Bend's Transportation Plan

Existing Conditions and Needs

July 25, 2018 (Draft)

Bend's Transportation Plan

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Summary

This report provides a description of existing transportation facilities and operations within the City of Bend and the Bend Metropolitan Planning Organization (MPO) area. The transportation facilities reviewed include roadway (motor vehicle travel), transit, walking, bicycling, and freight movement networks, along with intelligent transportation services and transportation demand management measures. Air, pipeline, and water transportation services are also discussed. This information will be used to provide a baseline for developing long-term actions.

The following aspects of Bend influence transportation:

- Rapid population growth has increased pressure on the transportation system;
- Tourism increases traffic volumes significantly, especially during the summer;
- Bend is a regional employment hub, with around half of employees from surrounding areas;
- There are major barriers to east-west connectivity for all modes of travel: Deschutes River, Burlington Northern Railroad, Highway 97, and the Parkway;
- Large areas are developed in a more rural pattern, generally lacking connectivity, walking and bicycling facilities, and mixed uses;
- Travel patterns can be affected by winter snow and ice and summer wildfires.

Key Findings for Roadways

- 70% of the arterials and collectors have 'Fair' to 'Very good' pavement condition;
- Out of a total of 26 bridges, 5 are 'Functionally Obsolete' and 2 are 'Very Poor' or 'Poor';
- Many arterials and collectors near the outskirts of the City are not built to urban standards;
- Of 67 study intersections have been analyzed, 25 do not meet current mobility targets;
- Although Bend has one of the lowest number of per capita annual crashes year compared to similar sized cities in Oregon, 18 high frequency crash locations were identified.

Key Findings for Transit

- Bend has a "hub and spoke" transit pattern which is less convenient for some trips;
- There is limited transit service in the outer sections of the City (except for Dial-a-Ride), a lack of transit service on Sundays, and limited inter-city and regional service;
- Majority of employment is within ¼ mile of transit service line, while only half of households are within a ¼ mile of transit service;
- Fewer than half of the arterials and collectors within ¼ mile of a transit stop have sidewalks on at least one side of the roadway (35%) and dedicated bicycle facilities (47%).

Key Findings for Walking Facilities

- Regional-level pedestrian corridor connectivity is limited by major barriers;
- 78% of arterials and collectors have sidewalks on one or both sides;
- Injury and fatal crashes involving pedestrians are clustered along higher-speed, higher-volume roadways, and multi-lane roadways lacking enhanced crossings.

Key Findings for Bicycling Facilities

- Regional-level bicycle corridor connectivity is limited by major barriers;
- Approximately 82% of arterials and collectors have dedicated bicycle facilities;
- Several major corridors in the "core area" are lacking dedicated bicycle facilities;
- Approximately 54% of arterials and collectors lack separation/buffers; and many high stress roadways serve key destinations;
- Crashes involving bicycles tend to be on multi-lane, high volume facilities without dedicated or protected bicycle facilities.

Key Findings for Freight Movement

- Off of the state highway system, few local routes are identified as freight routes;
- There are 10 at-grade rail crossings and 7 grade-separated rail crossings; at-grade rail crossings are a source of motor vehicle traffic delay in some locations;
- US 97 is a critical truck route in the Statewide Lifeline network;
- US 20 (3rd Street) queuing and signal delays impact freight movement;
- Travel Time Reliability issues impact freight movement on US 97 in the Cooley/Robal area.

Key Findings for Intelligent Transportation Services (ITS)

- There is a lack of access to real-time traffic conditions to improve incident response, emergency vehicle access, and travel time reliability;
- Traffic signal timing enhancements such as signal coordination, transit signal priority and signal transition during a railroad priority call are limited;
- Up-to-date ITS inventory is lacking.

Key Findings for Transportation Demand Management (TDM)

- TDM programs for the City are currently managed by Commute Options;
- The City has adopted code provisions that encourage implementing TDM measures;
- Juniper Ridge and COCC both have Transportation Demand Management programs.

Key Findings for Other Modes (Pipeline, Air, Marine Services)

- Major natural gas transmission lines are located along Bend's eastern boundary;
- The Bend Municipal Airport is located east of Bend in Deschutes County and provides service for private planes and airport-related businesses;
- Bend has no water-related transportation services.

Acronyms

ATR	Automated Traffic Recorders
BMPO	Bend Metropolitan Planning Organization
BNSF	Burlington Northern Santa Fe Railroad line
CCTV	closed circuit television
CET	Cascades East Transit
City	City of Bend
COCC	Central Oregon Community College
CTAC	Citywide Transportation Advisory Committee
CUFC	Critical Urban Fright Corridors
HCM	Highway Capacity Manual
ITS	Intelligent Transportation Systems
LOS	Level of Service
LTS	Bicycle Level of Traffic Stress
MTP	Bend MPO's Metropolitan Transportation Plan
ODOT	Oregon Department of Transportation
OSU	Oregon State University – Cascades Campus
PCI	pavement conditions index
s/veh	seconds per vehicle
SPIS	ODOT Safety Priority Index System
TDM	Transportation Demand Management
TSAP	Bend Transportation Safety Action Plan
TSP	Transportation System Plan
UGB	Urban Growth Boundary
v/c	Volume to capacity ratio

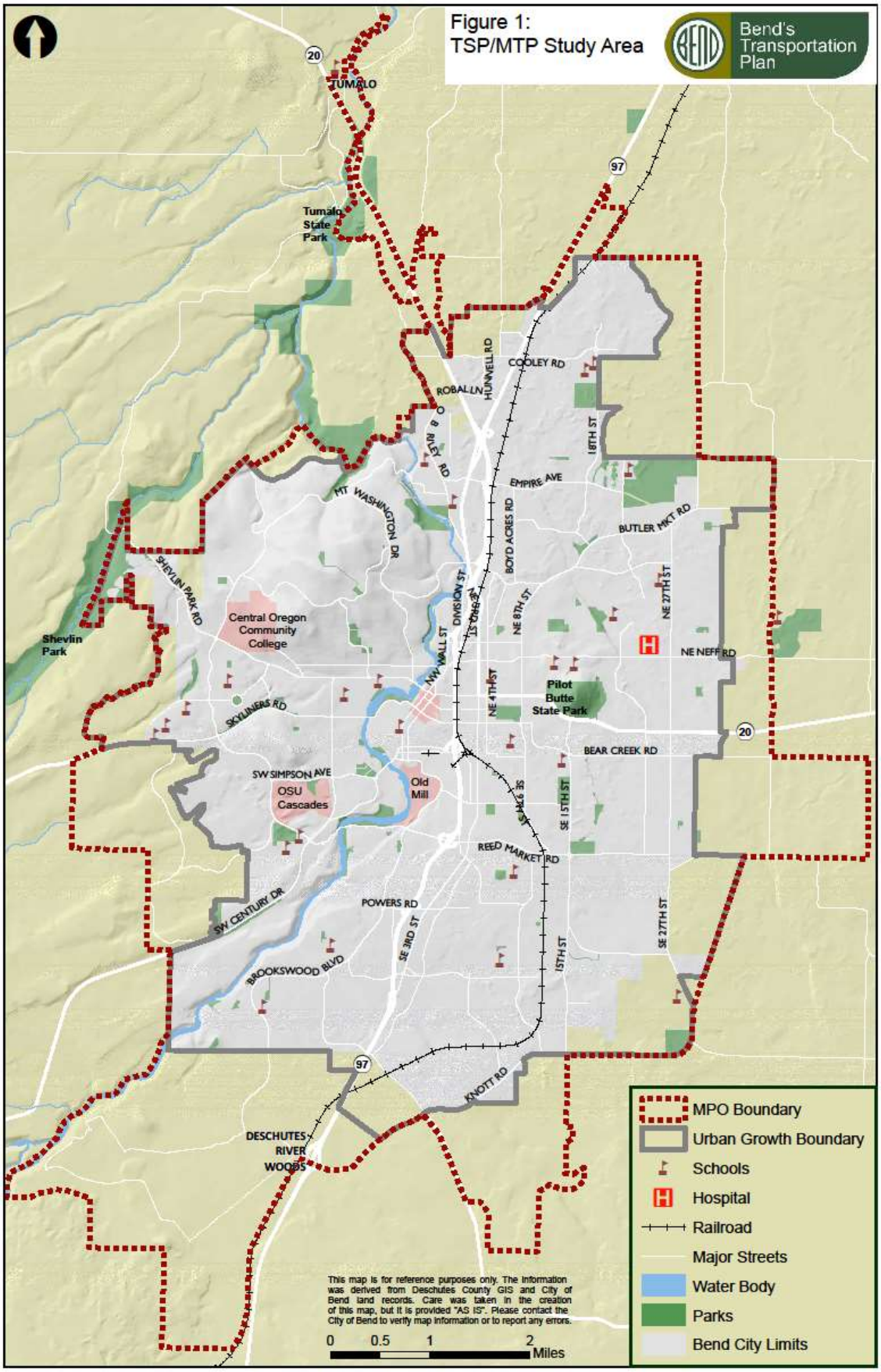
Introduction

This document summarizes existing transportation facilities and operations within the City of Bend (City) and the Bend Metropolitan Planning Organization (BMPO) area (Figure 1) as part of the updates to the City's Transportation System Plan (TSP) and the Bend MPO's Metropolitan Transportation Plan (MTP). The existing conditions needs assessment also includes input from the Citywide Transportation Advisory Committee (CTAC), the MPO Technical Advisory Committee, and the general public. The transportation facilities reviewed include street, transit, pedestrian, and bicycle networks along with freight, transportation demand management (TDM) measures, pipeline, air, and marine services. This information will be used to provide a baseline for developing long-term actions.

Field observations conducted in the spring of 2018, and inventories from the City of Bend, Deschutes County, and Oregon Department of Transportation (ODOT) were used to map existing transportation facilities to establish base year conditions.

As shown in Figure 1, the study area includes the City's Urban Growth Boundary (UGB) and the unincorporated communities of Tumalo, Deschutes River Woods, and Woodside Ranch. The Deschutes River flows through the study area. Some key destinations include Central Oregon Community College (COCC), the Oregon State University (OSU) Cascades campus, Mount Bachelor (located approximately 20 miles southwest of Bend), St. Charles Medical Center and the surrounding medical uses, downtown Bend, the Old Mill District, and the Bend Municipal Airport (located approximately 2 miles east of the Bend city limits).

Figure 1: Study Area



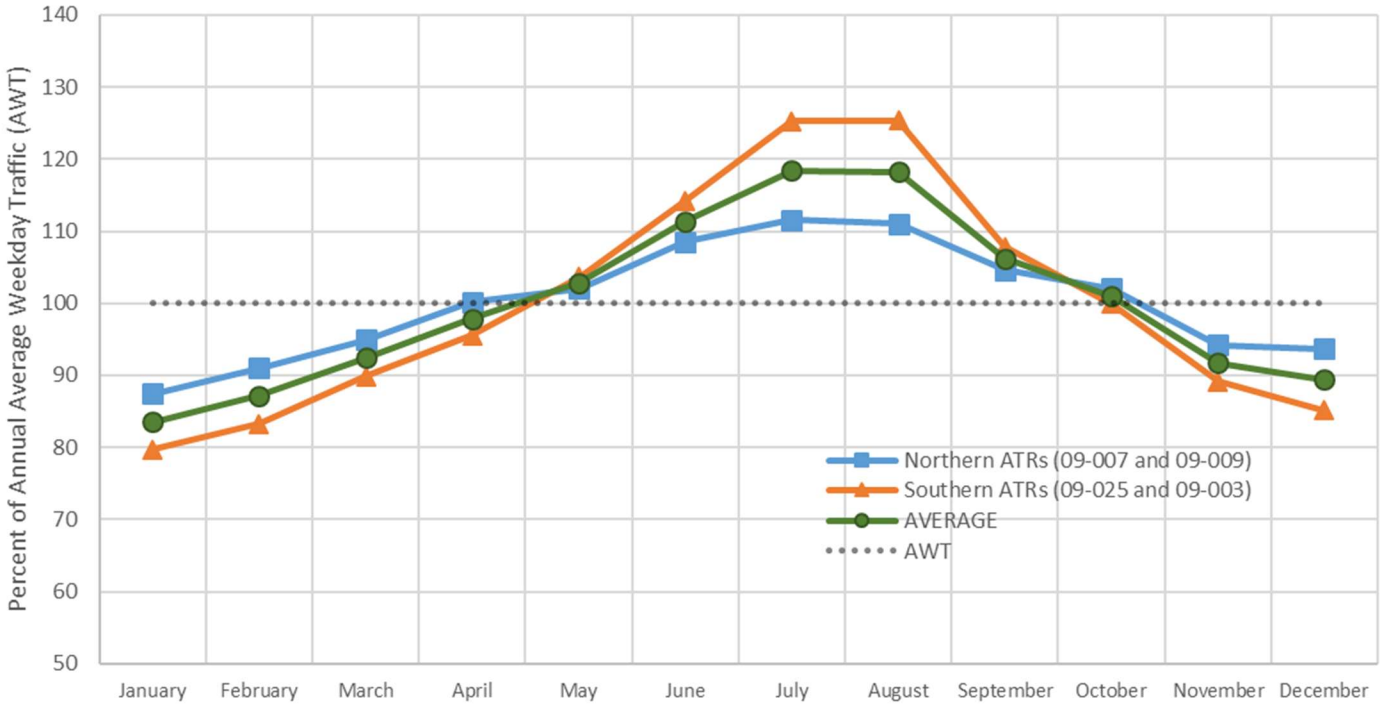
What Makes Bend Unique?

One of the first steps in planning for an effective transportation system is gaining an understanding of the current transportation network, geographic location, land use patterns, and unique characteristics of the study area (see Figure 2). The following are some key characteristics of Bend that affect transportation.

Tourism: The Bend area is a recreational/tourist hub during both the winter and summer months, generating over 5 million visitor days annually.[1] For example, Mount Bachelor (winter) and Sunriver (summer) are popular tourist destinations located southwest and south of the study area. During the summer, Bend's vibrant core area (generally bounded by Revere Avenue, Reed Market Road, 14th Street, and 3rd Street) attracts visitors. In addition, Bend has many second homes.

This regional recreation-based travel significantly increases traffic volumes throughout the study area, especially during the summer months. Data collected from ODOT Automatic Traffic Recorders (ATR) on US 97 within the City over the last five years indicates a 25% (north of Greenwood Avenue) to 45% (south of Greenwood Avenue) seasonal fluctuation in traffic volumes between summer (high) and winter (low), refer to Figure 2. Further information on Bend seasonal traffic volume trends is found the US 97 Parkway Plan.[2]

Figure 2. Corridor Volumes by Month



Barriers: US 97, the Burlington Northern Santa Fe (BNSF) Railroad line, and the Deschutes River generally extend north-south through the middle of the City, which creates barriers for east-west connectivity.

[1] Oregon Visitor-Trips and Visitor Days 2015 report – RRC Associates for Visit Bend, February 11, 2016.

[2] US 97 Parkway Plan Methodology Memorandum (pages 4-5), ODOT, March 2017.

The following irrigation major irrigation canals also create barriers throughout the City:

- Central Oregon Canal – barrier to east-west connectivity
- Main Canal – barrier to east-west connectivity
- Main – barrier to north-south connectivity
- Pilot Butte Canal – barrier to north-south connectivity
- North Unit Canal – barrier to north-south connectivity

Additionally, steep terrain can present challenges for connectivity across or around areas such as Awbrey Butte and the north side of Pilot Butte.

Growth: The City is one of Oregon's fastest-growing cities. Corresponding to this growth, over the past 5 years, vehicle travel has increased by almost 20%[3].

Regional Commute Patterns: Bend experiences a significant amount of regional travel, serving as an employment hub for residents that live in the smaller surrounding communities (e.g. Redmond, La Pine, and Prineville). Approximately 49% of the employees that work in the study area live in surrounding communities.[4] Approximately 10% of study area employees commute from Redmond, Terrebonne, Eagle Crest, Prineville, and Madras. Additionally, a large of number of people that live in Bend work in other communities (e.g. Redmond, Prineville). This regional employment-based travel can significantly increase traffic volumes throughout the study area during peak commute periods, especially along the US 97 corridor. Approximately 9.3% of workers in Bend work from home, nearly twice the national average of 5%. Carpool rates are near the national average, 8.8% in Bend versus 9% nationally.[5]

Land Use and Transportation Network Patterns: Bend has geographically grown over the past 30 years, including annexations of rural neighborhoods and roadways. These annexed areas generally lack complete urban streets (sidewalks, bike lanes, etc.) and often lack connected grid systems, which can limit route choices. In addition, the annexed areas generally lack a mixed land use pattern, which results in residents needing to travel to other areas of Bend for employment, shopping, and services.

Public Transportation Service: Bend's fixed-route public transit system was implemented approximately 10 years ago. The service today is operated by Cascades East Transit (CET) with financial support from the City. Bus services has limited frequency and requires transfers to cross Bend through a hub-spoke layout.

High Desert/Mountain Weather: Weather conditions also affect travel throughout the region, including Bend. The Bend area experiences moderately snowy winter months that can affect travel times and safety. The summers are hot and dry, creating wildfire threats throughout the region. Since wildfire locations are unpredictable, every major corridor within the study area serves an emergency access route. In particular, The City Fire Department has identified the following as evacuation routes:

- Skyliners Road
- Cascade Lakes Highway.
- Brookswood Boulevard
- OB Riley Road

[3] http://www.oregon.gov/ODOT/Data/Pages/Traffic-Counting.aspx#VMT

[4] Work Destination Analysis by Places, On the Map U.S. Census Bureau 2011-2015. Access May 2018.

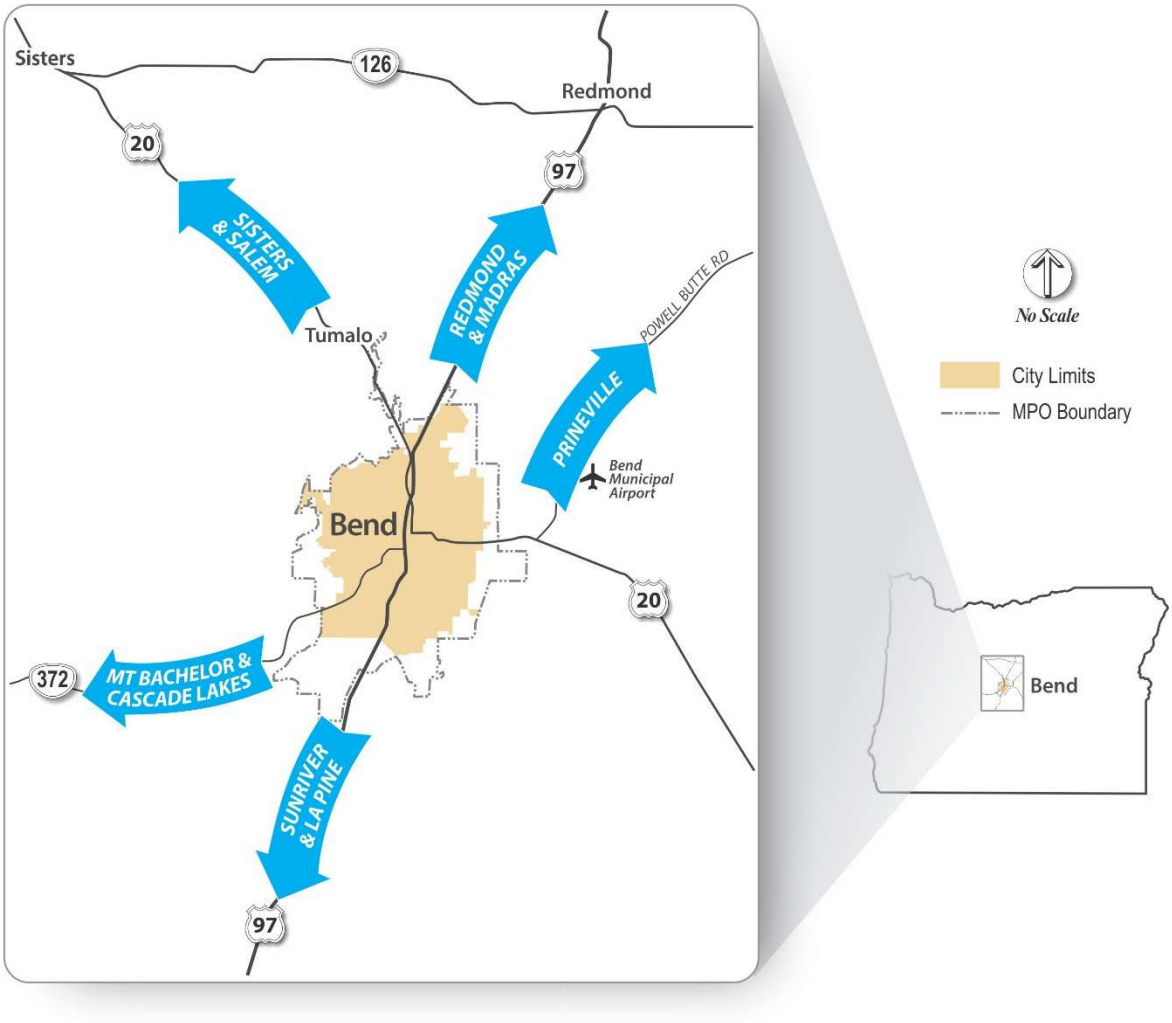
[5] U.S. Census Bureau, 2016 American Community Survey 1-Year Estimates. Access May 2018

- Shevlin Park Rd at Newport Avenue
- Knott Rd. at 27th St.
- China Hat Road

The Deschutes River Woods area currently only has one main entrance/exit point, Baker Road via US 97. During an emergency evacuation of the Deschutes River Woods area, US 97 can be temporarily closed in both directions to allow residents to evacuate quickly via an emergency access route (Frank Pennock Lane, which is gated).

Active Transportation Culture: Another fairly unique travel characteristic of Bend, is the relative popularity of walking, running, and biking in Bend, as compared to similarly-sized communities. The City of Bend has worked to provide facilities for actives through capital improvement projects and the TSP. The study area, however, has relatively low rates of walking and bicycling for work-based trips.

Figure 3. Regional Context



Environmental Justice and Title VI Populations

As part of the outreach to engage citizens and stakeholders during the TSP and MTP development process, special efforts will be made by the City and BMPO to involve disadvantaged populations such as seniors, non-English speaking communities, people with disabilities, and low-income groups (refer to Figure 4a-4d). In addition to these outreach efforts, the demographic information will be used throughout the project development and prioritization process.

According to the American Community Survey[6], the median home value in the City is approximately $300,000, while the median household income is about $55,000 annually (around $70,000 for a family). Within the City of Bend, 18% of the residents are living below the poverty level, which is above the statewide average of approximately 15%. Residents that identify as minorities represent 7% of Bend's population, which is below the statewide average of approximately 15%. About 1% of residents living in the study area have limited English proficiency and about 17% of residents living in the study area are over the age of 65 years. About 2% of households in the study area do not own a car.

[6] United States Census Bureau. American Fact Finder. 2012-2016 American Community Survey 5-Year Estimates. Accessed May 2018. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

Figure 4a: Demographic Analysis of Limited English Proficiency Residents

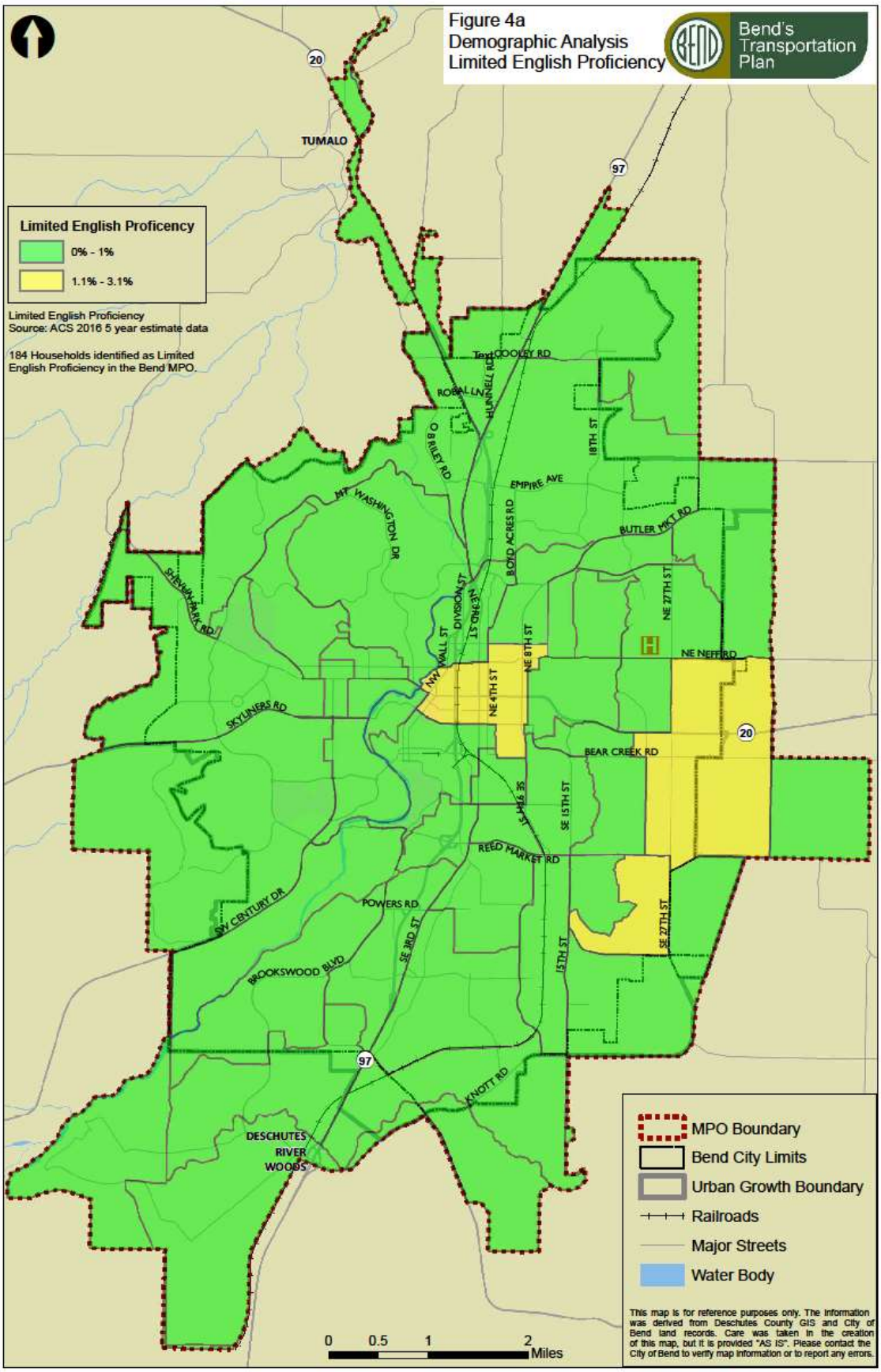


Figure 4b: Demographic Analysis of Low Income Residents

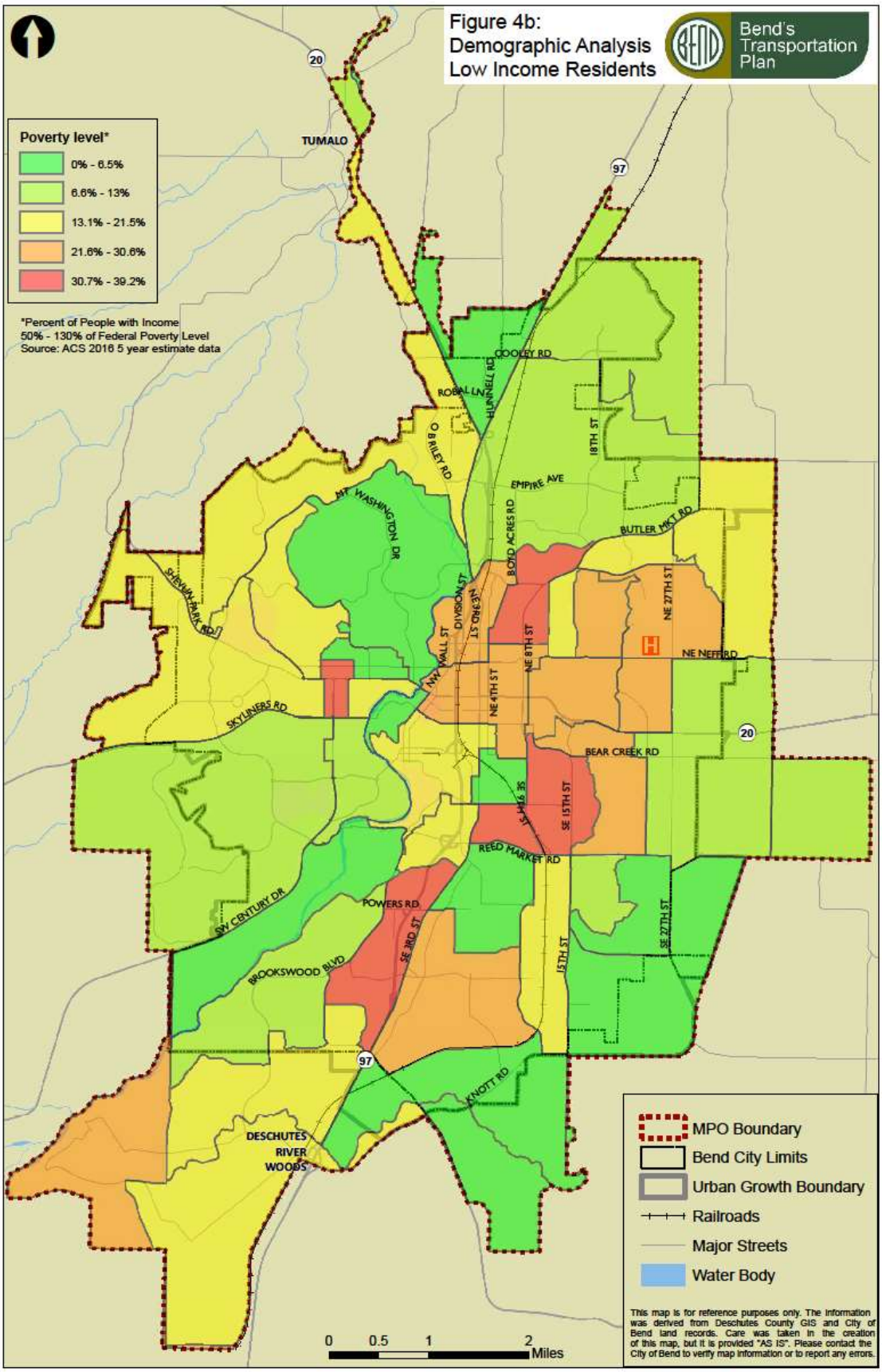


Figure 4c: Demographic Analysis of Disabled Residents

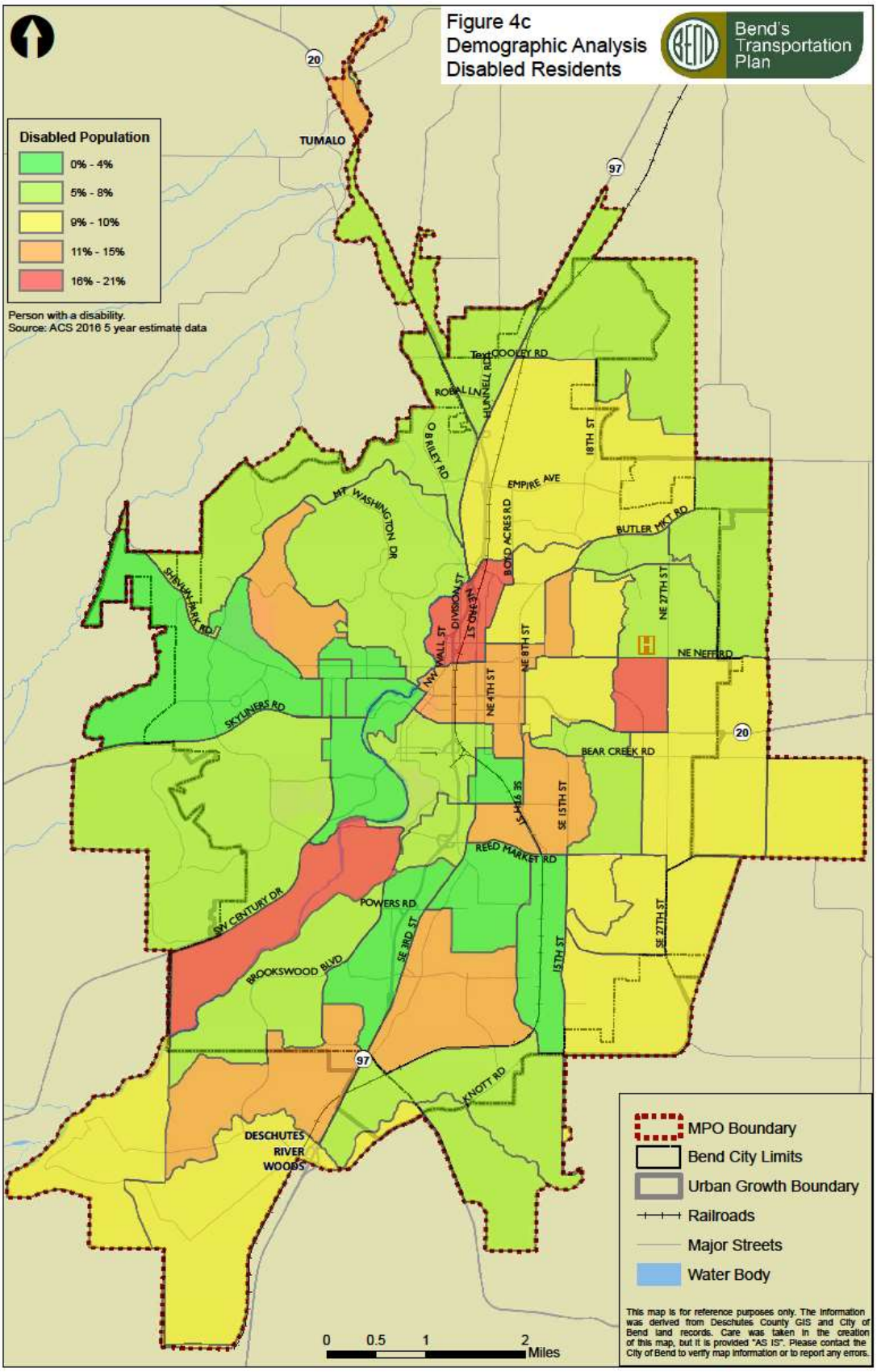
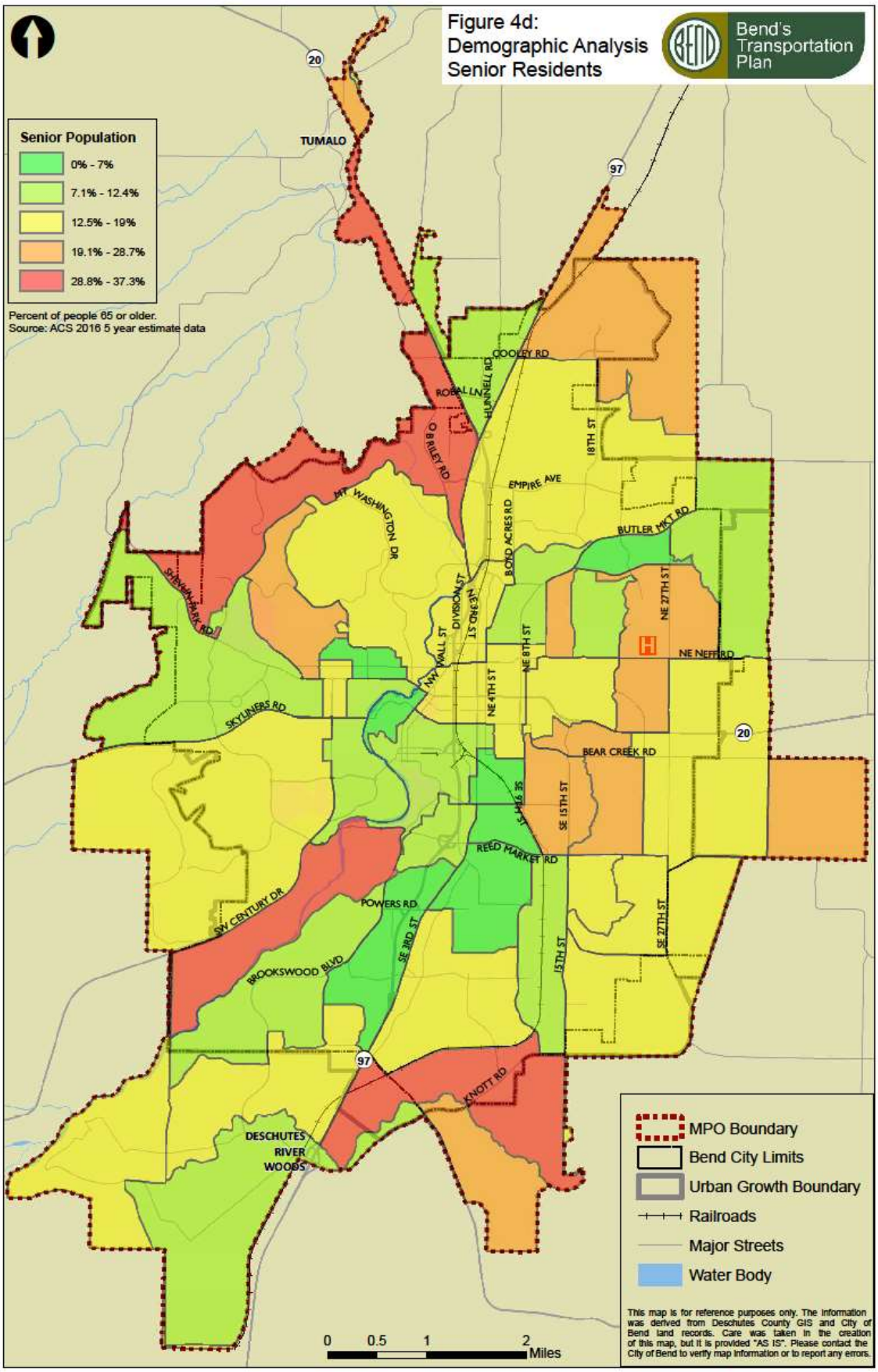


Figure 4d: Demographic Analysis of Senior Residents



Transportation Network Roadways

Roadway Characteristics

Characteristics of arterial and collector roadways were collected. Data collected includes number of lanes for each roadway segment, posted speed limit, roadway pavement conditions, bridge locations and conditions, and traffic signal locations and conditions. Each of these characteristics play a role in defining roadway capacity and operations throughout the roadway network in the study area. Overall, the city has roughly 845 total miles of arterial, collector, and local roadways. For those roads, there are roughly 838 miles (99%) of paved roads and 7 miles (1%) of gravel roads, which are mostly local in isolated segments.

Figure 6 shows the number of lanes to the roadways within the study area. Most of the roadways contain 2-3 lanes, while higher classified roadways such as US 97 and US 20 have 4-5 lanes. Overall, the collector-arterial system lacks 3-lane facilities in the areas furthest from the downtown core, reflecting the more rural nature of these parts of the City.

Figure 5: Typical 2-Lane and 3-Lane Corridors

Figure 7 illustrates posted speed limits on roadways within the study area. While US 97 and US 20 have posted speeds as high as 55 mph on the outskirts of the study area, the majority of the segments within Bend are posted at 45 mph. Other roadways on the outskirts of the study area also have posted speeds of 45 mph, including 27th Street, Butler Market Road, and Shevlin Park Road. The remaining arterial and collector streets have posted speed limits of 40 mph or less.

Figure 8 presents the existing pavement conditions on the roadways within the study area. The majority of arterial and collector roadways (70%) within the study area have ‘Fair’ to ‘Very Good’ pavement conditions. There are large portions of US 20, US 97, Cooley Road, Empire Avenue, Putnam Road, Greenwood Avenue, and Brosterhous Road that have ‘Poor’ pavement conditions and one segment along Alden Avenue with ‘Very Poor’ pavement conditions. The City has focused on improving pavement condition in recent years and has increased the Average pavement conditions index (PCI) to 71, just below the Council goal of 73.

Many of the existing roads were constructed informally and built with no subgrade or on cinders. While the surface PCI is improving with minor reconstruction, additional traffic may result in faster wear and deterioration. Full reconstruction to standard road surfacing is not typically feasible, so pavement conditions may continue to worsen over time.

Figure 9 identifies the locations and condition of the bridges in the study area, based on an inventory completed in 2013. As shown, there are six bridges in ‘Poor’ condition within the study area.

Bend has 26 bridges in the National Bridge Inventory, which are inspected every few years by ODOT. Of the 26 bridges, Archie Briggs Road over the Deschutes River is in 'Very Poor' condition and needs to be replaced. In addition, there is one bridge in 'Poor' condition, eight bridges in 'Fair' condition, and 15 bridges in 'Good' Condition. There are five bridges identified as functionally obsolete and one bridge identified as structurally deficient. Refer to the Appendix for details on the 2016/2017 bridge conditions. It should be noted that the classification 'structurally deficient' does not imply that it is unsafe, but typically that the bridge needs maintenance and repair and may be posted with weight restrictions. A functionally obsolete bridge indicates that the bridge was built to standards that do not meet minimum federal clearance requirements for a new bridge. In addition, there are many bridges over canals within the study area that are not wide enough to support people walking and biking. Again, this does not automatically mean the bridge is unsafe, but the term is also used as a priority status for federal bridge replacement and rehabilitation funding.

Figure 6: Bend and BMPO Number of Lanes

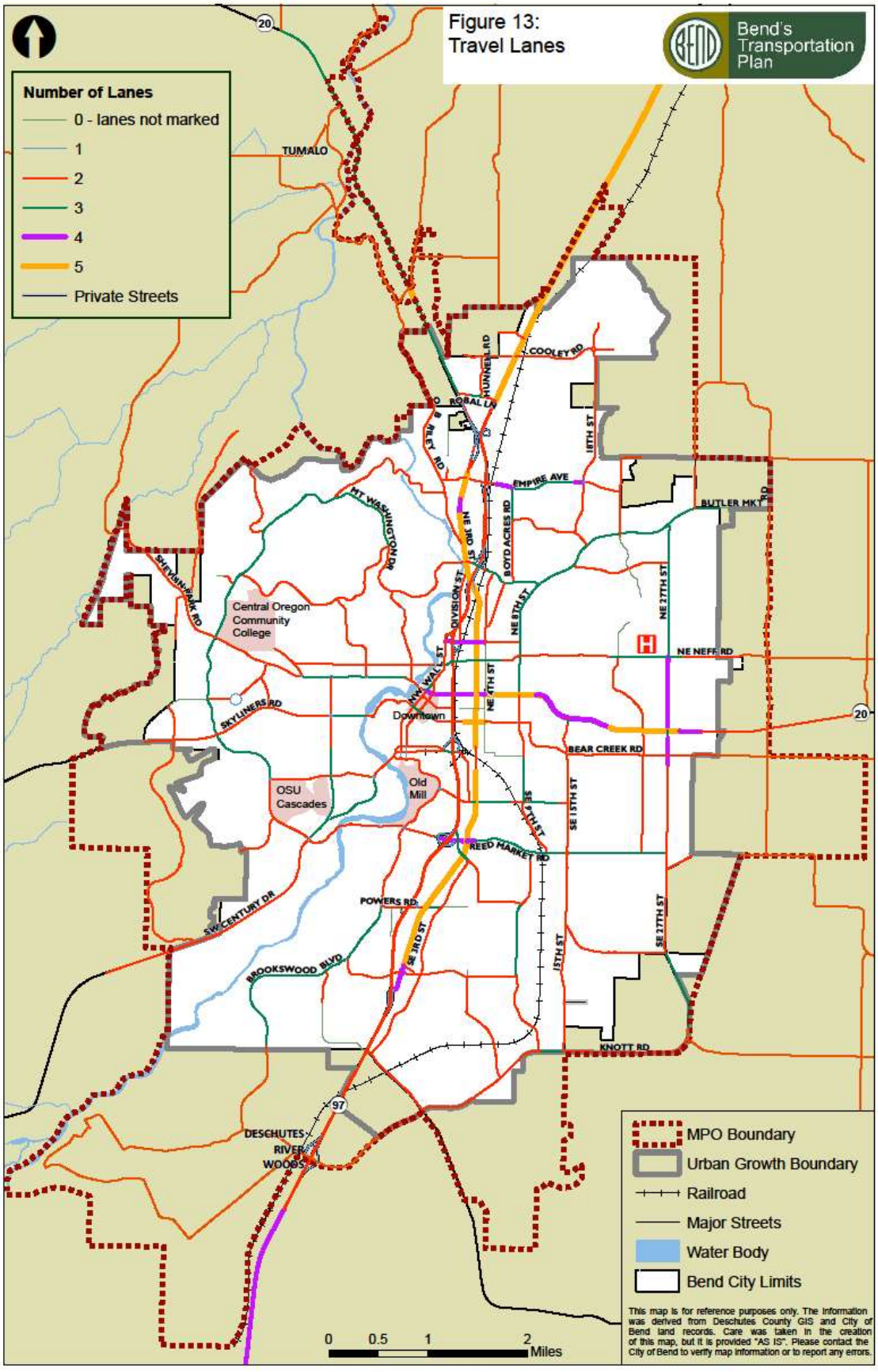


Figure 7: Bend and BMPO Posted Speed Limit

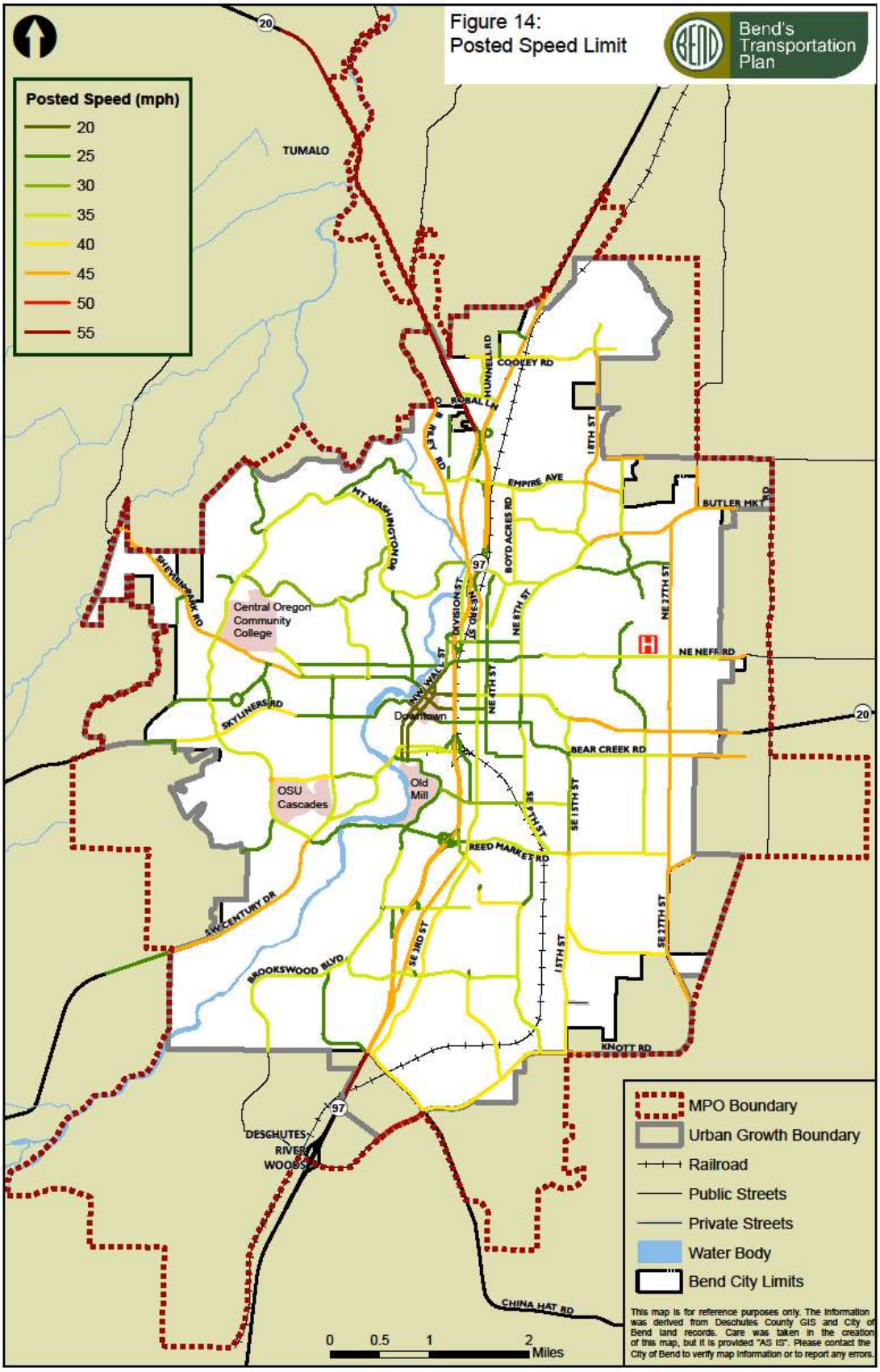


Figure 8: Bend and BMPO Pavement Conditions

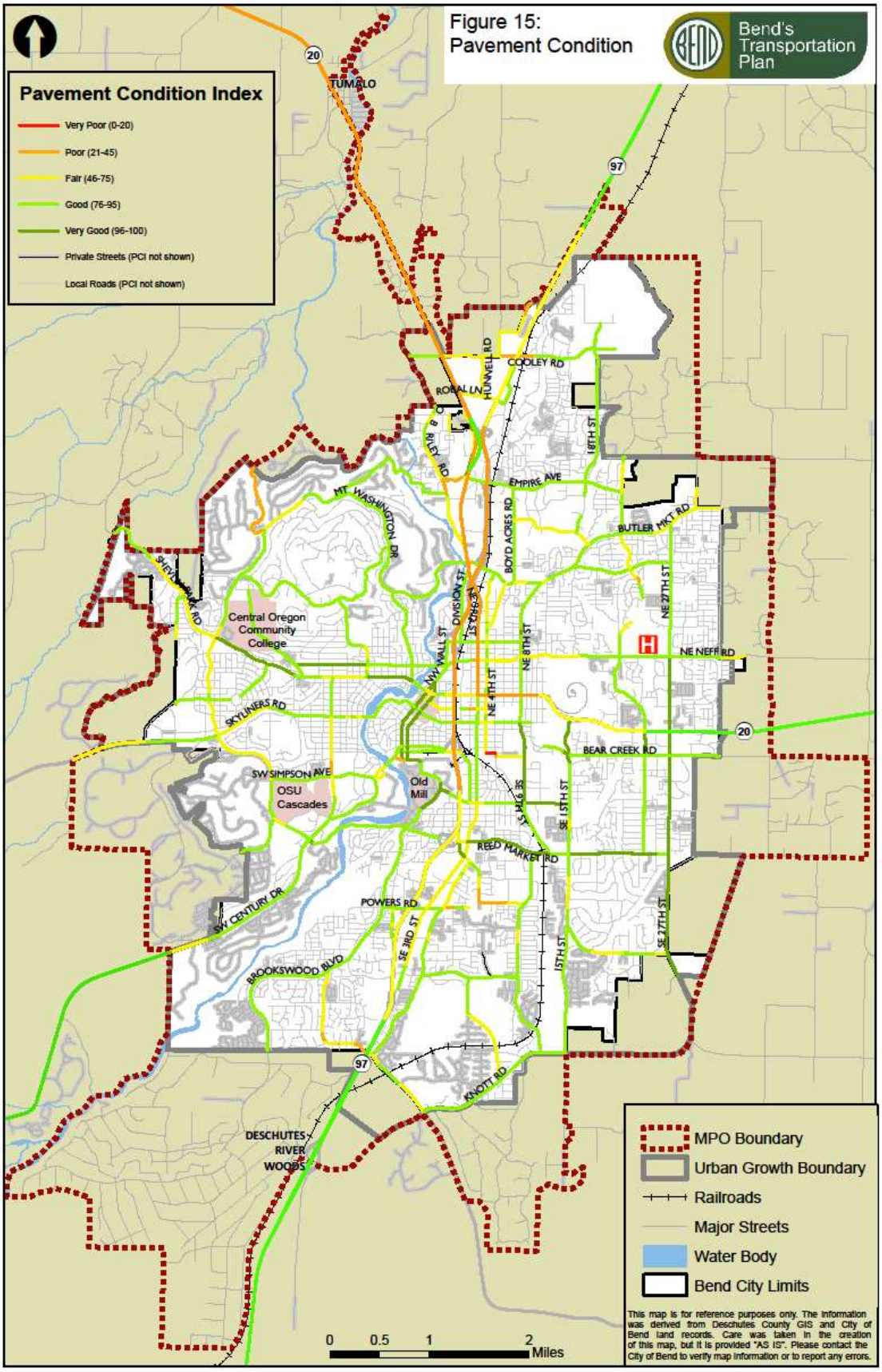
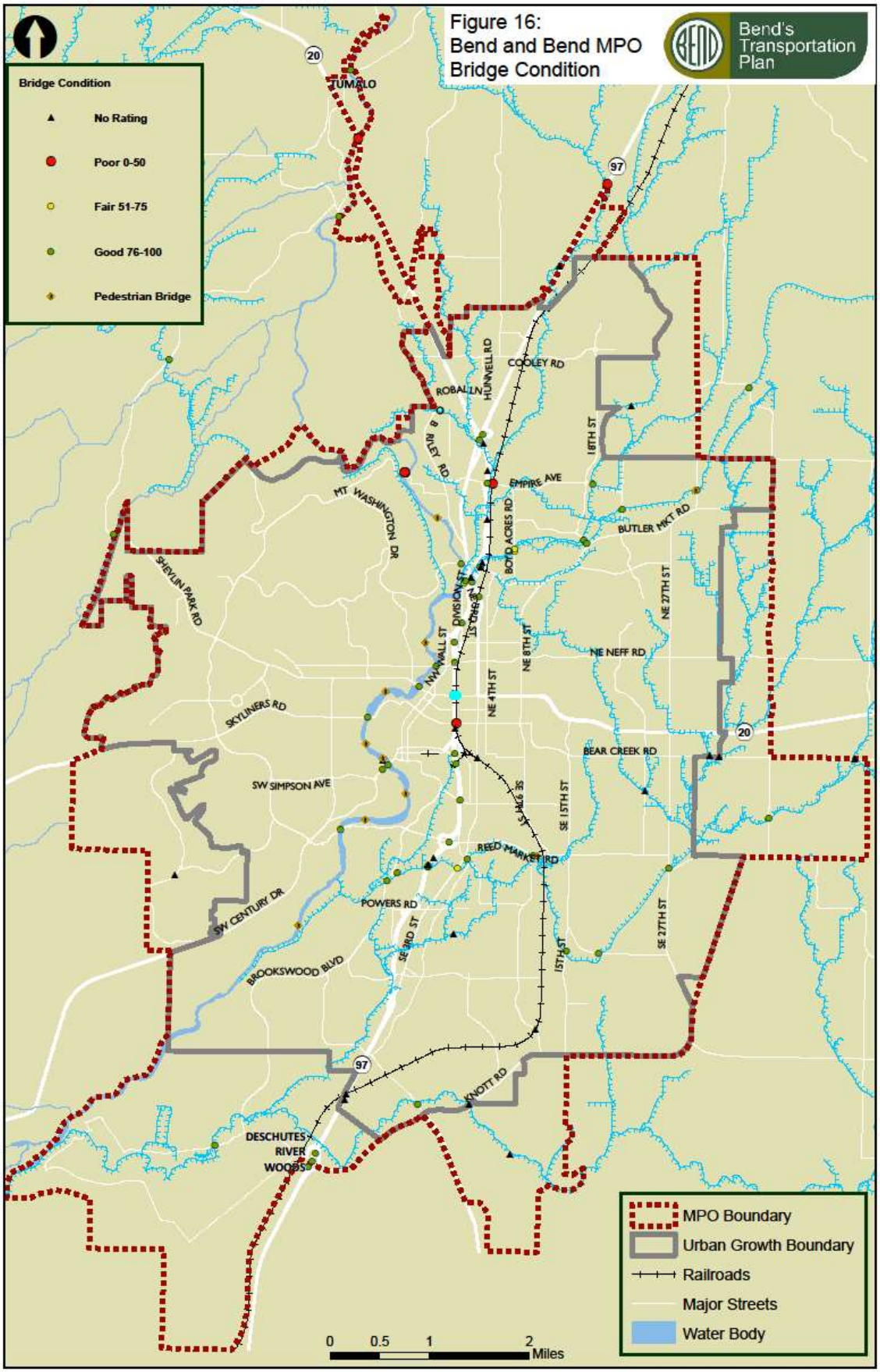


Figure 9: Bend and BMPO Bridge Condition



Roadway Functional Classification and Connectivity

To help manage the roadway network, the City of Bend and BMPO classify roadways based on a hierarchy according to the intended purpose of each road, as shown in Figure 10. Roadways intended for longer distance trips and higher volumes generally provide more design emphasis on mobility through the city; roadways that primarily provide access to local destinations, such as businesses or residences, tend to have more design emphasis on access and neighborhood livability. From highest to lowest intended mobility function, the classifications are described below.

- **Principal and Major Arterials** serve the major centers of activity, typically the highest traffic volumes, the longest trip desires, and a high proportion of the total urban area travel. They provide significant intra-area travel. In Bend, Principal Arterials include just 3rd Street and Greenwood Avenues. Because of the community pattern and lot layouts along these streets these principal arterials also perform the dual purpose of providing for direct access and egress for businesses and residences and serve transit. Major arterials include Reed Market Road (east of Bond Street), 27th Street (north of Reed Market Road), and Empire Avenue.
- **Minor Arterials** typically carry less traffic than major arterials and generally serve shorter trips in a smaller area. They often connect residential, industrial, commercial, and recreational uses. The provision of access has a greater emphasis than on principal arterials. Traffic volumes and speeds are generally still high, making physically separated walking and biking facilities a requirement to serve abutting land uses. However, many of the Minor Arterials in Bend are 25 mph in business districts and the central area.
- **Major Collectors** connect the arterial streets with minor collectors or local streets, neighborhoods, and commercial and industrial areas, providing a balance of access and travel.
- **Local Streets** provide direct access to properties in the study area and are not intended to provide efficient travel for through traffic. These roadways are often lined with businesses or residences and are designed to serve lower vehicle volumes at low speeds. People on bicycles commonly share the road with people in cars. In the many areas without sidewalks, pedestrians walk in the street or along its shoulders
- **Industrial Streets** include roads adjacent to industrial and manufacturing land uses that are designed to accommodate large vehicles such as trucks, trailers, and other delivery vehicles.

Due to the rapid growth in the Bend area and the historical evolution of the roadway system, there are a number of arterial and collector roadways that were constructed with residential homes fronting them, such as Portland Avenue and Wells Acres Road. These roadways provide direct access to residential homes, which is not typical for arterials and collectors. The likelihood of significant redevelopment along these roadways is small and thus these roadways will likely remain as constructed. On the other hand, Eagle Road is classified as a local road, but functions as a collector or arterial roadway. Eagle Road connects many local streets to Neff Road and Butler Market Road with limited residential homes directly fronting it. Additionally, a short segment of Bear Creek Road is classified as a local road but functions as a collector roadway.

Spacing and connectivity of major roadways is important for an efficient transportation system by providing direct routes, route choices that spread demand (reducing the need to have wider, higher-speed roadways), and a variety of facility types to balance mobility, access, and livability along difference roadway environments. The City's current TSP has spacing standards of one mile for arterial and a half-mile for collectors. Figure 11 identifies gaps in the arterial and collector grid system, based on these spacing guidelines. Note that some of these gaps may not be reasonable opportunities for improving connectivity due to established neighborhood development, topographic barriers, etc.

Roadway Jurisdiction

Agencies responsible for roads within the study area include ODOT, Deschutes County, the City, and private owners. Each jurisdiction sets the standard and maintenance policies associated with the transportation facilities within its jurisdiction. Figure 12 shows the study area roadway jurisdictions.

ODOT has jurisdiction over the highways within the study area. These highways accommodate freight, other long-distance travel and they are used for daily commutes and local trips. In the case of Highway 20 on 3rd Street and on Greenwood Avenues, the highway also serves abutting properties, which include commercial businesses. The City owns the majority of the other roadways within the city limits. Deschutes County has jurisdiction over the remaining roadways on the edges of the study area. There are also many private roadways throughout the study area. Private roadways in the study area tend to be residential with the exception of COCC and Old Mill District.

Key system findings for roadways include:

- **70% of the arterial and collector roadways have 'Fair' to 'Very Good' pavement conditions.**
- **Five bridges identified as 'Functionally Obsolete' during the last full bridge evaluation (five years ago)**
- **One bridge identified as 'Very Poor', another 'Poor' in recent evaluation of part of the system**
- **Several private roads provide neighborhood and, in some cases, commercial access throughout the City**
- **Many roads near the outskirts of the City do not have the cross section or access requirements pertaining to their classifications**

Figure 10: Bend and BMPO Roadway Functional Classifications

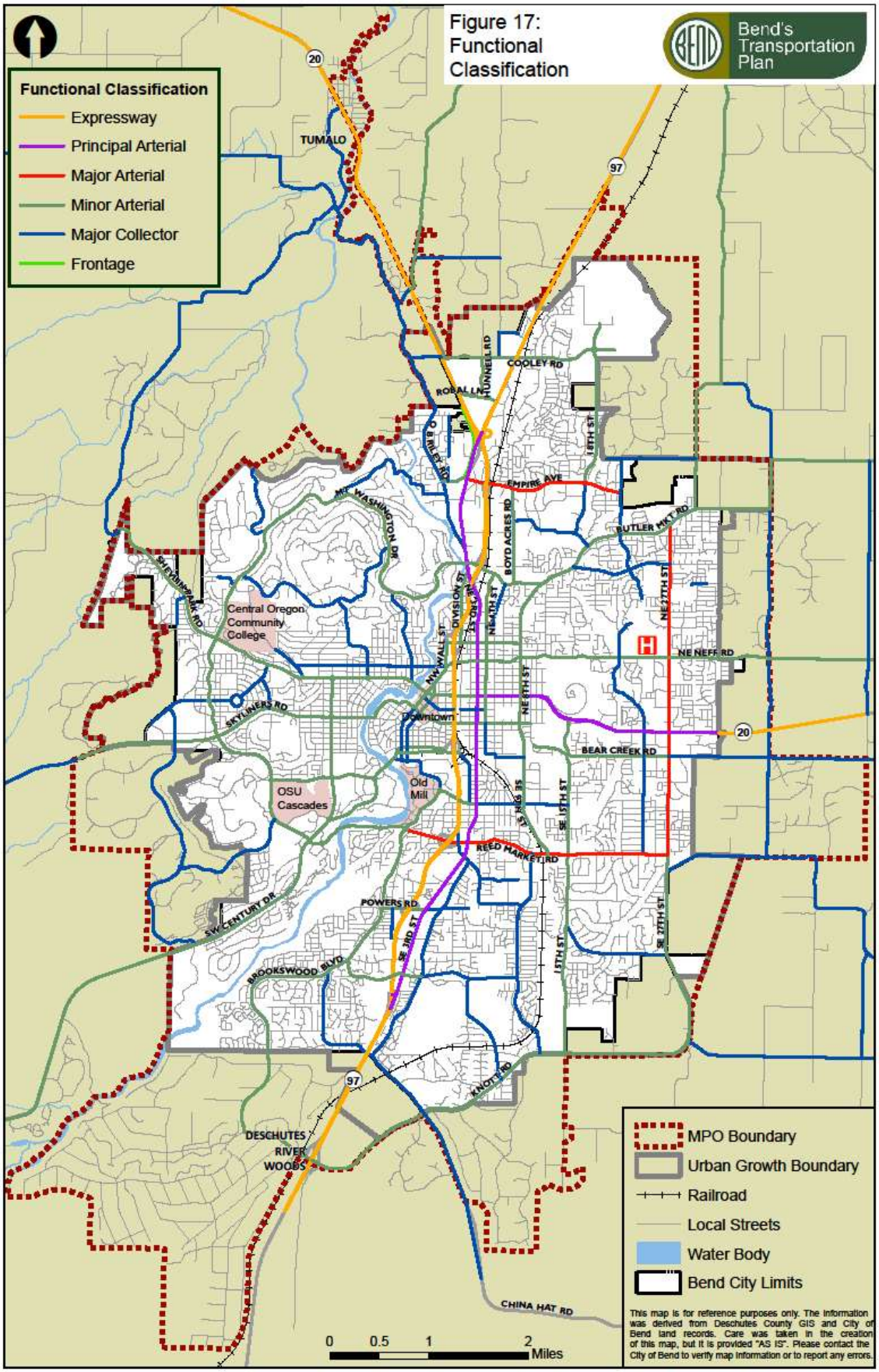


Figure 11: Potential Connectivity Opportunities in the Arterial/Collector Grid System

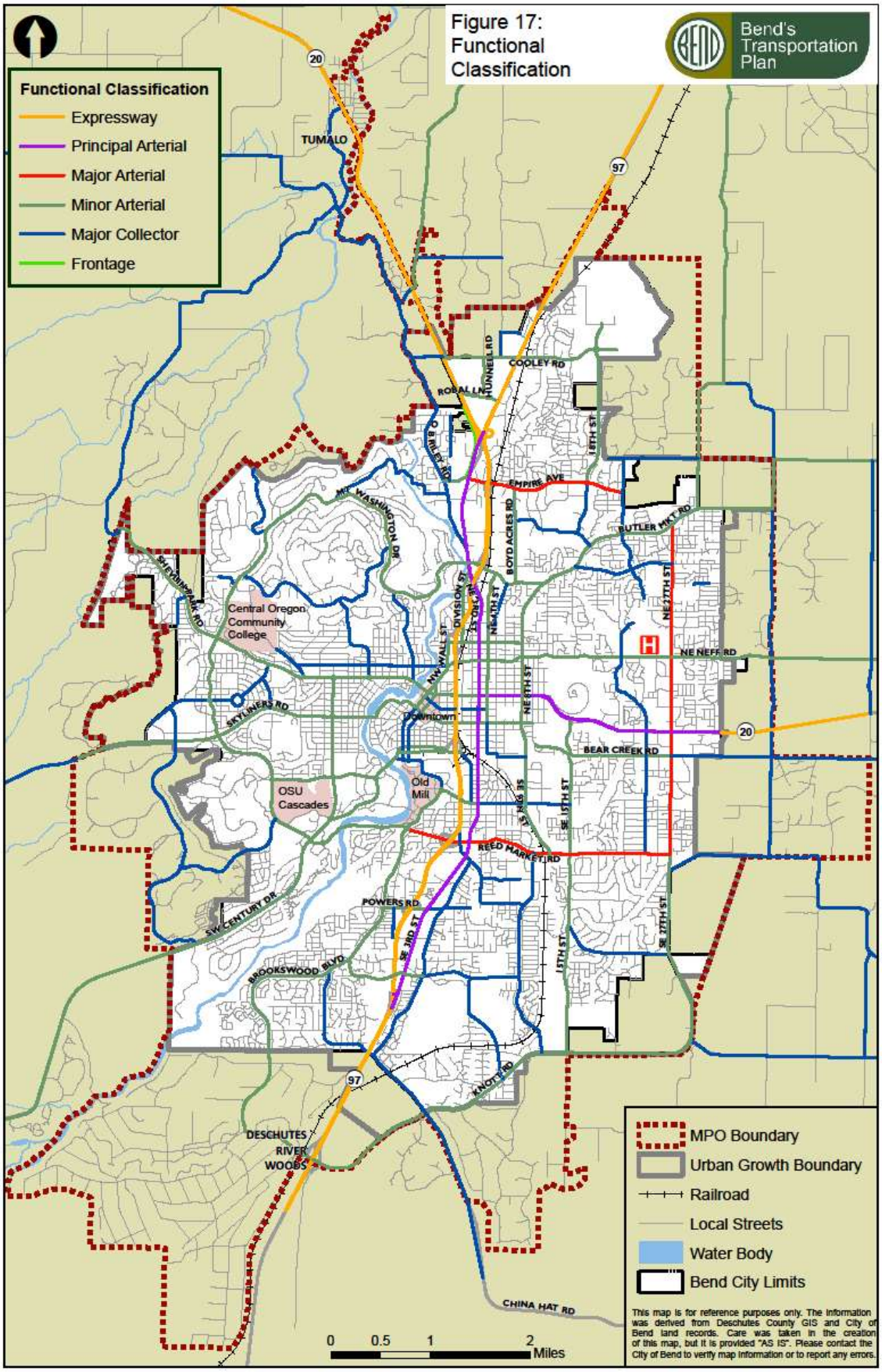
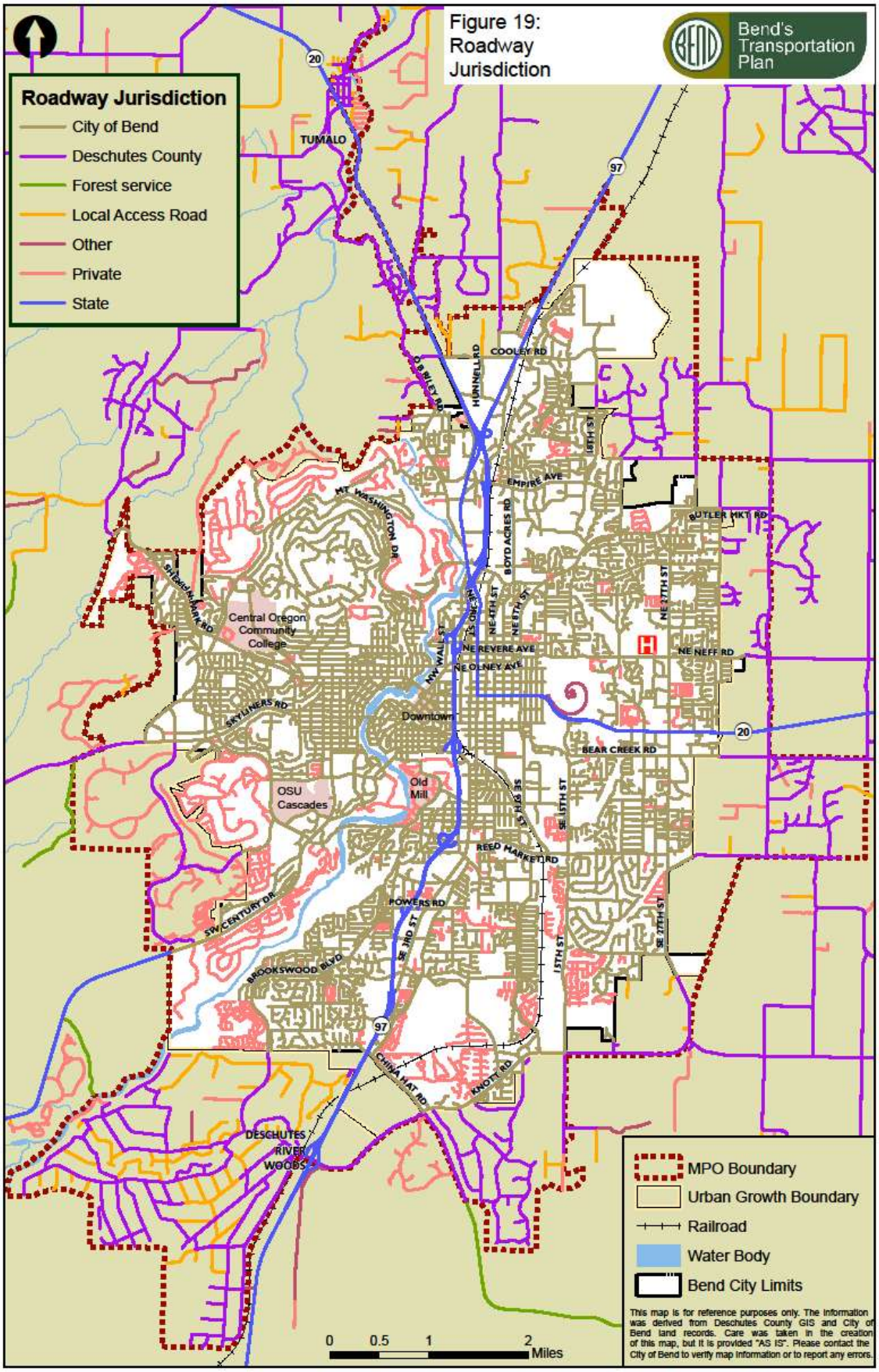


Figure 12: Bend and BMPO Roadway Jurisdiction



Traffic Operations

Intersection operations were analyzed based on the 2000 Highway Capacity Manual Edition[7] (HCM) for signalized intersections, and the HCM 6th Edition[8] for unsignalized intersections and roundabouts.

- Level of service (LOS) is a "report card" rating (A through F) based on the average delay experienced by people driving through the intersection. LOS A, B, and C indicate conditions where traffic moves without significant delays over periods of peak hour travel demand, which typically is 7-9 a.m. and 4-6 p.m. LOS D and E are progressively worse operating conditions. LOS F represents conditions where average vehicle delay has become excessive and demand has exceeded capacity. This condition is typically evident in long queues and delays. The City of Bend does not use LOS but rather the actual average delay experienced by vehicles at an unsignalized intersection as a mobility target. Deschutes County uses level of service for its roadway system.
- A volume to capacity (v/c) ratio is decimal representation (between 0.00 and 1.00) of the proportion of capacity that is being used (i.e., the saturation) at a turn movement, approach leg, or intersection. A lower ratio indicates smooth operations and minimal delays. A ratio approaching 1.00 indicates increasing congestion and reduced performance. If the ratio is greater than 1.00, the turn movement, approach leg, or intersection is oversaturated and usually results in excessive queues and long delays. The City of Bend and ODOT utilize v/c ratios for their respective systems.

Intersection turn movement counts and operations analysis for the 83 study intersections were broken out:

- 29 intersections were analyzed using counts collected during the p.m. peak period in April 2018
- 11 intersections were analyzed using counts from other project collected over the past two years
- 43 intersections have been counted and analyzed (27 intersection) in Phase 1 of the US 97 Parkway Plan[9] or will be analyzed (16 intersections) in Phase 2 of that study

All turn movement counts used for this analysis are included in the Appendices to this document.

The intersection turn movement counts were adjusted to account for seasonal variations in travel. The methodology from the ODOT Analysis Procedures Manual was applied to determine an appropriate seasonal factor, as discussed in the Methods and Assumptions Memorandum. The Bend Parkway Study used a mix of seasonal factors for US 97, varying from a local ATR[10] based commuter trend type in the north to a recreational type factor to the south. These seasonal adjustments were carried forward into this analysis. The seasonally adjusted volumes were used in the traffic operations analysis. Table 1 summarizes the existing average weekday

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[7] 2000 *Highway Capacity Manual*, Transportation Research Board, Washington DC, 2000.

[8] *Highway Capacity Manual 6th Edition*, Transportation Research Board, Washington DC, 2016.

[9] *US 97 Parkway Plan – Technical Memorandum #2: Existing Conditions*, DKS Associates, December 2017. Traffic volumes collected in April 2017.

[10] Electronic counting site on a roadway that counts vehicles continuously. ATR's collect 24-hour bidirectional volumes yearly and 24-hour vehicle classification counts every three years.

(City intersections) p.m. peak hour or 30th highest hour [11] peak seasonal (ODOT intersections) intersection operational levels at the study intersections.

Of the 67 study intersections currently analyzed, 25 fail to meet current jurisdictional mobility targets (23 intersections under ODOT jurisdiction and 2 intersections under City of Bend jurisdiction), as shown in Figure 13 and Table 2. An additional 16 intersections are pending analysis in Phase 2 of the Bend Parkway Study.

Table 1: Existing Intersection Traffic Operations PM Peak Hour

Intersection	Delay (s/veh)	Level of Service	Volume/ Capacity	Jurisdiction	Mobility Standard
Unsignalized Intersections					
US 20 & O.B. Riley/Cook Ave	11 / >300	B / F	0.08/**2.49**	ODOT	v/c ≤ 0.70
US 20 & Old Bend-Redmond Hwy	13 / >300	B / F	0.06/**>3.0**	ODOT	v/c ≤ 0.70
US 20 & Cooley Rd	16 / 22	C / C	0.18/0.36	ODOT	v/c ≤ 0.85
O.B Riley Rd & Archie Briggs Rd	8 / 15	A / C	0.04/0.38	City of Bend	Delay ≤ 50 s
Deschutes Market Rd & Butler Market Rd	10 / **98**	A / F	0.39/1.04	City of Bend	Delay ≤ 50 s
NE 27th St & Well Acres Rd	10 / 16	A / C	0.06/0.36	City of Bend	Delay ≤ 50 s
Hamby Rd & US 20	9 / 194	A / F	0.13/**1.18**	ODOT	v/c ≤ 0.70
SE 9th St & Reed Market Rd	11 / 45	B / E	0.21/0.79	City of Bend	Delay ≤ 50 s
Parrell Rd & Brosterhous Rd	9 / 27	A / D	0.12/0.61	City of Bend	Delay ≤ 50 s
SE 27th St & Ferguson Rd	9 / 21	A / C	0.06/0.36	City of Bend	Delay ≤ 50 s
SE 15th St & Knott Rd	9 / 21	A / C	0.18/0.16	City of Bend	Delay ≤ 50 s
China Hat Rd & Knott Rd	8 / 34	A / D	0.02/0.48	City of Bend	Delay ≤ 50 s
US 97 SB On-ramp & Empire Blvd	28 / >100	D / F	0.72/0.71	ODOT	v/c ≤ 0.85
US 97 SB Off-ramp & Butler Market Rd	- / 40	- / E	- /0.76	ODOT	v/c ≤ 0.85
US 97 NB Ramps & Butler Market Rd	10 / 15	B / C	0.12/0.04	ODOT	v/c ≤ 0.85
US 97 & Lafayette Ave	- / **>100**	- / F	- /**1.53**	ODOT	v/c ≤ 0.85
US 97 & Hawthorne Ave	- / **>100**	- / F	- /**>2.00**	ODOT	v/c ≤ 0.85
US 97 NB Ramps & Colorado Ave	29 /**>100**	D / F	0.88/**>2.0**	ODOT	v/c ≤ 0.85
US 97 & Truman Ave	- / **>100**	- / F	- /**1.00**	ODOT	v/c ≤ 0.85
US 97 NB Ramps & Reed Market Rd	- / **>100**	- / F	- /**1.53**	ODOT	v/c ≤ 0.85
Division St & Reed Market Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
US 97 & Reed Ln	- / 22	- / C	- /0.44	ODOT	v/c ≤ 0.85
US 97 SB Ramps & Powers Rd	9 / 38	A / E	0.07/0.83	ODOT	v/c ≤ 0.85
US 97 NB Ramps & Powers Rd	9 / 12	A / B	0.21/0.09	ODOT	v/c ≤ 0.85

[11] The 30th higest hour30 HV is commonly used for design purposes and represents the level of congestion that is typically encountered during the peak travel month.

Parrell Rd at Powers Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	Delay ≤ 50 s
US 97 & Badger Rd	- / 17	- / C	- /0.20	ODOT	v/c ≤ 0.85
US 97 & Pinebrook Blvd	- / 16	- / C	- /0.27	ODOT	v/c ≤ 0.85
SE 3rd St & Pinebrook Blvd	Pending[a]	Pending[a]	Pending[a]	City of Bend	Delay ≤ 50 s
US 97 & Ponderosa St	- / 16	- / C	- /0.27	ODOT	v/c ≤ 0.85
Parrell Rd & China Hat Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	Delay ≤ 50 s
US 97 SB Ramps & Baker Rd	28 / 36	A / E	0.34/**0.87**	ODOT	v/c ≤ 0.70
US 97 NB Ramps & Knott Rd	10 />100	B / F	0.31/**1.76**	ODOT	v/c ≤ 070
Intersection	**Delay (s/veh)**	**Level of Service**	**Volume/ Capacity**	**Jurisdiction**	**Mobility Standard**
Signalized Intersections					
US 20 & Robal Rd	24	C	**0.90**	ODOT	v/c ≤ 0.85
NE 27th St & Butler Market Rd	28	C	0.82	City of Bend	v/c ≤ 1.0
Boyd Acres Rd & Butler Market Rd	37	D	0.84	City of Bend	v/c ≤ 1.0
NE 27th St & Neff Rd	44	D	0.84	City of Bend	v/c ≤ 1.0
US 20 (NE 3rd St) & Olney Ave	48	D	0.68	ODOT	v/c ≤ 0.85
NE 8th Ave & US 20 (Greenwood Ave)	62	E	**0.96**	ODOT	v/c ≤ 0.85
US 20 (NE 3rd St) & Greenwood Ave	80	F	**0.98**	ODOT	v/c ≤ 0.85
Wall St & Franklin Ave	19	B	0.58	City of Bend	v/c ≤ 1.0
Bond St & Franklin Ave	23	C	0.66	City of Bend	v/c ≤ 1.0
SE 15th St & US 20 (Greenwood Ave)	23	C	0.84	ODOT	v/c ≤ 0.85
NE 3rd St & Franklin Ave	67	E	0.89	City of Bend	v/c ≤ 1.0
SE 27th Ave & US 20 (Greenwood Ave)	49	D	**0.87**	ODOT	v/c ≤ 0.85
Purcell Blvd & US 20 (Greenwood Ave)	51	D	**0.87**	ODOT	v/c ≤ 0.85
Wall St & Colorado Ave	14	B	0.59	City of Bend	v/c ≤ 1.0
Bond St & Arizona Ave	13	B	0.67	City of Bend	v/c ≤ 1.0
NE 3rd St & Wilson Ave	65	E	0.95	City of Bend	v/c ≤ 1.0
SE 27th St & Reed Market Rd	14	B	0.70	City of Bend	v/c ≤ 1.0
US 97 & Cooley Rd	62	E	**0.99**	ODOT	v/c ≤ 0.85
US 97 & Robal Rd	79	E	**1.02**	ODOT	v/c ≤ 0.85
US 20 & Empire Blvd	69	D	**0.96**	ODOT	v/c ≤ 0.85
US 97 NB Ramps & Empire Blvd	58	E	**0.87**	ODOT	v/c ≤ 0.85
Boyd Acres Rd at Empire Blvd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
US 20 (NE 3rd St) & O.B. Riley Rd	Pending[a]	Pending[a]	Pending[a]	ODOT	v/c ≤ 0.85
US 20 (NE 3rd St) & Butler Market Rd	41	D	**0.90**	ODOT	v/c ≤ 0.85
US 20 (NE 3rd St) & Division St	39	D	**0.97**	ODOT	v/c ≤ 0.85

Wall St & Revere Ave	22	C	0.69	ODOT	v/c ≤ 0.85
Division St & Revere Ave	11	B	0.62	ODOT	v/c ≤ 0.85
US 20 (NE 3rd St) & Revere Ave	Pending[a]	Pending[a]	Pending[a]	ODOT	v/c ≤ 0.85
Wall St & Portland Ave	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
Wall St & Greenwood Ave	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
US 97 SB Ramps & Colorado Ave	29	C	0.79	ODOT	v/c ≤ 0.85
US 97 SB Ramps & Reed Market Rd	34	C	**0.95**	ODOT	v/c ≤ 0.85
SE 3rd St & Reed Market Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
Intersection	**Delay (s/veh)**	**Level of Service**	**Volume/ Capacity**	**Jurisdiction**	**Mobility Standard**
US 97 & Powers Rd	64	E	**1.12**	ODOT	v/c ≤ 0.85
SE 3rd St & Powers Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
SE 3rd St & Badger Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
Roundabouts					
NE 18th St & Empire Blvd	12	B	0.74	City of Bend	v/c ≤ 1.0
Mt Washington Dr & Shevlin Park Rd	11	B	0.55	City of Bend	v/c ≤ 1.0
NW 14th St & Newport Ave	23	C	0.84	City of Bend	v/c ≤ 1.0
NW 14th St & Galveston Ave	25	C	0.86	City of Bend	v/c ≤ 1.0
Mt Washington Dr & Skyliners Rd	12	B	0.68	City of Bend	v/c ≤ 1.0
Colorado Ave & Simpson Ave	11	B	0.61	City of Bend	v/c ≤ 1.0
SW 14th St & Simpson Ave	16	C	0.75	City of Bend	v/c ≤ 1.0
Mt Washington Dr & Simpson Ave	10	B	0.60	City of Bend	v/c ≤ 1.0
Century Dr & Colorado Ave	9	A	0.51	City of Bend	v/c ≤ 1.0
Century Dr & Reed Market Rd	14	B	0.66	City of Bend	v/c ≤ 1.0
SE 15th St & Reed Market Rd	29	D	0.93[b]	City of Bend	v/c ≤ 1.0
Brookswood Blvd & Reed Market Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
Brookswood Blvd & Powers Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
Brookswood Blvd at Murphy Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0
SE 3rd St & Murphy Rd	Pending[a]	Pending[a]	Pending[a]	City of Bend	v/c ≤ 1.0

Delay, LOS and v/c for stop-controlled intersections reported for the major/minor approach.
[a]Intersection Analysis Pending Phase 2 of the Bend Parkway
[b]Train crossing at 9th Street observed in the field severely degraded operations at this intersection.

As shown in Table 1 and Figure 13, the intersection analysis uncovered several intersections that fail to meet mobility targets under existing traffic conditions. The congestion issues created by these failing intersections vary by location and intersection control type.

Capacity issues at signalized intersections can lead to queuing and delays for nearly all vehicles using the intersection.

The key traffic issues at **signalized** study intersections are summarized as follows:

- **US 97 and Cooley/Robal Road**: US 97 drivers experience significant queuing and delays at the Cooley Road and Robal Road signalized intersections, as observed during Phase 1 of the Bend Parkway Study. Southbound queues on US 97 frequently extend through the Cooley Road intersection, which already operates near capacity. US 97 serves both commuter travel between Bend and Redmond and recreational travel for Eastern Oregon. Under summer conditions, capacity issues on this segment of US 97 are further constrained, leading to a longer peak period.
- **US 20 (3rd Street) and Empire Boulevard:** The key issue at Empire and US 20 is the southbound left turn, which serves demand from both southbound US 97 and US 20 attempting to access land uses in northeast Bend.
- **US 20 (3rd Street) and Division/O.B. Riley/Mt Washington:** These intersections are mainly impacted by southbound queuing on US 20 (3rd Street) from the Division Street intersection.
- **East-West travel at 3rd Street:** The existing conditions analysis identified only one intersection (3rd Street and Greenwood Avenue) failing to meet mobility targets between Division Street and Wilson Avenue. However, field observations noted that all intersections that include east-west streets crossing under the Bend Parkway have significant eastbound queuing issues during the p.m. peak hour, possibly due to commuter travel from Downtown Bend and the west side of town to the residential land uses to the east. While the signalized intersections on 3rd Street at Olney Avenue, Franklin Avenue, and Wilson Avenue meet mobility standards, the delays and queuing for westbound movements cause drivers to attempt to bypass queues by using lower classification streets such as 2nd Street, making aggressive unsignalized turn movements and increasing traffic on local streets.
- **8th Street and US 20 (Greenwood Avenue):** This intersection had the longest peak period observed in the field. School traffic impacts the intersection first, followed by commuter traffic. Drivers on southbound 8th Street typically wait through a minimum one full signal cycle during the peak period, with queues extending as far north as Revere Avenue. Some queues were observed for westbound movements as well, also leading to some vehicles using neighborhood streets as bypass routes. Overall, the westbound queues generally cleared each cycle, and did to extend as far as the eastbound queues.
- **US 20 (Greenwood Avenue) and 27th Street/Purcell Boulevard:** These intersections experience a brief but intense peak during the evening commute. Signal cycle failures (vehicles stuck in queue for multiple signal timing cycles) occur at both intersections, with southbound queues extending more than 1,500 feet to the north. Traffic demand at these intersections is mostly commuters. Drivers also use alternative routes to avoid the 27th Street and US 20 signal, using Hamby Road instead of 27th Avenue.
- **Bend Parkway (US 97) and Powers Road:** This intersection was identified as failing to meet mobility targets in Phase 1 of the Bend Parkway Study. Recent improvements to the Murphy Road/US 97 interchange removed one of the southbound to eastbound movements from the Parkway. This may have increased the southbound jug-handle volume at the Parkway/Powers Road intersection. During the PM peak hour, the southbound jug-handle movement was observed to queue back around the loop ramp and occasionally back up the Parkway to Powers Road. Southbound traffic on the Parkway would then queue back to

near Reed Lane. Seasonal traffic also has a significant impact at this location, as traffic increases significantly on the Bend Parkway south of Reed Market Road during the summer months.

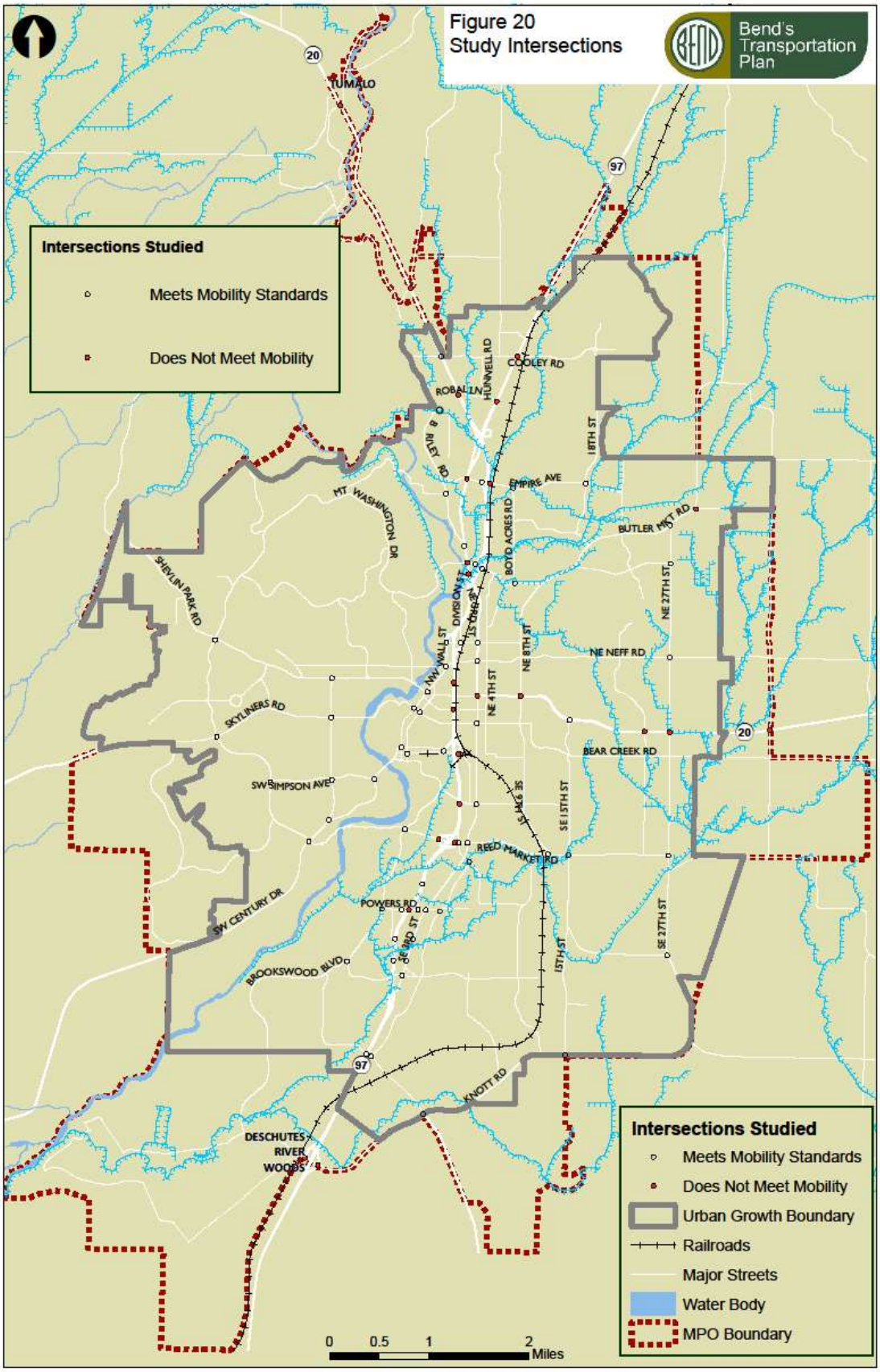
The key traffic issues at **roundabout** study intersections are summarized as follows:

- **Mt Washington Drive:** None of the roundabouts on Mt. Washington Drive fail to meet mobility targets for the PM peak hour. However, field observations noted extensive queueing caused by traffic from Summit High School. Southbound queues on Mt Washington Drive extend from Skyliners Road as far north Colter Avenue during the school peak, impacting operations at all the intersections in between.
- **Bond Street and Reed Market Road (Not yet analyzed):** This intersection experiences heavy demand during the PM peak hour, leading to queue spillback on all approaches. As typical of roundabout queues, none of the approaches are at a complete standstill, but rather operate as slow (< 5 mph) rolling queues. The queue spillback from this intersection impacts several intersections on Bond Street and Reed Market Road. Vehicles attempting to bypass the queue occasionally use neighborhood streets as an alternative route.

The key traffic issues at **unsignalized** study intersections are summarized as follows:

- **US 20 (north of Robal Road)**: US 20 north of Empire Boulevard experiences extreme seasonal variation due to the recreational characteristics of the route, which provides an east-west connection between eastern and western Oregon. The heavy seasonal traffic on US 20 conflicts with commuter demand between Bend and Redmond avoiding the US 97 corridor. This causes the Cook Avenue and Old Bend Redmond Highway intersections at US 20 to fail to meet mobility targets. Field observations of both these intersections indicated aggressive gap acceptance on the minor street approach, with drivers using major street traffic gaps lower than the HCM values to complete turn movements. Vehicles also occasionally made illegal two-stage left turns at the Cook Avenue and US 20, using the US 20 left turn lanes as median storage for the staged movement.
- **US 20 and Hamby Road**: The north-south demand at this intersection has increased in recent years due to congestion issues on 27th Street. US 20 traffic travels a high speed (speed recently lowered to 45 mph from 55 mph) at this location. However, drivers using Hamby still make aggressive gap acceptance decisions, especially for through movements. This driving behavior leads to some of the safety issues discussed in the following sections.
- **Bend Parkway (US 97) and Right In/Right Out Access Locations:** The issues at these intersections (Bend Parkway and Lafayette, Hawthorne, Truman, etc.) are discussed in Phase 1 of the Bend Parkway Study. The main issue at these locations is aggressive minor street right turn movements onto the Parkway, with gap acceptance averaging closer to 5.0 seconds than the typical 6.9 seconds assumed by the HCM methodology. Lower gap acceptance indicates aggressive driving behavior and is typically a symptom of heavy traffic on the mainline approach.

Figure 13: Study Intersections that Fail to Meet Mobility Targets in 2018



In addition to HCM intersection operations analysis, Phase 1 of the Bend Parkway Study (date) included Travel Time Reliability analysis of the US 97 Corridor through the City of Bend. Travel time reliability is a measure of the consistency in travel times over a corridor. Even in a congested corridor, if travel times can be confidently predicted drivers can plan their trips to arrive on time. However, where consistent travel times are less reliable, unexpected delays can make trip planning a frustrating experience. Travel time reliability is especially important for freight, as unreliable travel times may impact freight scheduling logistics. In addition, congestion indicated by travel time analysis leads to inefficient freight movement and increased emissions for trucks idling in traffic.

The Parkway Study found that peak period travel time (4:30 – 5:30 PM) was unreliable on the US 97 study corridor north of Empire Boulevard due to the congested nature of the peak periods at the at-grade intersections, mainly Cooley Road and Robal Road, see Appendix. US 97 south of Reed Market Road was also unreliable due to the at-grade intersection at Powers Road and the construction that has taken place over the past three years (e.g., Murphy Road interchange). The US 20/US 97 Business/SE 3rd Street corridor generally experiences worse travel time reliability than the Parkway. The worse reliability is likely due to the frequency of driveways and intersections along that corridor versus the Parkway's controlled access.

Key congestion findings for motor vehicles facilities include:

Signalized Intersections:

- **Capacity Issues for signals at Cooley Rd/Robal Rd and US 97**
- **Queuing issues on Hwy 20 (3rd Street) between Empire Blvd and Division St**
- **Significant queuing and delay due to east-west demand intersecting 3rd Street (between Revere Ave and Reed Market Rd)**
- **Heavy queuing on 8th St at US 20 (Greenwood Blvd)**
- **Queuing and heavy volume on 27th St and Purcell Blvd at US 20 (Greenwood Blvd)**
- **Unreliable travel time on US 97 in the Cooley/Robal Road and Powers Road areas**

Roundabouts:

- **Heavy demand and queuing at Brookswood Blvd/Reed Market Rd/Bond St roundabout**

Two-Way Stop Controlled (TWSC) Intersections:

- **Heavy mainline seasonal demand on US 20 north of Empire creates aggressive driving behavior at TWSC intersections**
- **Trip diversion observed from 27th Avenue to Hamby Road, combined with high mainline volumes, creates aggressive driver behavior at Hamby Rd/US 20**
- **Aggressive driver behavior observed at the Right In/Right Out locations along the Bend Parkway**

Other Issues:

- **Congestion at Powers Rd and US 97 triggered by limited connectivity in the area**
- **High intensity school-related peaking on Mt Washington Dr**

Traffic Safety

The current work program focuses on high level, regional safety issues. More detailed safety analysis will be performed as part of the upcoming Bend TSAP work program.

Crash data for the most recent six years available (2011-2016) on all roadways within the study area was obtained from ODOT. There were 4,953 reported vehicle crashes within the study area during the six-year span shown in Figure 14, yielding an average of over 826 crashes per year. For comparison to similar sized cities in Oregon (nine cities of 50,000 to 110,000 population), the number of annual crashes each year in Bend is one of the lowest on a per-capita basis.

Of the 4,953 vehicle crashes, there were 18 fatalities, 2,285 injuries, and 2,650 property-damage-only crashes. Although not part of the analysis period, it is important to note that there were two fatalities at the US 20/Hamby Road intersection between December 2017 and April 2018.

Approximately 70% of the crashes in the study period occurred at an intersection, 25% along a straight roadway segment and the remaining 5% of crashes occurred on other roadway characteristics such as on a bridge or on a curve. The majority of crashes involved an angle, rear-end or turning crash type. Other crash types include head-on, fixed object and sideswipe crashes.

Speed was a contributing factor for about 30% of the crashes, improper driving or disregarding the traffic control device accounted for about 15% of the crashes, careless or reckless driving accounted for about 12% of the crashes and failing to yield the right-of-way accounted for about 25% of the crashes.

There following 17 areas have been identified as high frequency crash locations relative to other intersections or roadways within the study area:

- US 20/Cook Avenue Intersection
- US 20/Old Bend-Redmond Highway Intersection
- US 20/Cooley Road Intersection
- US 20/Robal Road Intersection
- US 97/Cooley Road Intersection
- US 97/Robal Road Intersection
- Empire Avenue between US 20 and Boyd Acres Road
- US 20 between O.B. Riley Road and Division Street
- 3rd Street (US 20) between Revere Avenue and Murphy Road
- 8th Street between Revere Avenue and Greenwood Avenue (US 20)
- Neff Road/Purcell Boulevard Intersection
- Neff Road/27th Street Intersection
- Greenwood Avenue (US 20)/27th Street Intersection

- 15th Street/Reed Market Road Intersection[12]
- US 97 Pinebrook Boulevard Intersection[13]
- Powers Road between US 97 Southbound Ramps and 3rd Street
- Downtown Bend, along Franklin Avenue, Oregon Avenue, Bond Street, and Wall Street

ODOT Safety Priority Index System (SPIS)

ODOT maintains SPIS to identify potential safety problems on state highways. The SPIS network screening process aims to identify sites with higher crash histories for potential safety improvements. The highway is divided into one-tenth of a mile segments and those segments are ranked in terms of safety cost effectiveness. Each year ODOT develops a list of the top 10% SPIS sites. The most recent SPIS list[14] indicates that there are nine sites on state facilities within the study area that rank among the top 10% of SPIS sites. The nine sites located along US 97 and US 20 are listed in Table 2.

Table 2. Bend Area Top 10% ODOT On-State Facility SPIS Site Summary[a]

Highway	BMP[b]	EMP[c]	ADT[d]	Total Crashes	F & A Injury Crashes[e]	City/County	Connection
US 97	139.89	140.03	22,900	22	0	Bend	Powers
US 97	140.46	140.61	17,100	25	0	Bend	Pinebrook
US 20 (Central Oregon)	0.51	0.60	16.800	26	0	Bend	NE 4th Street
US 20 (Central Oregon)	0.60	0.68	16,800	22	0	Bend	NE 5th Street
US 20 (Central Oregon)	0.87	1.03	21,000	26	1	Bend	NE 8th Street
US 20 (Central Oregon)	0.96	1.05	21,000	24	0	Bend	NE 9th Street
US 20 (Central Oregon)	2.45	2.63	14,700	21	1	Bend	27th Street
US 20 (Central Oregon)	3.47	3.65	11,166	14	2	Deschutes County	Hamby Road/Ward Road
US 20 (McKenzie-Bend)	20.59	20.77	19,133	32	1	Bend	NE Olney Avenue

[a] ODOT SPIS Report 2016 (2013-2015 Data)
[b] BMP = Beginning Milepoint
[c] EMP = Ending Milepoint
[d] ADT = Average Daily Traffic
[e] F & A Injury Crashes = Fatal and Serious Injury Crashes

In addition, there are 10 sites on non-state facilities within the study area that rank among the top 10% of SPIS sites and are listed below.

- Northeast Franklin Avenue between 1st Street and 3rd Street
- Northwest Franklin Avenue near Sisemore Street

[12] Majority (about 80%) of the reported crashes at this intersection (between 2011-2016) occurred before the roundabout was constructed in the Fall of 2014.

[13] All of the reported crashes at this intersection (between 2011-2016) occurred before the median was installed in November 2015.

[14] 2016 On-State Top 10% SPIS Groups Table, ODOT, Region 4, November 2017.

- Northeast Neff Road near Purcell Boulevard
- Northeast Purcell Boulevard near Neff Road
- Northwest 9th Street between Portland Avenue and Ogden Avenue
- Powers Road near Parrell Road
- Southeast 3rd Street near Roosevelt Avenue
- Southeast 3rd Street between Miller Avenue and Woodland Boulevard
- Reed Market Road near 3rd Street
- Wilson Avenue between 2nd Street and 3rd Street

Bend Parkway Study Safety Findings

The US 97 Parkway Plan[15] analyzed crash data from 2011-2015. Critical crash rates, excess proportion of crashes, and SPIS ratings were used to flag safety-focus locations. The analysis identified the following 19 safety focus areas:

- US 97 & Cooley Road
- US 97 & Robal Road
- US 97 & Nels Anderson Place
- US 97 Southbound Ramps & Empire Boulevard
- US 20 & Butler Market Road
- US 97 Southbound Ramps & Butler Market Road
- US 97 Northbound Ramps & Revere Avenue
- US 97 Southbound Ramps & Revere Avenue
- US 97 & Lafayette Avenue
- US 97 & Hawthorne Avenue
- US 97 Southbound Ramps & Colorado Avenue
- US 97 Northbound Ramps & Reed Market Road
- US 97 Southbound Ramps & Powers Road
- US 97 & Powers Road
- US 97 Northbound Ramps & Powers Road
- US 97 & Badger Road
- US 97 & Pinebrook Boulevard
- US 97 & Ponderosa Street
- US 97 Southbound Ramps & Baker Road

[15] DRAFT Technical Memorandum #2: Existing Conditions – US 97 Parkway Plan, DKS Associates, August 11, 2017.

Other Safety Studies

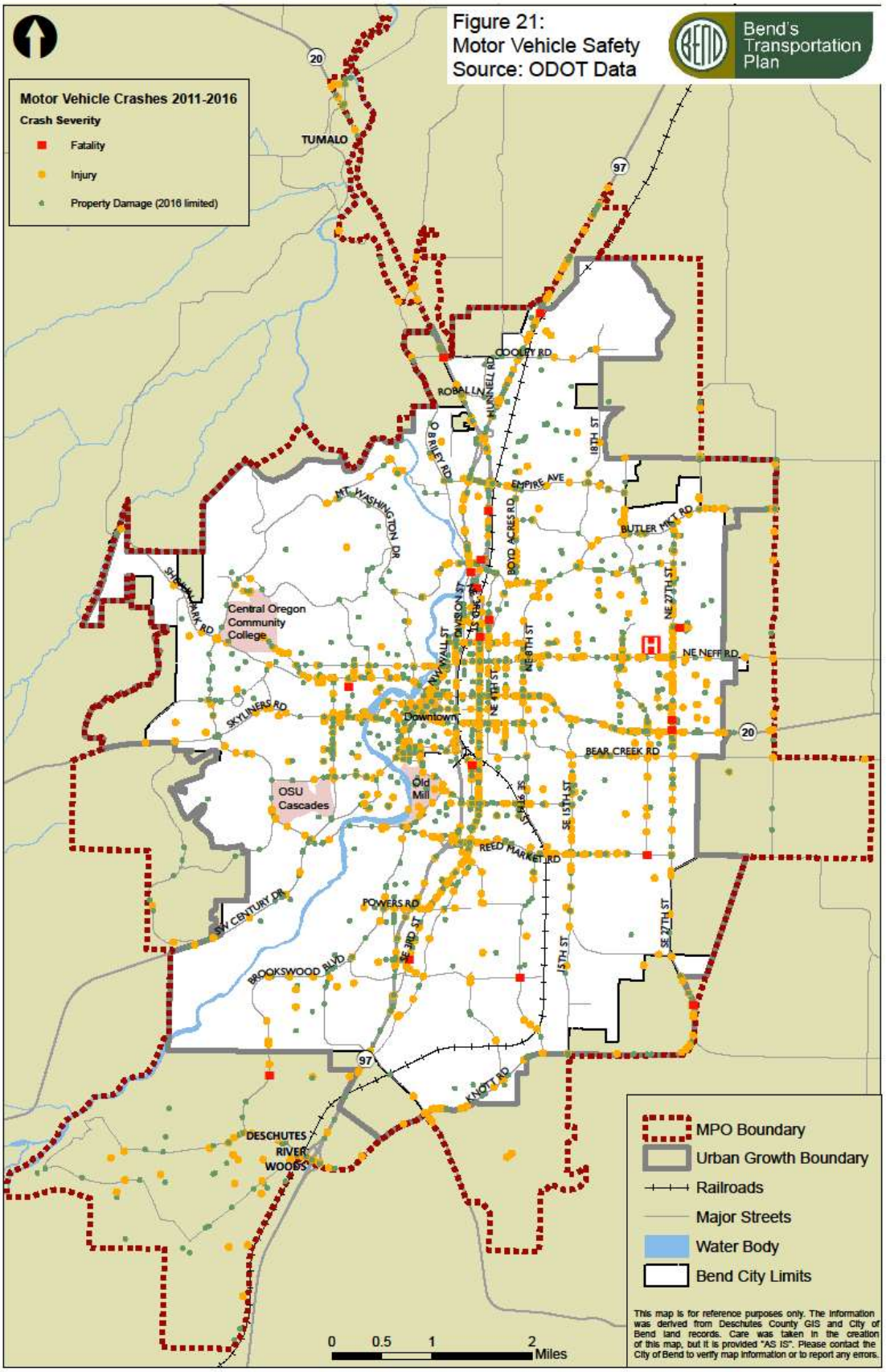
It is important to note that there are current safety analysis projects throughout the study area. For example, the ODOT All Roads Transportation Safety Program project is currently underway. Hot-spot crash locations involving fatal and serious injury crashes will be identified based on crashes between 2011 and 2015. The program uses a data-driven process that helps to prioritize safety projects for all public roadways. In addition, ODOT is performing a study on the US 20 corridor through Bend from Empire to 27th Street that will include recommendations for safety improvements.

Also, the Oregon TSAP Update was updated in 2017 and identifies transportation safety strategies for Oregon. Emphasis areas were identified based on crash frequency and injury severity, then used to help prioritize improvement programs. The TSAP identifies performance measures and sets annual targets to meet the overall safety vision of no fatalities or life-changing injuries on Oregon's transportation system by 2035. A TSAP will also be developed for the Bend area, with an expected completion date of early 2019. Results will be incorporated into the TSP and MTP.

Key safety findings for motor vehicles facilities include:

- **For comparison to similar sized cities in Oregon (nine cities of 50,000 to 110,000 population, the number of annual crashes each year in Bend is one of the lowest on a per-capita basis.**
- **18 high frequency crash locations were identified. Key areas or corridors include US 97, US 20/3rd Street, Empire Avenue, Downtown Bend, Neff Road, Reed Market Road, and 27th Street.**
- **Aggressive driving behavior (turning and crossing movements) was observed at two-way stop-controlled intersections along high speed/volume roadways (e.g., for US 20/Hamby Road and US 20/O.B. Riley/Cook Avenue.**
- **Nine segments on state facilities and 10 sites on non-state facilities were identified as top 10% ODOT SPIS locations.**
- **The Bend Parkway Plan (Phase 1), completed in August 2017 identified 19 safety focus areas on and near US 97.**
- **There are safety studies being completed concurrently with this MTP/TSP update process that will identify hot-spot crash locations and emphasis areas based on injury severity and crash frequency.**

Figure 14: Bend and BMPO Vehicle Crashes and Hot-Spots (2011-2016)



Transit Facilities

Public transportation in and around the study area is provided by CET through fixed-route service, inter-city bus service and recreational shuttle service. Transit options are available to/from the City of Bend, while there is currently no transit service from Bend to Tumalo.

Fixed Route Service

CET provides local fixed route service in Bend. There are currently 9 routes (Route 12 was eliminated on July 1, 2018) operating based on a "hub and spoke" pattern from the Hawthorne Station transit center, refer to Figure 15 for current routes. Service is provided on these routes between about 6:00 AM and 7:30 PM on weekdays and 7:30 AM and 5:30 PM on Saturday. Routes 1 (south 3rd Street), 3 (Newport Avenue), 4 (north 3rd Street), and 7 (Greenwood Avenue are the highest ridership routes in the system.

There is currently no local fixed route service on Sundays. Local fixed route service covers most of the central portions of the City of Bend. There are no transit routes covering outer northwest, northeast, and southeast quadrants of the city. The close-in communities of Tumalo and Deschutes River Woods also do not have fixed transit service.

CET also operates Dial-A-Ride, a complementary curb-to-curb, shared transit service, for low-income seniors and people with disabilities.

Highlights of access to transit service within the study area include:

- 53% of the population is within ¼ mile of transit service
- 85% of the employment is within ¼ mile of transit service
- 35% of arterial and collector roadways within ¼ mile of a CET transit stop have sidewalks.
- 47% of arterial and collector roadways within ¼ mile of a CET transit stop have dedicated bicycle facilities.
- Note that these numbers do not include the impacts to transit access due to the closure of Route 12.

Roadway Congestion Impacts to Transit Service

Traffic congestion throughout the network impacts the transit service reliability during the p.m. peak hour. Key transit corridors with significant p.m. peak hour traffic congestion include:

- 3rd Street (US 20 portion)
- Greenwood Avenue (US 20)
- 27th Street
- US 97 at Robal Road
- Brookswood Boulevard at Reed Market Road roundabout
- East-west bridge crossings of the Deschutes River (Colorado Ave, Galveston Ave and Newport Ave)
- Colorado Avenue at Simpson Avenue roundabout

The traffic congestion on these corridors degrades the quality of service and schedule reliability for transit drivers.

Inter-city Passenger Bus Service

CET provides regional connections to other cities in Central Oregon including:

- Route 24 - provides service between Redmond and Bend, with nine total round trips per weekday (no weekend service). The first bus departs Bend at 6:37 AM and the last bus arrives in Redmond at 8:27 PM.
- Route 29 - provides service between Sisters and Bend, with three total round trips per weekday (no weekend service). The first bus departs Bend at 6:40 AM and the last bus arrives in Bend at 6:17 PM.
- Route 30 - provides service between La Pine and Bend, with four total round trips per weekday (no weekend service). The first bus departs Bend at 7:35 AM and the last bus arrives in Bend at 5:12 PM.

There is also transit service available for inter-city connections outside of Central Oregon which include:

- Central Oregon Breeze – provides daily bus service between Bend and Portland with stops in Redmond, Terrebonne, Madras, Warm Springs, Government Camp, Welches, Sandy, Gresham, Portland Airport and Portland Union Station. The bus departs Bend at 7:00 AM and arrives in Portland at 11:00 AM; the return trip departs Portland at 1:30 PM and arrives in Bend at 6:00 PM. On Fridays and Sundays, a second bus departs Bend at 11:30 AM and arrives in Portland at 3:45 PM; the return trip departs Portland at 6:00 PM and arrives in Bend at 10:30 PM. During the holiday season (during Thanksgiving week and 10 days before Christmas thru a couple of days after the New Year), the second bus runs every day of the week.
- High Desert Point –an Amtrak shuttle service that provides service between Redmond Airport and Chemult Amtrak Station with stops in Bend, Sunriver and La Pine. There is one trip per day in each direction.
- Pacific Crest Bus Lines – provides daily bus service between Eugene and Bend with one stop in Sisters. There is one trip per day in each direction departing Bend
- Eastern Point – provides daily bus service between Bend and Ontario with stops in Brothers, Hampton, Riley, Burns, Buchanan, Drewsey Junction, Juntura, Harper and Vale. There is one trip per day in each direction.
- The People Mover – provides two daily bus services between Prairie City and Bend and Monument and Bend with one trip per day in each direction. The route between Prairie City and Bend stops in John Day, Mount Vernon, Dayville, Mitchell, Prineville, and Redmond. The route between Monument and Bend stops in Dayville, Mitchell, Prineville, and Redmond.

Recreational Bus Service

CET provides seasonal transit service including

- Ride the River – provides service between the Drake Park river 'get out' and the Old Mill 'put in' to help reduce the dependence of parking along Drake Park. This service is typically available between mid-June and Labor Day. This shuttle costs $3.00, which provides unlimited rides all day.
- Mountain Bus Service – provides service during the ski season between Hawthorne Station and Mt. Bachelor. There are stops at the Mt. Bachelor Park-N-Ride, Virginia Meissner Sno Park and Mt. Bachelor's West Village Lodge.
- Lava Butte Shuttle – provides service from the Lava Lands National Monument visitor's center to the summit of Lava Butte. This service is typically available between Memorial Day and Labor Day. This shuttle costs $2.00 per ride.
- Ride Bend – provides a free shuttle service between downtown Bend, Old Mill District, OSU Cascades, and Galveston Avenue. In 2018, the shuttle will operate June 29 through Labor Day, 7 days a week, Noon – 10 pm. Buses run every 15 minutes.

Other Transport Services

Other transportation services such as taxis, volunteer services and rides provided by provide door-to-door service and last-mile connections. They also typically operate during all hours of the day for trips that may fall outside of the regularly scheduled transit services. There are taxi services based in Bend that serve residents throughout the study area. TNCs such as Uber and Lyft are also currently available in Bend. These modes of travel are particularly popular for travel to/from the Redmond Airport, located in southeast Redmond.

Key transit system findings include:

Connectivity/Coverage:

- **Lack of consistent transit options for the Tumalo and Deschutes River Woods communities.**
- **Lack of transit service in the outer sections of northwest, northeast and southeast corners of City of Bend, except for Dial-a-Ride (available to qualified riders)**
- **Lack of transit service on Sundays**
- **Limited inter-city and regional service**
- **Transportation Network Companies (Lyft and Uber) are new to the area, providing additional coverage and hours of service.**

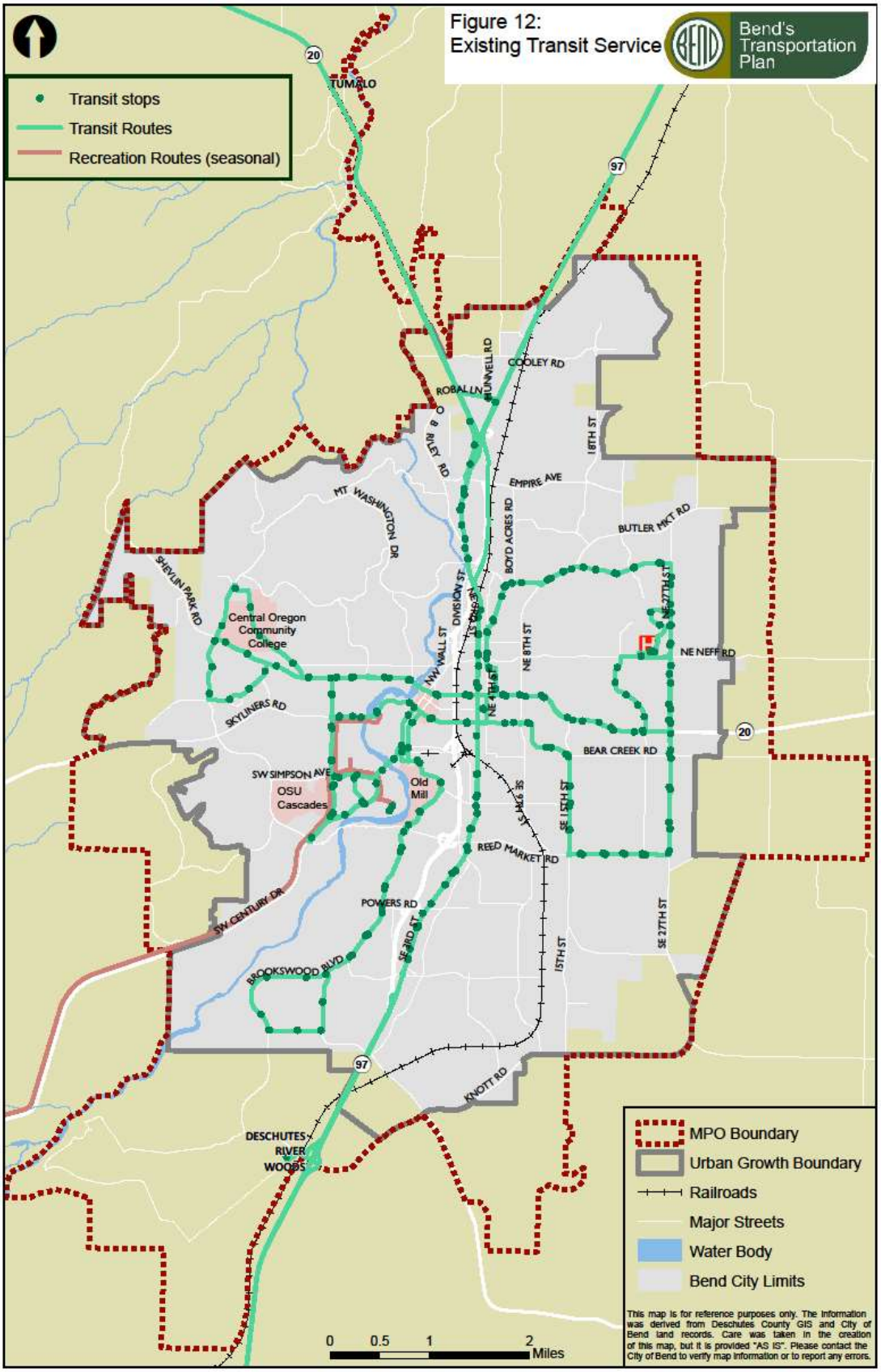
Access:

- **Majority of employment is within ¼ mile of transit service line, while only half of households are within a ¼ mile of transit service.**
- **Less than half of the arterial and collector roadways within ¼ mile of a CET transit stop have sidewalks on at least one side of the roadway (35%) and dedicated bicycle facilities (47%).**

Congestion Impacts on Operations:

- **Motor vehicle congestion at key locations on US 20, US 97, 27th Street, and east-west bridge crossings impact transit service reliability during the p.m. peak hour.**
- **Two roundabouts Colorado Avenue/Simpson Avenue and Brookswood Boulevard/Reed Market Road impact transit service reliability during the p.m. peak hour.**

Figure 15: Bend and BMPO Existing Transit Facilities



Pedestrian Facilities

This section describes the existing pedestrian facilities within the study area from a high-level regional perspective. Phase 2 of the work program will evaluate more detailed, neighborhood-level needs (including key crossing needs, connections to key destinations, continuity of facilities along corridors, etc.).

Pedestrian facilities include sidewalks, multi-use paths, trails, and crosswalks that help facilitate safe and efficient pedestrian travel. Existing pedestrian connectivity (presence of facilities) and pedestrian-related crashes were reviewed to identify gaps in the system and pinpoint major safety issues. Further pedestrian safety analysis will be included in the Bend Transportation Safety Action Plan (TSAP) future work program.

High-pedestrian activity locations include:

- Downtown
- Business Districts such as Downtown, Galveston, Newport, Medical Center area
- Recreational hubs (river and parks)
- Educational institutions

Pedestrian Facility Connectivity

Walking plays an important role in Bend's and BMPO's transportation mobility, and planning for people to walk helps provide a complete multi-modal transportation system. A complete system creates options and overall resiliency of the system to absorb social, environmental and technological changes over time. It also supports healthy lifestyles and addresses a social equity need to ensure that the young, the elderly, and those without access to a car have access to goods, services, employment, and education.

Figure 16 shows the locations of existing sidewalks along arterial and collector streets within the study area. The inventory process involved field reviews and digital mapping resources.

Overall, most of the arterial and collector roadways have sidewalks on at least one side of the roadway. There are approximately 205 miles of arterial and collector roadways within the BMPO area and about 140 miles of roadways have sidewalks on at least one side of the road. The southwest and southeast portions of the study area (much of which were developed with rural facilities at the time of development and incorporated into Bend in 1998) lack sidewalks, including Knott Road, 27th Street, and Century Drive. In addition, barriers such as high speed, wider streets, the Deschutes River, the BNSF railroad, and Bend Parkway (US 97) limit east-west pedestrian connectivity.

To evaluate significant regional facility gaps relative to barriers, the grid-system of arterial and collector corridors was reviewed to determine if through-corridors are spaced at one-mile apart for arterials and one-half mile apart for collectors, as is planned for in the City's existing TSP. Relative to crossings of major barriers that would be high-cost to cross (with grade-separated facilities), gaps are defined as locations where one-mile spacing of arterials are not provided.

In the core area of Bend where land use density lead to higher active transportation demand, a half-mile maximum spacing including collector corridors was applied. As shown in Figure 17, there are seven major locations of pedestrian connectivity gaps in the study area based on this methodology.

Figure 16. Bend and BMPO Existing Sidewalks

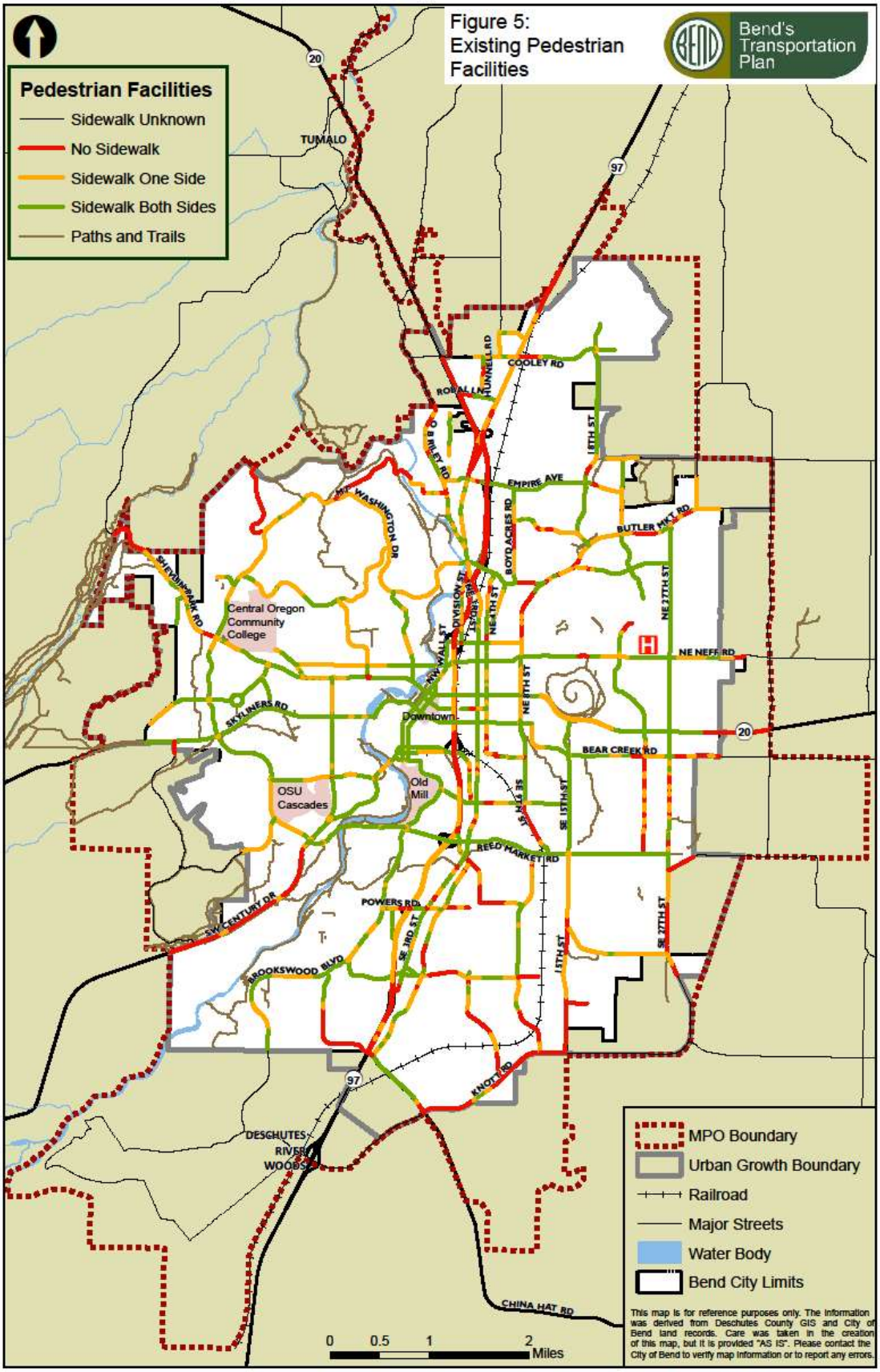
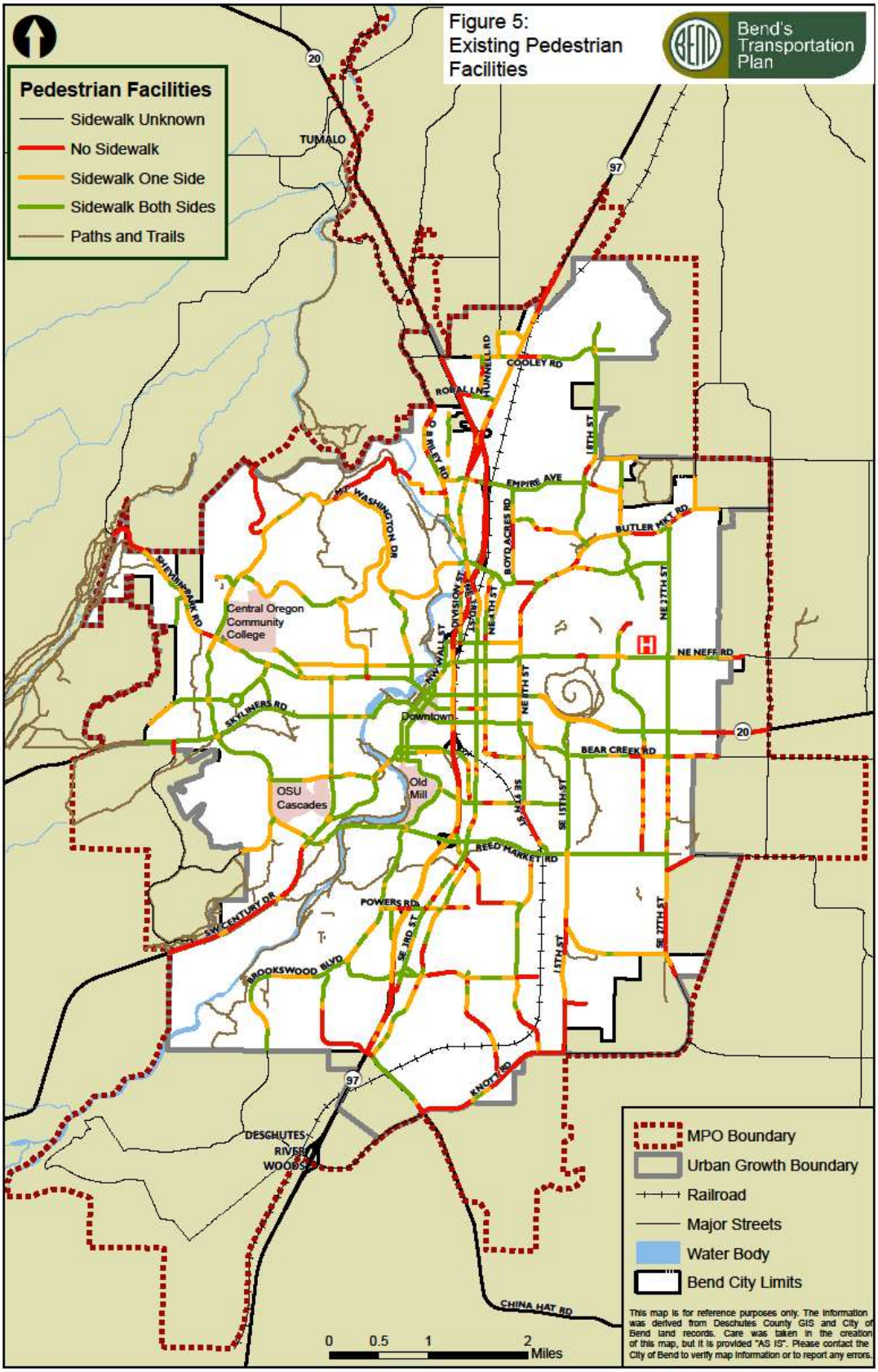


Figure 17. Bend and BMPO Existing Sidewalk Gaps



Pedestrian Safety

When looking at pedestrian travel, it is important to consider the safety aspects of the pedestrian system. Careful attention must be directed towards pedestrian crossings and locations where people walking are exposed to high vehicle speeds and volumes.

Crash data for the most recent six years available (2011-2016) on all roadways within the study area was obtained from ODOT and used to evaluate vehicle-pedestrian crash history. There were 66 vehicle-pedestrian crashes reported during the six-year span, shown in Figure 18, which is an average of 11 crashes per year. In comparison to similar sized cities in Oregon (cities of 50,000 to 110,000 population), the number of annual crashes involving pedestrians each year in Bend is the lowest on a per-capita basis.

Of the 66 vehicle-pedestrian crashes, there were seven pedestrian fatalities, 55 injuries, and three property-damage-only (PDO) crashes. Three of the fatal crashes occurred on US 20 between Butler Market Road and Revere Avenue and one fatal crash occurred on 4th Street between Butler Market Road and Revere Avenue. Most of the fatal crashes occurred under dark lighting conditions and dry road surface conditions. Of the seven fatal pedestrian crashes, the pedestrian was deemed at fault for four crashes, primarily because the pedestrian was illegally in the roadway; for example, the pedestrian disregarded the traffic signal.

There are clusters of vehicle-pedestrian crashes in the downtown area, along 3rd Street and along Galveston Avenue. Approximately 65% of the 66 vehicle-pedestrian crashes were at an intersection or alley, 34% occurred along a straight roadway segment, and the remaining crashes occurred on a hill. A majority (77%) of vehicle-pedestrian crashes occurred on dry pavement conditions, 12% occurred on icy or snowy pavement conditions, 8% occurred on wet pavement conditions, and the pavement conditions are unknown for the remaining crashes.

Key pedestrian system findings include:

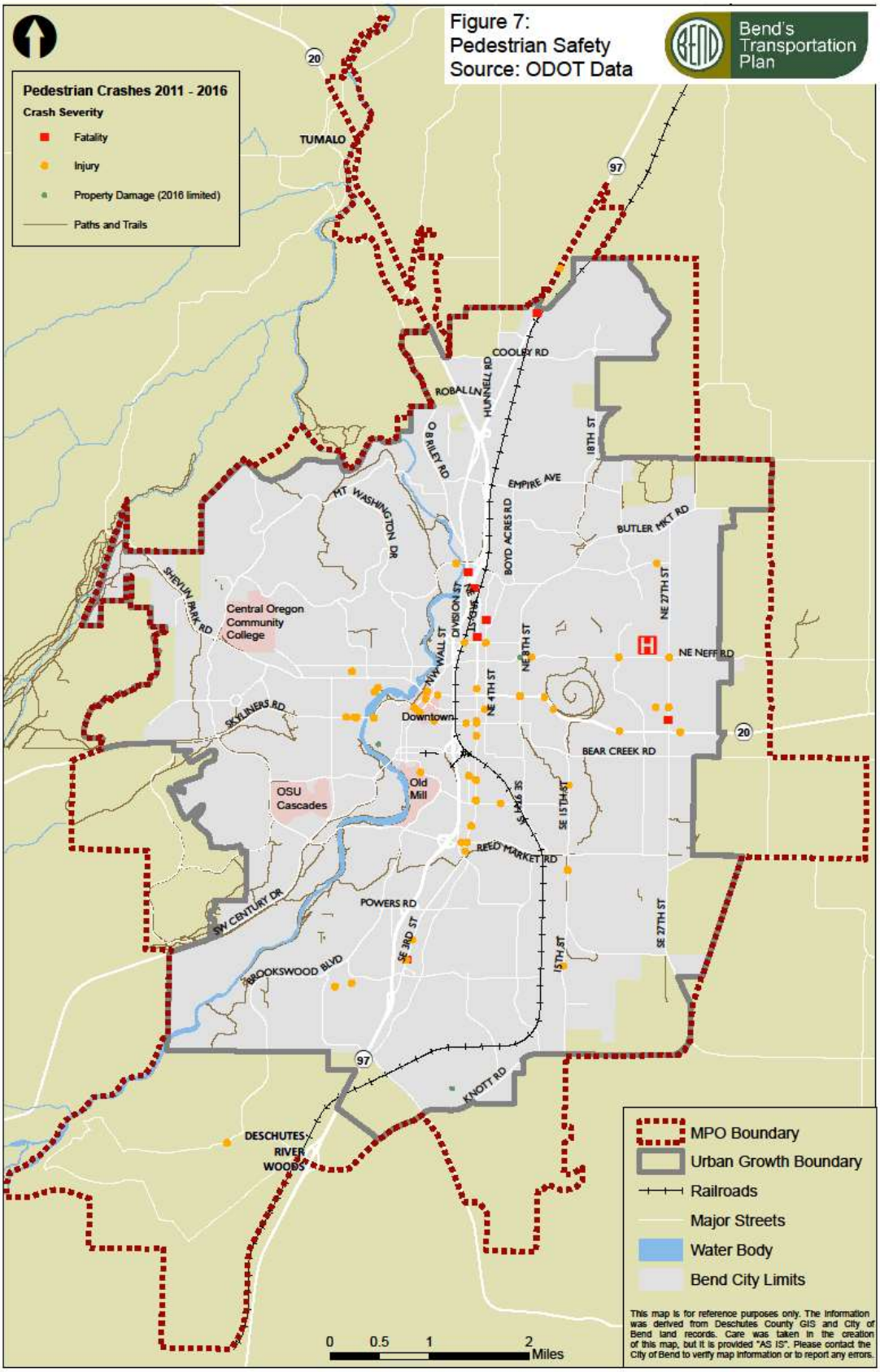
Connectivity:

- **Regional-level pedestrian corridor connectivity is limited by major barriers including US 97, US 20, the railroad tracks, and the Deschutes River. Seven gaps in the regional arterial and collector network were identified.**
- **Approximately 78% of arterial and collector roadways have sidewalks on one or both sides of the road.**
- **Some neighborhoods have a relatively high-portion of arterial and collectors without sidewalks, particularly in developed areas annexed into the City such as southwest and southeast Bend.**

Safety:

- **Injury and fatal crashes involving pedestrians are clustered along higher-speed, higher-volume roadways, and multi-lane roadways lacking enhanced crossings (e.g., 3rd Street).**

Figure 18. Bend and BMPO Vehicle-Pedestrian Crashes (2011-2016)



Bicycle Facilities

Bicycle facilities (including bicycle lanes and multi-use paths) along arterial and collector streets within the study area were reviewed to identify regional-level existing gaps in the network. Phase 2 of the work program will evaluate more detailed, neighborhood-level needs (including key crossing needs, connections to key destinations, continuity of facilities along corridors, etc.). The bicycle operations and crash history within the study area are described below.

Bicycle Facility Connectivity

Figure 19 shows the existing bicycle facilities in the study area. These facilities were compiled using Deschutes County GIS records. The majority of the collectors and arterials in the study area provide on-street paved bike lanes. The City of Bend standard bike lane width is 6 feet[16], meeting the ODOT standard.[17] Bike lanes currently connect the north, south, east, and west of Bend's city limits, providing cyclists a wide number of through-route options. For the most part, bike lanes are provided on both sides of roadways, totaling an estimated 108 miles in length.

Some key corridors in the core area of the study area lack dedicated bicycle facilities, including sections of 3rd Street, 4th Street, Greenwood Avenue, and Hawthorne Avenue. The fringes of the study area also have gaps in the bicycle network. Table 3 identifies the existing bike lane deficiency areas on arterials and collector roadways within the study area.

Barriers, including the Deschutes River, the BNSF railroad, and Bend Parkway (US 97) limit east-west bicycle connectivity in Bend. As described in the pedestrian facilities discussion, a regional facility spacing evaluation was conducted to determine bicycle system gaps relative to major barriers for the bicycle network. As show in Figure 20, there are seven major locations of bicycle through-corridor gaps in the study area. The City also has some enhanced bike facilities such as a raised bike lane on Reed Market Road, green bike lanes on Riverside Boulevard and Franklin Avenue, and a protected bike lane on Bond Street and Franklin Avenue.

In addition to on-street bike lanes, the Bend and BMPO area features many paved and unpaved trails and walkways, also displayed in Figure 19. As shown, trails are provided along almost the entire extent of the Deschutes River within the study area, providing a scenic route for walkers, runners, and bicyclists. There are approximately 95 miles of public trail facilities in the study area. These trails serve as recreational facilities for people walking, running, and biking, and also provide active transportation routes for commuters.

Overall, the existing bike lane and trail system provides connections to and from many neighborhoods, schools, parks, and retail centers. Cyclists desiring to travel through the study area can select from the many designated routes on the major roadways or can share the road with motor vehicles on the lower volume, neighborhood streets to reach appropriate destinations.

[16] City of Bend Design Standards Part II, City of Bend, 2018.

[17] Highway Design Manual Chapter 13, ODOT, 2012. Page 13-3

Figure 19: Bend and BMPO Existing Bicycle Facilities

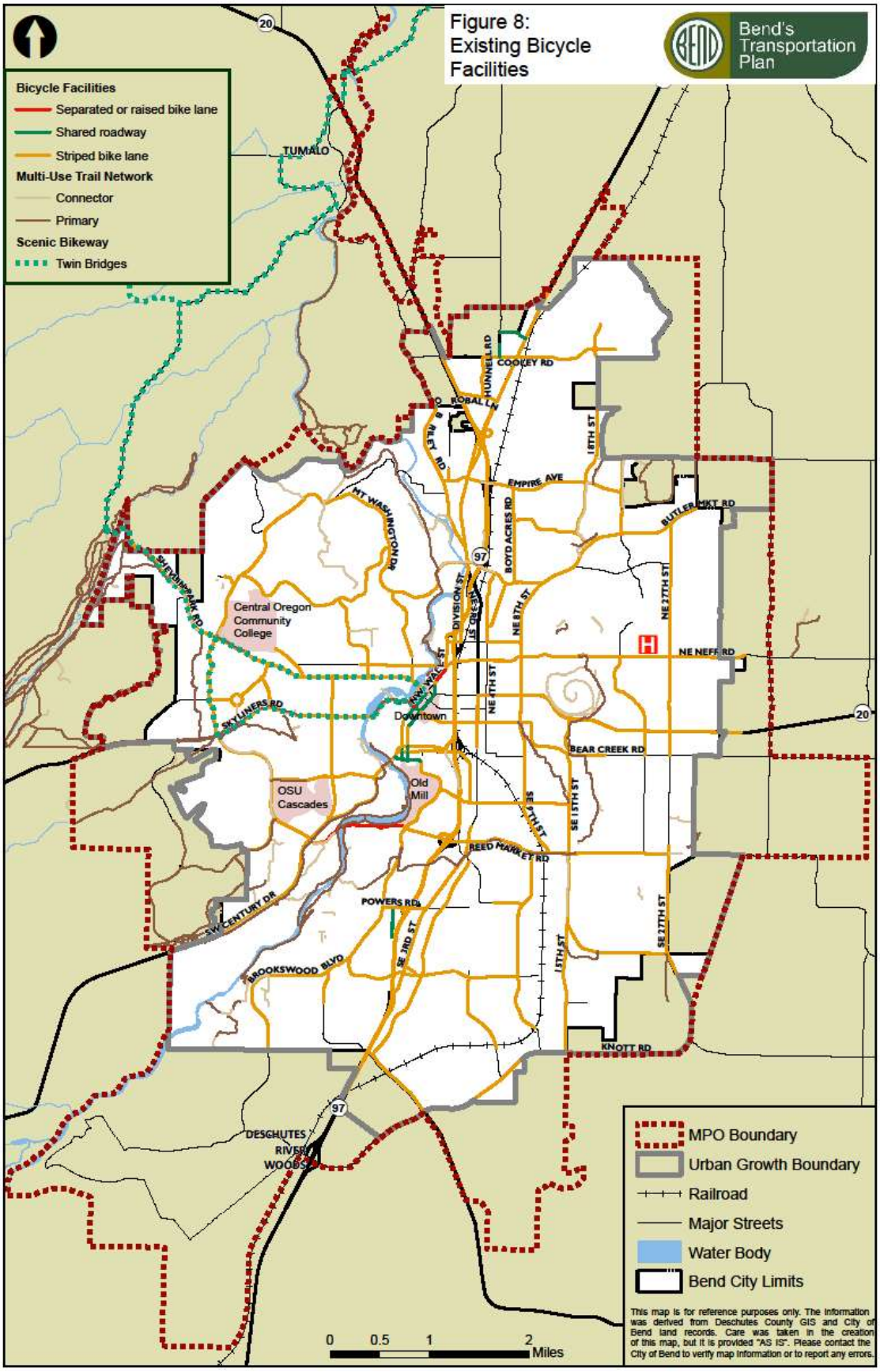


Figure 20: Bend and BMPO Existing Bicycle Facility Gaps

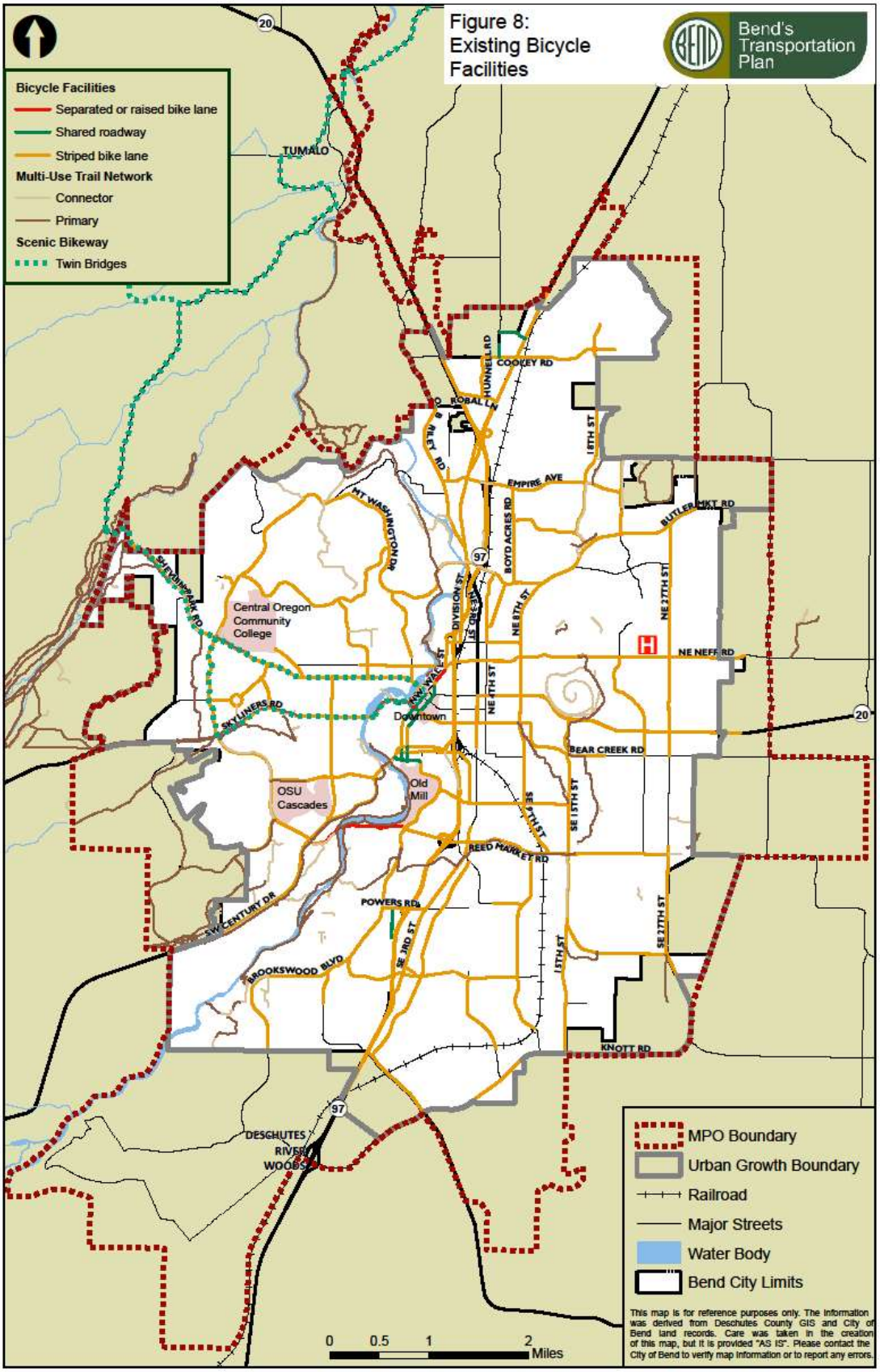


Table 3: Existing Bike Lane Deficiency Areas

Roadway	Extents	Functional Class	Area
Cooley Road	O.B. Riley Road to US 20	Major Collector	BMPO
Cooley Road	US 20 to NW Hunnell Road	Minor Arterial	Bend
Archie Briggs Road	Mt. Washington Drive to O.B. Riley	Major Collector	Bend
Britta Street	Hardy Road to Halfway Road	Major Collector	Bend
Putnam Road	Mt. Washington Drive to North UGB	Major Collector	Bend
Skyline Ranch Road	Chianti Lane to Shevlin Park Road	Major Collector	Bend
Portland Avenue	12th Street to College Way	Major Collector	Bend
Crosby Drive	NW Clearwater Drive to Skyliners Road	Major Collector	Bend
Skyline Ranch Road	Macalpine Loop to Skyliners Road	Major Collector	BMPO
Awbrey Road	Newport Avenue to Roanoke Avenue	Major Collector	Bend
Greenwood Avenue	Wall Street to 3rd Street	Minor Arterial	Bend
Hawthorne Avenue	Wall Street to US 97, US 97 to 4th Street	Major Collector	Bend
Revere Avenue	Division Street to 4th Street	Minor Arterial	Bend
3rd Street	Division Street to Irving, Cleveland Avenue north to Railroad tracks	Principal Arterial	Bend
4th Street	Revere Avenue to Franklin Avenue	Minor Arterial	Bend
4th Street	Franklin Avenue to Alden Avenue	Major Collector	Bend
Alden Avenue	4th Street to 5th Street	Major Collector	Bend
Logsden Street	Alden Avenue to Glenwood Drive	Major Collector	Bend
Glenwood Drive	Logsden Street to 9th Street	Major Collector	Bend
Wells Acres Road	Butler Market Road Street to 27th Street	Major Collector	Bend
Purcell Boulevard	Butler Market Road to South Terminus	Major Collector	Bend
Purcell Boulevard	Neff Road to North Terminus	Major Collector	Bend
Deschutes Market Road	Butler Market Road to North City Limits	Major Collector	BMPO

Roadway	Extents	Functional Class	Area
Bear Creek Road	Cessna Drive to 27th Street	Minor Arterial	Bend
Bear Creek Road	27th Street to East UGB	Major Collector	Bend
Pettigrew Road	Reed Market Road to Bear Creek Road	Major Collector	Bend
27th Street	Reed Market Road to Bear Creek Road	Major Arterial	Bend
Stevens Road	27th Street to East UGB	Minor Arterial	Bend
Brosterhous Road/Division Street	Cleveland Avenue to Kobe Street, Knott Road to Windsor Drive	Major Collector	Bend
Powers Road	3rd Street to Parrell Road	Major Collector	Bend
Chase Road	Parrell Road to East Terminus	Major Collector	Bend
Ponderosa Street/Lodgepole Drive	Mahogany Street to US 97	Major Collector	Bend
Country Club Drive	Mountain High Loop to Knott Road	Major Collector	Bend

Bicycle Facility User Environment

A "Bicycle Level of Traffic Stress" (LTS) analysis was conducted to characterize the bicycling experience on the arterial and collector system. This methodology[18] breaks road segments into four classifications for measuring the effects of traffic-based stress on bicycle riders and their effects on facility usage as well as safety. The measure of traffic stress quantifies the perceived safety issue of being in close proximity to vehicles, primarily considering the physical distance to traffic and the speed of traffic.

The results of the Bicycle LTS analysis are illustrated in Figure 21. Many of the existing high-stress locations, gaps, and barriers to safe bicycling are near key destinations that attract bicycle activity including:

- 27th Street and Neff Road near St. Charles Hospital
- 3rd Street/Hwy 20 along the retail/service corridor from US 97 to Murphy Road
- Century Drive and Colorado Avenue near OSU Cascades
- Greenwood Avenue crossing 3rd Street and US 97 near downtown Bend
- Newport Avenue near COCC

Bicycle Facility Safety

To evaluate bicycle safety within the study area, the most recent six years (2011-2016) of reported vehicle crashes made available by ODOT was reviewed and analyzed. There were 139 vehicle-bicycle crashes during the six-year span shown in Figure 22, yielding an average of 23

[18]Mineta Transportation Institute Report 11-19. *Low stress Bicycling and Network Connectivity.* May 2012. Analysis Procedures Manual Chapter 14.4, ODOT. December 2017.

serious crashes per year. For comparison to similar sized cities in Oregon (cities of 50,000 to 110,000 population, the number of annual crashes involving pedestrians each year in Bend is higher on a per-capita basis. Organized by location, 17% occurred at traffic signals, 9% occurred at roundabouts, 48% occurred at stop-controlled intersections and the remaining 26% occurred away from intersections.

The majority of vehicle-bicycle crashes (85%) involved a crossing or turning movement. About half of these involved either the bicycle or vehicle in the act of a turning maneuver while the other half of these involved either the bicycle or vehicle crossing a roadway (e.g. a vehicle traveling north to south colliding with a bicycle traveling east to west on the intersecting street).

There were 12 (9%) vehicle-bicycle crashes that occurred at single-lane roundabouts due to failing to yield right-of-way or following too closely. The remaining 6% of all vehicle-bicycle crashes involved rear-end, sideswipe, backing or parking collision types.

Of the 139 vehicle-bicycle crashes, there were two fatalities, 125 injuries, and 12 PDO crashes. One fatality occurred during the day and the crash was attributed to reckless driving, although the roadway was an unimproved arterial roadway with no bike lane, curb, or sidewalk. The second fatality occurred during dusk and the cyclists was illegally in the roadway and not visible (e.g. wearing dark or non-reflective clothing).

Figure 22 shows the majority of vehicle-bicycle crashes occurred on arterial and collector streets, most of which have dedicated bicycle facilities, but those facilities need to be modernized to prevent vehicle-bicycle crashes. Either the driver or cyclists failing to yield right of way was the crash cause in approximately 70% of these crashes. While this crash causation appears to be human error, the design of roadways, intersections, and crossings also contribute to the crash occurrence. The City is developing a Bicycle Facilities Design Guide to adjust designs to help prevent these crashes.

Figure 21: Bend and BMPO Existing Bicycle Level of Traffic Stress

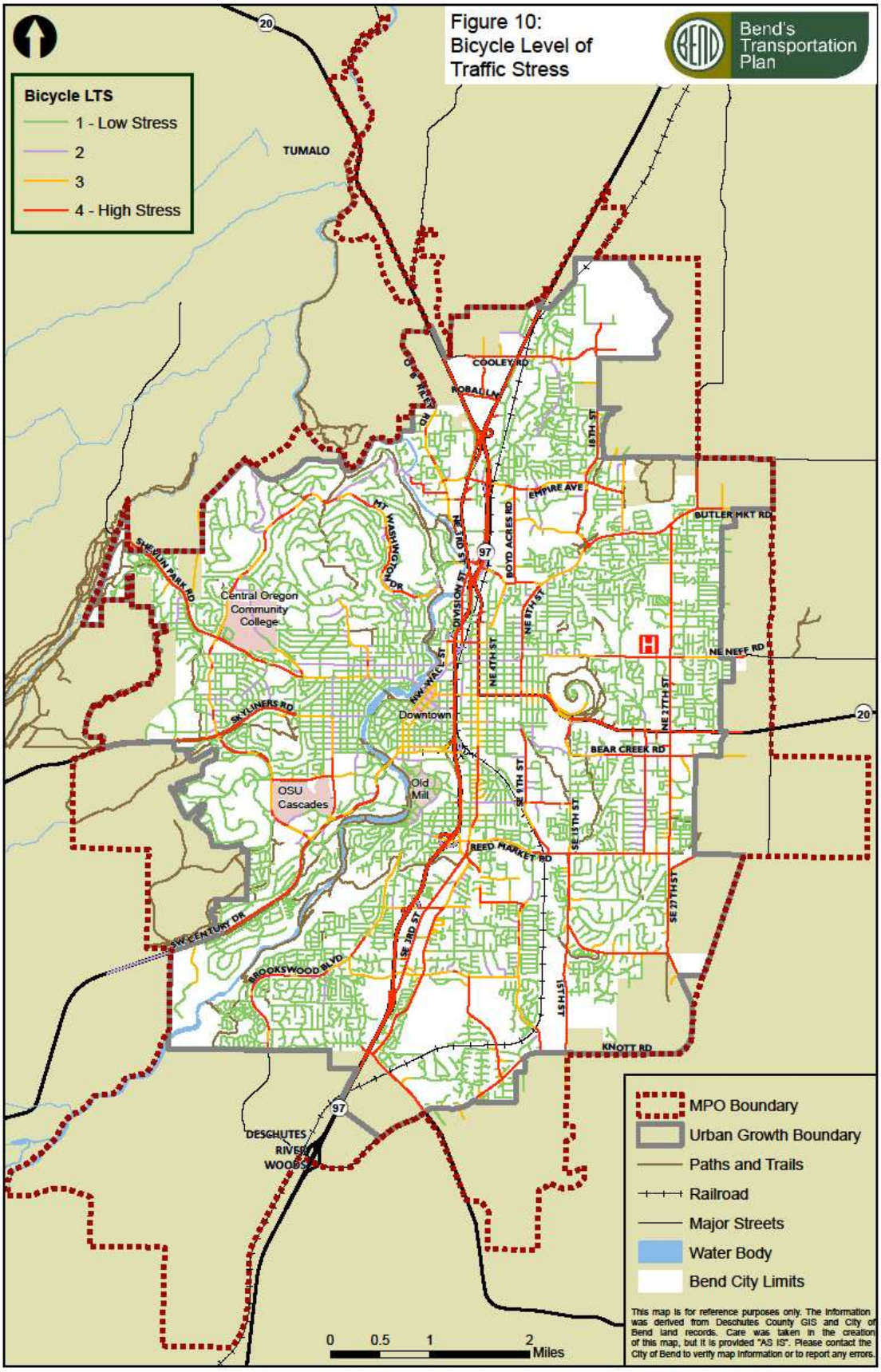
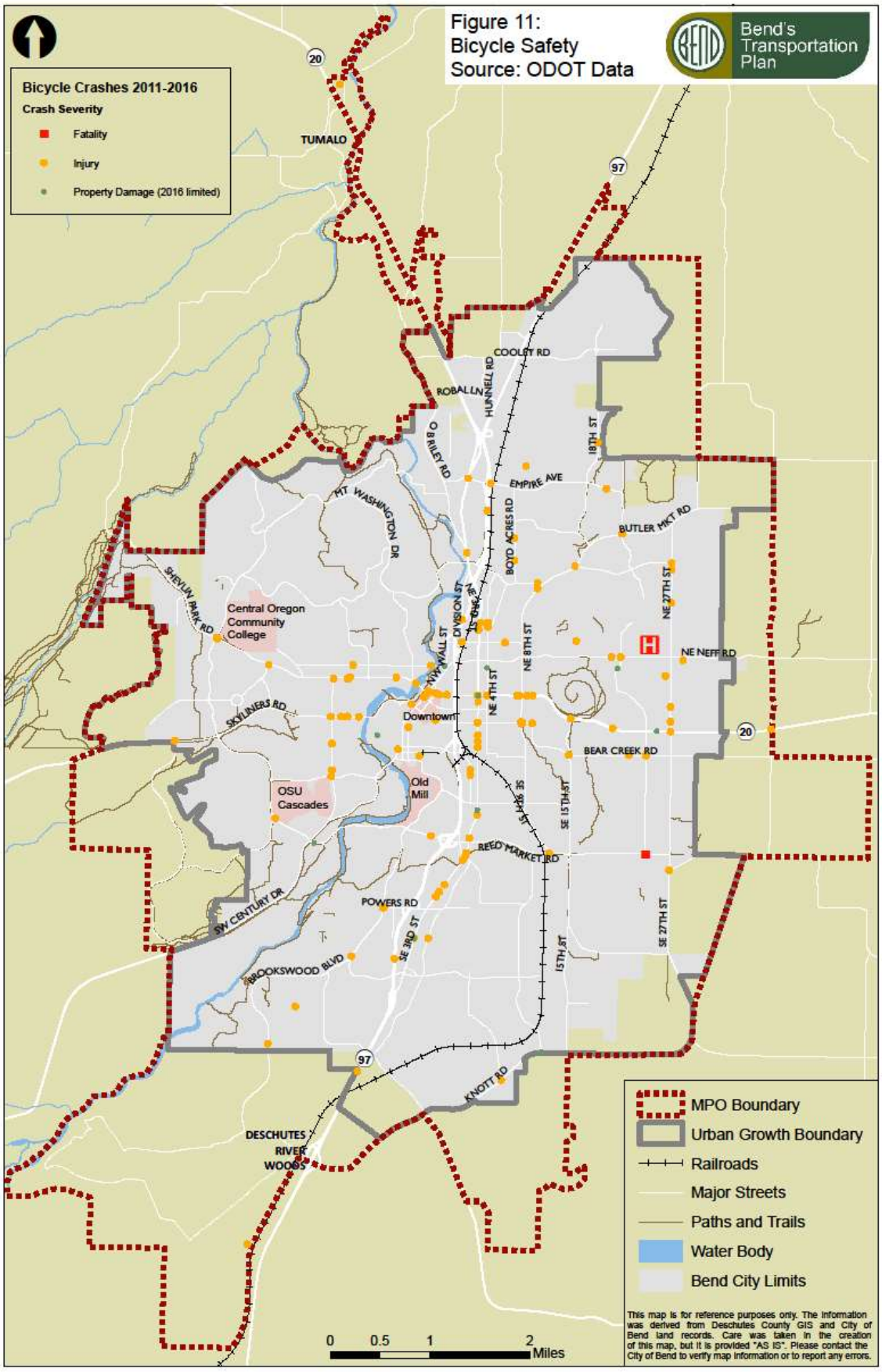


Figure 22: Bend and BMPO Vehicle-Bicycle Crashes (2011-2016)



Key bicycle system findings include:

Connectivity:

- **Regional-level bicycle corridor connectivity is limited by major barriers including US 97, US 20, 3rd Street, the railroad tracks, and the Deschutes River. Seven gaps in the regional arterial and collector network were identified.**
- **Approximately 82% of arterial and collector roadways have dedicated bicycle facilities**

Access:

- **Several major corridors in the "core area" are lacking dedicated bicycle facilities, including 3rd Street, 4th Street, Greenwood Avenue, Bond Street, Wall Street, and Hawthorne Avenue.**
- **Corridors near the fringes of the urban area are lacking dedicated bicycle facilities.**

User Environment:

- **Approximately 54% of arterial and collector roadways are highly stressful environments for cyclists (lacking separation/buffer along high-speed/high-volume roadways).**
- **Many of these highly stressful environments for people riding are near key destinations including COCC, OSU Cascades, St. Charles Medical Center, schools, and downtown Bend.**

Safety:

- **Crashes involving bicycles tend to be on multi-lane, high volume facilities without dedicated or protected bicycle facilities.**

Freight

Truck Freight

The movement of raw and finished goods plays a vital role in the economy. The majority of these goods are transported via motor carrier; therefore, efficient truck mobility is crucial to economic vitality. The designation of through truck routes provides for this efficient movement while at the same time maintaining neighborhood livability, public safety, and minimizing maintenance costs of the roadway system. There are two designated truck routes within the study area, US 97 (Bend Parkway) and US 20.

US 97 is the key north-south connection for Central Oregon. It provides connections between California and Washington and is the primary route between regional destinations from The Dalles to Klamath Falls. US 97 is classified by ODOT[19] as a Statewide Highway and has been designated as a part of the National Highway System, a Federally Designated Truck Route, a State Freight Route, an Expressway, and a Reduction Review Route[20]. The segment from milepoint 134.67 to 141.91 (south of Robal Road to south of the Murphy Road interchange) has also been designated as a Truck Bypass.[21] Oregon Transportation Commission (OTC) designated bypasses to maintain and increase mobility of through traffic and relieve congestion in downtown areas.[23] Within the bypassed area, US 97 is known as the Bend Parkway. Once US 97 becomes the Bend Parkway, 3rd Street, which runs parallel to the Parkway, becomes US 20 (north of Greenwood Avenue)/US 97 Business Route. As a parallel route to I-5, US 97/Bend Parkway also offers critical resiliency to Oregon's freight network and is designated a Tier 1/Phase 1 Lifeline Route in case of a major seismic event.

The Bend Parkway also is designated as an Expressway, with a primary function of providing travel between communities and connections to recreation areas with minimal interruptions, recognizing Bend as a key destination for key regional and economic drivers

US 20 (McKenzie-Bend Highway) is classified by ODOT as a Statewide Highway and has been designated as a part of the National Highway System. It is also designated as a Reduction Review Route (which limits the ability to narrow the roadway in order to protect oversize load mobility). In addition, US 20 (McKenzie-Bend Highway) between Tumalo and Empire Avenue has been designated a Federally Designated Truck Route, a State Freight Route and an Expressway.

US 20 (Central Oregon), also known as Greenwood Avenue, is classified by ODOT[22] as a Statewide Highway and has been designated as a part of the National Highway System, a Federally Designated Truck Route, a State Freight Route and Reduction Review Route.

Table 4 summarizes available 2017 truck freight volumes based on data collected at permanent ODOT ATR stations within the City of Bend.

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19 *1999 Oregon Highway Plan*, ODOT, May 1999.

20 As a Reduction Review Route, these state highways are subject to review during planning, project development, development review, and maintenance for any proposed actions that would permanently reduce the vehicle-carrying capacity of the highway.

21 A short segment from Milepoint 141.12 to 141.86 does not appear to be designated as a Bypass.

22 *1999 Oregon Highway Plan*, ODOT, May 1999.

Table 4: Existing Truck Volumes on Freight Routes within the Bend and BMPO Area

Route	Automatic Traffic Recorder Location	2017 Average Daily Traffic	Truck ADT	Truck %
US 20	0.47 mile north northwest of Innes Market Road (about 5 miles north of Tumalo)	10,800	1,500	13.8
US 20	1.49 miles east of Powell Butte Road	3,000	800	26.5
US 97	0.49 mile south of Empire Avenue	52,100	4,600	8.9
US 97	0.23 mile south of Revere Avenue	49,500	4,400	8.9
US 97	0.07 mile north of Pinebrook Boulevard	19,900	1,900	9.4
US 97	0.17 mile south of China Hat Road	25,100	1,900	7.59

Truck Route Connectivity and Access

Streets designated as Freight Routes in the study area are recognized as being appropriate and commonly traveled corridors for truck passage. Decisions affecting maintenance, operation, or construction on a designated freight route must address potential impacts on the safe and efficient movement of truck traffic. However, the intent is not to compromise the safety of other street users to accommodate truck traffic, especially in areas where many conflicts with vulnerable travelers (e.g., people walking and biking) may be present. There are a few locations within the study area that may benefit from a local truck route designation such as the Juniper Ridge area, the City's largest (and mostly undeveloped) industrial and business park area, or Butler-Brinson area.

Critical Urban Freight Corridor

In addition to ODOT's truck freight classifications, the MTP identified six miles of Critical Urban Fright Corridors (CUFC). CUFCs are one component of the National Highway Freight Network that provide critical connectivity. The CUFC designation helps to prioritize and allocate limited federal funding to improve system performance and efficient movement of freight. There are several criteria that must be met for a corridor to be granted this designation. Federal Highway Administration (FHWA) encourages States to consider first and last mile connections between freight corridors and freight intensive land such as ports and rail terminals.

The following segments have been adopted by Oregon Transportation Commission (OTC) and identified in the Oregon Freight Plan[23] as CUFCs in the study area:

- US 97 between Bend City Limits (north) and Empire Avenue

[23] Oregon Freight Plan, ODOT, Adopted June 15, 2011 (Revised November 17, 2017).

- US 20 between Cooley Road and US 97 Southbound On-Ramp at Division Street
- US 20 between Webster Street and Greenwood Avenue
- US 20 between 3rd Street and 8th Street
- Empire Avenue between US 20 and US 97 Northbound Ramps
- US 20 at Old Bend Redmond Highway

Truck Route Performance

The congestion issues on 3rd Street (US 20) create issues for freight travel along this freight route, requiring trucks to stop at most signalized intersections. The southbound left turn movement at US 20 (3rd Street) and Greenwood Avenue operates at capacity during the p.m. peak hour, impacting trucks using the US 20 freight route. Oregon Freight Highway Bottlenecks Project identified this corridor as a tier 2 bottleneck, which indicates this route experiences significant freight truck delay, unreliability and increased transportation costs.

The lack of adequate bicycle facilities on 3rd Street (US 20) also increases safety issues related to truck and bicycle conflicts.

Congestion at Cooley Road/Robal Road and US 97 intersection impact corridor travel time reliability for freight using the US 97 route.

Rail Freight

BNSF and Union Pacific currently operate manifest trains, which carry a variety of boxcars, tanker cars, lumbers, etc., through the study area. The rail track, owned by BNSF, runs parallel to US 97 at the north city limits before veering east just south of Colorado Avenue towards the industrial zone. The rail track is regulated under the Federal Railroad Administrations Class 1, 2, 3 and 4 track standards. In this, there are no weight or dimensional restrictions for freight movements through the study area.

Intersections of the rail track and roadways can create operational and safety issues. Currently, there are a total of 19 crossings. Of these, 11 are at-grade crossings featuring active traffic control devices (automatic gates). Of the remaining grade-separated crossings, 4 are over grade crossings where the railway travels over the roadway and 4 are under grade crossings where the roadway spans over the railway.

For the most part, grade separated crossings are preferred as they proved a safe crossing opportunity and eliminate large traffic delays. For example, the Reed Market Road at grade crossing has been a source of motor vehicle traffic delay during the p.m. peak hour. During field observations[24], vehicle queues westbound on Reed Market Road extended back to 15th Street and beyond. This particular at-grade rail crossing on Reed Market Road is challenging because it is next to a switch yard and the switching events are random. The delays resulting from at-grade rail crossing impact emergency vehicle access and travel time reliability.

[24] Field observations completed between 4:00 and 6:00 p.m. on April 19, 2018.

Key freight system findings include:

Connectivity:

- **Off of the state highway system, few local routes are identified as freight routes. Identification of local truck freight routes could help prioritize/protect the movement of truck traffic in key areas.**
- **There are 11 at-grade rail crossings with automatic gates and 8 grade-separated rail crossings (4 over crossings and 4 under crossings).**
- **At-grade rail crossings can be a major source of motor vehicle traffic delay, such as the crossing on Reed Market Road at 9th Street.**

Resilience:

- **US 97 is a critical truck route in the statewide Lifeline network, providing an alternative route to I-5.**

Congestion:

- **US 20 (3rd Street) queuing and signal delays impact freight movement**
- **Travel Time Reliability issues impact freight movement on US 97 in the Cooley/Robal area**
- **Rail movements on Reed Market Road can create vehicle congestion**

Safety:

- **Truck/Bicycle conflicts occur along US 20 (3rd Street)**

Intelligent Transportation Systems

The existing Intelligent Transportation Systems (ITS) inventory from the Deschutes County ITS Plan[25] is shown in Figure 23.

ODOT Region 4 in Bend currently houses several ITS systems, including remote weather information systems, video detection cameras, closed circuit television (CCTV) cameras, and an oversize vehicle closure telephone system. These are all monitored and managed by the Bend Traffic Operations Center which is currently suited to successfully carry out tasks in incident management, emergency management, traffic management, traveler information, winter operations, and maintenance operations.

Seven CCTV cameras are currently installed along US 97 (Bend Parkway). These cameras are used to monitor current traffic conditions and aid with incident, emergency, and traffic management strategies. There is one variable message sign located on US 97, south of China Hat/Baker Road. Currently there are four ODOT and five City of Bend ATR recorder stations within the study area. These are located on US 97 and US 20, and on the key east-west river crossing connections. Weather stations are used in an effort to aid travelers and maintenance crews in adverse weather conditions. There are two weather stations located in Bend in the northern part of the city. Typical measurements include air and pavement temperature, precipitation, wind speed and direction, and humidity. With the addition of new traffic signals and modifications, video detection systems are becoming more common. These units take the place of inductive loop detectors to allow for actuated traffic signal operations. A large sum of information reported from these field devices is broadcasted to the public via ODOT's Trip Check website[26].

The following needs were identified in the Deschutes County ITS Plan:

- Traffic Operations and Management
  - Automate, collect and disseminate real-time traffic conditions information (e.g. congestion/incident detection)
  - Remote, continuous access to real-time data (e.g. traffic signals, detectors)
  - Traffic signal timing improvements (e.g. coordination on 27th Street and signal transition during a railroad priority call)
  - Update interconnect and available conduit inventory
- Incident Management
  - Automate vehicle height detection warning system for 3rd Street railroad undercrossing
  - Address lack of alternate routes for US 97
  - Provide advanced information, communicate alternative routes
  - Lack of shoulders on Parkway increases incident delay
  - Improve safety for incident responders

[25] Deschutes County ITS Plan, DKS Associates, June 2011.

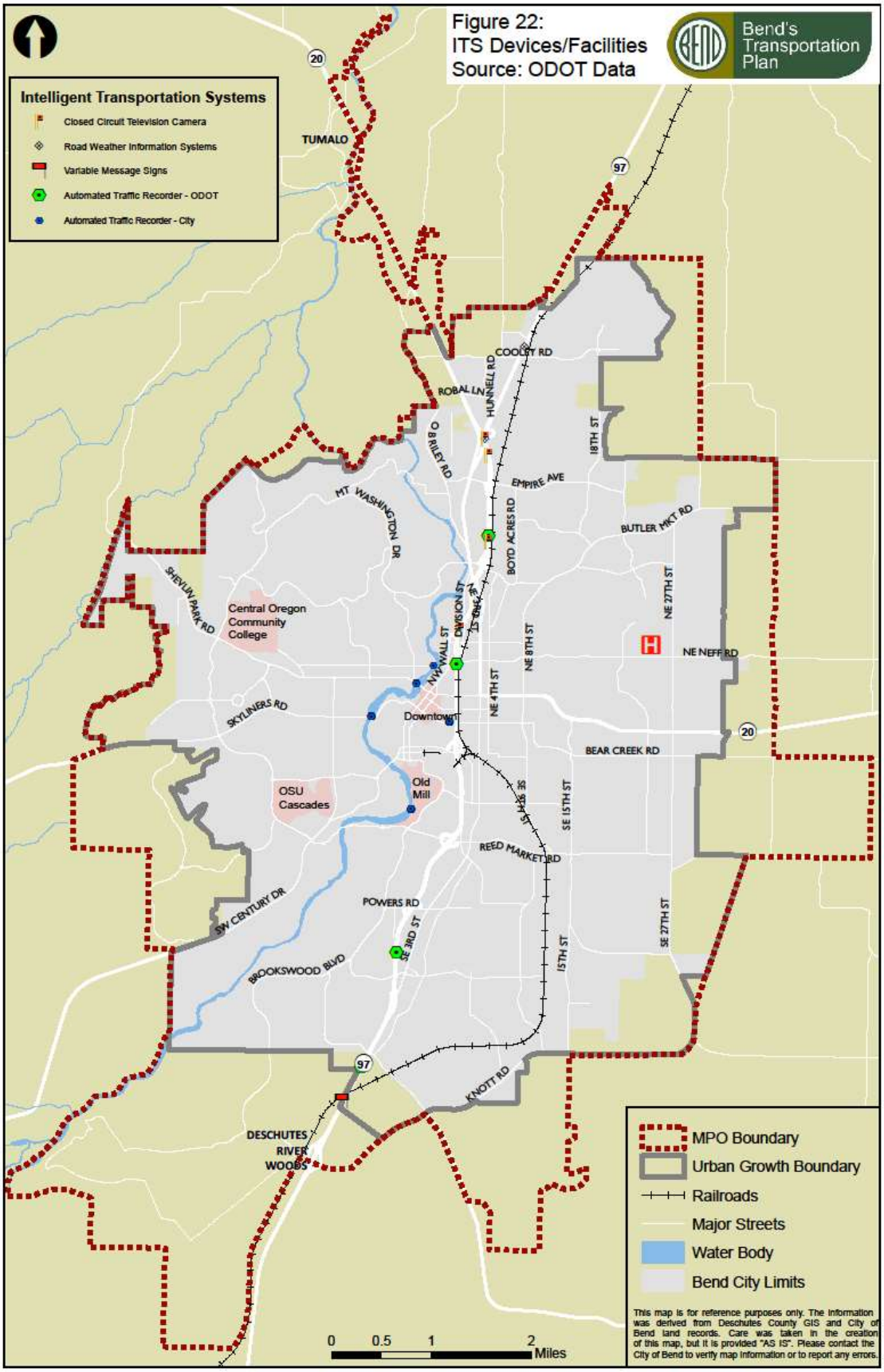
[26] ODOT, TripCheck (https://www.tripcheck.com)

- Special Events
  - Need traffic control plans and shuttles for special events
- Traveler Information
  - Provide real-time traveler information (e.g. at key decision points, weather information)
- Public Transportation Management
  - Maintain transit travel time reliability and provide transit arrival information
  - Implement transit signal priority
  - Encourage transit use to Mt. Bachelor to reduce congestion issues on Century Drive.
- Emergency Management
  - Reduce emergency response times
  - Provide advance information about rail crossings for fire response and or during an evacuation
  - Identify evacuation routes
  - Driver education at roundabouts for yielding to emergency vehicles

Key transportation system issues for ITS include:

- **Lack of access to real-time traffic conditions to improve incident response, emergency vehicle access, transit travel time reliability, and safety**
- **Lack of real-time traveler information at key decision points including travel time, weather information and special event information**
- **Limited traffic signal timing enhancements such as signal coordination, transit signal priority and signal transition during a railroad priority call (signal changes timing when a train is approaching)**
- **Lack of up-to-date ITS inventory including device types and locations and available conduit inventory**

Figure 23: Bend and BMPO Intelligent Transportation System Devices/Facilities



Transportation Demand Management

Commute Options, a local non-profit agency, contracts with several entities to coordinate travel options and transportation demand management activities in Central Oregon. Commute Options provides the following TDM-related services:

- Coordinates the Drive Less Connect on-line program
- Coordinate the Drive Less Challenge
- Works with CET to promote transit ridership, including the group pass sales program.

Provides information to the public, employers and their employees on TDM activities. The Bend Development Code (4.7.400 (3)) allows a project applicant to reduce net new trip generation for a proposed development by developing a detailed TDM program. The TDM program must show that the proposed trip reductions will reduce the proposed development's trips and demonstrate that there are adequate resources to manage and maintain the proposed TDM program. The proposed elements of the TDM program are evaluated by the City to determine trip reduction rates. A maximum trip reduction of 25% is allowed for combined TDM program elements. The TDM Trip Reductions table identifies 5% trip reductions allowed to be taken to the trip generation by providing:

- Employee showers, lockers, and secure indoor bike parking;
- No more than the minimum required parking and achieves that by providing the maximum permitted on-street parking and/or using shared parking agreements
- A minimum of 5% of the overall required parking for free priority parking for carpools/vanpools designated by signs

A project can also can get 10% trip reduction by:

- Being located within ¼ mile of a transit line if the employer participated in CET's Group Bus Program
- Charges the actual cost of providing off-street parking and provides free parking to car/vanpools
- Participating in a TDM incentive program

COCC and Juniper Ridge are both special districts within Bend that have Overlay Zones, including trip reduction programs (see Bend Development Code, Section 2.7.1000 and 2000).Other Modes

Waterways

The Deschutes River flows through the study area and serves as a scenic and recreational waterway. The river has several dams and does not play a role in the transportation of people or freight. In addition, the study area has several large irrigation canals, both covered and uncovered, that in some locations act as barriers or neighborhood definition features. There are also existing and planned trails along some of the canals.

Pipeline Facilities

Two major natural gas transmission lines, operated by Pacific Gas & Electric Transmission-Northwest, pass through Bend. These transmission pipelines extend north-south through the

state and are located approximately 1 to 2 miles east of the Bend urban area. Cascade Natural Gas provides the natural gas service to the city of Bend. No other major utility pipelines serve or pass through the Bend urban area.

Air Facilities

The Bend Municipal Airport (Airport Identifier BDN) is located at 63136 Powell Butte Highway, approximately three miles northeast of city limits. It is a non-towered airport and classified as a Category 2 – Business or High Activity General Aviation Airport with a single 5,260-foot runway. In this, there is no scheduled passenger service to/from the airport. In addition, a separate eight-acre Helicopter Operations Area was constructed in 2017.

The existing runway was reconstructed in 2007. Approximately 240 aircraft in combination with 18 aviation type businesses are currently based at the airport. The airport was established in 1942 in response to World War II training efforts.

The Bend Airport Master Plan[27] found runway extension, pavement maintenance (runway, taxiways, and airport aprons), hangar facilities, navigational aids and lighting, fuel storage, fencing and improving internal roadways to be key needs over the next twenty years. The Oregon Aviation Plan also found similar needs identified in the Bend Airport Master Plan.

Pilot Butte Airport (Airport Identifier 8OR5) is a private use airstrip located south of Pilot Butte in the City of Bend. It consists of a 20-foot wide by 2,400-foot asphalt runway.

Key Other Mode system findings include:

Connectivity:

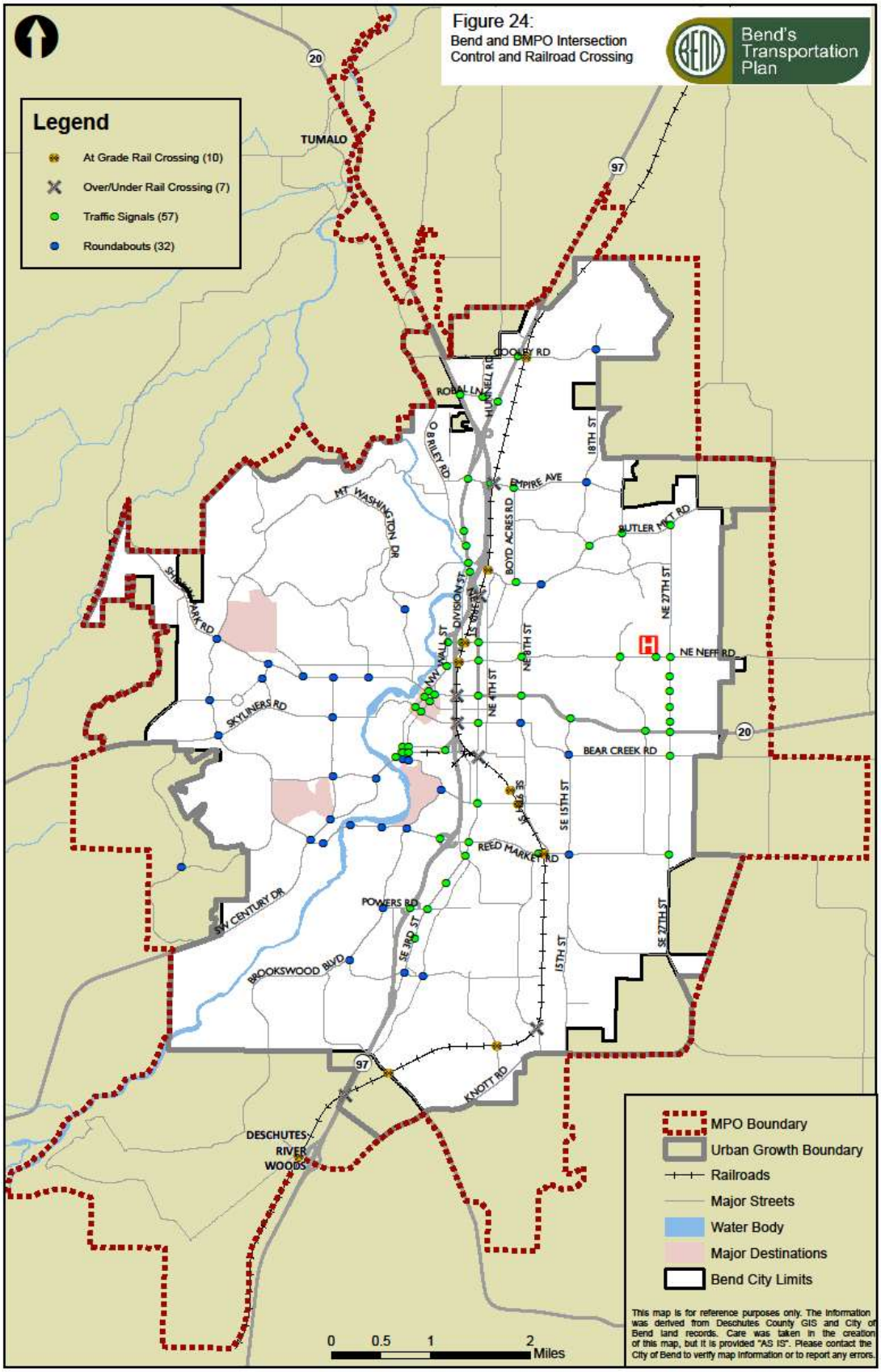
- **Butler Market Road provides a key connection between the BMPO area and the Bend Municipal Airport.**

Access:

- **There is a lack of public transit options to the airport, but there are new transportation network companies providing service (e.g. Uber and Lyft)**

[27] Bend Municipal Airport: Airport Master Plan Update, Century West Engineering Corporation, October 2013.

Figure 24: Bend and BMPO Intersection Control and Railroad Crossings



Environmental Considerations

The existing MTP includes and a detail environmental considerations chapter that includes a high-level screening of certain environmental features that may be affected by the plan (relative to the construction of new facilities). The environmental data contained in the chapter were originally collected in 2007 (https://www.bendoregon.gov/Home/ShowDocument?id=18133). The intent of the chapter is to address environmental considerations early in the transportation planning process to help ensure environmental impacts from transportation projects are minimized reducing overall project costs and impacts. However, the evaluation does not replace a full Environmental Impact Analysis that may be required for significant regional projects. The chapter addresses: Water Resources; Fish, Wildlife & Habitat Resources; Hazards; Climate Change; Air Quality; Scenic Resources; Historic and Cultural Preservation; Recreation Resources; Environmental Justice; and Noise.

While the BMPO is highly scenic and has significant environmental resources, there are relatively few identified conflicts between the proposed MTP transportation projects and environmental resources. This is primarily due to the small number of rivers, streams and wetlands; an historic absence of anadromous fish; and the nature of the transportation projects proposed. The transportation projects proposed consist primarily of improvements to existing roads. There are few new roads proposed. This could change in the future and the information in this document and the map layers gathered should provide information necessary for analysis of future planning efforts. The major environmental conflict from transportation projects is storm water runoff. Storm water runoff impacts fish and wildlife, water quality, and results in flooding of major intersections. Other potential conflicts include wildlife crossings, air quality and climate change, and restricted lands.

Wildfire evacuation and network resiliency are other important environmental factors to consider. Since the location of a wildfire is unpredictable, all routes throughout the entire study area are key emergency fire evacuation routes. It is important to provide and identify alternative routes for emergency evacuation. One critical location is the Deschutes River Woods area, which currently only has one main entrance/exit point (Baker Road via US 97). During an emergency evacuation of the Deschutes River Woods area, US 97 can be temporarily closed in both directions to allow the residents to quickly evacuate. There is an emergency access road, Frank Pennock Lane, between Cheyenne Road and US 97, near Comanche Lane, that can be opened during the evacuation. Most other locations in the study area have more than one evacuation route.

Key environmental consideration findings include:

Resilience:

- **Emergency evacuation routes include all major corridors due to the random nature of wildfire risk.**

Safety:

- **Wildlife crossing locations in the fringe areas of the study area can be vulnerable areas for both residents and animals.**