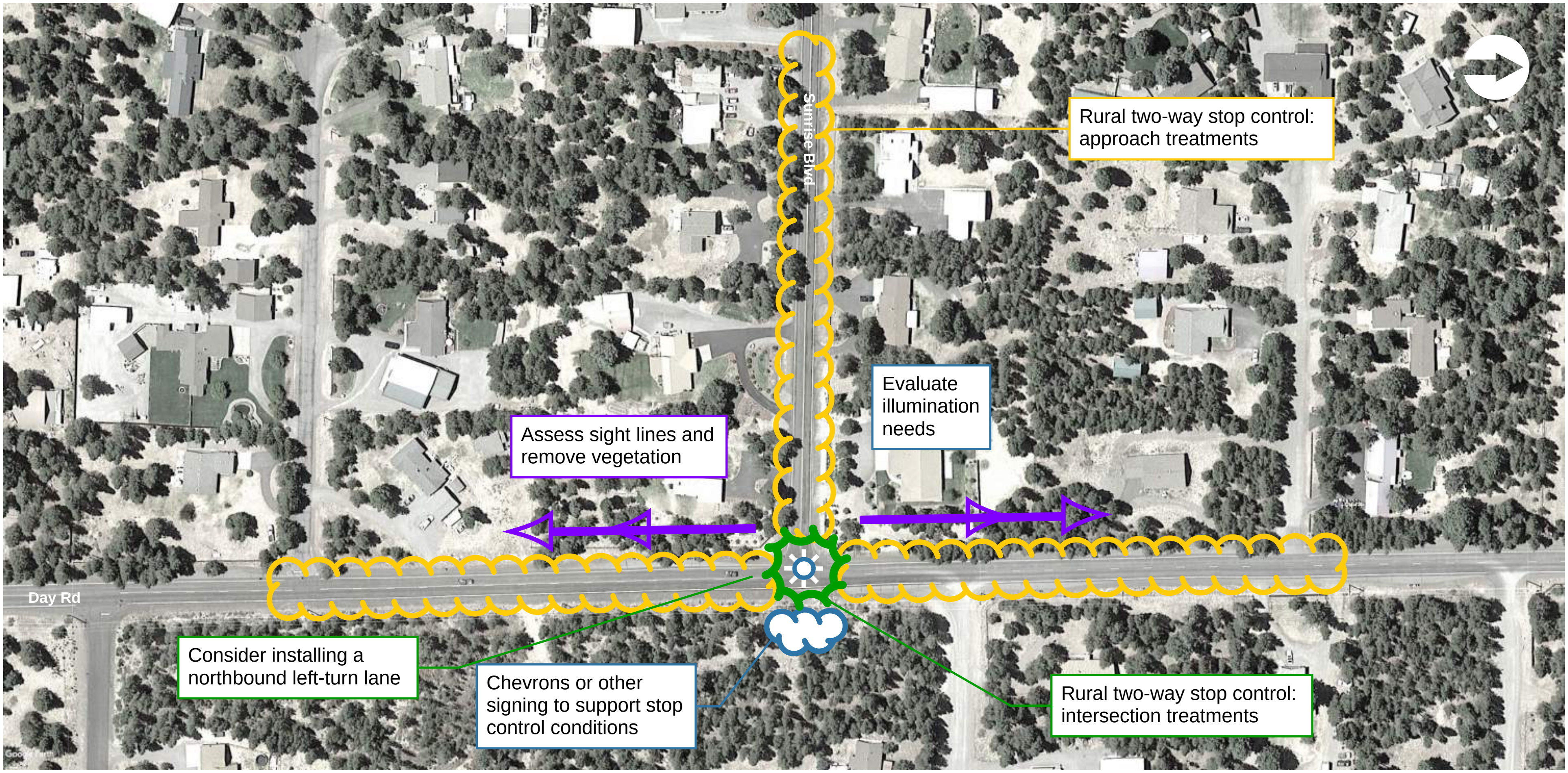
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
U-turn

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 55
Crash Diagram



Sunrise Blvd
Day Rd
Rural two-way stop control: approach treatments
Evaluate illumination needs
Assess sight lines and remove vegetation
Consider installing a northbound left-turn lane
Chevrons or other signing to support stop control conditions
Rural two-way stop control: intersection treatments

Not to Scale

5.2.18 Huntington Road & 3rd Street (La Pine)

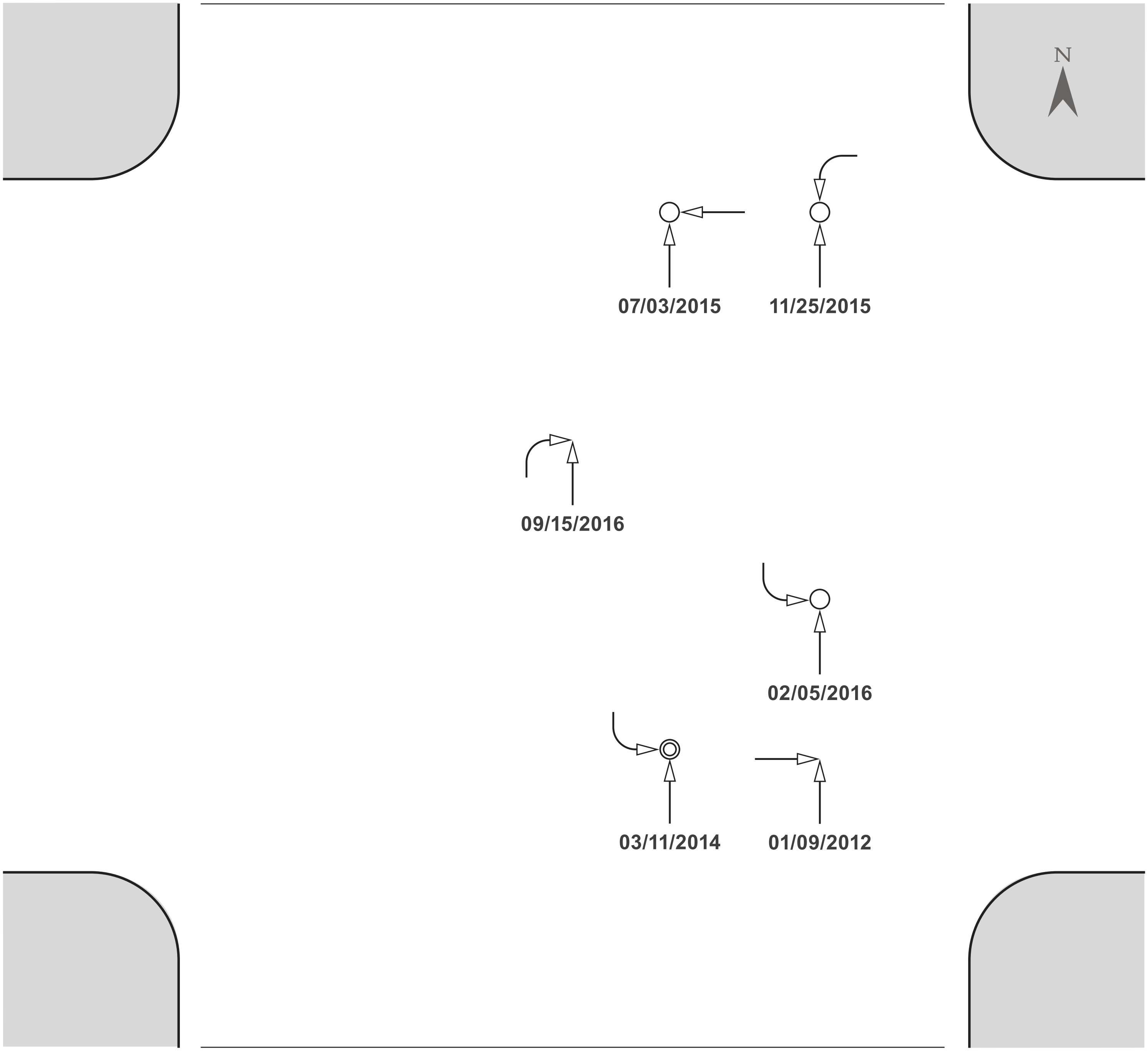
Huntington Road & 3rd Street is a two-way stop-controlled intersection in La Pine. Eastbound and westbound approaches are stop controlled. Huntington Road is as a major collector that runs parallel to Highway 97, and 3rd Street is classified as a minor collector roadway. This intersection is in a developed, commercial area in La Pine and therefore experiences urban traffic patterns.

There were six reported crashes at the intersection between 2012 and 2016, including four turning movement crashes and two angle crashes, as shown in Figure 57. Four crashes resulted in an injury, with one being a fatal or incapacitating injury.

Figure 58 illustrates a potential concept, which includes assessing sight lines, installing crosswalks to increase visibility and awareness of pedestrians, and evaluating converting the intersection to an all-way stop-controlled intersection. An all-way stop-control intersection may function well to accommodate the heavier traffic volumes from multiple approaches of the intersection in the urban area. Actual treatments would be determined during project development.

East-West Street **Huntington Road** From: **01/01/2012** To: **12/31/2016**

North-South Street: **3rd Street** Date Prepared: **04/04/2019**



Number of Collisions

2	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
6	**Total Collisions**

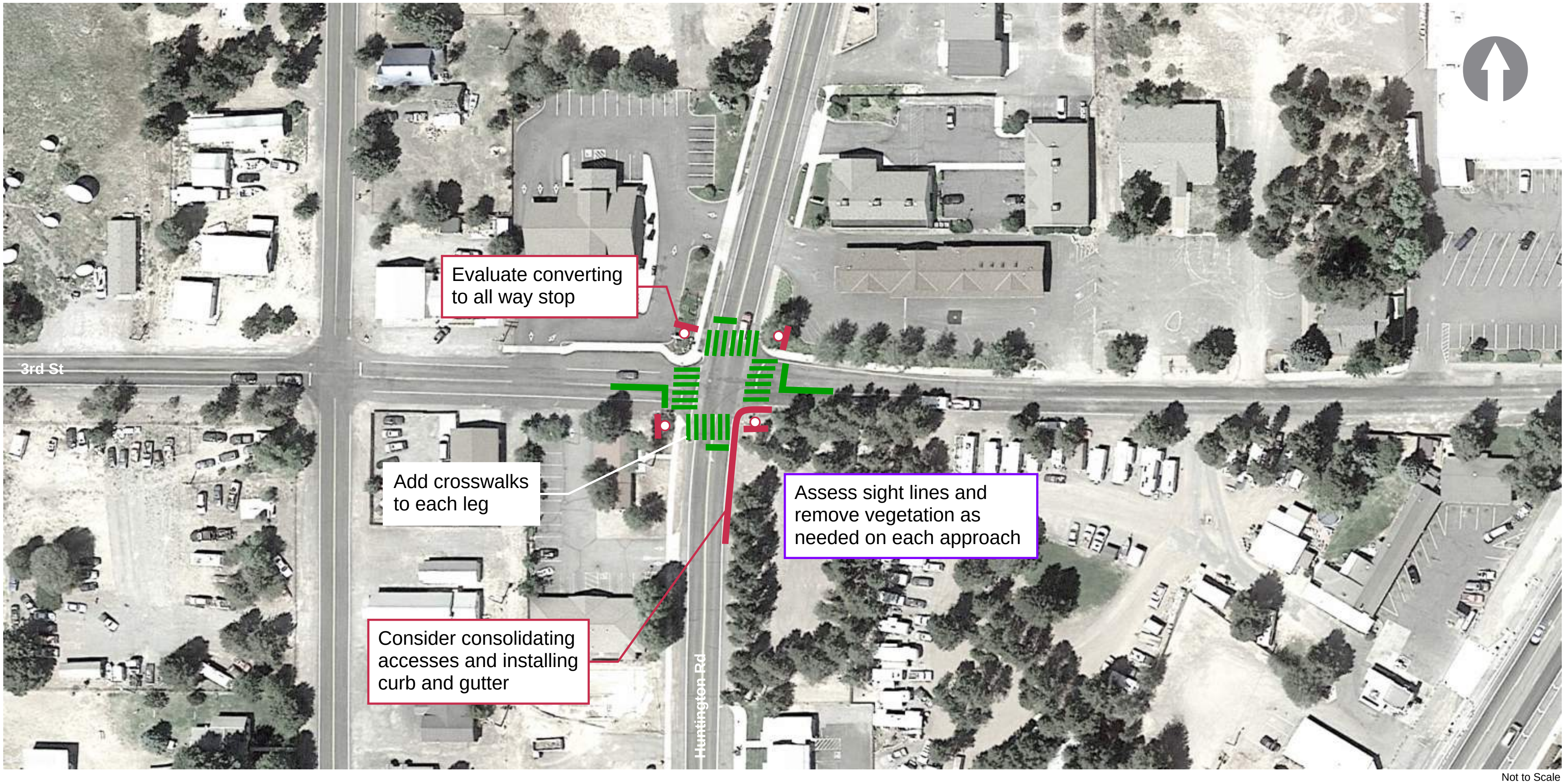
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 57
Crash Diagram


3rd St
Huntington Rd
Evaluate converting to all way stop
Add crosswalks to each leg
Assess sight lines and remove vegetation as needed on each approach
Consider consolidating accesses and installing curb and gutter
Not to Scale

5.2.19 5th Street/6th Street & Glacier Avenue and 5th Street/6th Street Highland Avenue (Redmond)

The four intersections on the corners of the block bounded by 5th Street, 6th Street, Glacier Avenue, and Highland Avenue were analyzed together to understand how system-wide treatments may be beneficial. 5th Street and 6th Street are arterial roadways. Glacier Avenue and Highland Avenue are principal arterial roadways and provide connections to Highway 97 one block east of 5th Street. 5th Street, 6th Street, Glacier Avenue, and Highland Avenue are one-way roadways. Vehicle movement for 5th Street is northbound, 6th Street is southbound, Glacier Avenue is westbound, and Highland Avenue is eastbound. The four intersections are signalized. The adjacent land use is commercial.

5th Street & Glacier Avenue

As shown in Figure 59, thirteen crashes were reported between 2012 and 2016. Seven crashes resulted in some level of injury with no fatal or incapacitating injuries. The most common collision type reported at 5th Street and Glacier Avenue was angle (ten crashes).

6th Street & Glacier Avenue

From 2012 to 2016, 27 crashes were reported at 6th Street and Glacier Avenue. Seventy percent of crashes reported some level of injury with none resulting in a fatal or incapacitating injury. The most common collision type reported was angle, as shown in Figure 60. Eight crashes occurred in dark, dusk, or dawn conditions. One non-incapacitating injury bicyclist crash was reported at this intersection.

5th Street & Highland Avenue

Figure 61 shows 13 reported crashed at the intersection of 5th Street and Highland Avenue, including six non-incapacitating injury crashes. The most common collision type was angle (eight crashes), followed by three turning movement crashes, one fixed-object crash, and one sideswipe crash.

6th Street & Highland Avenue

Between 2012 and 2016, 33 crashes were reported at 6th Street and Highland Avenue; nearly half (14 crashes) resulted in an injury with no fatal or incapacitating injuries. As shown in Figure 62, the most common collision type were angle crashes (28 crashes). Three rear-end crashes, one backing crash, and one fixed-object were also reported at the intersection.

Area Concept

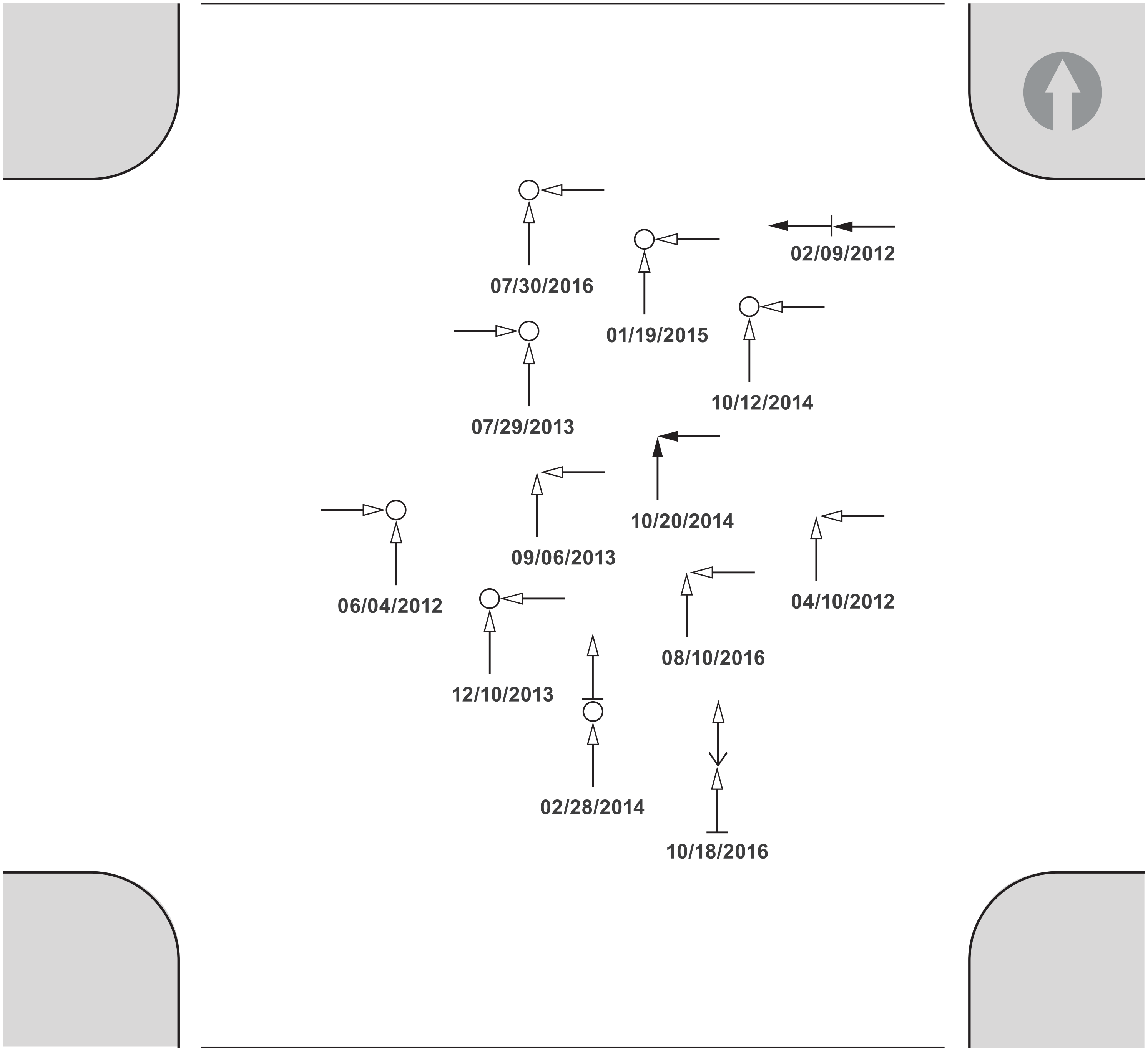
The concept for this study area, shown in Figure 63, includes installing side-mounted traffic signals, evaluating signal timing, and assess conversion of nearby stop-controlled intersections to signalized intersections. Actual treatments would be determined during project development.

East-West Street **Glacier Avenue**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **5th Street**

Date Prepared: **06/23/2019**



Number of Collisions

6	**Property Damage Only**
7	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
13	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

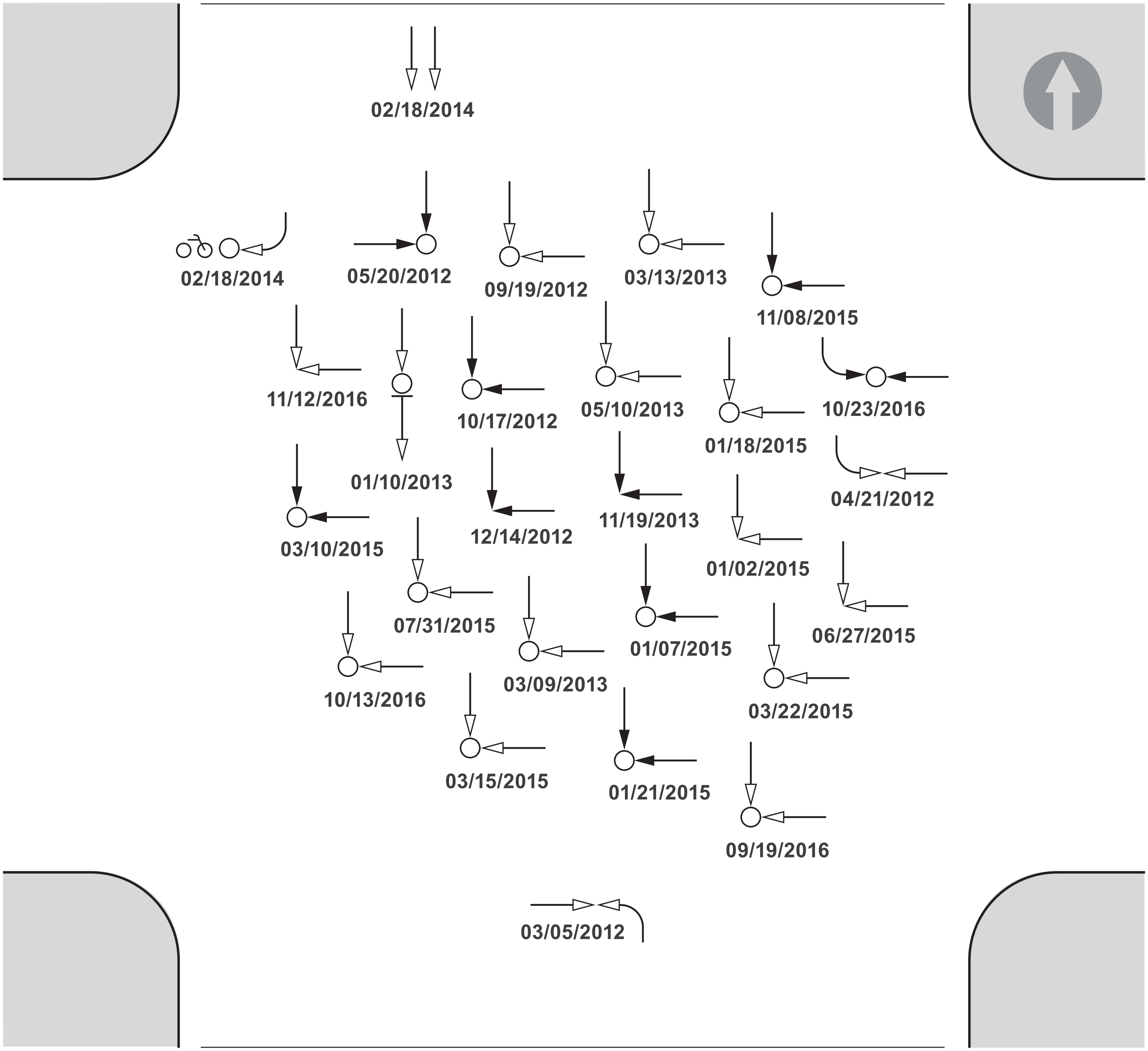
Figure 59
Crash Diagram

East-West Street **Glacier Avenue**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **6th Street**

Date Prepared: **06/23/2019**



Number of Collisions

8	Property Damage Only
19	Non-incapacitating Injury Collisions
0	Fatal and Incapacitating Injury Collisions
27	Total Collisions

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

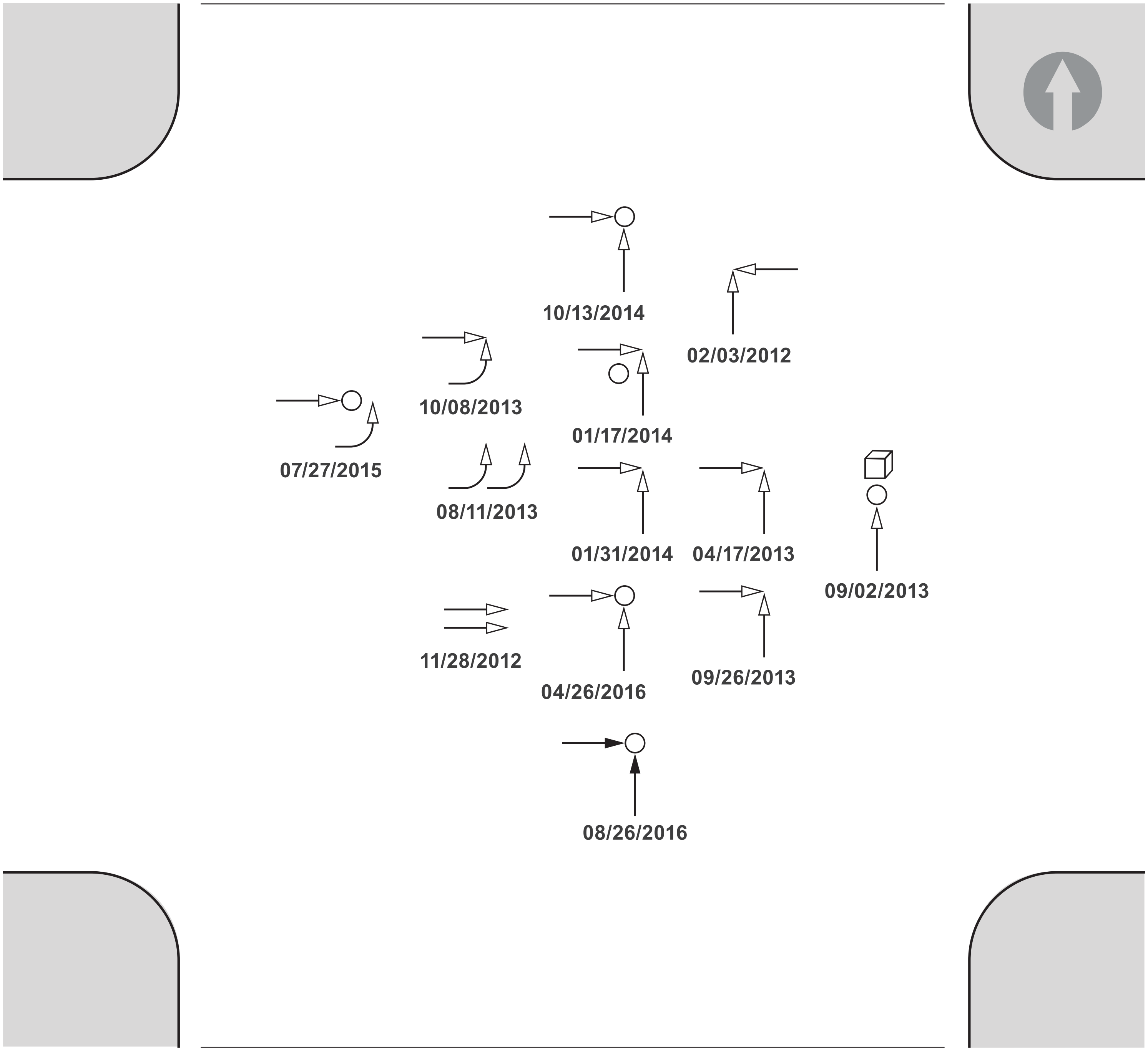
Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 60
Crash Diagram

East-West Street **Highland Avenue** From: **01/01/2012** To: **12/31/2016**

North-South Street: **5th Street** Date Prepared: **06/21/2019**



Number of Collisions

7	**Property Damage Only**
6	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
13	**Total Collisions**

Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

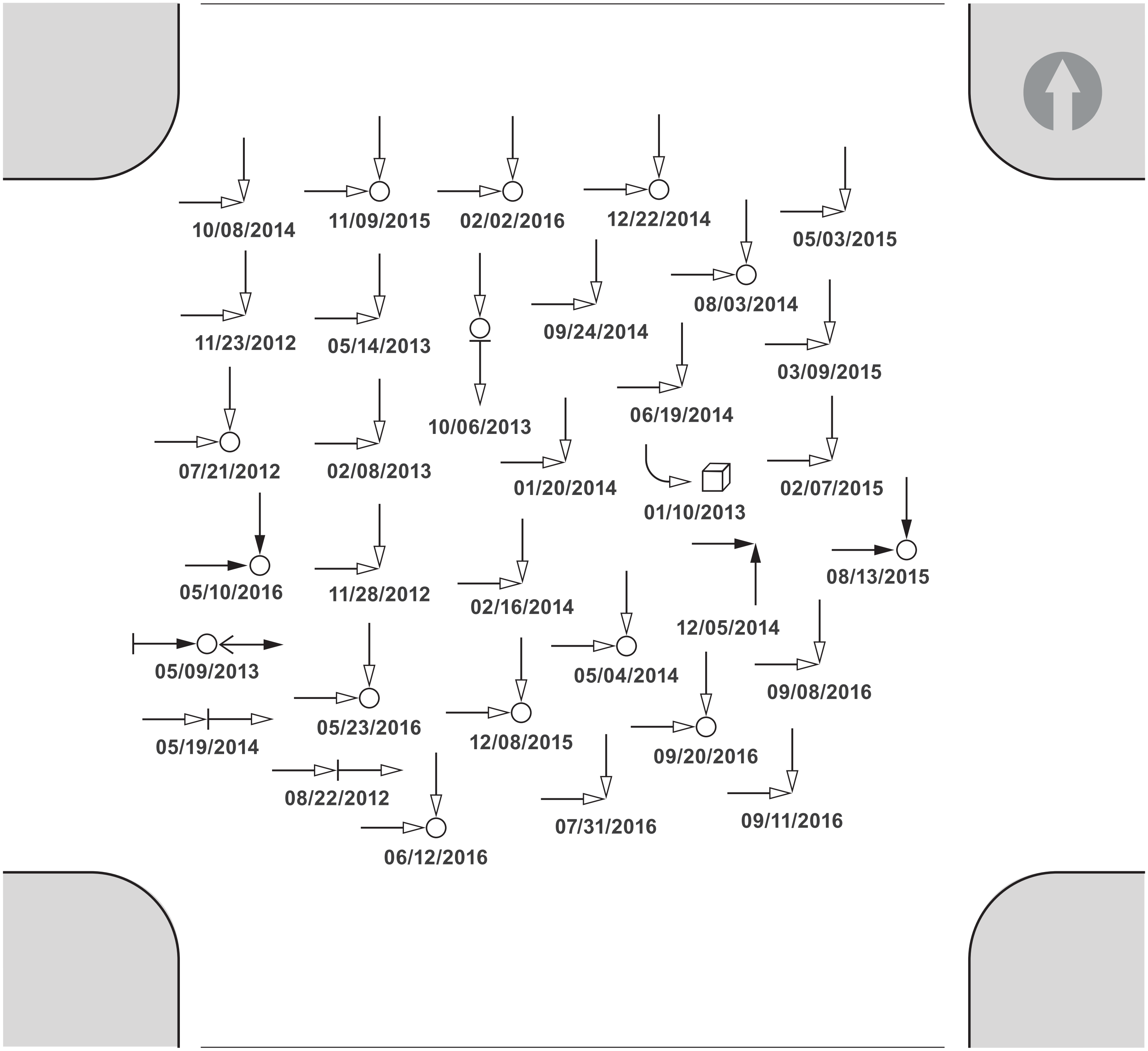
Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 61
Crash Diagram

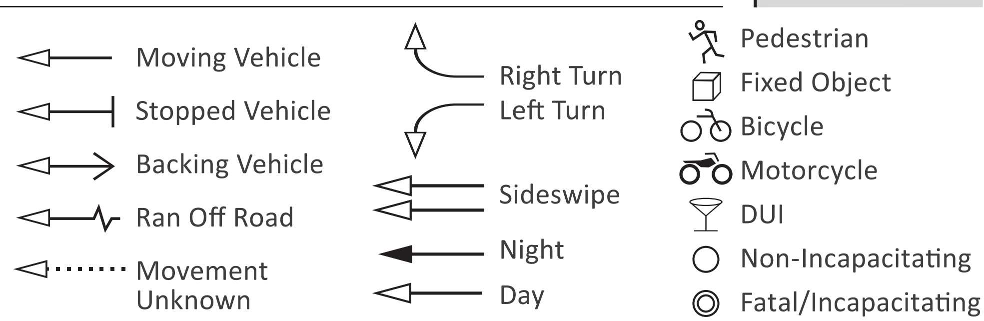
East-West Street **Highland Avenue** From: **01/01/2012** To: **12/31/2016**

North-South Street: **6th Street** Date Prepared: **06/21/2019**



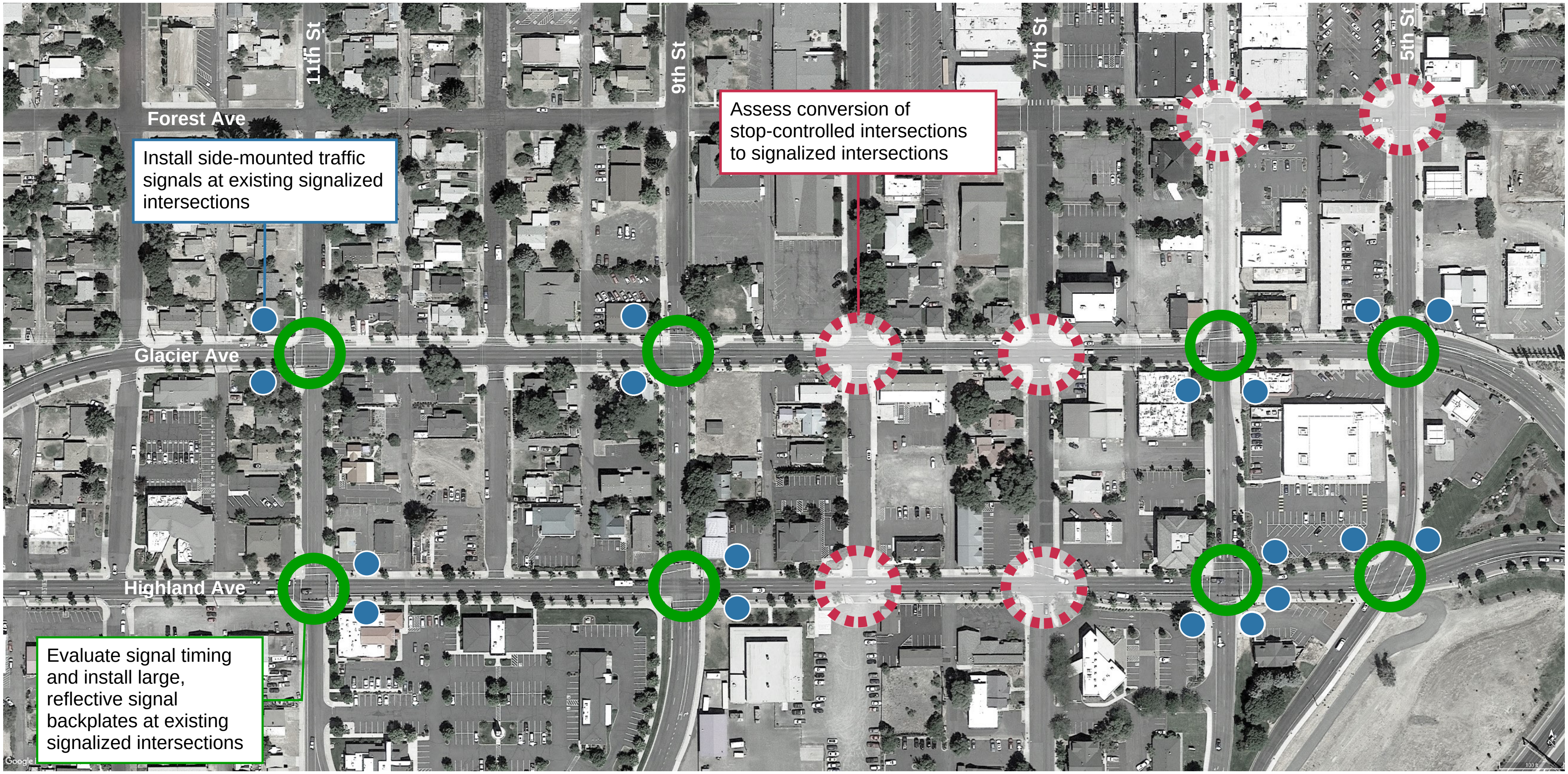
Number of Collisions

19	Property Damage Only
14	Non-incapacitating Injury Collisions
0	Fatal and Incapacitating Injury Collisions
33	Total Collisions



Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 62
Crash Diagram



Not to Scale

Proposed signalized intersection

Existing signalized intersection

Proposed side-mounted signals

5.2.20 7th Street & Black Butte Boulevard (Redmond)

7th Street and Black Butte Boulevard is a stop-controlled intersection with stop-controlled northbound and southbound approaches. 7th Street is a local road, and Black Butte Boulevard is a minor arterial. Both intersection roadways are two-lane roadways. Bike facilities are provided on Black Butte Boulevard; a bike lane exists west of 7th Street and sharrows exist east of 7th Street. Marked pedestrian crosswalks are provided across the northbound and southbound approaches. Sidewalks are provided on both sides of the street for 7th Street and Black Butte Boulevard. The surrounding land use is residential and commercial.

Figure 64 shows five crashes were reported at the intersection between 2012 and 2016. Four crashes reported some level of injury with one being fatal or incapacitating. Three crashes were reported as angle crashes. One rear-end and one turning movement crash were also reported. Two crashes involved a motorcycle, including one that resulted in a fatal or incapacitating injury.

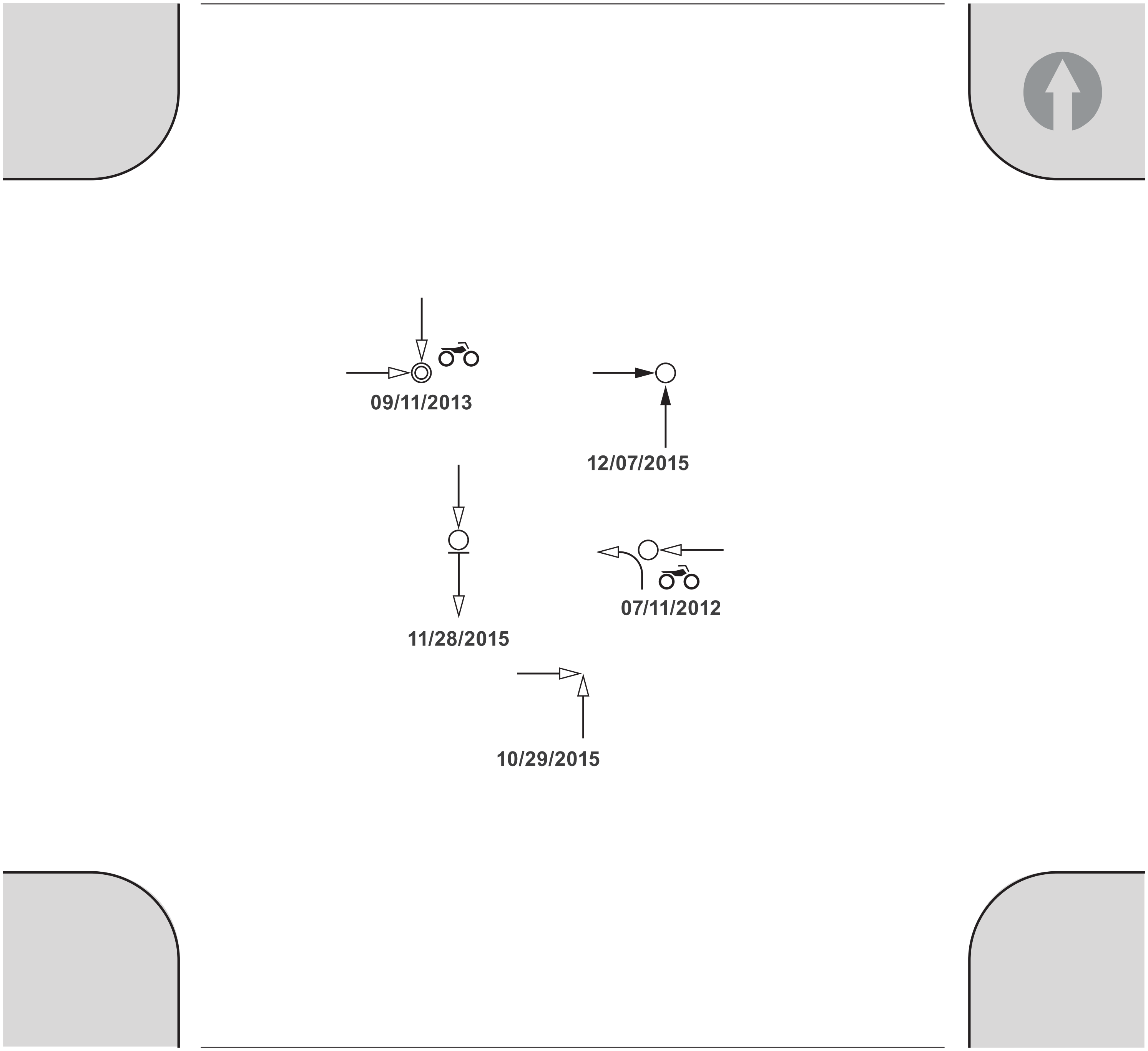
Low-cost treatments, proposed in Figure 65, include improving intersection awareness with additional stop signs, stop ahead pavement markings, stop bars, and centerlines on side streets. In addition, crosswalks should be assessed along Black Butte Boulevard to determine if additional crosswalks should be installed at stop-controlled intersections. Actual treatments would be determined during project development.

East-West Street **7th Street**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Black Butte Blvd**

Date Prepared: **07/10/2019**



Number of Collisions

1	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
5	**Total Collisions**

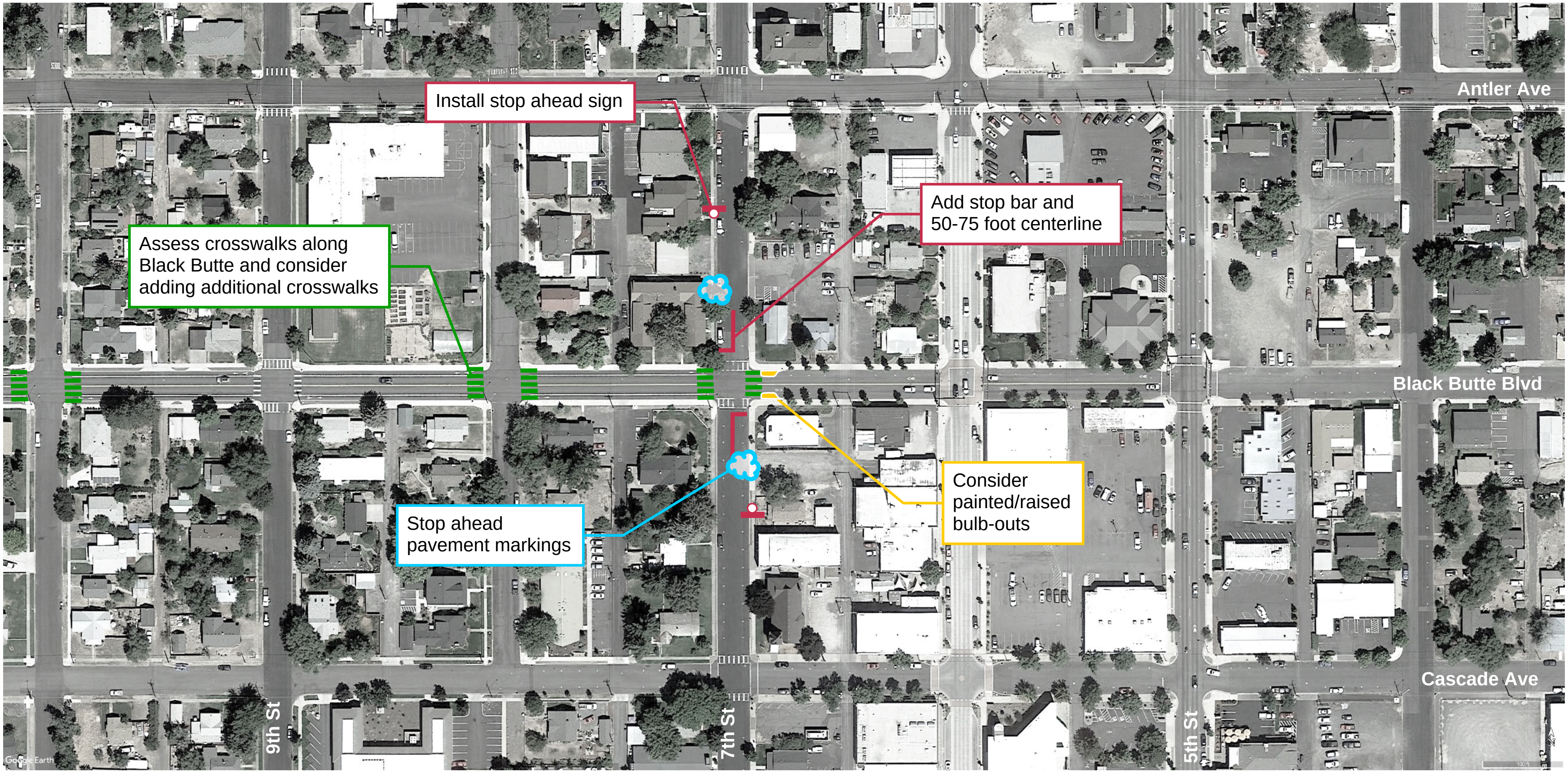
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 64
Crash Diagram



Not to Scale

KITTELSON & ASSOCIATES

Redmond Location-Specific Concepts
7th Street & Black Butte Boulevard

Figure 65

5.2.21 OR 126 & Highway 20 (Sisters)

OR 126 and Highway 20 are both state highways. OR 126 serves as a major east-west connection between Redmond and Sisters. Highway 20 serves as a major east-west connection across Oregon. The intersection of these roadways, located just east of Sisters, allows for a free westbound right-turn movement from OR 126 onto Highway 20. Highway 20 runs uncontrolled east-west through this location.

Seven crashes were reported at this intersection between 2012 and 2016, as shown in Figure 66. Four crashes resulted in some level of injury with one reported as fatal or incapacitating. Of the reported crashes two were fixed-object or other-object crashes, three were turning movement crashes, one was an angle crash, and one was a rear-end crash.

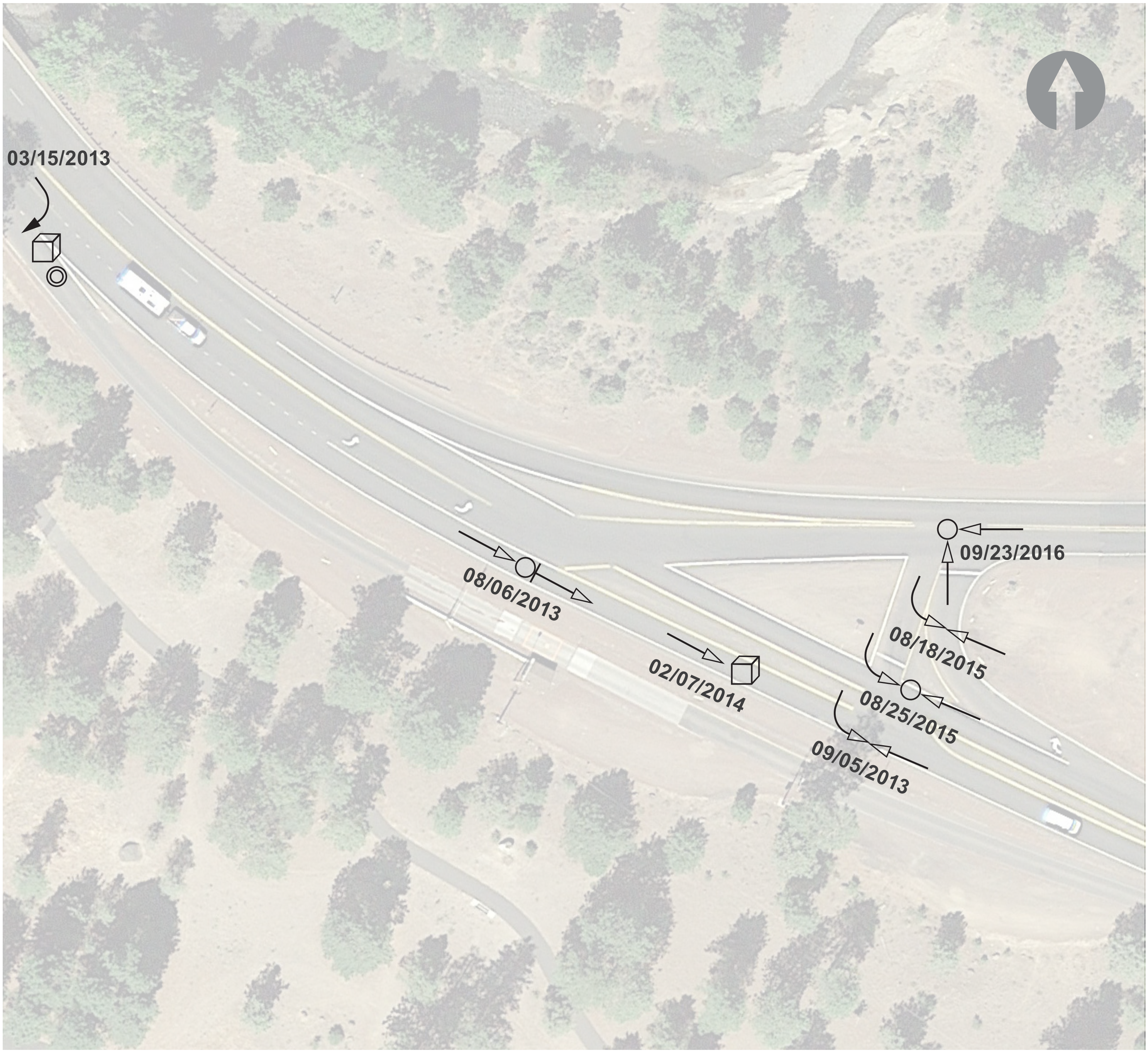
As shown in Figure 67, concept recommendations include installing curb and gutter on intersection approaches, installing gateway treatments, assessing location and configuration of truck weigh station, and realigning the intersection to square up the intersection. Consideration of a roundabout is also recommended to address turning movement and rear-end crashes. Actual treatments would be determined during project development and will need to be led by ODOT.

East-West Street **OR 126**

From: **01/01/2012** To: **12/31/2016**

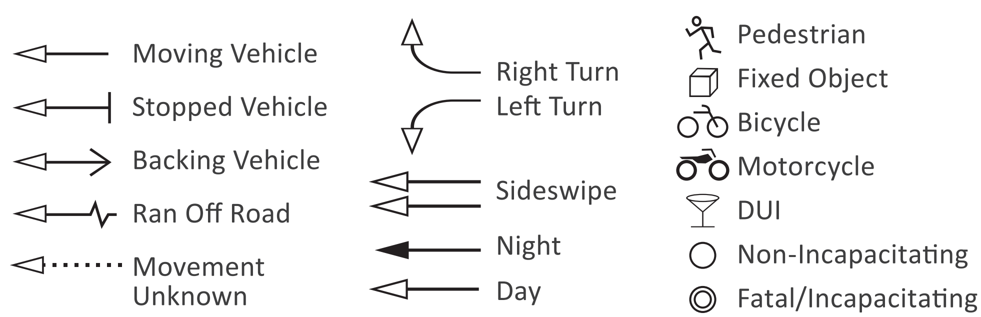
North-South Street: **Highway 20**

Date Prepared: **06/23/2019**



Number of Collisions

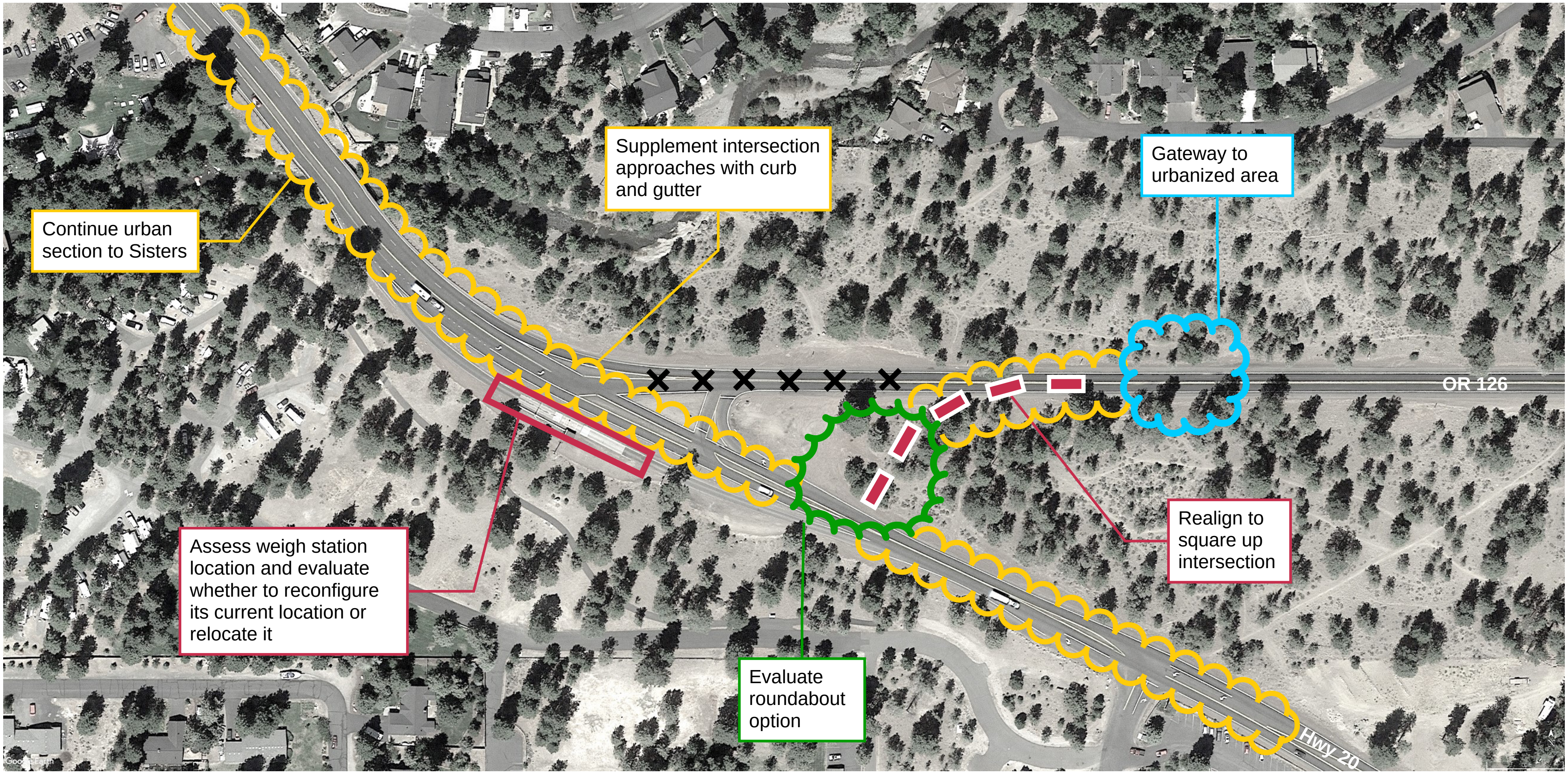
3	**Property Damage Only**
3	**Non-incapacitating Injury Collisions**
1	**Fatal and Incapacitating Injury Collisions**
7	**Total Collisions**



Deschutes County, Oregon

DUI represents a collision where alcohol and/or drugs were reported

Figure 66
Crash Diagram



Continue urban section to Sisters
Supplement intersection approaches with curb and gutter
Gateway to urbanized area
OR 126
Assess weigh station location and evaluate whether to reconfigure its current location or relocate it
Evaluate roundabout option
Realign to square up intersection
Hwy 20

Not to Scale

5.2.22 Locust Street & Highway 20 (Sisters)

Locust Street and Highway 20 is a stop-controlled intersection of an arterial and collector roadway. Highway 20 is a major east-west highway connection between Bend and Sisters and is designated as truck/freight route. Locust Street and Highway 20 are a two-lane roadways with on-street parking provided on the west side of Locust Street south of Highway 20. A dedicated westbound right and eastbound left turn-lane are on Highway 20. A bike lane is provided on Highway 20 as well as a pedestrian crosswalk on the west leg of the intersection.

Figure 68 shows five crashes were reported at the intersection, including four non-incapacitating injury crashes and one property damage only crash. Rear-end crashes were the most commonly reported (three crashes); one angle crash and one turning movement were also reported.

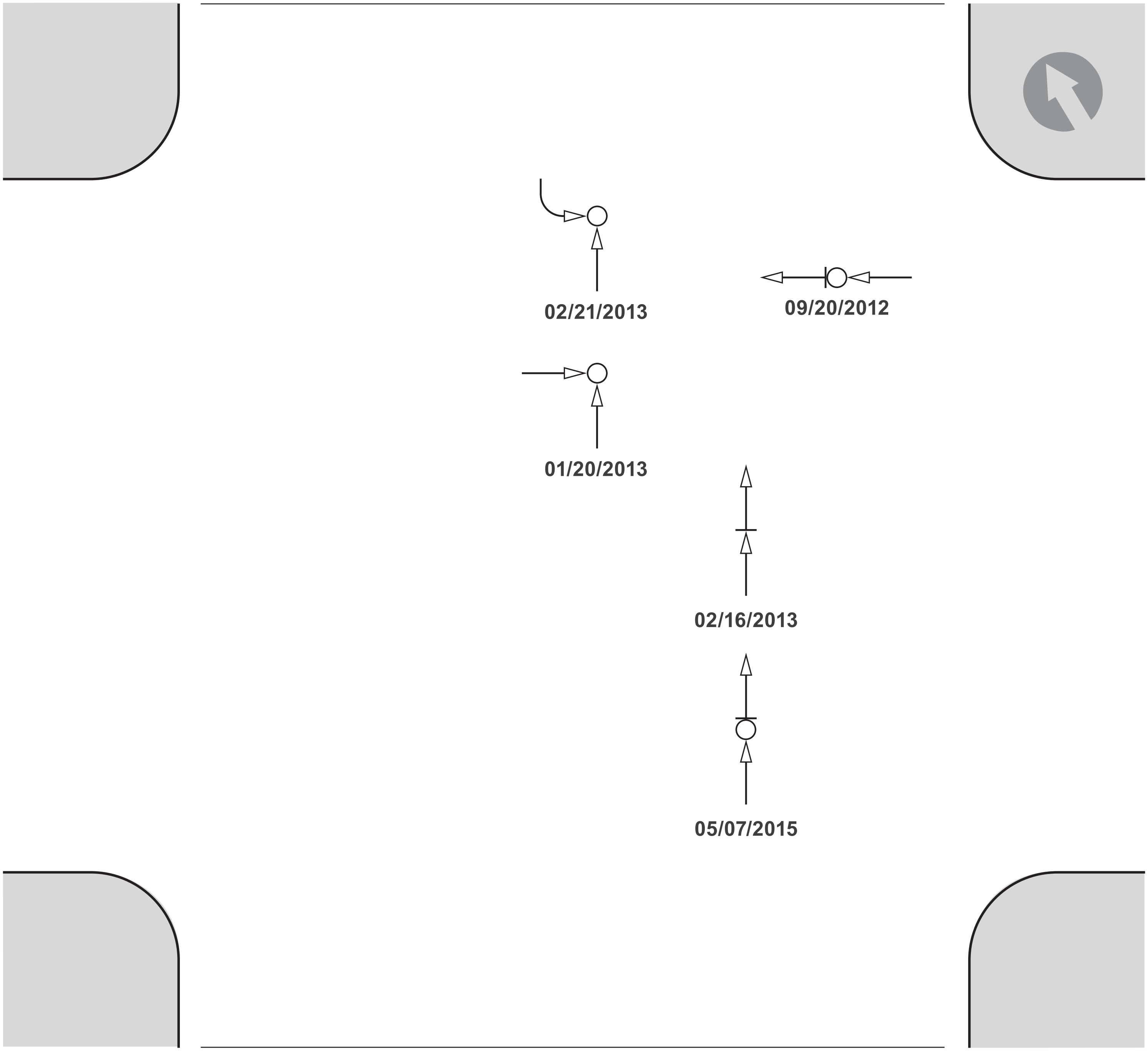
Specific low-cost treatments recommended in Figure 69 include pavement markings to better define travel lanes and the continuation of the bicycle lane through the intersection with green paint. Higher cost treatments include installing a raised median and curb and gutter from the OR 126 and Highway 20 intersection to increase awareness of the approaching urban area. Actual treatments would be determined during project development.

East-West Street **Highway 20**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Locust Street**

Date Prepared: **06/23/2019**



Number of Collisions

1	**Property Damage Only**
4	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
5	**Total Collisions**

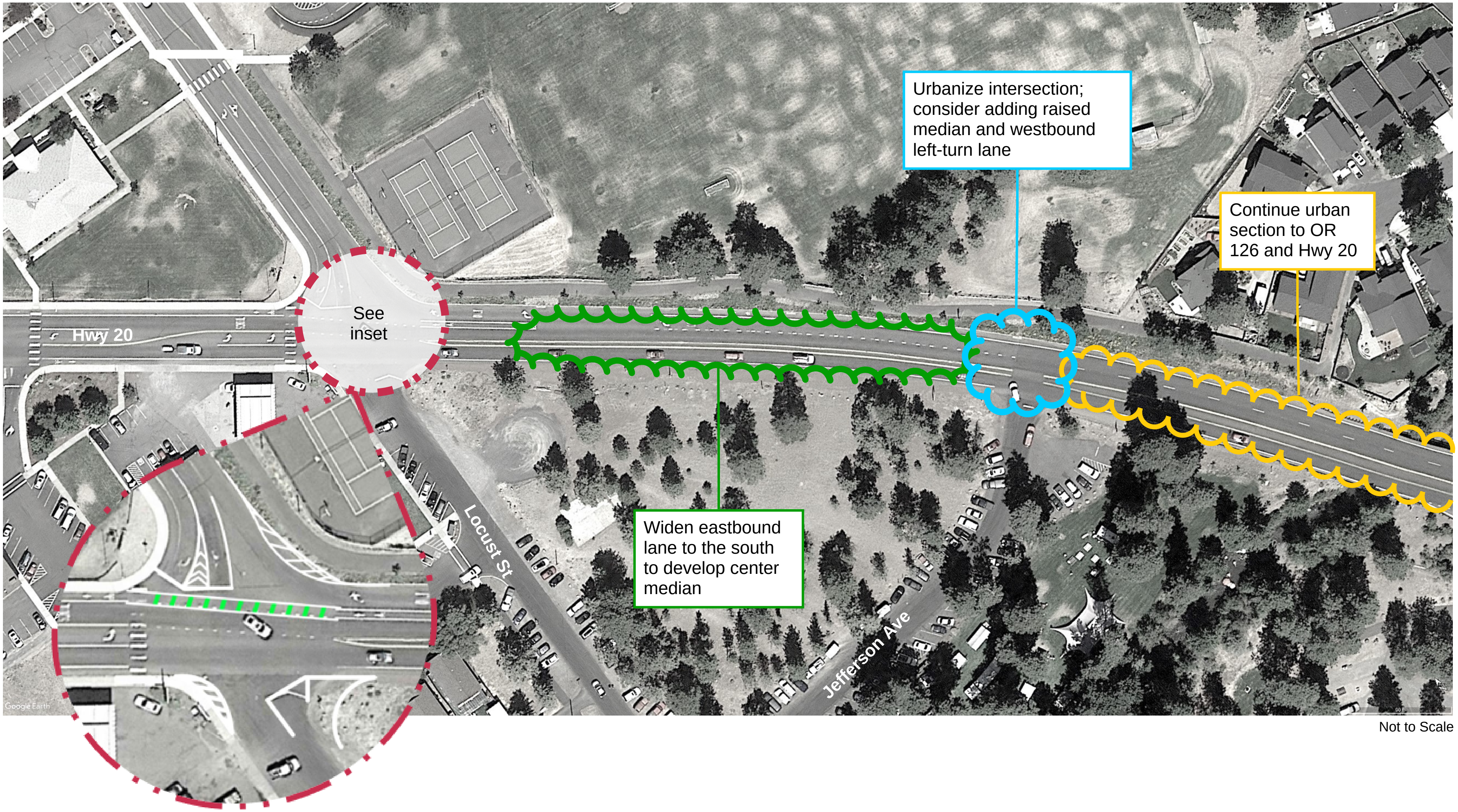
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 68
Crash Diagram



Urbanize intersection; consider adding raised median and westbound left-turn lane
Continue urban section to OR 126 and Hwy 20
See inset
Hwy 20
Widen eastbound lane to the south to develop center median
Locust St
Jefferson Ave

Not to Scale

5.2.23 Locust Street & Cascade Avenue (Sisters)

Locust Street and Cascade Avenue is a stop-controlled intersection, with stop-controlled eastbound and westbound movements. Locust Street is a collector, and Cascade Avenue is a local street. Both roads are two-lane roadways. There is a dedicated westbound right-turn lane on Cascade Avenue. Pedestrian crosswalks are provided on the north, east, and west legs of the intersection.

Four property damage only crashes were reported at the intersection between 2012 and 2016. As shown in Figure 70, three crashes were rear-end crashes, and one crash was a turning movement crash. One rear-end crash occurred in non-daylight conditions.

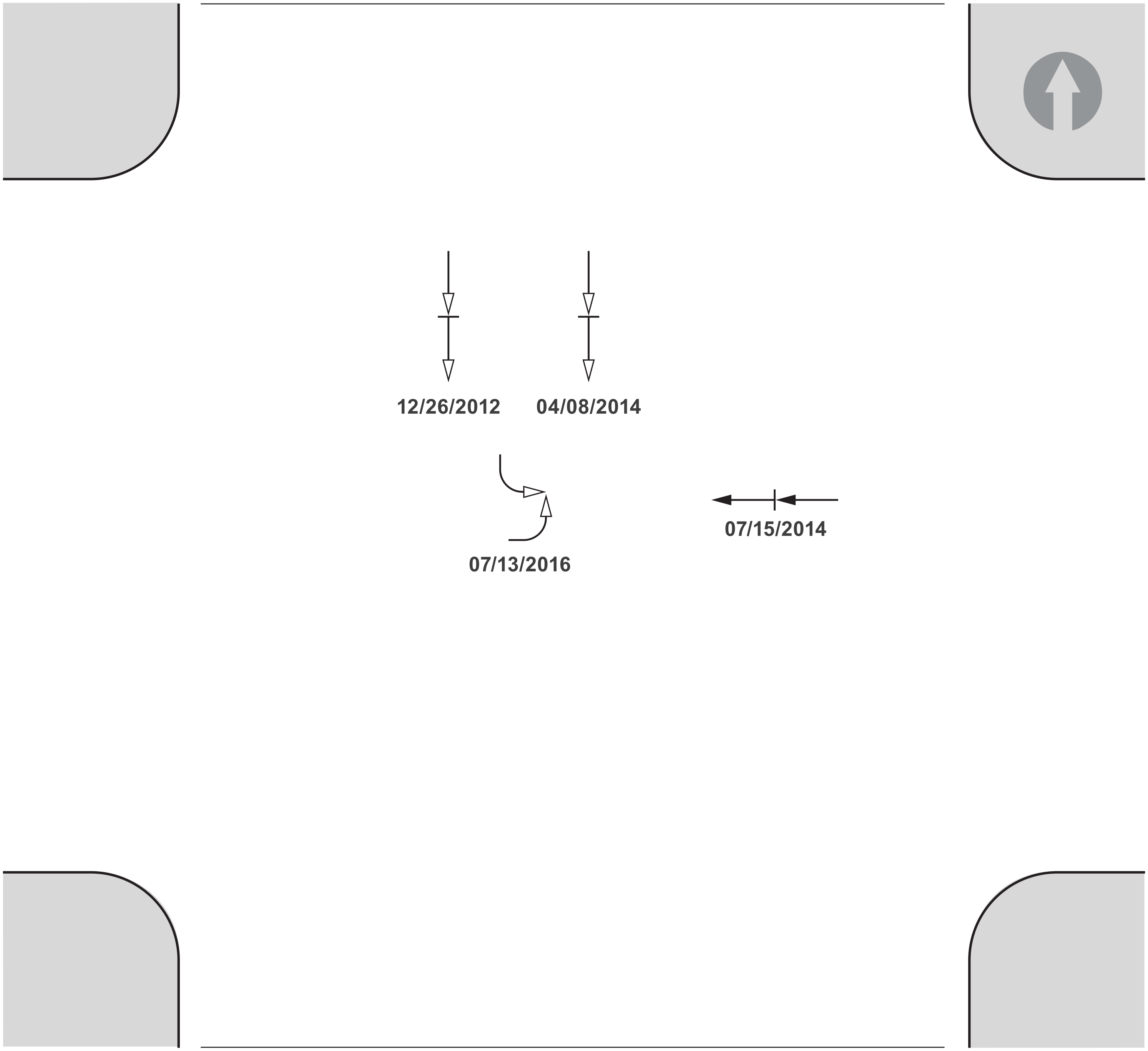
As shown in Figure 71, the recommended low-cost treatments to increase intersection visibility include installing ADA ramps, adding a stop bar on the eastbound and westbound approaches, adding continental striping to existing crosswalks, and installing a continental crosswalk on the northbound approach.

East-West Street **Cascade Avenue**

From: **01/01/2012** To: **12/31/2016**

North-South Street: **Locust Street**

Date Prepared: **06/23/2019**



Number of Collisions

4	**Property Damage Only**
0	**Non-incapacitating Injury Collisions**
0	**Fatal and Incapacitating Injury Collisions**
4	**Total Collisions**

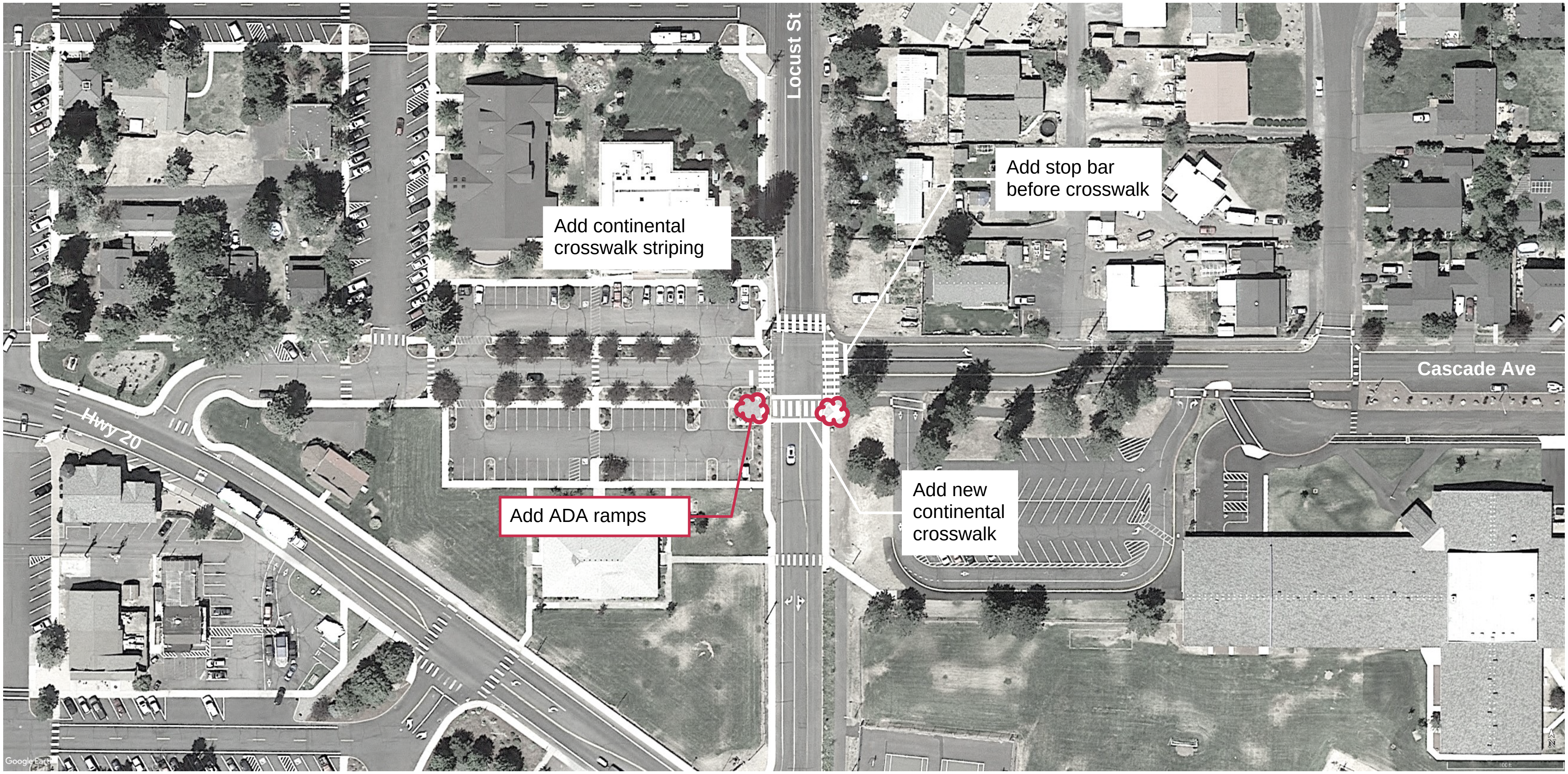
Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown

Right Turn
Left Turn
Sideswipe
Night
Day

Pedestrian
Fixed Object
Bicycle
Motorcycle
DUI
Non-Incapacitating
Fatal/Incapacitating

Deschutes County, Oregon
DUI represents a collision where alcohol and/or drugs were reported

Figure 70
Crash Diagram


Locust St
Cascade Ave
Hwy 20
Add stop bar
before crosswalk
Add continental
crosswalk striping
Add ADA ramps
Add new
continental
crosswalk
Google Earth

Not to Scale

5.3 EXCESS PROPORTION OF SPECIFIC CRASH TYPES SCREENING

The excess proportion performance measure quantifies, for a given location, the difference between the observed proportion of a specific collision type and the proportion among the relevant reference population (i.e., all intersections). The excess proportion is the difference between a site's proportion and the chosen threshold. For example, if 40 percent of reported intersection collisions are angle collisions, a site with 70 percent angle collisions would represent a 30 percent excess proportion. The largest such excess proportion represents the greatest potential for improvements targeting a specific collision type.

Kittelson used the excess proportion screening to identify locations with a concentration of collision or environmental characteristics. The excess proportion screening helps to identify locations that would benefit from a particular countermeasure or suite of treatments (e.g., system locations with a high incidence of run-off road collisions would benefit from similar treatments). These locations are intended to help the County and cities identify priority locations for implementation of systemic recommendation from the Systemic Solutions in Section 3, as well as focus some of the Non-Infrastructure Recommendations such as enforcement and education, summarized in Section 6.

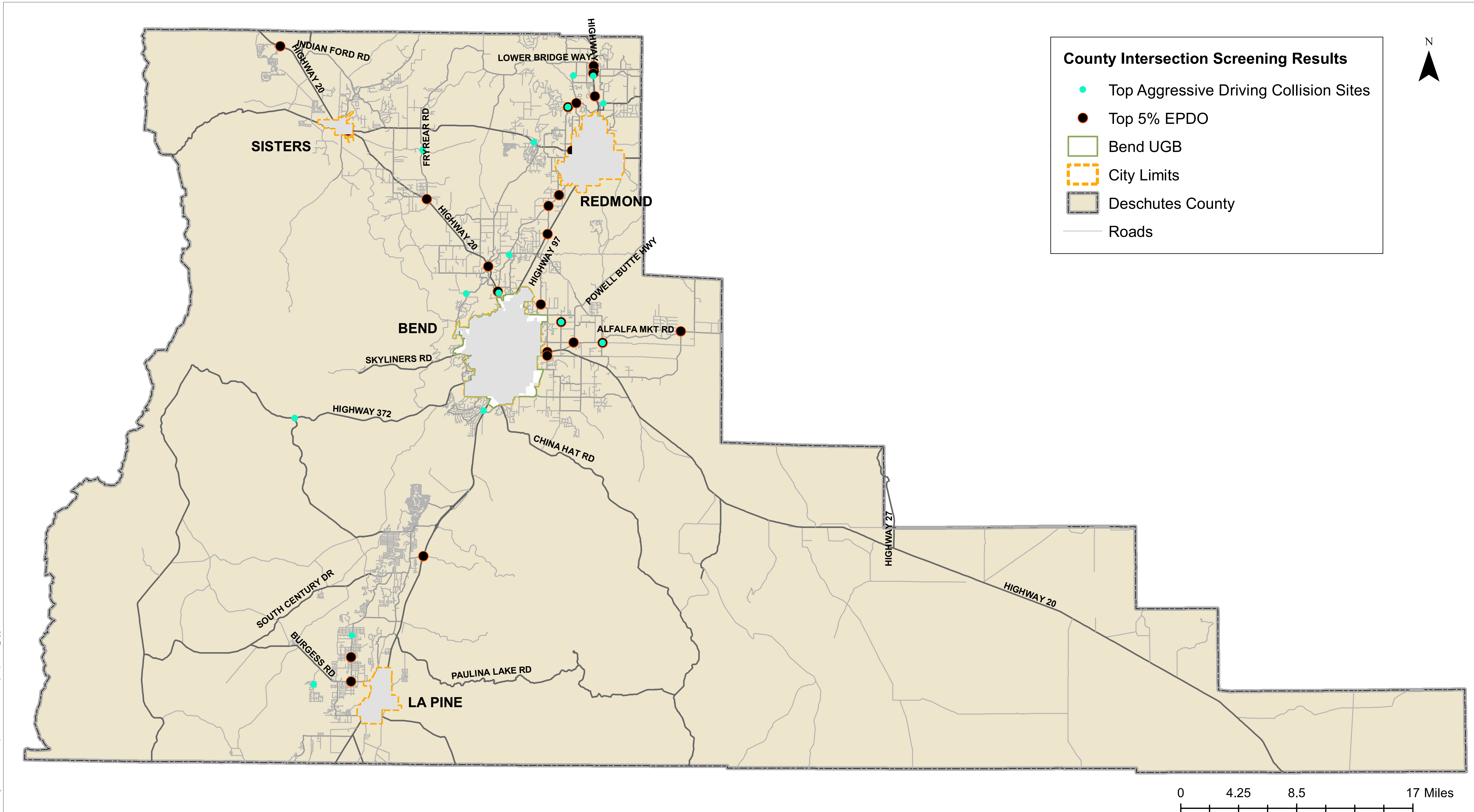
Kittelson identified the following emphasis areas in the existing conditions work to be associated with increased risk of severe outcomes and were therefore used for the excess proportion of specific crash types screenings:

- **Aggressive driving (excessive speed) collisions:** Figure 72 through Figure 74 illustrates the top intersections and segments with excess proportion of aggressive driving collisions in the County, including intersections in Redmond. Aggressive driving collisions include those involving speed and following too closely. The Speed Management Toolbox, presented in Section 4, and the Education and Enforcement recommendations in Chapter 6 best address these crash types.
- **Dark, with no street lights present**: Figure 75 through Figure 77 illustrates the top intersections with excess proportion of crashes occurring during dark conditions with no street lights present (according to the crash reports) in the County, including intersections in La Pine and Redmond. These locations may benefit from installing additional illumination and/or roadway delineation, as summarized in the Systemic Toolbox.
- **Angle collisions (includes angle and turning movement collisions)**[3]: Figure 78 through Figure 80 illustrate the top intersections with excess proportion of angle and turning movement crashes in the County, including intersections in La Pine and Redmond. These locations may be good candidates for the systemic signalized and unsignalized intersection treatments, particularly those that increase intersection awareness.
- **Rear-end collisions**[3]: Figure 81 through Figure 83 illustrate the top intersections with excess proportion of rear-end crashes in the County, including intersections in Redmond and Sisters. These locations may be good candidates for the systemic signalized and unsignalized intersection treatments, particularly those that increase intersection awareness.
- **Head-on collisions**[4]: Figure 84 illustrates the top segments with excess proportion of head-on collisions in the County. These locations may be good candidates for the speed management toolbox, roadway departure systemic countermeasures, and increased enforcement.

[3] This collision characteristic was only screened at intersection locations
[4] This collision characteristic was only screened along segments

- **Roadway departure (includes fixed object and non-collisions)**[4]: Figure 85 illustrates the top segments with excess proportion of roadway departure crashes in the County. These locations may be good candidates for the roadway departure systemic toolbox and increased enforcement.
- **Alcohol/drug involvement**: Figure 86 and Figure 87 illustrate the top intersections and segments with excess proportion of alcohol/drug impaired crashes. These locations may be good to target for education outreach and enforcement actions.

The maps showing the results of each screening also include the top 10 percent of intersections and segments based on the EPDO screening to illustrate where the excess proportion of specific crash types also overlaps with high crash frequency and severity.



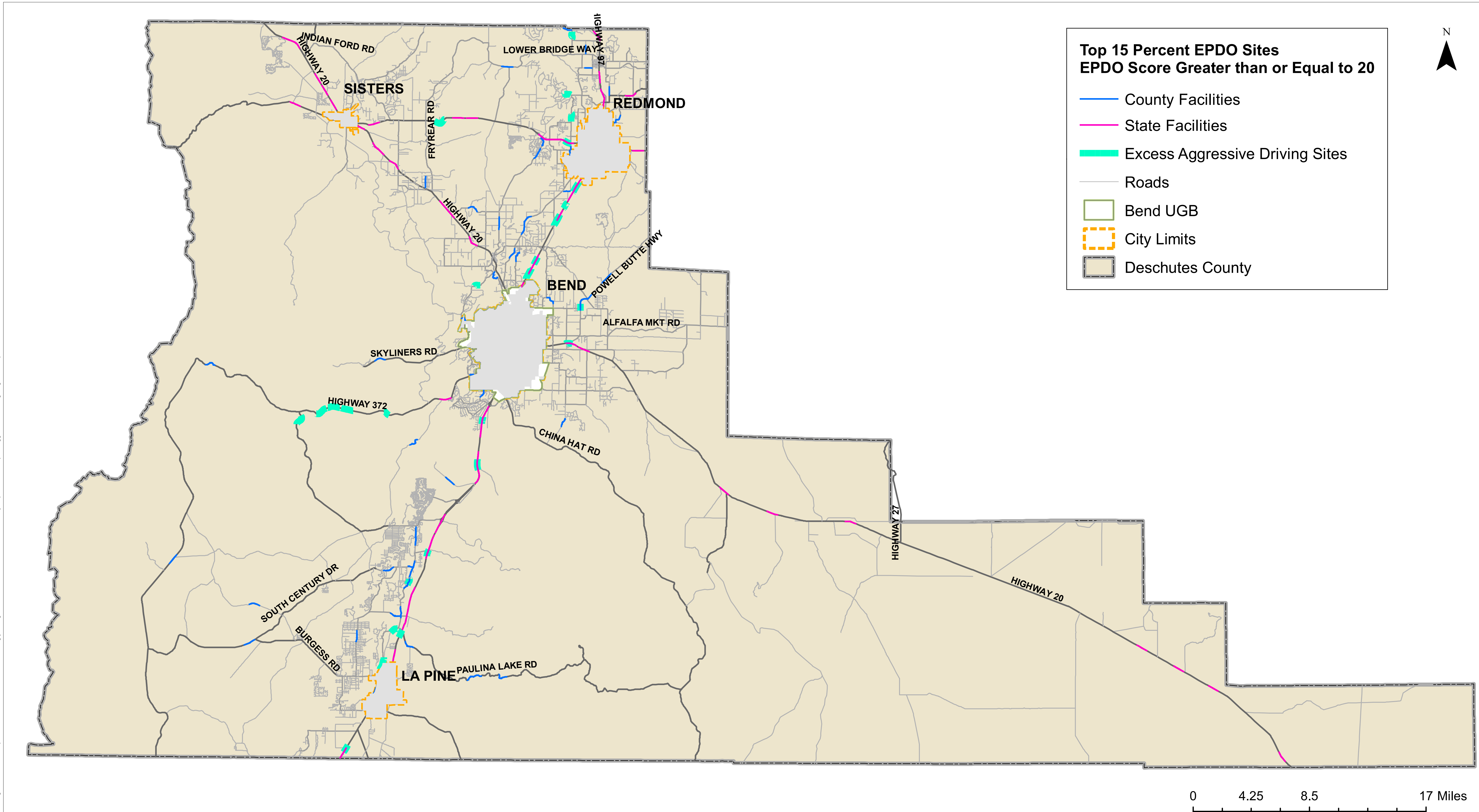
Equivalent Property Damage (EPDO) Only Scoring
Top EPDO Scores and Aggressive Driving Collision Intersections
Deschutes County, 2012 - 2016

Figure
72

H:\21\21829 - Deschutes County TSAP\gis\Final TSAP maps -- MGA\F73 County Top EPDO_Aggr_Intersections.mxd - mralston - 8:06 PM 7/2/2019

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



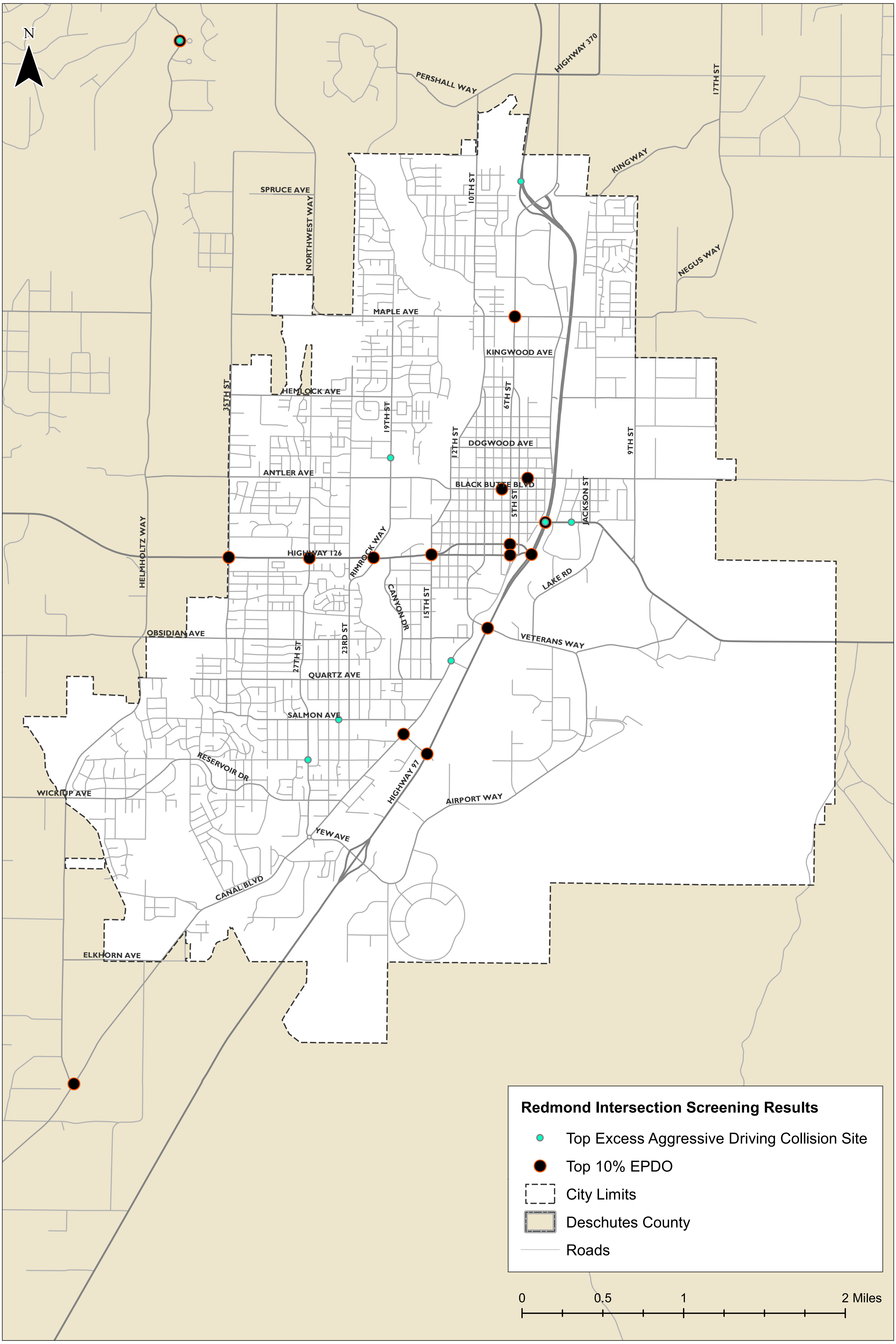
Equivalent Property Damage Only Scoring and Excess Proportion
Top 15 Percent EPDO Scores and Excess Aggressive Driving Sites
Deschutes County, 2012-2016

Figure
73

H:\21\21829 - Deschutes County TSAP\gis\final TSAP maps -- MGA\alternatives -- not showing just highest EPDO excesses\F74 ALT County Top 15% EPDO plus Aggressive Driving Segment Maps.mxd - malston - 8:32 PM 7/2/2019

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
Data Source: Deschutes County; Bend MPO



Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Aggressive Driving Collision Sites
Redmond, Deschutes County, 2012 - 2016

Figure 74

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KITTELSON & ASSOCIATES

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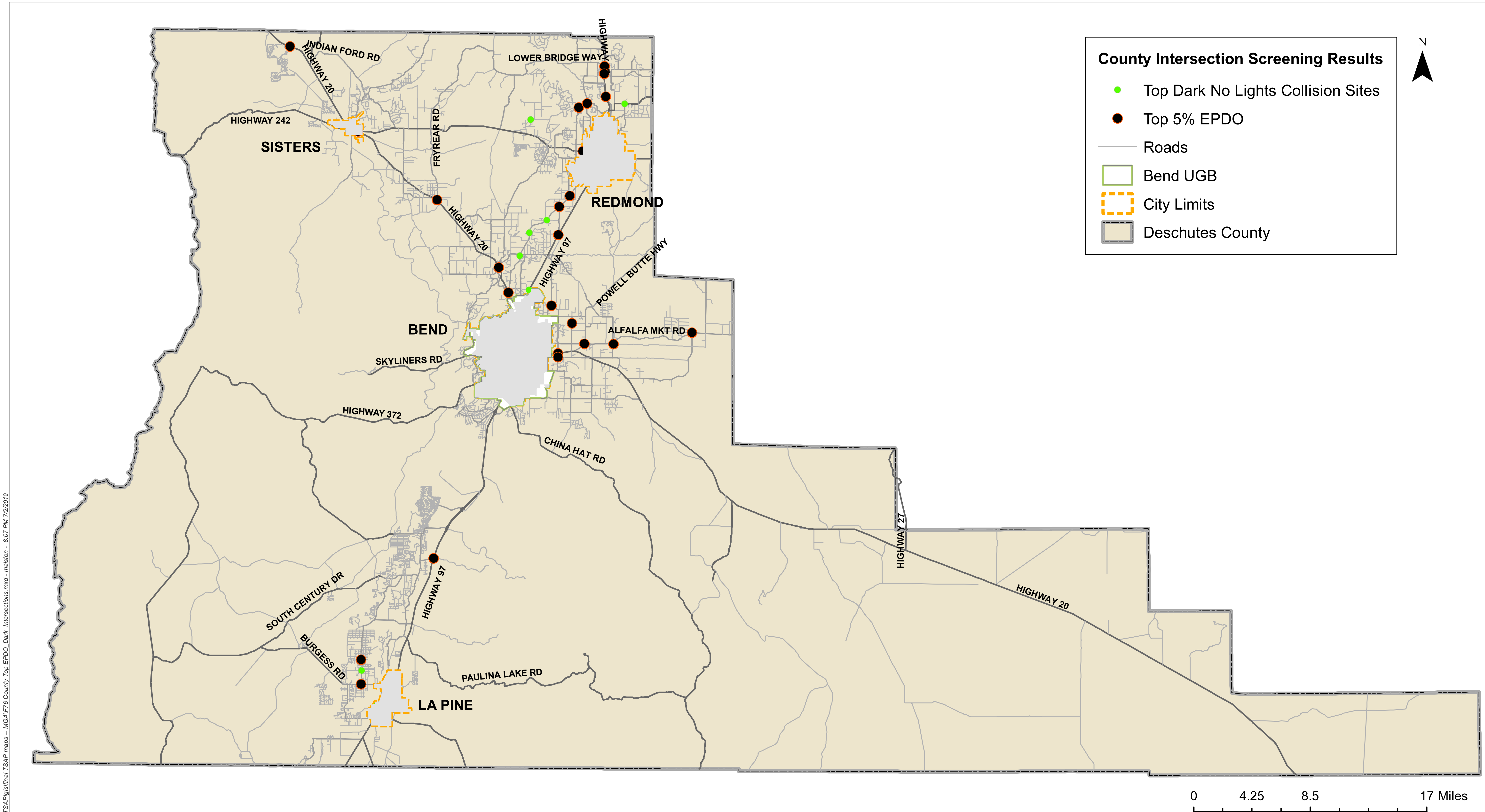


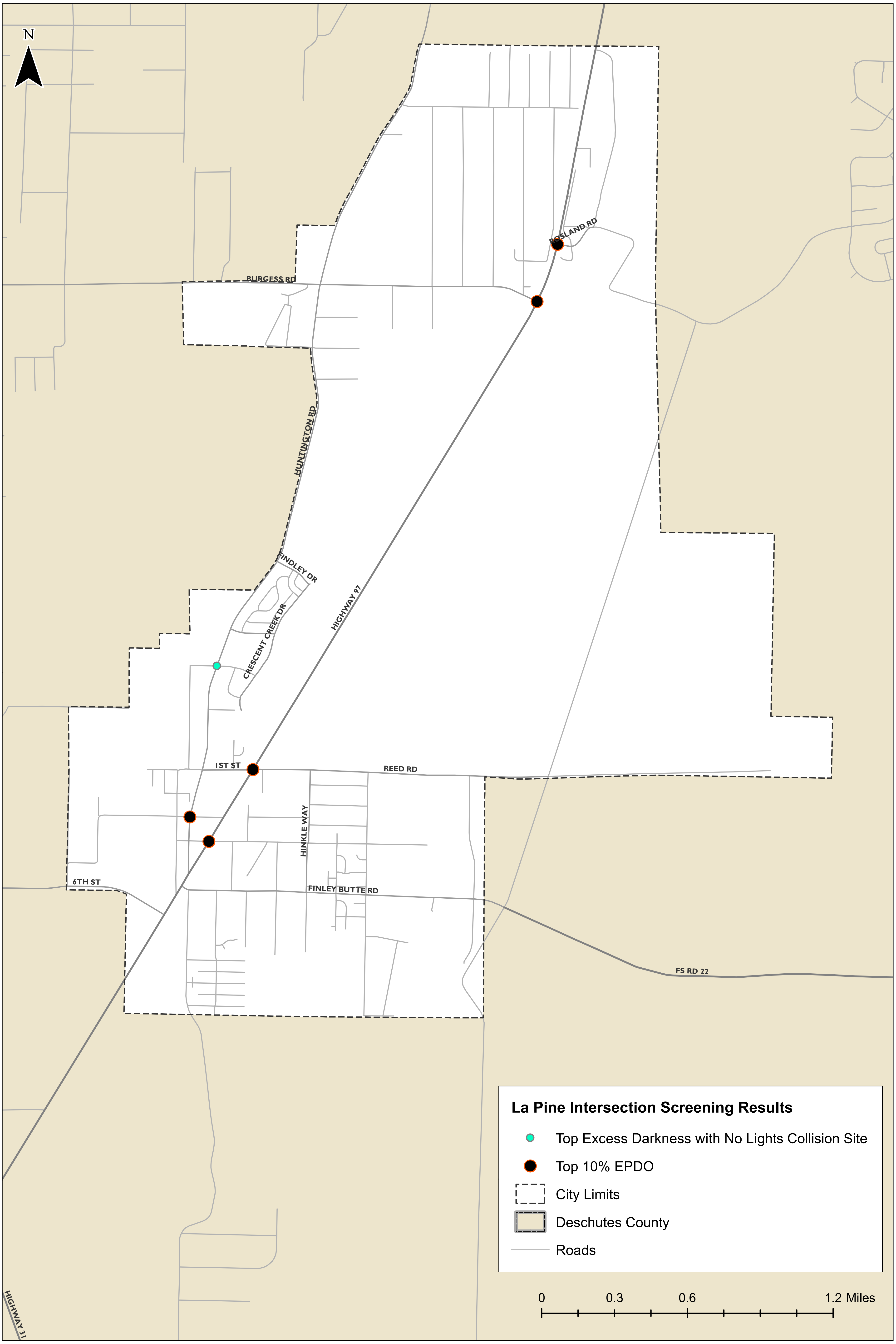
Equivalent Property Damage (EPDO) Only Scoring
Top EPDO Scores and Dark With No Street Lights Collision Intersections
Deschutes County, 2012 - 2016

Figure
75

H:\21\21829 - Deschutes County TSAP\gis\final TSAP maps -- MGA\F76 County Top EPDO_Dark_Intersections.mxd - malston - 8:07 PM 7/2/2019

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



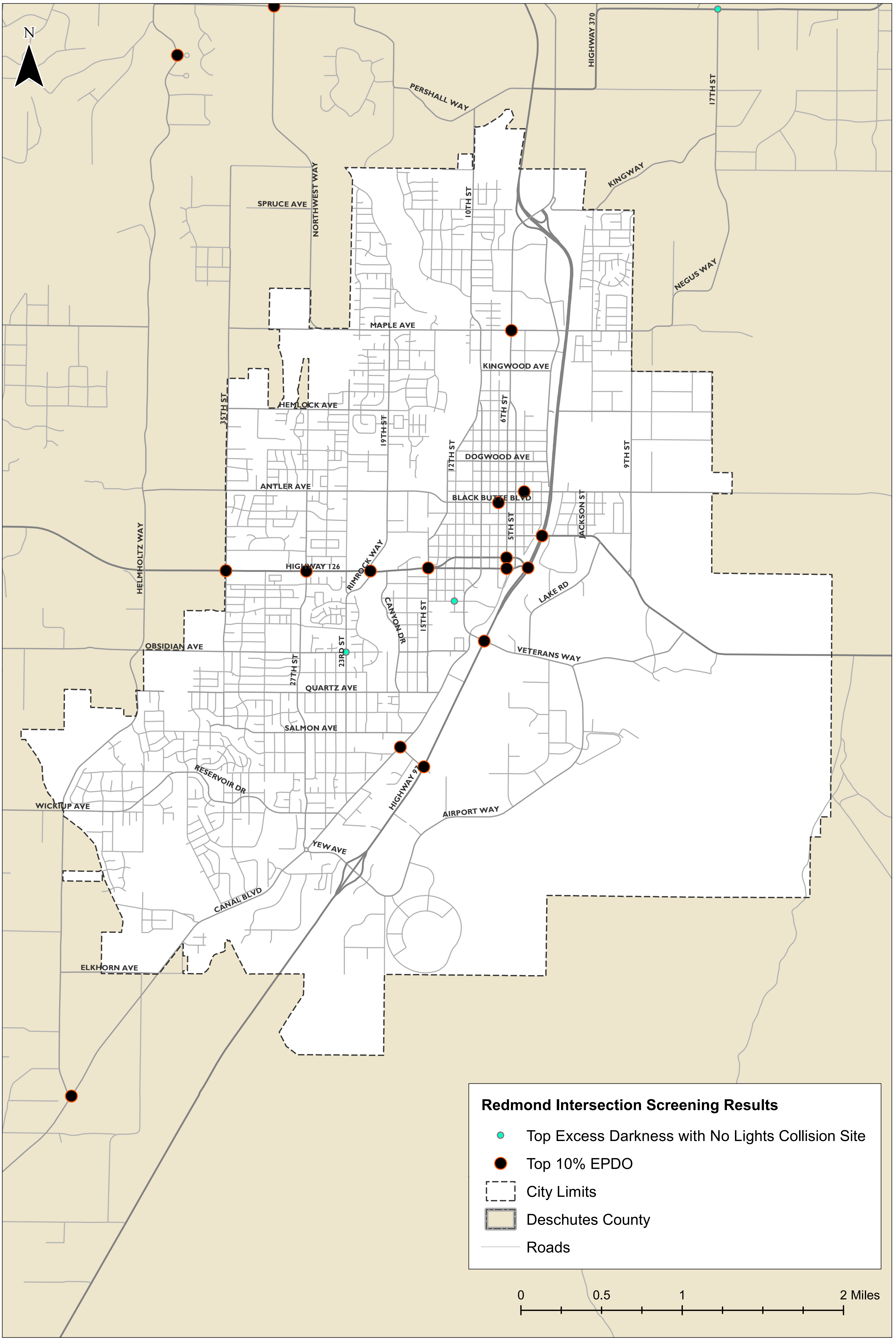
Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Darkness with No Lights Collision Sites
La Pine, Deschutes County, 2012 - 2016

Figure 76

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl

KITTELSON & ASSOCIATES

H:\21\21829 - Deschutes County TSAP\gis\location prioritization maps\cities\La Pine EPDO_Dark Intersections.mxd - ahunter - 11:10 AM 7/3/2019



Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Darkness with No Lights Collision Sites
Redmond, Deschutes County, 2012 - 2016

Figure 77

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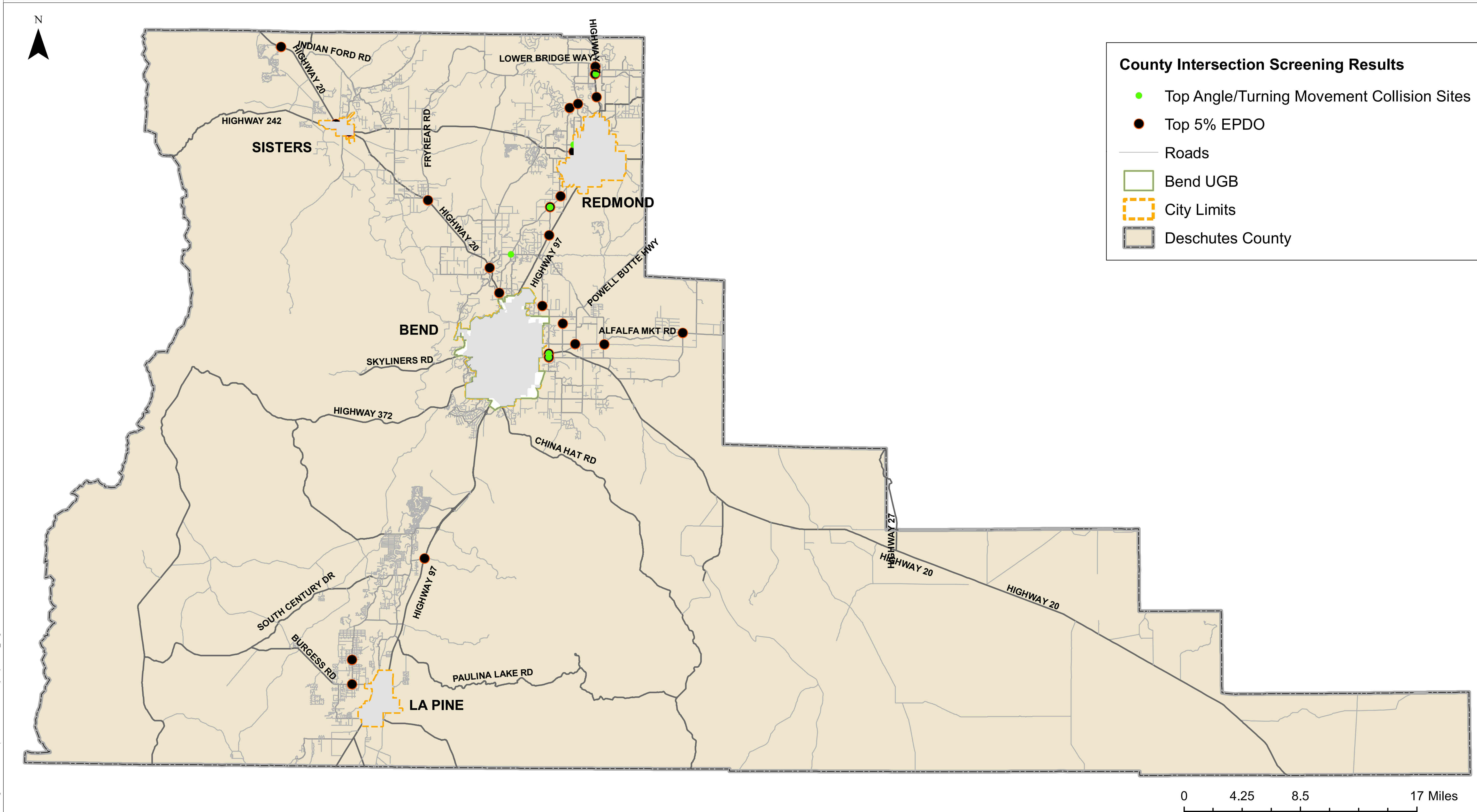
KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



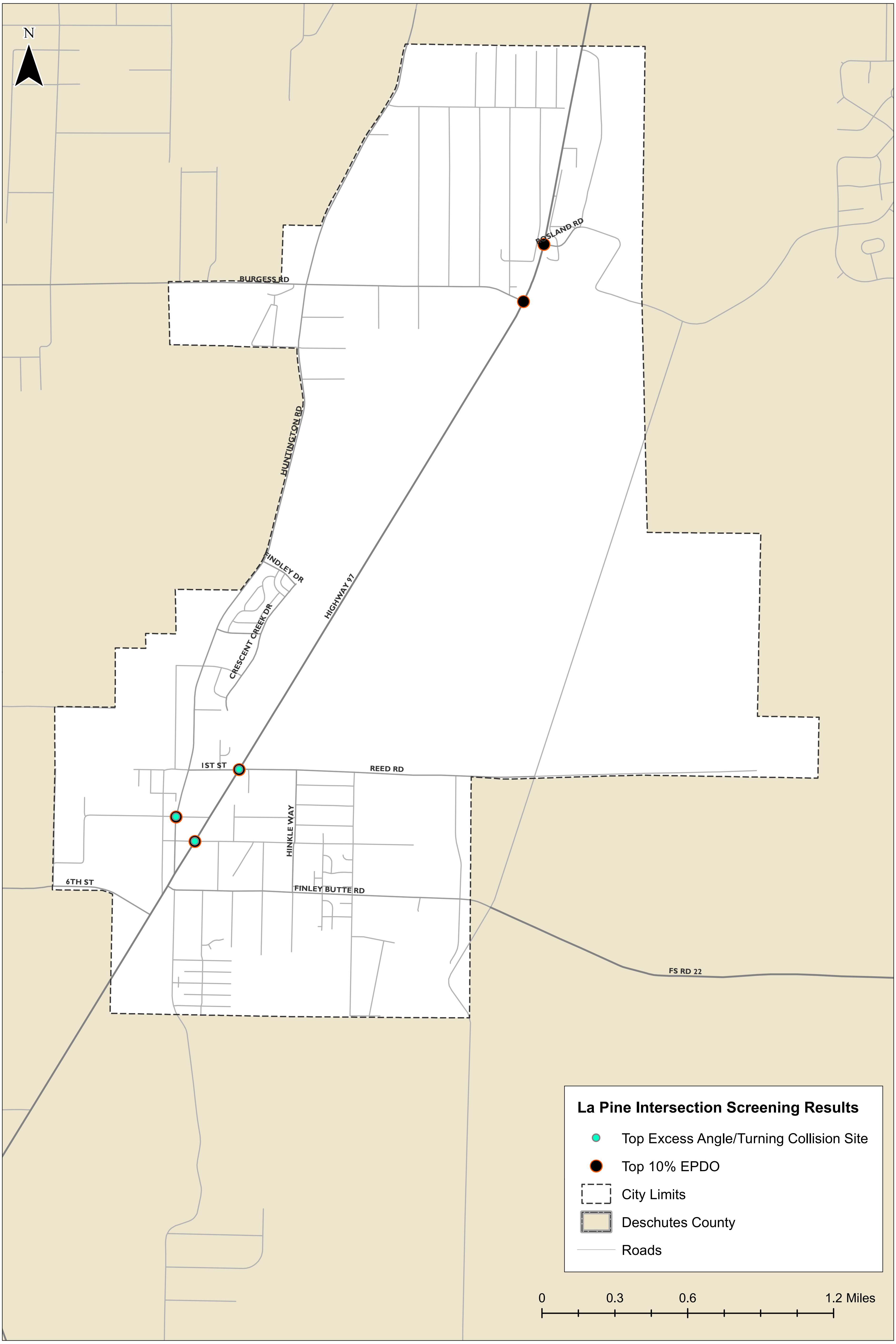
Equivalent Property Damage (EPDO) Only Scoring
Top EPDO Scores and Angle/Turning Movement Collision Intersections
Deschutes County, 2012 - 2016

Figure
78

H:\21\21829 - Deschutes County TSAP\gis\Final TSAP maps -- MGA\F79 County Top EPDO_Angle Intersections.mxd - malston - 8:04 PM 7/2/2019

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



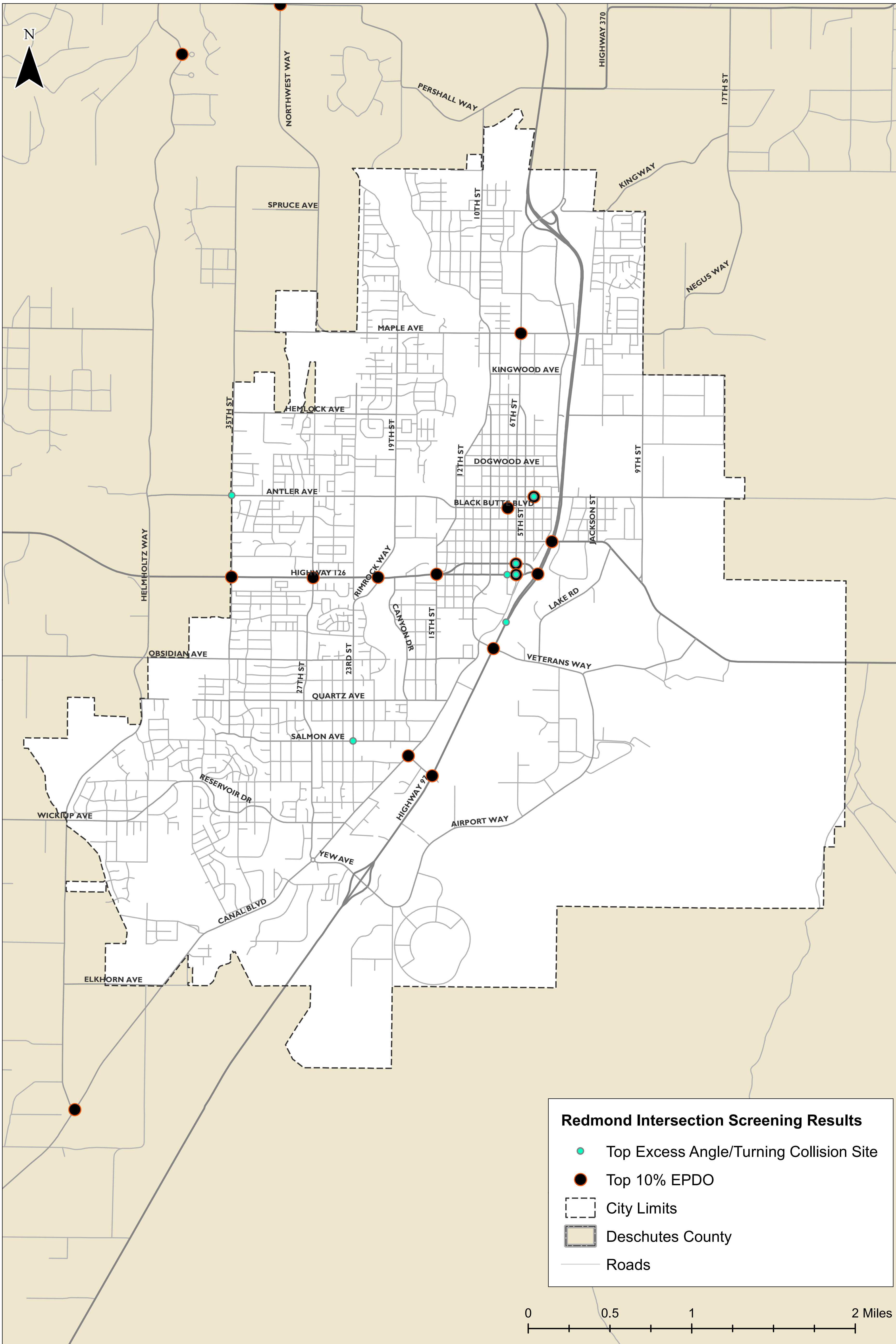
Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Angle/Turning Collision Sites
La Pine, Deschutes County, 2012 - 2016

Figure 79

H:\21\21829 - Deschutes County TSAP\gis\location prioritization maps\cities\La Pine EPDO_Angle Intersections.mxd - ahunter - 11:07 AM 7/3/2019

KITTELSON & ASSOCIATES

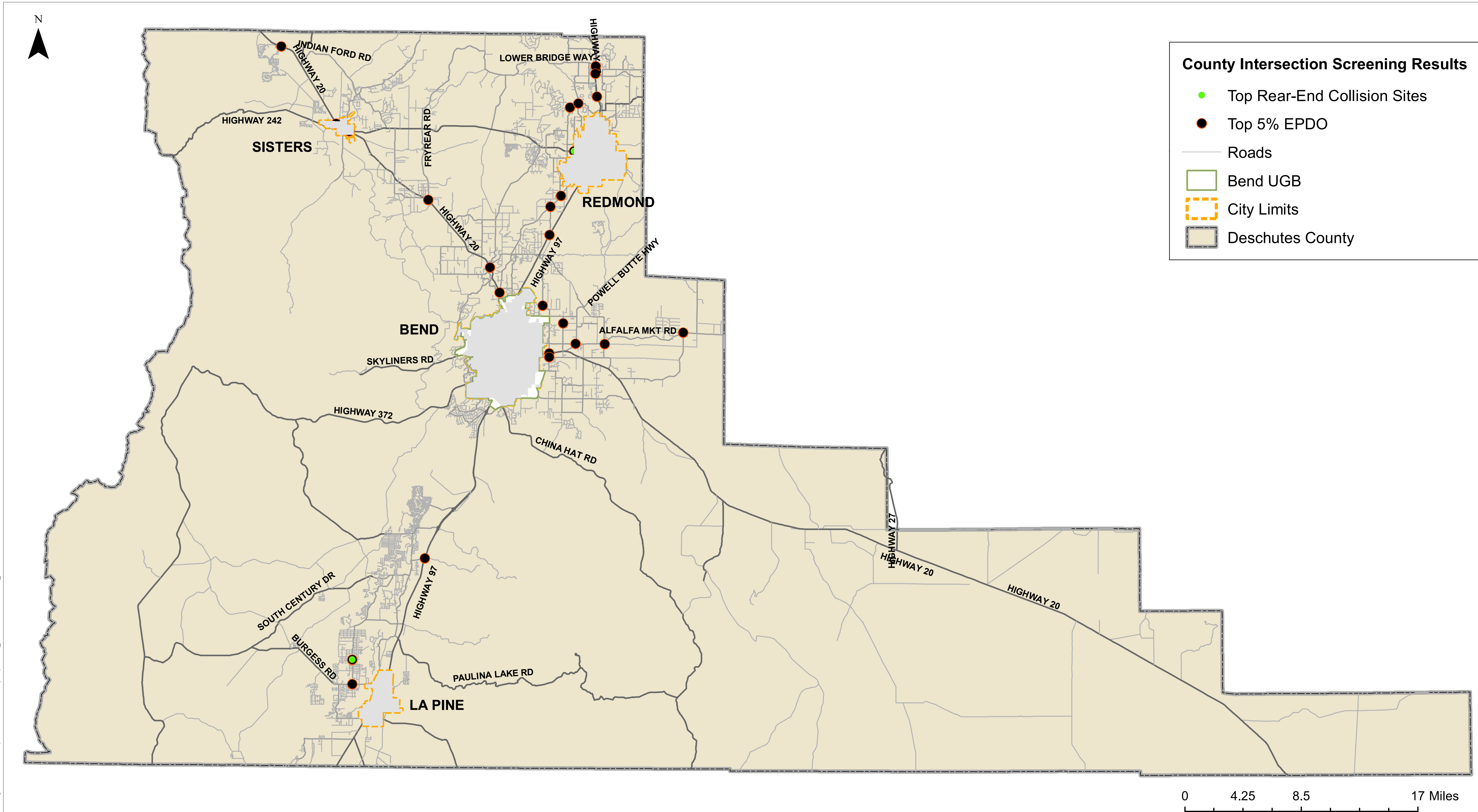
Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Angle/Turning Collision Sites
Redmond, Deschutes County, 2012 - 2016

Figure 80

H:\21\21829 - Deschutes County TSAP\gis\location prioritization maps\cities\Redmond EPDO_Angle Intersections.mxd - ahunter - 11:34 AM 7/3/2019



Equivalent Property Damage (EPDO) Only Scoring
Top EPDO Scores and Rear-End Collision Intersections
Deschutes County, 2012 - 2016

Figure
81

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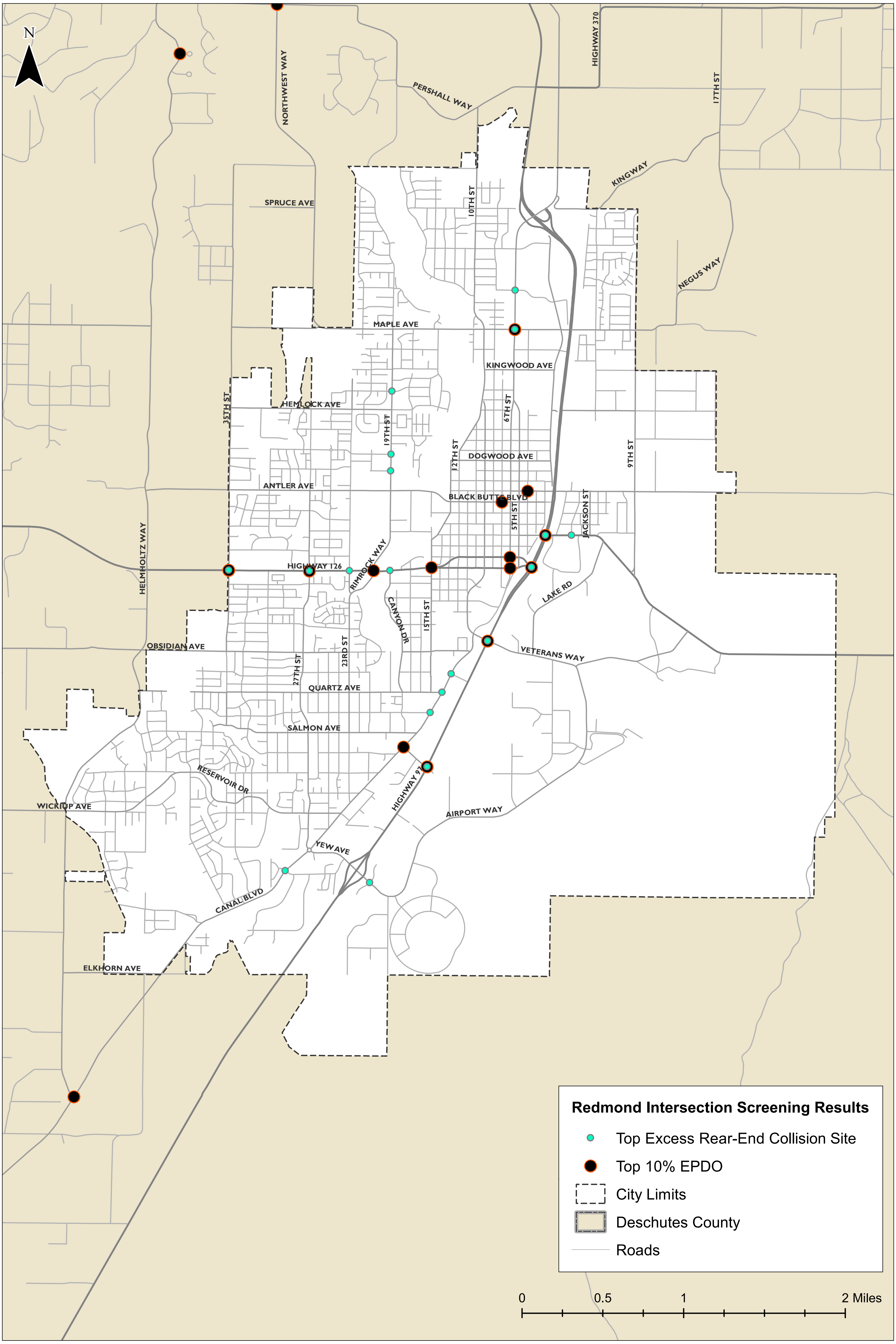
KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl



Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Rear-End Collision Sites
Redmond, Deschutes County, 2012 - 2016

Figure 82

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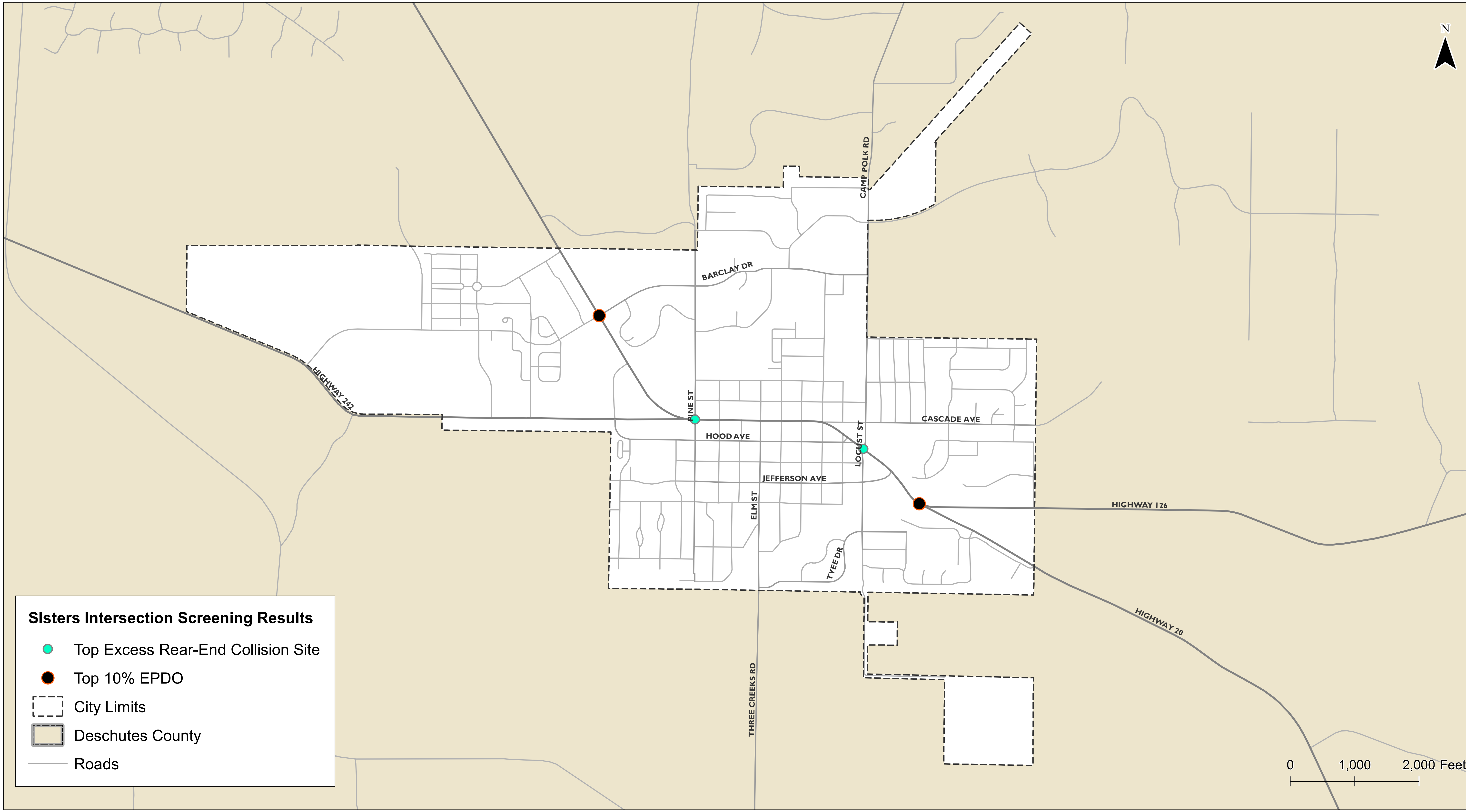

Equivalent Property Damage Only (EPDO) Scoring and Exess Proportion
Top EPDO Scores and Excess Rear-End Collision Sites
Sisters, Deschutes County, 2012 - 2016

Figure 83

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KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
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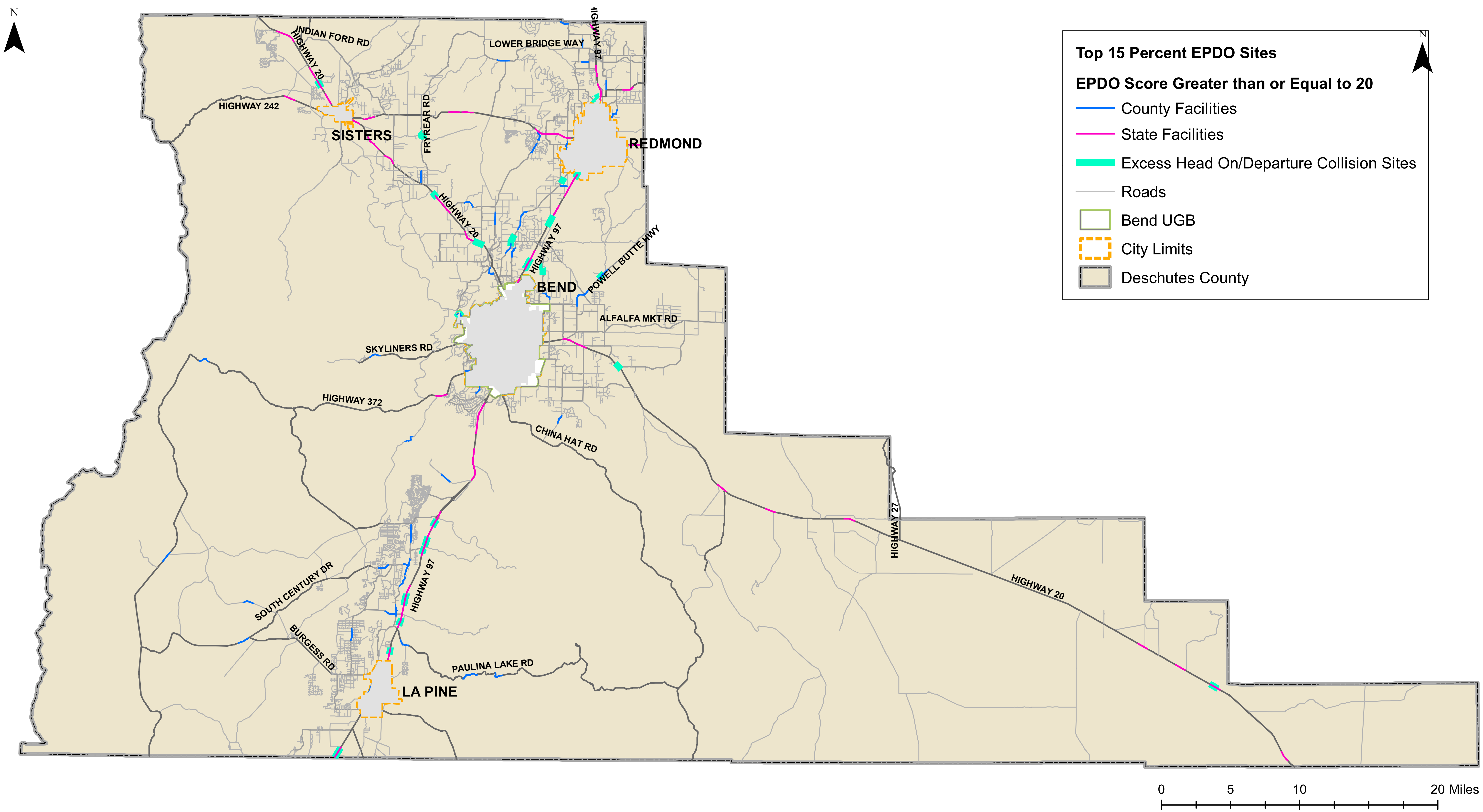


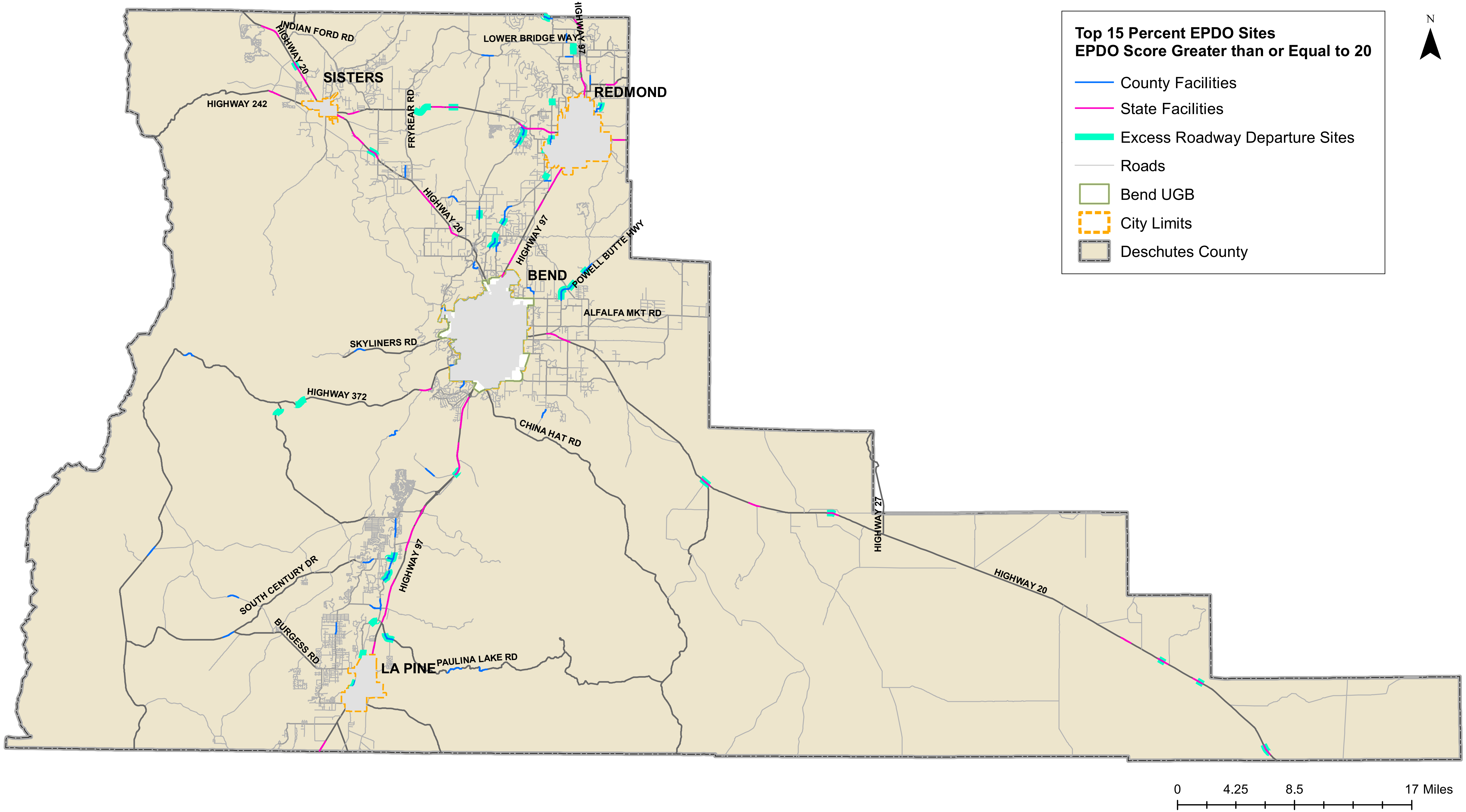
Equivalent Property Damage Only Scoring and Excess Proportion
Top 15 Percent EPDO Scores and Excess Head On Collision Sites
Deschutes Coutny, 2012 - 2016

Figure
84

H:\21\21829 - Deschutes County TSAP\gis\final TSAP maps -- MGA\alternatives -- not showing just highest EPDO excesses\F85 ALT - County Top 15% EPDO plus Head On Segment Maps.mxd - malston - 8:20 PM 7/2/2019

KITTELSON & ASSOCIATES

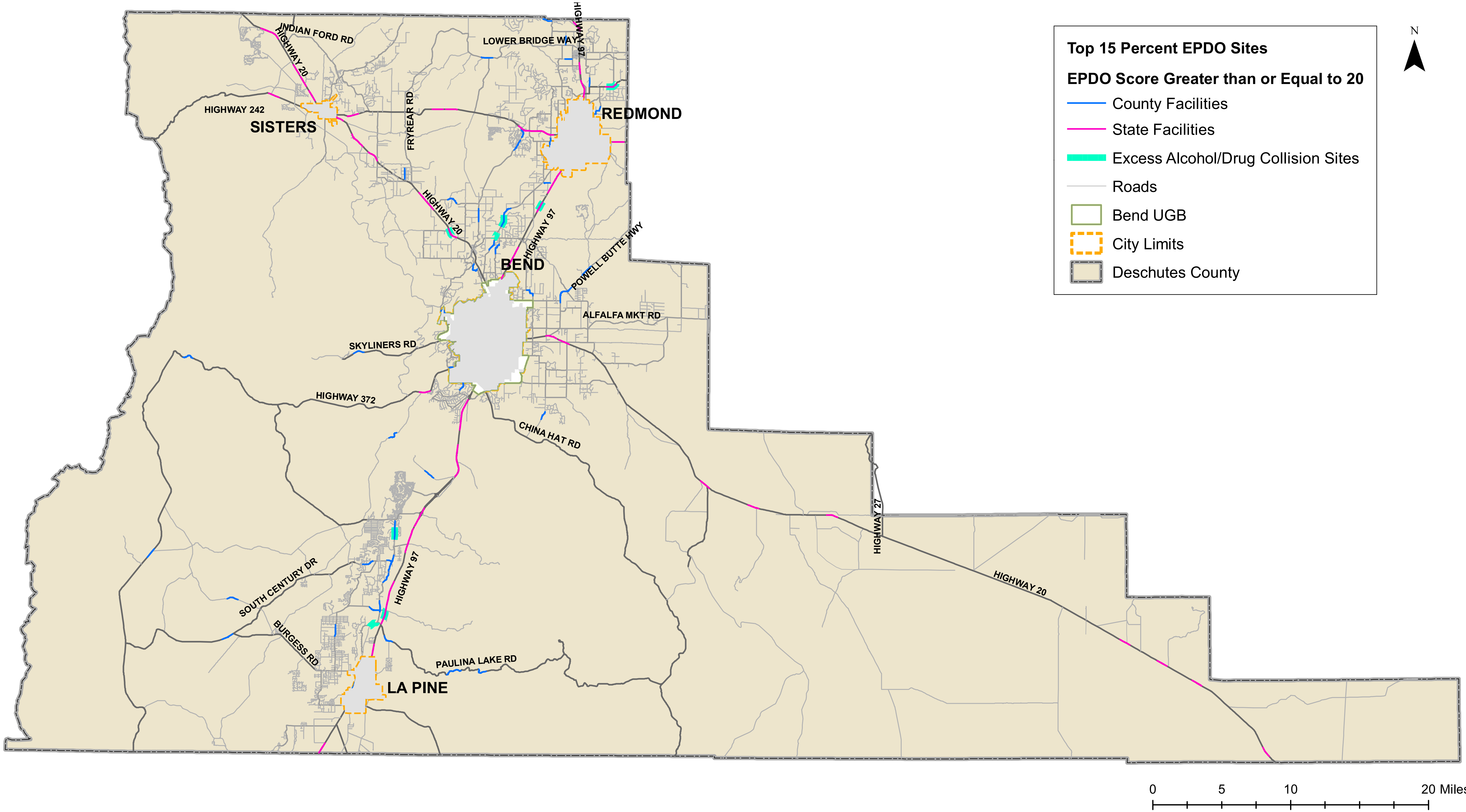
Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
Data Source: Deschutes County; Bend MPO



Equivalent Property Damage Only Scoring and Excess Proportion
Top 15 Percent EPDO Scores and Excess Roadway Departure Sites
Deschutes County, 2012-2016

Figure
85

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
Data Source: Deschutes County; Bend MPO

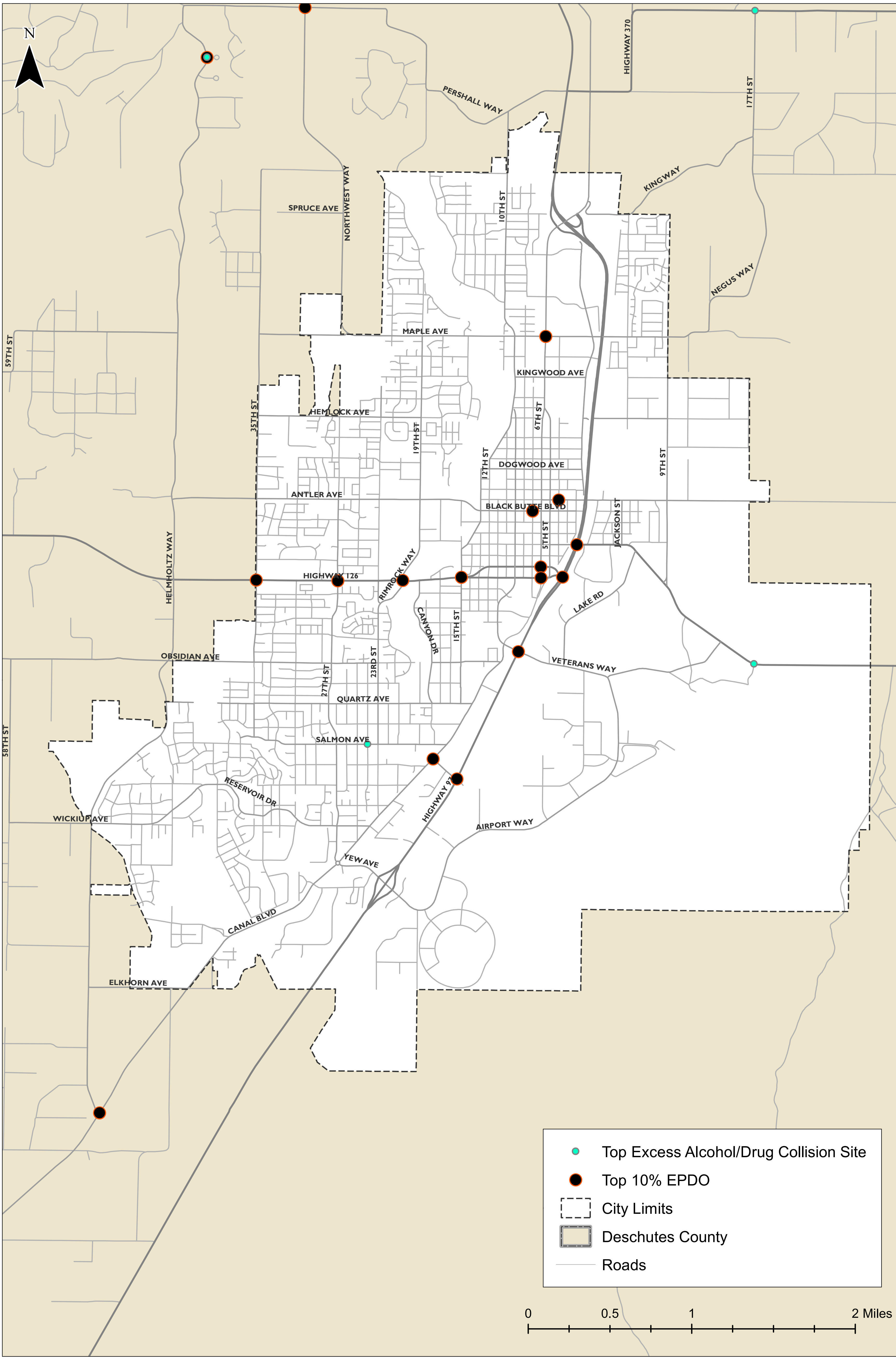


Equivalent Property Damage Only Scoring and Excess Proportion
Top 15 Percent EPDO Scores and Excess Alcohol/Drug Collision Sites
Deschutes County, 2012 - 2016

Figure
86

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
Data Source: Deschutes County; Bend MPO



Equivalent Property Damage Only (EPDO) Scoring and Excess Proportion
Top EPDO Scores and Excess Alcohol/Drug Collision Sites
Redmond, Deschutes County, 2012 - 2016

Figure 87

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KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl

Photo: Kittelson & Associates, Inc.

SECTION 6

NON-INFRASTRUCTURE MEASURES

6. NON-INFRASTRUCTURE MEASURES

A comprehensive approach to transportation safety acknowledges that policy, planning, programming, and projects are multidisciplinary and involve "the 7Es" of safety:

- Engineering;
- Emergency Medical Services (EMS);
- Enforcement;
- Education;
- Encouragement;
- Equity; and
- Evaluation.

This section summarizes the additional programs and actions that are recommended to comprehensively address transportation safety in Deschutes County. Many of the actions work towards helping Deschutes County achieve a positive transportation safety culture. Therefore, Section 6.1 discusses transportation safety culture, and Section 6.2 provides the summary of the action items.

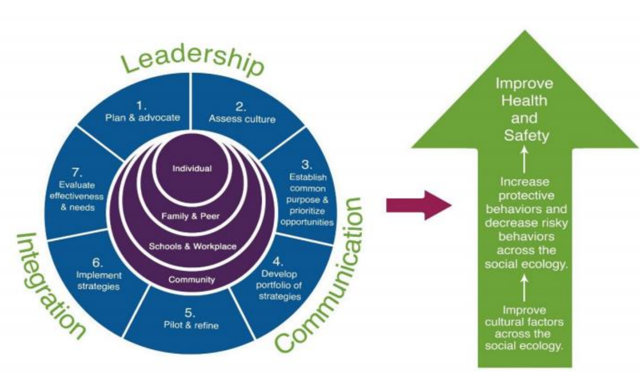
6.1 TRANSPORTATION SAFETY CULTURE

Safety Culture is the attitude residents share about safe driving and other forms of transportation. Deschutes County recognizes the need to grow a positive safety culture and to have agreement within the community that serious injury and death from a vehicle crash is not acceptable. [i] [5]

6.1.1 NATIONAL EFFORTS RELATED TO SAFETY CULTURE

There are many national efforts to use as tools to develop a Safety Culture program in Deschutes County and the Bend area. The report, *A Road to Zero: A vision for achieving zero roadway deaths by 2050*, was released in the midst of national discussions about motor vehicle safety issues. This report may help guide such programs for Deschutes County and the Bend area. Another approach is through the Center for Health and Safety Culture from Montana State University. This program provides community training programs that includes a framework and messaging protocol that would help set up a program approach.

Positive Culture Framework from Montana University Center for Health and Safety Culture[1]



[1] Graphic courtesy Montana State Universtity

More national efforts include:

- **The Road to Zero Coalition** is made up of 687 members ranging from

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[5] National Highway Traffic Safety Administration (NHTSA) 2017 "USDOT Releases 2016 Fatal Traffic Crash Data." Press Release https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data

advocacy organizations to government to public health experts. Its report on strategies to get to zero traffic deaths identifies creating a positive safety culture as one of the three key strategies. It provides several resources on its website covering a variety of topics.

- **The Toward Zero Deaths** national strategy details how to shift culture away from transportation risk acceptance. It brings together various state and local initiatives to pursue a highway system that is free of fatalities. Several cities, counties, and states around the country have adopted initiatives, including the City of Portland and the Oregon Department of Transportation (ODOT).
- **The Transportation Research Board Safe Systems Committee** identifies research needs, explains research findings to the public, and creates partnerships between organizations focused on Safety Culture.

6.2 ACTION ITEMS

Table 6 summarizes Action Items for working towards a safety culture that promotes attentive driving, sober driving, and awareness of individual impacts on roadway safety. These reflect a wide range of potential actions the County and other partners/stakeholders can consider to work towards reducing fatal and severe crashes. Many of the actions identified are not the responsibility of the County to implement. It is expected that the County will work with its partners, including ODOT, the Bend MPO, the City of Bend, and others to develop an implementation plan that summarizes how and when some of these will be addressed; the actions may take many years to be initiated.

Table 6. General Safety Culture and Educational Action Items

Action Item	Description	Emphasis Area(s)	Participating Agencies	Funding Need
A1	Create and implement a Regional Transportation Safety Committee to coordinate on transportation safety and implement the Action Items identified in the TSAP. Other representatives from various outreach or advocacy groups will also be helpful to help with outreach. City and County staff participation from various departments such as police, streets, capital projects, engineering, and community development will help promote coordination across departments and the share of resources and data to coordinate transportation safety efforts. Regular meetings should occur at which the committee share data/resources, implements the Deschutes County and Bend Area TSAP Action Items, and identifies new actions needed based on more recent crash history.	Safety Culture	ODOT, Deschutes County, City of Bend, Bend MPO, Redmond, Sisters, La Pine, Police, Sheriff, District Attorney's office, Emergency Services, OLCC, Department of Public Health	$$$
A2	Consider staffing needs or a consultant position to lead the Regional Transportation Safety Committee and lead implementation of the Action Items in the TSAP. Staff may be part of Deschutes County or ODOT to better serve the full region. Seek funding for this position.	Safety Culture	ODOT, Deschutes County	$$
A3	Create a Deschutes County Safety Communications Plan, including an education and public outreach system, that promotes a roadway safety culture that emphasizes attentive driving, sober driving, calm driving, driving at appropriate speeds, and awareness of individual impact on roadway safety. This should be a comprehensive and ongoing program.	Safety Culture, Aggressive Driving	ODOT, Deschutes County, Bend MPO, City of Bend	$$
A4	Develop a Safety Communications Calendar that provides monthly messages to emphasize in Deschutes County. Develop a plan for recurring educational events throughout the year(s). Provide educational programs at community events.	Safety Culture	Deschutes County, ODOT	$$
A5	Provide educational materials to visitors through partnerships with Visit Bend and local hotels/resorts.	Safety Culture	Deschutes County, Bend MPO, City of Bend, Visit Bend	$$
A6	Develop and maintain policies to support the actions identified in the TSAP and to better incorporate safety into long-range planning and the project development process.	Safety Culture	Deschutes County	$
A7	Increase traffic enforcement during times of either high traffic volume or highest risk times, based on the reported available crash data patterns, and at locations identified in the TSAP based on reported crash data.	Safety Culture, Enforcement	Police/Sheriff, Deschutes County	$$
A8	Evaluate the need for increased Sheriff's Office staffing to increase enforcement.	Safety Culture, Enforcement	Police/Sheriff, Deschutes County	$$
A9	Evaluate options for automated enforcement of speeding and red-light running in key locations.	Safety Culture, Enforcement	Police/Sheriff, Deschutes County, ODOT	$

Action Item	Description	Emphasis Area(s)	Participating Agencies	Funding Need
		, Aggressive Driving		
A10	Provide bystander training courses to the public to educate residents how to respond in an emergency event.	Emergency Response	Police, EMS, Hospitals	$$
A11	Reduce (optimize) response time to crashes. Work with the EMS Council and Oregon Area Trauma Advisory Board to complete this.	Emergency Response	EMS, Police	$
A12	Develop criteria for identifying and designating safety corridors within the County.	Aggressive Driving, Safety Culture	Deschutes County, ODOT	$
A13	Encourage employers and families to institute policies related to driving safely, including attentive driving, by sharing the National Safety Council's sample contract in its Distracted Driving Toolkit.	Safety Culture, Distracted Driving	Deschutes County, Employers, Local cities	$
A14	Educate youth and adults on the importance of paying attention when using the transportation system.	Safety Culture, Distracted Driving	Deschutes County	$
A15	Continue to implement an unmarked patrol unit to combat distracted driving. Evaluate partnering with the City of Bend to expand this program.	Safety Culture, Distracted Driving, Enforcement	County Sheriff, Police, City of Bend	$$
A16	Develop an educational campaign to promote sober driving. Provide educational posters, social media posts, and public service announcements to inform the public about the dangers of impaired driving, including alcohol and drugs. Work in schools to educate students on the consequences of impaired driving. Emphasize that driving while or after using marijuana is impaired driving.	Safety Culture, Impaired Driving	Deschutes County, ODOT, Bend MPO, Schools	$
A17	Increase Driving Under the Influence and impaired driving enforcement through data-driven saturation patrols and provide officers with Drug Recognition Expert Training and standardized field sobriety tests training.	Impaired Driving, Enforcement	Police, County Sheriff, Deschutes County	$$
A18	Continue to support the Shared Future Coalition and increase education about the consequences of impaired driving (alcohol and drugs). Explore partnerships with local cities to expand the program. Education should emphasize the effects of marijuana on the body to help drivers understand that driving while or after using marijuana is impaired driving. Grow partnerships and support existing efforts to reduce underage drinking, underage marijuana use, and drug use through funding, educational outreach, and coalition membership. Partner with substance abuse treatment programs.	Safety Culture, Impaired Driving	Deschutes County (Shared Future Coalition)	$$
A19	Develop repeat DUI driver offender programs focused on treating the causes of DUI.	Impaired Driving	District Attorney's Office	$

Action Item	Description	Emphasis Area(s)	Participating Agencies	Funding Need
A20	Support the City of Bend in formalizing rideshare locations in the downtown area and near locations with multiple restaurants, bars, and pubs to encourage greater use of cabs and rideshare options.	Safety Culture, Impaired Driving	Bend MPO, City of Bend, Downtown Bend, Restaurants and Bars, Cab and Rideshare companies, Deschutes County	$$
A21	Coordinate with local bars, businesses, and rideshare companies to develop and offer a program that provides users with a discount for taking a cab or rideshare to or from drinking establishments.	Safety Culture, Impaired Driving	Bend MPO, City of Bend, Downtown Bend, Restaurants and Bars, Cab and Rideshare companies; Deschutes county	$
A22	Coordinate with area business groups and event promoters to develop and offer a program that provides users with a discount for taking a cab or rideshare to or from special events (such as Bit of Bend, Summerfest, etc.).	Safety Culture, Impaired Driving	Bend MPO, City of Bend, Downtown Bend, Restaurants and Bars, Cab and Rideshare companies; Deschutes county	$
A23	Report matter-of-fact crash statistics in a manner meant to inform potential riders of the risks associated with choosing the motorcycle as a mode of transportation.	Safety Culture; Motorcycles	Deschutes County, ODOT, Bend MPO, City of Bend	$
A24	Conduct targeted outreach using various means, relationships, and venues to encourage a change in safety culture to convince motorcyclists to enact safe riding practices. Work with motorcycle shops to educate riders about the behaviors associated with higher risk such as discouraging group rides. Provide educational posters, social media posts, and educational placards to inform motorcyclists of the consequences of crashes and promote safe riding practices, safety equipment, gear choice (full face helmets, full gloves, appropriate jackets and pants, boots, etc. and All the Gear All the Time (ATGATT)), importance of lights or reflective gear at night, the importance of not riding the wrong way, the importance of not riding impaired, and motorcycle handling skills and maintenance.	Safety Culture, Motorcycles	Deschutes County, ODOT	$
A25	Encourage more education programs for riders who have taken a break from riding. Work with motorcycle retailers to encourage education for new riders and continued training after receiving their endorsement.	Safety Culture, Motorcycles	Deschutes County, ODOT	$
A26	Continue partnership with Commute Options and Pedestrian Advisory Committee (BPAC).	Safety Culture, Pedestrians / Bicyclists	Deschutes County, BPAC	$
A27	Continue to provide local educational programs at schools and other venues (safety fairs, community events, etc.) for both students and parents, including: educate parents about traffic safety, including safe parking locations when lining up for school pick-up; educate students and parents about the importance of reflective	Safety Culture, Pedestrians / Bicyclists	Commute Options, Schools	$$

Action Item	Description	Emphasis Area(s)	Participating Agencies	Funding Need
	clothing when walking or biking at night; educate students and parents on safe pedestrian and bicycle practices including safe crossing practices and not playing behind vehicles or near streets; educate about the importance of adult supervision; provide educational materials for students to share with parents about the risks associated with distracted driving, including distracted pedestrians.			
A28	Collaborate with the Department of Public Health to work on active transportation, safe routes to school, health impact assessments, and rural access to health care. Include transportation safety in public health education programming.	Safety Culture	Deschutes County Health Department	$
A29	Support Commute Options to continue the "Friendly Driver" program for truck drivers and expand it beyond truck drivers to include drivers associated with businesses and business activities. This program currently educates truck drivers on how to operate in the presence of people walking and biking. Offer incentive programs to encourage businesses to expand this program beyond truck drivers.	Safety Culture; Pedestrians/ Bicyclists	Commute Options, Local Businesses, Deschutes County	$$
A30	Evaluate where opportunities exist for new educational and promotional programs for pedestrians and bicyclists over time.	Safety Culture; Pedestrians/ Bicyclists	Commute Options, Deschutes County	$
A31	Conduct adult pedestrian and bicycle outreach, such as safe crossing practices and new pedestrian/bicycle infrastructure education.	Safety Culture; Pedestrians/ Bicyclists	Commute Options, Deschutes County	$
A32	Educate drivers and bicyclists about bicycle transportation, including proper driver and bicyclist behavior and rules of the road for bicyclists, when to dismount, how to use sidewalks and crosswalks, how to ride through roundabouts, common crash types, etc.	Safety Culture; Pedestrians/ Bicyclists	Deschutes County, Bend MPO, ODOT, Commute Options	$
A33	Coordinate with BPAC to reintroduce placards with rules for bicyclists, pedestrians, and motor vehicle drivers.	Safety Culture; Pedestrians/ Bicyclists	BPAC	$
A34	Design roadways integrating pedestrian and bicyclist safety considerations by providing appropriate pedestrian and bicyclist infrastructure, encouraging slower motor vehicle speeds, and minimizing conflict points between pedestrians, bicyclists, and motorists. Treatments may include: Sidewalks, pathways, and other walkways separating pedestrians from motor vehicles along roadways; Enhanced roadway crossings; Shared lane markings, wayfinding, traffic calming for lower speed and volume roadways, and enhanced striping (striping, buffers, rumble strips) to facilitate striping durability on higher volume roadways; Increasing physical separation between people biking and	Pedestrians/ Bicyclists	Deschutes County, ODOT	$$

Action Item	Description	Emphasis Area(s)	Participating Agencies	Funding Need
	motor vehicles as motor vehicle volumes and speeds increase, including physical barriers at higher speeds and volumes.			
A35	Develop a countywide bicycle route map that identifies the preferred bicycle routes (lower volume, lower speed, and available shoulders) and provide wayfinding to direct cyclists to these routes. Illuminate pedestrian crossings near schools in the County.	Pedestrians/ Bicyclists	Deschutes County	$$
A36	Complete the sidewalk system in unincorporated communities by closing gaps in the sidewalk system and providing appropriately designed crossings where needed.	Pedestrians/ Bicyclists	Deschutes County, ODOT	$$$
A37	Provide transportation options through infrastructure that allows for transit, walking, and other forms of transportation, where possible. Partner with transportation assistance programs to promote non-driving options for seniors.	Senior Drivers	COIC, CET, Deschutes County, ODOT	$$
A38	Support driver education programs and safety education for younger drivers in rural areas. Support peer-based safe driving marketing efforts and outreach programs in high schools to provide driver and non-motorized travel safety education. Support family-based driver education to leverage parental influence.	Safety Culture; Young Drivers	ODOT, Commute Options	$
A39	Begin safety education before young people reach driving age, as early as preschool. Partner with groups such as Safety Towns and school districts.	Safety Culture; Young Drivers	Commute Options, Safety Towns, School District	$
A40	Seasonally educate drivers about proper driving behavior and vehicle preparations for winter conditions.	Safety Culture; Winter Driving	ODOT, Deschutes County, Deschutes County	$
A41	Evaluate opportunities to implement weather warning systems, particularly on state highways.	Winter Driving	ODOT, Deschutes County	$
A42	Integrate technology advancements to improve transportation safety.	Technology	Deschutes County, ODOT	$$
A43	Evaluate options to collect and use traffic volume, near-misses, and other data to understand where perceived safety issues may exist	Technology	Deschutes County, ODOT	$$
A44	Evaluate the ability to use crowdsourcing technology to identify risks and locations for additional assessment	Technology	Deschutes County, ODOT	$$
A45	Evaluate opportunities to use lidar, radar, and/or photo enforcement	Technology	Deschutes County, Police, ODOT	$$
A46	Evaluate opportunities to implement weather warning systems, particularly on state highways.	Technology	Deschutes County, ODOT	$
A47	Update the TSAP every 3 to 5 years.	Monitoring	Deschutes County	$
A48	Evaluate the need to increase sheriff staffing to increase enforcement. Explore funding opportunities to increase enforcement.	Enforcement	Sheriff's Department, Police, Deschutes County	$

Photo: Kittelson & Associates, Inc.

SECTION 7

PLAN IMPLEMENTATION AND EVALUATION

7. PLAN IMPLEMENTATION AND EVALUATION

This section describes the performance measures Deschutes County may use to evaluate the success of this Plan and the steps needed to determine how to update this Plan in the future. The cities of Redmond, Sisters, and La Pine may choose to develop their own performance measures to track progress as well.

7.1 PERFORMANCE MEASURES

Performance measures are used to evaluate progress in completing the actions identified in the TSAP and in achieving the desired outcomes of the Plan (reducing fatal and severe injury crashes to work towards zero fatal and severe injuries). The Oregon TSAP identifies two general types of performance measures: effectiveness performance measures and efficiency performance measures. Effectiveness performance measures track the outcomes of the TSAP, and efficiency performance measures track the success of implementing the Plan. This section focuses on the effectiveness measures the County will use to track outcomes.

7.1.1 EFFECTIVENESS (OUTCOME) MEASURES

Measures the County will use to evaluate the ongoing success of the Plan toward achieving its ultimate goal of zero fatal and severe injury crashes in Deschutes County include:

- Total number of fatal and severe injury crashes reported on County roads in unincorporated Deschutes County
- Fatal and severe injury crash rate (crashes per VMT, based on annual VMT estimates for the Bend MPO area) for County roads in the unincorporated County[6]
- Number of fatal and severe injury crashes on County roads by the following categories:
    - Pedestrian-involved crashes
    - Bicyclist-involved crashes
    - Motorcyclist-involved crashes
    - Alcohol or drug-involved crashes
    - Speed-involved crashes
    - Lane departure crashes (includes fixed object, non-collision (overturn), head-on, and sideswipe-meeting crashes)

Fatal and severe crashes should be reported annually, and performance should be based on the latest five-year annual average number of crashes. Using the annual average will help to normalize for random fluctuations in crashes each year.

The County's performance between 2012 and 2016 is summarized in Table 7 below.

[6] The Bend MPO area provides annual VMT estimates for the MPO area. Although this does not reflect all of Deschutes County, it may be used in calculation of a crash rate. If the County develops annual VMT estimates in the future, these should be used in place of the Bend MPO VMT estimates.

Table 7. Deschutes County TSAP Effectiveness (Outcome) Performance Measures

Performance Measure	Number of Reported Fatal and Severe Injury Crashes (2012-2016)	Fatal/Severe Injury Crash Rate per 100 Million VMT (2012-2016)
Fatal Crashes	12	0.45
Severe Injury Crashes	65	2.45
Fatal or Severe Crashes involving:		
Pedestrians	0	0.00
Bicyclists	4	0.15
Motorcyclists	20	0.75
Alcohol or Drugs	20	0.75
Speed	32	1.20
Lane Departure	55	2.07

7.2 PLAN UPDATES AND EVALUATION

This Plan relies on crash data from 2012 through 2016. Crash data should be reviewed annually and performance measures updated to track progress towards reducing fatal and severe injury crashes. More substantial updates to the TSAP to reevaluate the entire network and the site-specific locations should occur at longer intervals. Update cycles for complete updates to the TSAP should be approximately every five to seven years, when adequate updates to crash data are available and after substantial progress has been completed on items identified in the 2019 Deschutes County TSAP.

County staff should report on the performance measures listed above annually. As crash and other data are available, the County can evaluate the plan's progress (i.e., approximately every 5-7 years). The County and its partners should holistically assess the Plan's progress and current data trends and technologies to determine whether this Plan should be updated and to what extent (e.g., to incorporate new technologies or practices, to modify action items based on what is and is not working, to address emerging crash trends).

Evaluation needs to be included as part of each activity so that actions, projects, and partnerships can be modified as needed. The ability to adjust the Plan will better help build a road to success and, ultimately, help the County achieve its long-term goal of eliminating fatal and severe injury crashes.

Appendix 4 includes a scope of work for the County to use in completing annual updates to and evaluate performance of the TSAP.

Appendix 1 Framework Memorandum

Appendix 2 Executive Summary of Crash Analysis (Unincorporated Deschutes County)

Appendix 3 Existing Conditions Memorandum (including Unincorporated Deschutes County, La Pine, Redmond, and Sisters)

Appendix 4 Annual Update Procedure

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