U.S. 97: South Parkway Murphy Interchange Interchange Area Management Plan

FINAL

Technical Memorandum #3

Transportation Facilities and Traffic Operations Existing Conditions

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October 2006

LIST OF ACRONYMS

ADT	Average Daily Traffic
ATR	Automatic Traffic Recorder
BAT	Bend Area Transit
CIP	Capital Improvement Plan
DHV	Design Hour Volumes
FY	Fiscal Year
HCS	Highway Capacity Software
HDM	Highway Design Manual
IAMP	Interchange Area Management Plan
IMSA	Interchange Management Study Area
LOS	Level of Service
MEV	Million Entering Vehicles
MP	Mile Post
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
MVMT	Million Vehicle Miles Traveled
NHS	National Highway System
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
PDO	Property Damage Only
ROW	Right of Way
SBPRS	South Bend Parkway Refinement Study
SIP	Safety Investment Program
SPIS	Safety Priority Index System
TEV	Total Entering Volume
TPAU	Transportation Planning Analysis Unit
TSP	Transportation System Plan
TWSC	Two-Way Stop-Controlled
UGB	Urban Growth Boundary
v/c	Volume to capacity
VMS	Variable Message Sign

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Executive Summary

The purpose of Technical Memorandum #3 is to summarize and develop background information about the transportation system in the Interchange Management Study Area (IMSA) of the U.S. 97: South Parkway Murphy Interchange. The information described in this memorandum is based on information provided by staff from the Oregon Department of Transportation (ODOT) and the City of Bend. Existing traffic counts were provided by ODOT from counts taken by both ODOT and a traffic consultant at 17 study area intersections. Safety information in the form of crash records was provided from ODOT's crash data base and from the City of Bend Police Department. The traffic counts and crash information provide the necessary data to describe existing traffic conditions along the Bend Parkway (U.S. 97) and Third Street, from Powers Road to Ponderosa/China Hat Roads, and at the on/off ramps of the Baker/Knott Road interchange.

Technical Memorandum #3 is divided into five key sections. The sections are summarized in the following paragraphs.

Physical Features Summary

A general description of roadway facilities is summarized in this section. The descriptions include street classification, lane configuration, posted speed, and whether the facility has sidewalks or bike paths. A description of lane configuration and type of traffic control is provided for key intersections. The distances between the existing intersections and interchanges along the Bend Parkway are described. Currently all of the intersections and interchanges do not meet spacing standards as described in the 1999 Oregon Highway Plan (OHP).

Traffic Operations Analysis

This section assesses the current traffic operations (Year 2005) at key study area intersections using the 30th highest hour design hour traffic volumes per procedures developed by ODOT's Transportation Planning Analysis Unit (TPAU). The intersection traffic operations were analyzed using the Synchro analysis software package, which is a macroscopic model similar to the Highway Capacity Software (HCS), and like the HCS, is based on the methodologies outlined in the 2000 Highway Capacity Manual. The analysis investigated volume to capacity (v/c) ratios, average delay per vehicle, and queuing at the study area intersections. Intersection operations are compared with applicable ODOT operational and mobility standards and City operational standards.

The existing conditions traffic operation analysis indicates most of the study area intersections meet applicable standards with three exceptions: U.S. 97 at Powers Road; U.S. 97 at SE Third Street; and U.S. 97 at Ponderosa Road/China Hat Road. The results of the analysis for these intersections are shown in Table A.

As seen in Table A, the three aforementioned intersections do not meet the OHP or the Highway Design Manual (HDM) mobility standards for the v/c ratio requirements. As an intersection approaches capacity, its ability to serve traffic demand begins to break down, often resulting in longer queues and average delay.

TABLE A: KEY INTERSECTION TRAFFIC OPERATIONS ANALYSIS RESULTS FOR EXISTING (YEAR 2005) 30TH HIGHEST HOUR						
Intersection		**Critical Movement**	**v/c Ratio**	**LOS**	**OHP Std.[1]**	**HDM Std.[2]**
3	U.S. 97 @ Powers Rd.	n/a[4]	**0.95**	B	0.80	0.75
14	U.S. 97 @ 3rd St.	n/a[4]	**0.91**	B	0.80	0.75
15	U.S. 97 @ Ponderosa Rd./China Hat Rd.	WBL/T	0.59	E	0.90	0.75
		WBR	0.59	A	0.90	0.75
		EBL/T	**>1.0**	**F**	0.90	0.75
		EBR	**>1.0**	**F**	0.90	0.75

Notes:
1. 1999 Oregon Highway Plan Mobility Standards (Table 6)
2. 2003 ODOT Highway Design Manual Mobility Standards (Table 10-1)
3. Operational standards for City of Bend roadway facilities (Source: City of Bend Development Code Chapter 4.7). Shown as v/c ratio (seconds of delay)
4. Signalized intersection. LOS and v/c are for overall intersection.

Signal Warrants

The unsignalized intersections studied in the IMSA were analyzed as to whether they met possible signal warrants. The signal warrants are based on the 2003 Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD provides a series of eight signal warrants that consider different traffic conditions under which a signal may be warranted. The analysis indicates that two intersections meet signal warrants:

- *U.S. 97 at Ponderosa Road/China Hat Road:* This intersection meets both Signal Warrants 1 and 2; however, long term proposals for this intersection include converting the intersection to right-in/right-out with acceleration lanes, or constructing an overpass of U.S. 97.
- *Third Street at Pinebrook Boulevard:* This intersection also meets Warrant 1 and Warrant 2 as described in the MUTCD. Currently the spacing between Pinebrook Boulevard and Murphy Road is less than 400 ft and may not meet spacing requirements. With the proposal for Murphy Road to be relocated to the south away from Pinebrook Boulevard, it is proposed this location be reassessed at that time.

Safety Summary

A summary of crash information at the key intersections and along roadway segments is provided. The crash information was obtained from ODOT and the City of Bend, for U.S. 97 from Powers Road to the Baker/Knott Road interchange, and along Third Street from Powers Road to the intersection with U.S. 97.

The intersection crash rate along the U.S. 97 Parkway, and along Third Street, indicated the intersection rates are below the 1.0 crash rate, which is a rate at which a location is potentially problematic and a candidate for further investigation.

Segment crash rates indicate that U.S. 97 from Powers Road to the Third Street intersection has a crash rate of 1.26, which exceeds the 0.78 comparable state average for U.S. 97. The proposed Build Alternative H-Modified, Option 1 (as defined in the South Bend Parkway Refinement Study) would significantly reduce the crashes along the Parkway. For the section of U.S. 97 south of the Third

Street intersection, ODOT staff has prepared a proposal for an approximate $4.5 million preservation/safety project that would reduce accidents along this section.

Summary of Planned and Programmed Projects

A summary description of planned/programmed transportation projects is included in this section. The projects described include roadway, transit, bicycle, and pedestrian projects within the IMSA.

1. Physical Features Summary

1.1 Existing Study Area Transportation Facilities

The South Parkway Murphy Crossing Interchange Area Management Plan (IAMP) covers an area east and west of the U.S. 97/Bend Parkway alignment, from Powers Road to Baker Road. With the opening of the southern section of the U.S. 97 Bend Parkway for traffic in August of 2001, traffic shifted on the street network in the study area. The transportation analysis task addresses several key intersections within the IAMP study area. **Figure 1** indicates the street system in the study area, the type of traffic control at the intersections, and identifies the key intersections to be analyzed as part of the IAMP. **Figure 2** indicates the existing lane configuration at the key intersections.

1.1.1 ODOT Roadways

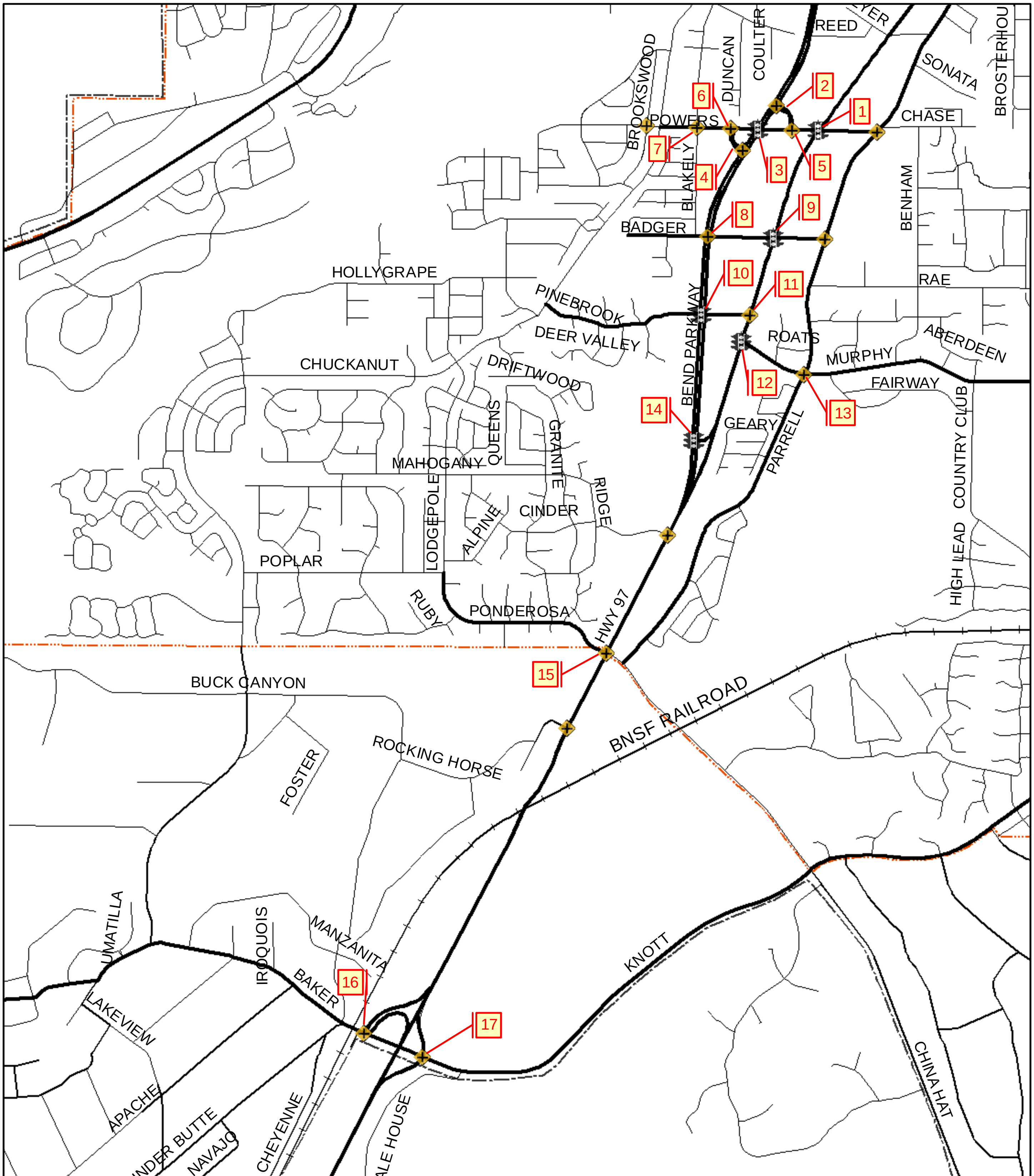
U.S. 97 Bend Parkway*:* This north/south roadway facility is under ODOT jurisdiction. The Bend Parkway is a four-lane roadway (two lanes in each direction) with a divided median and shoulders along its length. In the study area, there are three traffic signals along the U.S. 97 Parkway (at Powers Road, Pinebrook Boulevard, and Third Street), and four unsignalized intersections (at Badger Road: physically restricted to right-in/right-out, Romaine Village access: full turn movements allowed, Ponderosa/China Hat: full turn moments allowed, and Rocking Horse Road: full turn movements allowed). There is a sidewalk along the Parkway to Romaine Village Way. The posted speed is 45 miles per hour to just south of the China Hat/Ponderosa intersection, where it changes to a posted 55 miles per hour to the south through the Baker Road/Knott Road interchange.

1.1.2 City of Bend Roadways

Third Street: Old U.S. 97 (Business 97) is now under the City of Bend jurisdiction. This is a north/south facility that parallels the Bend Parkway and consists of four travel lanes and a center left turn lane from its junction at a traffic signal with U.S. 97 Parkway south of Murphy Road, through the study area beyond Powers Road. Third Street is classified as a Principle Arterial in the City of Bend Transportation System Plan (TSP) and provides multiple access points to commercial development along its corridor. Bike lanes are marked along the length of Third Street, with sidewalks typical but intermittent. The posted speed in the study area is 45 miles per hour. The posted speed drops to 35 miles per hour north of Reed Lane.

Powers Road*:* Is a two-lane east/west facility in the study area with two-way stops at Brookswood Boulevard and Parrell Road at the west and east edge of the study area, and existing traffic signals at U.S. 97 Parkway and Third Street. Bike lanes exist between Brookswood Boulevard and Third Street. Sidewalks occur along Powers Road between Third Street and the southbound U.S. 97 Parkway connection, and west of Brookswood. Powers Road is classified as a Major Collector in the City of Bend TSP. Posted speed is 25 to 35 miles per hour.

Brookswood Boulevard*:* Is outside the study area (to the west), but connects with Powers Road, Pinebrook Boulevard and Lodgepole/Ponderosa Drive. Brookswood Boulevard is classified as a Minor Arterial in the City of Bend TSP and is a two-lane facility with bike lanes and pedestrian sidewalks north of Honey Pod Way. Posted speed is 35 to 45 miles per hour.



Legend

Metropolitan Planning Organization (MPO) Boundary

Urban Growth Boundary (UGB)

0 0.35 0.7
Miles

N

Transportation

Railroad

Signalized Intersection

Unsignalized Intersection

1-17 Intersections Analyzed in IAMP

Water Features

River

Stream

Canal

South Parkway Murphy Interchange IAMP

Figure 1

Project Vicinity

N

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Legend

Intersections Analyzed in IAMP

Traffic Signal

Stop Sign

South Parkway
Murphy Interchange IAMP

Figure 2
Existing Lane Configurations and Traffic Control

***Murphy Road**:* Is an east/west facility on the east side of the U.S. 97 Parkway that creates a T-intersection with Third Street (from Parrell Road to the east) at a traffic signal. Murphy Road is a two-lane facility with bike lanes in the study area and is classified as a Major Collector in the City of Bend TSP. The posted speed is 35 miles per hour.

***Parrell Road**:* Is a north/south roadway on the east side of the study area that connects between Brosterhouse Road on the north and China Hat Road on the south. Currently there are stops along Parrell Road at Murphy Road and China Hat Road. Parrell Road is a two-lane facility that is classified as a Major Collector in the City of Bend TSP. There are existing bike lanes along Parrell Road between Murphy Road and Powers Road. Sidewalks are typical but intermittent along this facility. The posted speed is 40 miles per hour in the study area.

Lodgepole Drive/Ponderosa Road/China Hat Road: These street sections generally run east/west and connect between Brookswood Boulevard on the west, through the study area to the east to Knott Road. These facilities are two-lane roadways with bike lanes on China Hat Road. Sidewalks are intermittent along these roadways. Lodgepole Drive/Ponderosa Road/China Hat Road is classified as a Major Collector in the City of Bend TSP. Posted speed is 25 miles per hour.

***Badger Road**:* Is a short east/west street section that connects between Parrell Road on the east side of the study area to Blakely Road just west of the U.S. 97 Parkway, and ends in the neighborhood area west of Blakely Road. Currently along Badger Road, there is a signal at Third Street, a stop sign at Parrell Road, and a stop with right-in and right-out only at the U.S. 97 Parkway. Badger Road has bike lanes between Third Street and the Parkway, and sidewalks are typical along its length. Badger Road is classified as a local road in the City of Bend TSP. The posted speed is 25 miles per hour.

***Pinebrook Boulevard**:* Is a short two-lane east/west street connection that currently runs from Brookswood Boulevard west of the study area to Third Street east of U.S. 97 Parkway. Currently, Pinebrook Boulevard has a traffic signal at the U.S. 97 Parkway, with stop signs at Brookswood Boulevard and Third Street. Bike lanes exist from Third Street to west of the U.S. 97 Parkway, and sidewalks are intermittent. Pinebrook Boulevard is a local road in the City of Bend TSP.

***Romaine Village Way**:* This is a local street connection between a residential area to the west of the U.S. 97 Parkway, and connects with U.S. 97 as a stop controlled T-intersection, with full access to and from U.S. 97. The facility has marked bike lanes and a sidewalk. This roadway is classified as a local road in the City of Bend TSP.

1.1.3 Deschutes County Roadways:

Rocking Horse Road: This County roadway runs from Buck Canyon Road to the west and comes to a T-intersection with U.S. 97 on the east, between China Hat Road and the Burlington Northern Santa Fe Railroad Crossing. Currently Rocking Horse Road has full access to U.S. 97 and there is a northbound left turn lane from U.S. 97 to westbound Rocking Horse Road.

***Baker Road/Knott Road**:* These roadway facilities typically run east/west. Baker Road connects to the west with Brookswood Boulevard and continues to the west, and to the east connects to U.S. 97 at a full interchange connection. Knott Road connects with Baker Road at the east side of the U.S. 97 interchange. The Deschutes County TSP has identified Baker Road, from the U.S. 97 intersection to the Brookswood Boulevard intersection, for a future functional classification upgrade from Rural

Collector to Rural Arterial. Baker Road (west of U.S. 97) has a posted speed of 35 miles per hour. Knott Road (east of U.S. 97) has a posted speed of 50 miles per hour. Both roadways have bike lanes.

1.1.4 Railroad Facilities

Burlington Northern Santa Fe Rail Road: This railroad facility crosses China Hat Road at-grade, crosses over U.S. 97 (grade separated structure), and crosses Baker Road at-grade west of the U.S. 97 southbound on/off ramp junction.

TABLE 1: SUMMARY OF TRANSPORTATION FACILITIES IN THE TRANSPORTATION ANALYSIS AREA

Roadway Name	Agency Jurisdiction	Roadway Classification	Number of Travel Lanes	Side-walks	Bike Lanes	Posted Speed
U.S. 97 Bend Parkway	ODOT	Expressway	4 lane Divided Hwy	Intermittent	Shoulder Area	45 mph - 55 mph
Third St.	City of Bend	Principal Arterial	5	Intermittent	Yes	45 mph
Powers Rd.	City of Bend	Major Collector	2	Intermittent	Intermittent	35 mph
Brookswood Blvd.	City of Bend	Minor Arterial	2	North of Honey Pod Way	North of Honey Pod Way	35 mph
Murphy Rd.	City of Bend	Major Collector	2	No	Yes	35 mph
Parrell Rd.	City of Bend	Major Collector	2	Typically One side	Yes Powers-Murphy Planned Murphy-China Hat	40 mph
Lodgepole Dr.- Ponderosa Rd.- China Hat Rd.	City of Bend	Major Collectors	2	Intermittent	Planned Currently Intermittent	25 mph
Badger Rd.	City of Bend	Local Road	2	Intermittent	No	25 mph
Rocking Horse Rd.	City of Bend	Local Road	2	No	No	25 mph
Pinebrook Blvd.	City of Bend	Local Road	2	Intermittent	Yes	25 mph
Romaine Village Way	City of Bend	Local Road	2	Intermittent	Yes	25 mph
Baker Rd.- Knott Rd.	Deschutes County	Rural Collector	2	No	Yes	35 mph - 50 mph
BNSF Railroad	Burlington Northern Santa Fe	Main Line	1 main line track	NA	NA	

1.2 U.S. 97 Parkway – Existing Intersections and Spacing

There are existing standards set for signalized intersections and interchanges on expressways, as outlined in the OHP and as directed by Oregon Administrative Rule (OAR). Currently there are seven at-grade intersections and one interchange in the IAMP transportation study analysis area:

At-Grade Intersections: (1) Powers Road, (2) Badger Road, (3) Pinebrook Boulevard, (4) Third Street, (5) Romaine Village Way, (6) Ponderosa Road/China Hat Road and (7) Rockinghorse Road.

Interchange: at Baker Road/Knott Road

None of the intersections or interchanges in their current configurations meet the OHP spacing standards. **Table 2** indicates the existing intersection spacing by segment along U.S. 97.

TABLE 2: EXISTING BEND PARKWAY / U.S. 97 INTERSECTION SPACING

Segment	Approximate Spacing	Spacing Standard
Powers Rd. (MP 139.97) to Badger Rd. (MP 140.30)	1,740 Feet	2,640 Feet [1]
Badger Rd. (MP 140.30) to Pinebrook Blvd. (MP 140.52)	1,160 Feet	2,640 Feet [1]
Pinebrook Blvd. (MP 140.52) to Third St. (MP 140.87)	1,850 Feet	2,640 Feet [1]
Third St. (MP 140.87) to Romaine Village Way (MP 141.87)	1,795 Feet	2,640 Feet [1]
Note (.66 correction in MP spacing Between 141.00 and 142.00)		
Romaine Village Way (MP 141.87) to Ponderosa Rd./China Hat Rd. (MP 142.24)	1,955 Feet	2,640 Feet [1]
Ponderosa Rd./China Hat Rd. (MP 142.24) to Rockinghorse Rd. (MP 142.46)	1,160 Feet	2,640 Feet[1]
Rockinghorse Rd. (MP 142.46 to Baker Rd./Knott Rd. southbound off-ramp (approx. MP 143.18)	3,800 Feet	10,560 Feet [2]

1 Spacing Standard for at grade intersections in OHP, Table 13, Pg. 193
2 Spacing Standard for nearest interchange ramp in OHP, Table 19, Pg. 199

2. Existing Traffic Operations Analysis

This section reports on the existing traffic conditions within the study area. It describes the existing traffic volumes, seasonal factor adjustments, and intersection operations.

2.1 Existing Traffic Volumes

Existing traffic volumes for the roadways within the study area were determined using several sources of information. Sixteen-hour counts were preformed by ODOT at most of the study area intersections. The ODOT counts were supplemented by traffic counts conducted by consultants for other studies. Automatic Traffic Recorders (ATRs) within or near the study area were used in the development of 30th highest hour volumes and to estimate daily traffic at intersections. The methods of determining the traffic volumes are described in detail in this segment of the report.

2.1.1 Turning Movement Counts

Sixteen-hour traffic counts were conducted by ODOT at the following intersections:

- U.S. 97 at NB off/on Ramp Terminal at SW Powers Road
- U.S. 97 at SB off/on Ramps to Powers Road
- U.S. 97 at SW Badger Road
- U.S. 97 at SW Pinebrook Boulevard
- U.S. 97 at Third Street
- SE Third Street at SW Powers Road
- SE Third Street at SW Badger Road
- SE Third Street at SW Pinebrook Boulevard
- U.S. 97 at SW Ponderosa Road/SE China Hat Road
- U.S. 97 SB Ramps at Baker Road
- SW Powers Road at SW Blakely Road
- SE Murphy Road at SE Parrell Road

The majority of the ODOT traffic counts were collected between October 31 and November 30, 2005. U.S. 97 at SE Third Street was counted in April 2004. The data sheets for these counts can be found in Appendix A**.**

At intersections not counted by ODOT, historical counts were obtained. These counts were performed in April or December 2005. Historical counts were obtained for the following intersections:

- U.S. 97 at SB off/on Ramp Terminal at SW Powers Road
- SE Third Street at SE Murphy Road

The turning movement volumes for the intersection of U.S. 97 at SW Powers Road were obtained through interpolation of the count data at the ramp terminals. The same process was used for U.S. 97 northbound off/on ramps at Powers Road and the ramp terminal of northbound U.S. 97 at Knott Road.

2.1.2 Average Daily Traffic Volumes

The average daily traffic (ADT) volumes for each of the highways inside the study area of the interchange were obtained from the 2004 ODOT Traffic Volume Tables, which is the most recent volume table available. The ADT for these highways is listed in Table 3**.**

TABLE 3: ADT VOLUMES FOR STUDY AREA HIGHWAYS

Highway Segment	2004 ADT	Estimated 2006 ADT
U.S. 97: MP 137.36 (ATR 09-009, 0.04 miles south of Revere Ave. Interchange)	38,600	40,500
U.S. 97: MP 140.12 (0.01 miles south of Powers Rd. Interchange)	23,000	25,050
U.S. 97: MP 140.58 (0.01 miles south of Pinebrook Blvd.)	18,600	19,450
U.S. 97: MP 142.41 (ATR 09-003, 0.17 miles south of China Hat Rd.)	22,100	22,700
U.S. 97: MP 143.47 (0.01 miles south of Baker Rd.)	16,100	16,550

Source: ODOT 2000-2004 Volume Tables, DEA calculations.

For non-highway roadways and intersections, the ADT was established using an industry accepted approximation of ADT, which is ten times the total entering volume (TEV) at the intersection during the evening (PM) peak hour of traffic. The PM peak for this analysis is from 4:00 to 5:00 p.m. The ADT for these intersections is listed in Table 4.

TABLE 4: ADT VOLUMES FOR STUDY AREA INTERSECTIONS

Intersection		Total Entering Volume (TEV)[1]	Estimated ADT (10 x TEV)
1	SE Third St. at SW Powers Rd.	2,200	22,100
2	U.S. 97 at NB Connection From SW Powers Rd.	1,085	10,850
3	U.S. 97 at SW Powers Rd.	3,230	32,300
4	U.S. 97 at SB Connection From SW Powers Rd.	2,200	22,000
5	SW Powers Rd. at U.S. 97 NB Ramp Terminal	1,035	10,350
6	SW Powers Rd. at U.S. 97 SB Ramp Terminal	1,110	11,100
7	SW Blakely Rd. at SW Powers Rd.	730	7,300
8	U.S. 97 at SW Badger Rd.	1,980	19,800
9	SE Third St.at SW Badger Rd.	2,000	20,000
10	U.S. 97 at SW Pinebrook Blvd.	2,305	23,050
11	SE Third St. at SW Pinebrook Blvd.	1,550	15,500
12	SE Third St. at SW Murphy Rd.	1,975	19,750
13	SW Murphy Rd. at SE Parrell Rd.	850	8,500
14	U.S. 97 at SE Third St.	2,410	24,100
15	U.S. 97 at SW Ponderosa Rd./China Hat Rd.	2,580	25,800
16	Baker Rd. @ U.S. 97 SB Ramp Terminal	1,205	12,050
17	Knott Rd. @ U.S. 97 NB Ramp Terminal	820	8,200

1. Based on ODOT and historical manual turning movement counts, 2005/2006
Source: David Evans and Associates, Inc.

2.1.3 Design Hourly Volumes

The traffic analysis for the IAMP is based on design hourly volumes (DHVs) rather than average turning movement volumes. These volumes are assumed to represent the 30^{th} highest hour of traffic during the year. ODOT's Transportation Planning Analysis Unit (TPAU) has developed procedures for calculating current and future year DHVs.

The DHVs are calculated by applying a seasonal factor to the peak hour volumes. The 30^{th} highest hour volume usually occurs during the peak month of the year. The peak hour volume is multiplied by the seasonal factor to obtain the 30^{th} hour volume.

2.1.4 Seasonal Adjustment Factors

The seasonal adjustment factor is found by using the ATR closest to the location of interest with similar traffic flows, area type, and lane configuration. Often a representative ATR is not located within the study area, so an ATR within the state having similar qualities can be used. To find the seasonal factor, the ADT from the highest month reported by the ATR is divided by the ADT listed by the ATR representing the month project counts were taken. Although five years of ATR data are examined to determining the ADTs of the peak and count months, the data from the years with the high and low ATR values are removed before the remaining three years are averaged.

For U.S. 97, two ATRs were used to determine seasonal factors: ATR 009-003 located at MP 142.41, 0.17 miles south of China Hat Road; and ATR 009-009 located at MP 137.36, 0.04 miles south of the Revere Avenue Interchange, which is just north of the project study area. The roadway characteristics of these two ATRs closely represent the study area. ATR 009-003 represents more of the seasonal variation due to recreational traffic while ATR 009-009 more closely represents the commuter traffic within the City of Bend area. In order to account for both traffic characteristics, the seasonal factors for these two ATRs were averaged. ATRs 009-003 and 009-009 yielded seasonal factors of 1.25 and 1.11, respectively, for counts taken in the October/November months, generating an average seasonal factor of 1.18. A seasonal factor of 1.25 was generated for December counts. The seasonal factors by count month are shown in Table 5.

Using the TPAU methodology for developing seasonal factors by finding ATR locations on facilities with similar roadway characteristics, it was determined that the two ATRs most closely representing SE Third Street within the study area are ATR 18-018 (located in Klamath Falls) and ATR 09-020 (located in Redmond). As with the ATRs used for U.S. 97, the resulting seasonal factors from these ATRs were averaged, resulting in a seasonal factor of 1.09 for the October/November traffic counts and a seasonal factor of 1.19 for the traffic counts taken in December. The seasonal factors by count month are shown in Table 5.

Through discussions with TPAU, it was decided that no seasonal factor would be applied to local roads, such as at the intersection of SE Murphy Road at SE Parrell Road, since these intersections are located within mostly residential areas that are not likely to experience seasonal fluctuations like SE Third Street and U.S. 97.

TABLE 5: SEASONAL FACTORS FROM ATR DATA

	Seasonal Factor by Count Month		
Roadway	**April**	**Oct./Nov.**	**Dec.**
U.S. 97	1.26	1.18	1.25
Third St.	-	1.09	1.19
Local Roads	n/a	n/a	n/a

The seasonal factors were applied to the traffic counts for all movements of the intersections along U.S. 97 and Third Street. For example, a seasonal factor of 1.09 was applied to all turning movements associated with the intersection of SE Third Street at SW Powers Road, not just those moving along Third Street.

2.1.5 Existing 2005 Traffic Volumes

The PM traffic volumes collected were multiplied by their appropriate seasonal factors, rounded to the nearest five vehicles and balanced (since the counts were collected on different days). The resulting peak hour volumes can be found in **Figure 3.**

In comparing the traffic volumes obtained for the IAMP (2005) with the volumes from the SBPRS study (2002), it appears the traffic has increased on the U.S. 97 Bend Parkway by 20-30% in the north section and by approximately 20% south of the Third Street intersection. The v/c ratios increased from 0.57 at Bend Parkway/Third Street and from 0.71 at Bend Parkway/Powers Road to 0.95 and 0.91 respectively.

A comparison of the IAMP and the SBPRS traffic volumes shows an increase of through traffic along Third Street in the 4-5% range; however, some of the internal street intersections (Badger Road/Murphy Road) have a 20-25% increase. There seems to be greater circulation to/from the internal cross streets along Third Street.

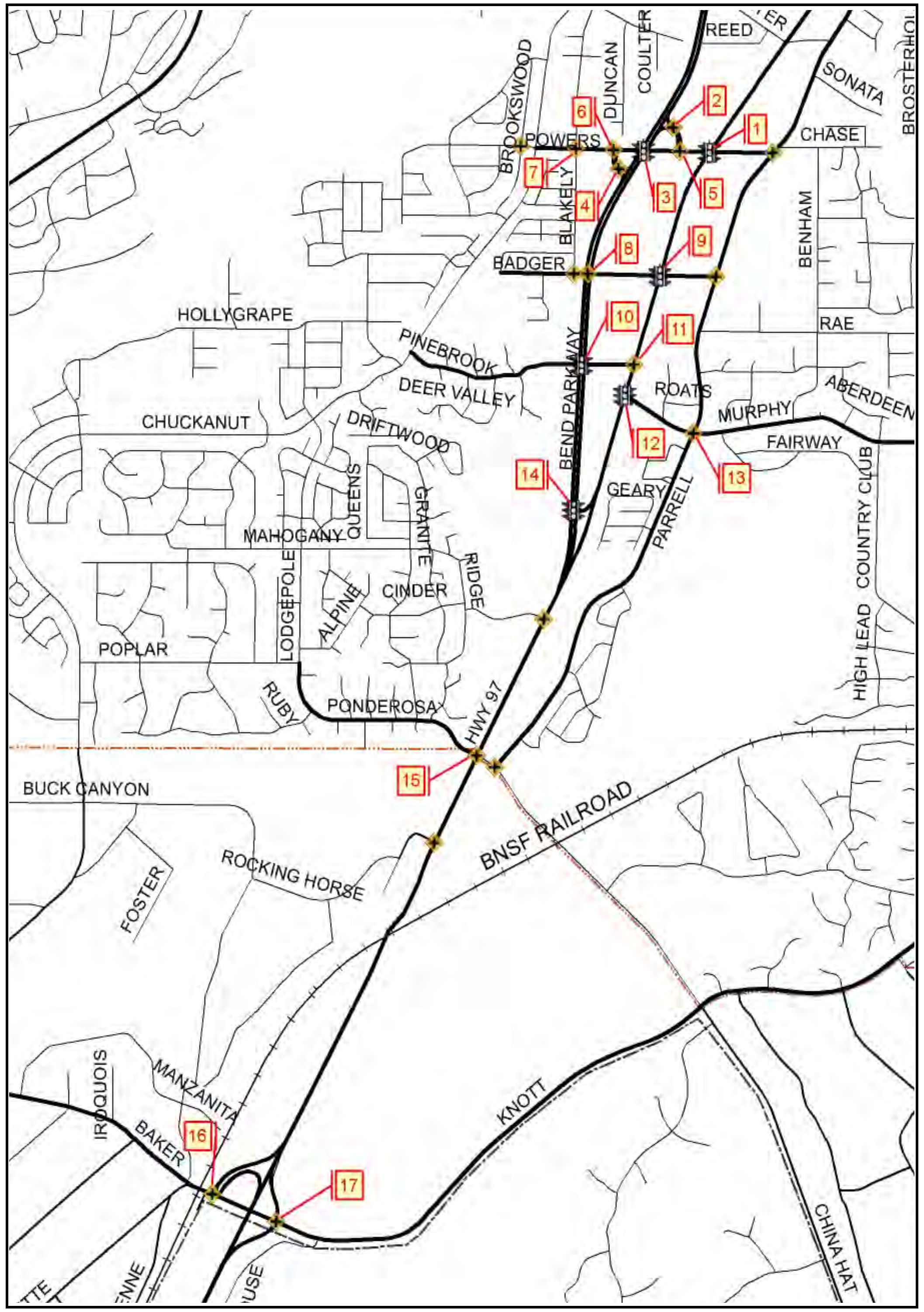
2.2 Traffic Operations Analysis

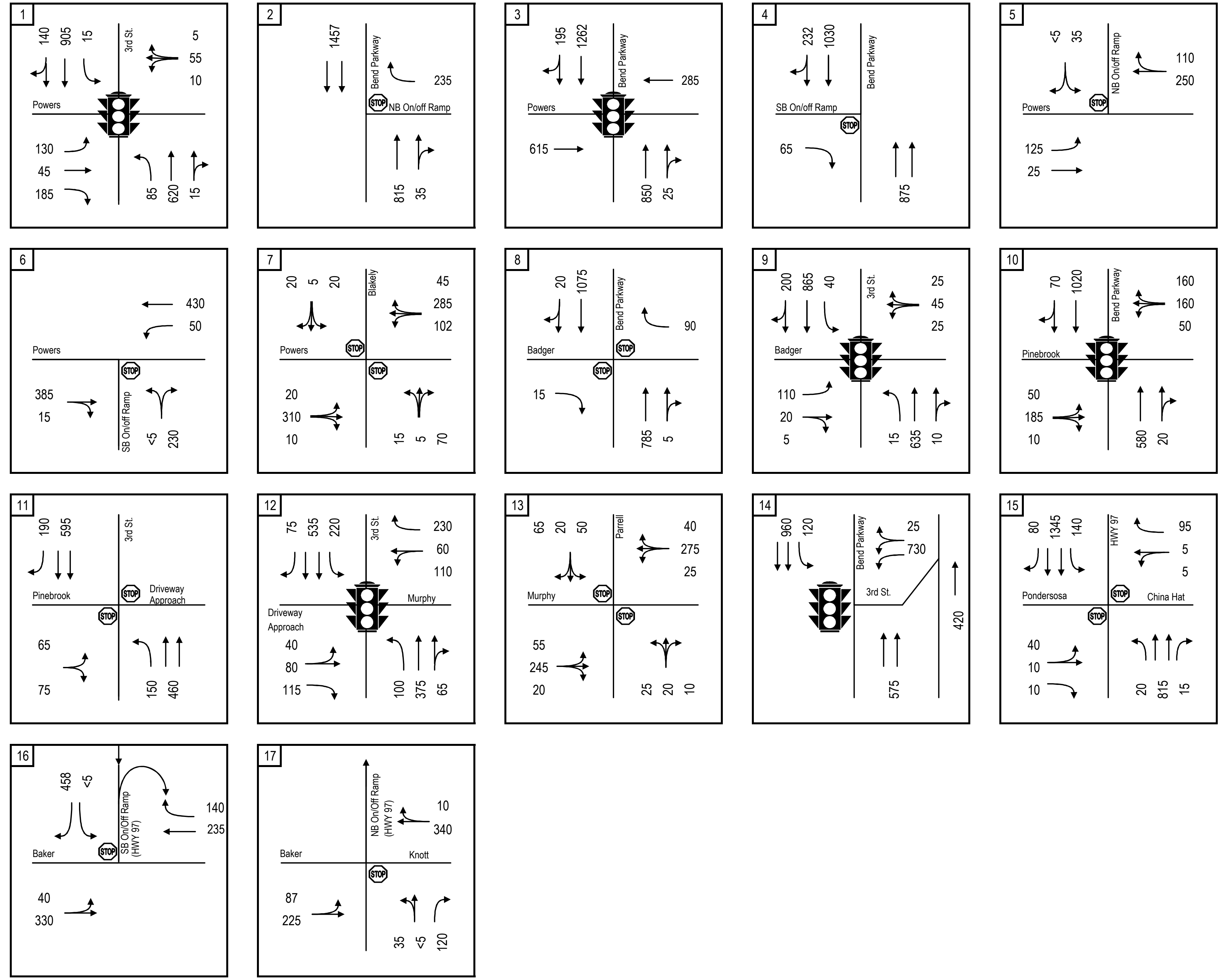
Intersection operations were examined as part of the existing traffic conditions analysis of the IAMP study area. The procedures and results are described in this section.

2.2.1 Operational Criteria

ODOT has established policies in the OHP that set standards for projects on ODOT facilities. Goal 1, Policy 1F (Highway Mobility Standards) details the v/c ratio standards for peak hour operating conditions. The v/c ratio represents the ratio of measured traffic demand (volume) divided by the maximum carrying volume for the roadway or intersection (capacity). When the v/c ratio approaches 0.0, traffic conditions are generally good with free flow travel conditions present. As the v/c ratio approaches 1.0, traffic becomes more congested along roadways and “platoons” of traffic are formed while at intersections, traffic conditions become more unstable with longer delays.

ODOT applies two sets of operational standards (mobility standards) to different types of projects. For planning and project analysis of existing conditions and no-build conditions the applicable mobility standards are found in Table 6 of the OHP. For planning and project analysis of build alternatives, the applicable mobility standards are specified in Table 10-1 of the 2003 Highway Design Manual (HDM). Mobility standards are dependent on the roadway classification and area type, and apply during peak operating conditions through the planning horizon year, which is year 2030. Both are presented in terms of v/c ratios, and they are shown in Table 7.





N

Legend

Intersections Analyzed in IAMP

Traffic Signal

Stop Sign

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South Parkway
Murphy Interchange IAMP

Figure 3

Existing Traffic Volumes

According to the OHP, U.S. 97 (The Dalles-California Highway Number 4) is under the following classifications: State Highway, on the National Highway System (NHS), Freight Route, Expressway, located inside and outside the Urban Growth Boundary (UGB), and Rural Lands outside UGB. The following OHP requirements apply to this highway:

- Maximum v/c ratio of 0.80 for Statewide Expressways inside the UGB and in an MPO.
- Maximum v/c ratio of 0.70 for highways outside the UGB located in Rural Lands.
- For unsignalized intersections, state highway movements that do not have to stop must meet the v/c requirements of Table 6 of the OHP. For intersections outside the UGB on rural lands, the movement that must stop or yield right-of-way must not exceed a v/c ratio of 0.75. Inside the UGB, the movement must not exceed the v/c ratios of 0.90 for the District/Local Interest roads in a MPO as shown in Table 6 of the OHP.

The City of Bend has established standards for intersection operations within the City's public road system. The requirements are as follows:

Two-way Stop Control
- Delay of 50 seconds or less for each individual lane group, and
- Volume to capacity ratio of 1.0 or less for lane groups, and
- 95th percentile queuing must be contained by the available storage length.

All-Way Stop Control
- Total intersection delay must be 80 seconds or less.

Signalized Intersections
- For the intersection as a whole, delay must be 80 seconds or less, and
- Volume to capacity ratio of 1.0 or less for intersection as a whole, and
- 95th percentile queuing must be contained by the available storage length.

Another standard for measuring traffic capacity and quality of service of roadways at intersections is level of service (LOS). At both stop-controlled and signalized intersections, LOS is a function of control delay, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Six standards have been established ranging from LOS A where there is little or no delay, to LOS F, where there is delay of more than 50 seconds at unsignalized intersections, or more than 80 seconds at signalized intersections.

It should be noted that although delays can sometimes be long for some movements at a stop-controlled intersection, the v/c ratio may indicate that there is adequate capacity to process the demand for that movement. Similarly at signalized intersections, some movements, particularly side street approaches or left turns onto side streets, may experience longer delays because they receive only a small portion of the green time during a signal cycle but their v/c ratio may be relatively low. For these reasons it is important to examine both v/c ratio and LOS when evaluating overall intersection operations. Both are evaluated in the analyses that follow. It should be noted that all of the roadway jurisdictions use v/c, not LOS, as a measure of performance.

Table 6 summarizes the LOS criteria for both signalized and unsignalized intersections based on the Synchro manual's criteria.

TABLE 6: LEVEL OF SERVICE CRITERIA

	Control Delay (seconds/vehicle)	
Level of Service	**Signalized Intersections**	**Unsignalized Intersections**
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

Note: The LOS criteria are based on control delay, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay.

Source: Transportation Research Board, Highway Capacity Manual, 2000, p. 16-2 for signalized intersections and p. 17-2 for unsignalized intersections.

Note that the LOS criteria for unsignalized intersections are somewhat different than the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, there are a number of driver behavior considerations that combine to make delays at signalized intersections less onerous than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to two-way STOP-controlled (TWSC) intersections must remain attentive to the task of identifying acceptable gaps and avoiding vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than signalized intersections. For these reasons, it is considered that the total delay threshold for any given LOS is less for an unsignalized intersection than for a signalized intersection. Because LOS accounts for driver expectations, while v/c ratios do not, unsignalized intersections can often have a very poor approach LOS while maintaining a relatively good approach v/c ratio.

2.2.2 Traffic Operations Software

For intersection analysis, the Synchro/SimTraffic analysis software package was chosen to evaluate intersection operations for the closely spaced study area intersections. Synchro is a macroscopic model similar to the Highway Capacity Software (HCS), and like the HCS, is based on the methodologies outlined in the 2000 Highway Capacity Manual. Per ODOT standard, the ideal saturation flow was set at 1,800 vehicles per hour for all traffic analysis.

The Synchro model explicitly evaluates traffic operations under coordinated and uncoordinated systems of signalized and unsignalized intersections. Synchro calculates traffic arrival types, calculates right-turn-on-red capacity, and determines v/c ratios. SimTraffic simulations were used to establish intersection and movement delays as well as 95th percentile queue lengths.

2.2.3 Existing Intersection Operations

This section summarizes the traffic operations analysis that was conducted for the study area intersections under existing (seasonally adjusted) traffic volume conditions. Table 7 summarizes the results for all analysis area intersections and also presents agency operational standards to enable comparison with intersection results. Table 8 summarizes queuing on critical approach legs at the same intersections. Critical movements at unsignalized intersections are typically the minor street left turns or, in the case of single-lane approaches, the minor street approaches. These movements are required to yield to all other movements at the intersection and thus are subject to the longest delays and have the least capacity. Left turns from the major street are also subject to delays since motorists making these maneuvers must also yield to on-coming major street traffic. Bold numbers in the tables represent v/c ratios that exceed the mobility standards and approaches with long queues. Supporting simulation outputs are in Appendices C and D.

TABLE 7: EXISTING (YEAR 2005) 30TH HIGHEST HOUR TRAFFIC OPERATIONS ANALYSIS RESULTS

Intersection		Critical Movement	v/c Ratio	LOS	OHP Std.[1]	HDM Std.[2]	C.O.B. Std.[3]
1	Third St. @ Powers Rd.	n/a[4]	0.64	B	-	-	≤1.0 (80.0)
2	U.S. 97 @ NB Connection From Powers Rd.	WBR	0.32	B	0.90	0.75	-
3	U.S. 97 @ Powers Rd	n/a[4]	**0.95**	B	0.80	0.75	-
4	U.S. 97 @ SB Connection From Powers Rd.	EBR	0.43	A	0.90	0.75	-
5	Powers Rd. @ U.S. 97 NB Ramp Terminal	SBLR	0.05	B	0.90	0.75	-
6	Powers Rd. @ U.S. 97 SB Ramp Terminal	NBR	0.39	B	0.90	0.75	-
7	Powers Rd. @ Blakely Rd.	NBLTR	0.20	A	-	-	≤1.0 (50.0)
		SBLTR	0.17	A	-	-	≤1.0 (50.0)
8	U.S. 97 @ Badger Rd.	WBR	0.16	A	0.90	0.75	-
9	Third St. @ Badger Rd.	n/a[4]	0.60	A	-	-	≤1.0 (80.0)
10	U.S. 97 @ Pinebrook Blvd.	n/a[4]	0.64	B	0.80	0.75	-
11	Third St. @ Pinebrook Blvd.	EBLTR	0.67	D	-	-	≤1.0 (50.0)
		NBL	0.20	B	-	-	≤1.0 (50.0)
12	Third St. @ Murphy Rd.	n/a[4]	0.91	C	-	-	≤1.0 (80.0)
13	Murphy Rd.@ Parrell Rd.	NBL/T/R	0.17	B	-	-	≤1.0 (50.0)
		SBL/T/R	0.32	A	-	-	≤1.0 (50.0)
14	U.S. 97 @ Third St.	n/a[4]	**0.91**	B	0.80	0.75	-
15	U.S. 97 @ Ponderosa Rd./China Hat Rd.	WBL/T	0.59	E	0.90	0.75	-
		WBLR	0.59	A	0.90	0.75	-
		EBL/T	**>1.0**	**F**	0.90	0.75	-
		EBR	**>1.0**	**F**	0.90	0.75	-
16	Baker Rd. @ U.S. 97 SB Ramp Terminal	SBR	0.61	B	0.80	0.60	-
17	Knott Rd. @ U.S. 97 NB Ramp Terminal	EBL	0.20	A	0.80	0.60	-
		NBL/T	0.19	B	0.80	0.60	-

Notes:
1. 1999 Oregon Highway Plan Mobility Standards (Table 6)
2. 2003 ODOT Highway Design Manual Mobility Standards (Table 10-1)
3. Operational standards for City of Bend roadway facilities (Source: City of Bend Development Code Chapter 4.7). Shown as v/c ratio (second of delay)
4. Signalized intersection. LOS and v/c are for overall intersection.

TABLE 8: EXISTING (YEAR 2005) 30TH HIGHEST HOUR 95TH PERCENTILE QUEUES

	Intersection	Movement	95% Queue[3] (feet)
1	Third St. @ Powers Rd.	EBL	100
		EBR	100
		NBL	75
		SBL	25
2	U.S. 97 @ NB Connection From Powers Rd.	WBR	125
3	U.S. 97 @ Powers Rd.	EBT	**350**[1,2]
		SBT/R	500
4	U.S. 97 @ SB Connection From Powers Rd.	EBR	50
5	Powers Rd. @ U.S. 97 NB Ramp Terminal	EBL	75
		SBL/R	50
6	Powers Rd. @ U.S. 97 SB Ramp Terminal	WBL	75
		NBL/R	150
7	Powers Rd. @ Blakely Rd.	NBLTR	75
		SBLTR	75
8	U.S. 97 @ Badger Rd.	EBR	50
		WBR	75
9	Third St. @ Badger Rd.	EBL	100
		NBL	50
		SBL	50
10	U.S. 97 @ Pinebrook Blvd.	EBL/T	200
		WBL/T	250
11	Third St. @ Pinebrook Blvd.	EBL/R	200
		NBL	100
		SBL	25
12	Third St. @ Murphy Rd.	EBR	75
		WBR	150
		NBL	225
		SBL	225
		SBR	75
13	Murphy Rd. @ Parrell Rd.	NBL/T/R	75
		SBL/T/R	100
14	U.S. 97 @ Third St.	WBL	225
		SBL	150
15	U.S. 97 @ Ponderosa St.	EBL/T	200
		WBL/T	50
		NBL	50
		SBL	75
16	Baker Rd. @ U.S. 97 SB Ramp Terminal	SBL	25
		SBT	225
17	Knott Rd. @ U.S. 97 NB Ramp Terminal	NBL/T	50

Notes:
1. Storage bay at or above capacity.
2. Queue extends into adjacent intersection(s).
3. Queue lengths determined from SimTraffic simulations

As shown in Tables 7 and 8, most study area intersections currently operate with acceptable v/c ratios, queuing and level of service. Three intersections that warrant further discussion include U.S. 97 at SW Powers Road, U.S. 97 at SE Third Street, and U.S. 97 at SW Ponderosa Road.

The operational analysis indicates that U.S. 97 at SW Powers Road operates at a v/c ratio of 0.95, and the eastbound traffic queues past its storage capacity and has been observed blocking traffic from the U.S. 97 southbound off ramp from entering eastbound traffic on Powers Road.

The intersection of U.S. 97 at Third Street currently operates with a v/c ratio of 0.91, which exceeds OHP standards, yet operates at a LOS B. This indicates that while the intersection operates under heavy volumes approaching the intersection's capacity, overall the delay experienced by traffic is quite low (on average less than 20 seconds per vehicle). The southbound left turn movement experiences 41 seconds of delay per vehicle (LOS D).

The eastbound approach to U.S. 97 at SW Ponderosa Road operates at a v/c ratio greater than 1.0. The implication of this is that since the capacity of the approach is being exceeded, traffic is not being served, and a queue begins to form. The volumes of this approach are fairly small, but the delay experienced by drivers at times exceeds 3 minutes. Mainline U.S. 97 serves very large volumes at this intersection, leading drivers on the eastbound approach to experience long delays waiting for acceptable gaps in traffic. Although not currently in the Safety Priority Index System (SPIS) top 10%, this intersection has been in the past. ODOT currently has plans that will convert this intersection to right-in/right-out, thereby increasing safety and operations by eliminating high-delay movements such as eastbound left turns.

3. Signal Warrant Analysis

The need for traffic signals at intersections is established by evaluating existing and projected traffic conditions against traffic signal warrants contained in the 2003 Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD provides eight signal warrants that consider different conditions under which a new signal may be warranted. The most commonly applied signal warrants are based on traffic volumes, although the MUTCD contains signal warrants based on crash experience, coordinated signal systems, and warrants for signals at pedestrian and school crossings.

MUTCD Warrant 1, Eight-Hour Vehicular Volume, requires that certain volume thresholds are met for each of any eight (8) hours in an *average* day, and has two condition requirements. Condition A is met when a high volume of traffic is present on an intersecting roadway, and Condition B is met when mainline volumes are so high that traffic on the minor street experiences excessive delay. MUTCD Warrant 1 is met when *either* Condition A or Condition B is met.

MUTCD Warrant 2, Four-Hour Vehicular Volume, requires that volume thresholds are met for each of any four (4) hours in an average day, and has one condition that must be met. This warrant is met when the combined mainline volumes are plotted against the highest of the minor street volumes, and that plotted point exceeds the threshold curves related on the chart.

OAR 734-020-0400 through 734-020-0500 provides the process for the approval for traffic signal installations. OAR 731-020 provides specific guidance on the application of signal warrants in Oregon. Meeting signal warrants does not guarantee that a signal shall be installed. For installation of signals, OAR 731-020-0490 (1) provides that traffic volumes sufficient to meet signal warrants must be met within three years of signal installation.

As specified in OAR 734-020-0460 (2), before a signal can be installed a comprehensive traffic engineering study must be undertaken to determine the need for a signal beyond the warrants. The traffic signal investigation must include an evaluation of traffic conditions and physical characteristics of the proposed traffic signal location. OAR 734-020-460 (4) requires additional analyses that include evaluations of speeds, highway type, grades, sight distance, existing level of service and conflicting accesses. OAR 734-020-0480 requires progression analyses to be conducted to evaluate the impact of a new signal on the existing or future signal system. The State Traffic Engineer will make the final decision on the installation of a signal. OAR 734-020-490 (1) requires that a traffic signal being constructed shall be met the warrants within three years of the proposed installation, and (2) if the purpose of the signal construction is to aid traffic from a private development it must meet warrants within one month of construction, or the operation should be delayed until a time that it meets the warrants.

Signal warrant analysis results are summarized in Table 9. Complete signal warrant worksheets are contained in Appendix E.

TABLE 9: SIGNAL WARRANT ANALYSIS SUMMARY

Location	Warrant 1, Eight-Hour Vehicular Volume Met? Condition A	Condition B	Warrant 2, Four-Hour Vehicular Volume Met?
SW Powers Rd. at U.S. 97 NB Ramp Terminal	NO	NO	NO
SW Powers Rd. at U.S. 97 SB Ramp Terminal	n/a[1]	n/a[1]	n/a[1]
U.S. 97 at SW Ponderosa Rd./China Hat Rd.	NO	YES	YES
SE Third St. at SW Pinebrook Blvd.	NO	YES	YES
SE Murphy Rd. at SE Parrell Rd.	NO	NO	NO[2]
SW Powers Rd.at SW Blakely Rd.	NO	NO	NO
Baker Rd. at U.S. 97 SB Ramp Terminal	NO	NO	NO
Knott Rd. at U.S. 97 NB Ramp Terminal	n/a[1]	n/a[1]	n/a[1]

1. Sufficient Volume Data not available
2. SBPRS report recommended and signed for 2022 traffic conditions

The signal warrant analyses showed that the intersections of U.S. 97 at Ponderosa Road and SE Third Street at Pinebrook meet the MUTCD signal warrants. It should be noted that although the intersections of SW Powers with the U.S. 97 ramp terminals do not meet signal warrants (or lack sufficient volume data for analysis as in the case of the U.S. 97 southbound ramp terminal), these would not meet signal spacing standards since they are too close to the signalized intersection of U.S. 97 at Powers. The results of this warrant analysis for each intersection are discussed below.

U.S. 97 At Ponderosa Road/China Hat Road

This intersection met both Signal Warrants 1 and 2. Further warrant analysis showed it also met Warrant 3 (peak hour). While the procedures for reducing right turn volumes for TPAU's Preliminary Warrants are followed for the westbound right turns, the intersection does not meet these warrants. In the South Bend Parkway Refinement Study, each of the proposed build alternatives includes converting the intersection to right-in/right-out with acceleration lanes, or building an overpass. These proposals would eliminate the need for a signal.

SE Third Street At SW Pinebrook Boulevard

This intersection currently is operating within traffic operations standards. The intersection meets Condition B or Warrant 1 and also Warrant 2. Currently the spacing between this intersection and the intersection of SE Third Street at Murphy Road is less than 400 feet, and may not meet spacing requirements. In the future, if the proposed changes to Murphy occur as described in the South Bend Parkway Refinement Study, the intersection of SE Third Street with Murphy Road will be relocated to the south and this may not be an issue. Within a year of this work being completed, a new warrant analysis should be performed at this intersection.

4. Safety Summary – Existing Conditions

A safety analysis was conducted to determine if there were any significant documented safety issues within the analysis area and to recommend measures at specific locations or general strategies for improving overall safety. The safety analysis included a review of crash history data supplied by the ODOT Crash Analysis and Reporting Unit and through City of Bend Police reports for a three year period (2002, 2003, and 2004). The crash information through ODOT is collected from police reports (local/county/state), and required crash reports from drivers who have been in accidents. These reports are compiled by ODOT staff into a computer data base by day/month/calendar year and by location.

4.1 Calculation of Crash Rates

The crash rates were calculated from ODOT-provided crash data. For a crash to be considered associated with an intersection, it must occur within 0.05 mile (265 feet) of the intersection. Beyond this region, crash data is placed in the segment category. It should be noted that this analysis only accounts for those crashes that were reported. In Oregon, legally reportable crashes are those involving death, bodily injury or damage to any one person's property in excess of $1,000 (August 31, 1997 thru December 31, 2003) or $1,500 (after January 1, 2004).

Intersection and segment crash rates were calculated using the following equations.

$$rate_{\text{int}} = \frac{(Crashes \cdot 1{,}000{,}000)}{(365 \cdot Years \cdot ADT)} \quad \text{and} \quad rate_{segment} = \frac{(Crashes \cdot 1{,}000{,}000)}{(365 \cdot Years \cdot Length \cdot ADT)}, \text{ where}$$

Rate_{int} = Crash rate per Million Entering Vehicles (MEV)

$\text{Rate}_{\text{segment}}$ = Crash rate per Million Vehicle Miles Traveled (MVMT)

Crashes = Number of crashes during the time segment

Years = Number of years being studied

ADT = Average Daily Traffic volume

Length = Length of roadway segment being studied (for segment rates).

The number of crashes was determined from ODOT crash data. At intersections, the sum of all PM peak hour entering volumes from each leg were multiplied by ten to estimate an intersection ADT. For roadway segments the ADT was determined using the ODOT Volume Tables. Crash rates were then calculated for the entire three-year study period.

4.2 SPIS Data

The Safety Priority Index System (SPIS) is a method developed by ODOT for prioritizing locations where funding for safety improvements can be spent most efficiently and effectively. Based on crash data, the SPIS score is influenced by three components: crash frequency, crash rate, and crash severity. Three years of crash data are analyzed to determine a SPIS score for a specific location. SPIS locations meet one of two criteria during the previous three years: (1) three or more crashes at the same location, or (2) one or more fatal crashes at the same location. ODOT produces a list of the sites with the top 10% SPIS scores each year.

For the year 2006, which includes crash data for 2003, 2004, and 2005, the SPIS scores at or above 45.49 are in the top 10%. There are no top 10% SPIS locations in the analysis area although the areas encompassing the intersections of U.S. 97 at Powers and U.S. 97 at Ponderosa are in the top 20%.

4.3 U.S. 97/Bend Parkway Crash Analysis

The southern section of the U.S. 97 Bend Parkway transportation facility was opened for traffic in August of 2001. This section of the Bend Parkway (from the Reed Market interchange to the connection at Third Street) has several at-grade intersections, instead of grade separated interchanges as are typical in the northern sections of the Bend Parkway. The greater the number of potential vehicle conflicts (conflict points along with traffic volumes), typically the higher the number of crashes that will occur on a roadway.

In the study area section of U.S. 97 Bend Parkway (Powers Road to Third Street) in the three-year period (2002 through 2004) 35 crashes were reported, including one fatality, 15 non-fatal injury crashes with a total of 29 injuries, and 19 property-damage-only (PDO) crashes. Of these 35 reported crashes on the Parkway section of U.S. 97, 22 crashes were coded as rear end, 8 coded as angle crashes, with 2 as fixed object, and 1 each for left turn, right turn and sideswipe crashes. Table 10 summarizes the crash data for this section. Detailed crash information is included in the Appendix. The proposed Build Alternative H-Modified, Option 1 (as defined in the South Bend Parkway Refinement Study), would remove the existing signals and cross street access in the study area, which would significantly reduce the crashes along this section of the U.S. 97 Bend Parkway.

The fatality crash that occurred at the Parkway and Third Street signalized intersection occurred in February 2002 on a clear dry day in the early afternoon. A northbound vehicle from U.S. 97 turned onto the Bend Parkway and failed to stop at the signal at Third Street and struck a southbound left turning vehicle broadside, which hit a third vehicle. Beside the fatality there were four serious injuries as part of this same accident. This is the first traffic signal for northbound vehicles for miles and it is not expected, especially if a driver is inattentive or distracted by other factors.

South of the Third Street signalized intersection with the Parkway, the Parkway merges into the original U.S. 97 alignment to the south. This section of the U.S. 97 roadway, beginning at mile post 141.52 to just south of the Baker Road/Knott Road interchange at mile post 144.01, reported 32 crashes in a three-year period (2002 through 2004). Of theses reported crashes 12 were PDO crashes, and 20 were non-fatal injury crashes with a total of 28 injuries. Of these 32 reported crashes on U.S. 97 (south of Third Street), 6 crashes were coded as rear end, 7 coded as angle crashes, with 4 as fixed object, 5 as left turn, 3 as sideswipe, 1 as right turn, 2 as bike, and 1 each as hit animal, head-on, overturn and pedestrian crashes. This data is also summarized in Table 10 and detailed crash information is included in Appendix F.

ODOT staff have prepared a Draft Project Prospectus for an approximate $4.5 million estimated preservation/safety project that would consist of two main elements: 1) grind out and inlay the existing travel lanes and overlay the entire roadway section between mile post 142.0 and MP 146.50; 2) between MP 141.0 and MP 142.5 install a median barrier that would extend from the existing barrier on U.S. 97 to the vicinity of the signal at the Third Street intersection. For year 2003 the segment between MP 141.0 and MP 142.5 had a Safety Investment Program (SIP) category of 4 and SPIS value of 38.8 which is in the top 15% statewide.

TABLE 10: REPORTED CRASHED U.S. 97 MILEPOST 139.68 TO MILEPOST 144.00

Intersection Location Coded by Milepost 3 Year Period (2002, 2003 & 2004)	Type of Control	Total Crashes	PDO (Property Damage Only)	Injury Crash	Total Injuries	Fatal Crash
BEND PARKWAY						
Powers Rd. N/Conn. - MP 139.86	Stops Conn. Right-in/Right-out	3	2	1	1	
Powers Rd. Intersection – MP 139.97	Signalized	6	3	3	3	
Powers Rd. S/Conn. - MP 140.00	Stops Conn. Right-in/Right-out	2	1	1	1	
Badger Rd. Intersection – MP 140.30	Stops Side Street Right-in/Right-out	2	1	1	4	
Pinebrook Blvd. Intersection – MP 140.52	Signalized	10	5	5	6	
Third St. Intersection - MP 140.87	Signalized	12	7	5	14	1
	Subtotal	**35**	**19**	**15**	**29**	**1**
U.S. 97 - HIGHWAY 4						
Third St. Split – MP 141.03		2	1	1	1	
Romaine Village Ct. MP 141.87	Stops Side Street Full Access	3	1	2	2	
Between Romaine & Ponderosa[1]		2	1	1	2	
Ponderosa/China Hat – MP 142.24	Stops Side Street Full Access	5	1	4	7	
Between Ponderosa & Rocking Horse		3	1	2	3	
Rocking Horse – MP 142.46-.50	Stops Side Street Full Access	5	1	4	6	
MP 142.60- MP 143.00[2]		3		3	3	
MP 143.00 to approximately 143.48 (Knott/Baker Rd. Over-crossing structure)	Sbd on/off-ramps Nbd on/off-ramp at Overcrossing	9	6	3	4	
	Subtotal	**32**	**12**	**20**	**28**	**0**
	Total	**67**	**31**	**35**	**57**	**1**

1 One of the recorded crashes hit an animal, the other crash was an off road incident with ice contributing

2 Crashes involved a pedestrian and 1 crash involved a bike

4.4 Third Street Crash Analysis

The crash information along Third Street was obtained through the City of Bend, and is based on crash information from ODOT records and City of Bend Police Department reports. Table 11 shows a summary of the reported crash incidents coded to the four intersections in the study area for years 2002, 2003 and 2004. More detailed crash information is included in Appendix F.

The reported crashes are coded by total crashes (including those occurring at driveways, alleys, etc. away from the intersection), and by crashes coded as occurring at the intersection. A total of 62 accidents were reported in these three years along Third Street between the Bend Parkway and Powers Road. Of these 62 reported crashes, 17 were coded as rear end, 13 coded as angle, 19 coded as left turns, 2 coded as right turns, 5 coded as fixed object, 2 coded as backing, and 2 coded as sideswipe crashes.

Two intersections along Third Street in the study area are showing on the City of Bend and the Deschutes County Top Intersection Crash Locations. Year 2002 crash information was the last year an annual area wide Crash Report was completed. The Deschutes County Top Intersection Crash Location report indicated Third Street at Murphy Road was ranked in a group at # 9 in year 2002 with 5 reported crashes. The City of Bend 2000-2002 Top Intersection Crash Locations (including state highways) listed Third Street at Badger Road in a group at #9 with 16 total reported crashes in a 3-year period.

TABLE 11: REPORTED CRASHES THIRD STREET MILEPOST 140.20 TO MILEPOST 141.95

Intersection Location Coded by Intersection MP 3-Year Period (2002, 2003 and 2004)	Type of Control	Total Crashes	PDO Crash	Injury Crash
Powers Rd. Intersection: MP 141.83 – 141.95	Signalized	15	9	6
Between Powers and Badger: MP 141.53 – 141.83	Uncontrolled	9	6	3
Badger Rd. Intersection: MP 141.45 -141.53	Signalized	8	4	4
Between Badger and Pinebrook: MP 141.45 – 141.51	Uncontrolled	6	3	3
Pinebrook Blvd. Intersection: MP 141.29-141.30	Stops Side Street	6	2	4
Between Pinebrook and Murphy: MP 140.26-141.29	Uncontrolled	2	2	0
Murphy Rd. Intersection: MP 140.20-140.26	Signalized	9	3	6
Between Murphy and Third Parkway: MP 140.87-140.89	Uncontrolled	7	5	2
	Total	**62**	**34**	**28**

4.5 Intersection Crash Rates

The reported crashes between the years 2002 and 2004 were summarized by location for each of the study area intersections. Intersection crash rates were calculated and are shown in Table 12.

TABLE 12: INTERSECTION CRASH RATES

	Intersection	Crashes	ADT	3 Year Crash Rate
1	Third St. @ Powers Rd.	15	22,100	0.62
2	U.S. 97 @ NB Connection From Powers Rd.	3	10,850	0.25
3	U.S. 97 @ Powers Rd.	6	32,300	0.17
4	U.S. 97 @ SB Connection From Powers Rd.	2	22,000	0.08
8	U.S. 97 @ Badger Rd.	2	19,800	0.09
9	Third St. @ Badger Rd.	8	20,000	0.37
10	U.S. 97 @ Pinebrook Blvd.	10	23,050	0.40
11	Third St. @ Pinebrook Blvd.	6	15,500	0.35
12	Third St. @ Murphy Rd.	9	19,750	0.42
14	U.S. 97 @ Third St.	12	24,100	0.45
15	U.S. 97 @ Ponderosa Rd/China Hat Rd.	5	25,800	0.18

The safety analysis showed that none of the intersections in the study area have a crash rate significantly greater than that of the surrounding area. As a rule of thumb, intersections with crash rates of 1.0 or above are potentially problematic and are candidates for further investigation. As Table 12 shows, all of the intersection crash rates are well below the threshold value of 1.0.

4.6 Segment Crash Rates

Crashes were also examined along U.S. 97 within the study area. U.S. 97 was divided into two segments: from the northbound on ramp of Powers to the intersection with SE Third Street; and from Third Street to the Baker Road/Knott Road interchange. The segment crash rates are shown in Table 13.

TABLE 13: SEGMENT CRASH RATES

Roadway Segment	Crashes	ADT	3 Year Crash Rate
U.S. 97: NB on ramp from Powers Rd. to Third St.	35	25,050	1.26
U.S. 97: Third St. to Baker Rd. Interchange	32	22,700	0.53

As shown in Table 13, the crash rate of U.S. 97 between Powers Road and Third Street is 1.26, which exceeds the comparable state average for U.S. 97 in the section is 0.78. As mentioned earlier in this section, the proposed Build Alternative H-Modified, Option 1 would remove the existing signals and cross street access in the study area, which would significantly reduce the crashes along this section of the U.S. 97 Bend Parkway.

5. Summary of Planned and Programmed Projects

The following is a summary description of the planned and programmed system improvements, which include roadway, transit, bicycle and pedestrian projects within the IAMP study area.

Programmed Projects

5.1 Variable Message Sign – ODOT

Variable Message Sign (VMS) for northbound traffic at milepost 142.7 on U.S. 97: The Dalles-California Highway (004). MP 142.7 is south of the U.S. 97 over crossing of the Burlington Northern Santa Fe Railroad (see **Figure 4**). This VMS project will provide useful and necessary information to the public for inclement weather and emergency roadway situations, including Amber Alerts. Estimated completion date is December 31, 2007.

5.2 Murphy Road – City of Bend

The City of Bend Capital Improvement Program (CIP) has apportioned $500,000 to the Murphy Road (Brookswood to 15th) project for FY 2005/06. The total roadway cost has been identified at $4.5 million dollars. According to the CIP, the initial $500,000 budget will be used for "initial study, preliminary engineering, and limited ROW acquisition for the corridor." The study will identify project needs and estimated costs, with full development of the corridor requiring additional City funds and outside funding resources.

5.3 Bend Area Transit Project – City of Bend

The opening of the Bend Area Transit (BAT) system is scheduled for September 2006. This will be a fixed route system that will supplement the current City of Bend Dial-a-Ride component. There will be a system of seven fixed routes, with two of the proposed routes operating in the IAMP study area. Proposed Route #1 (South Third Street) will operate on Third Street to the Murphy/Pinebrook intersections. Route #1 will connect to Route #2 (Brookswood), which will operate on Brookswood Boulevard to Pinebrook, and then on Pinebrook to Third Street

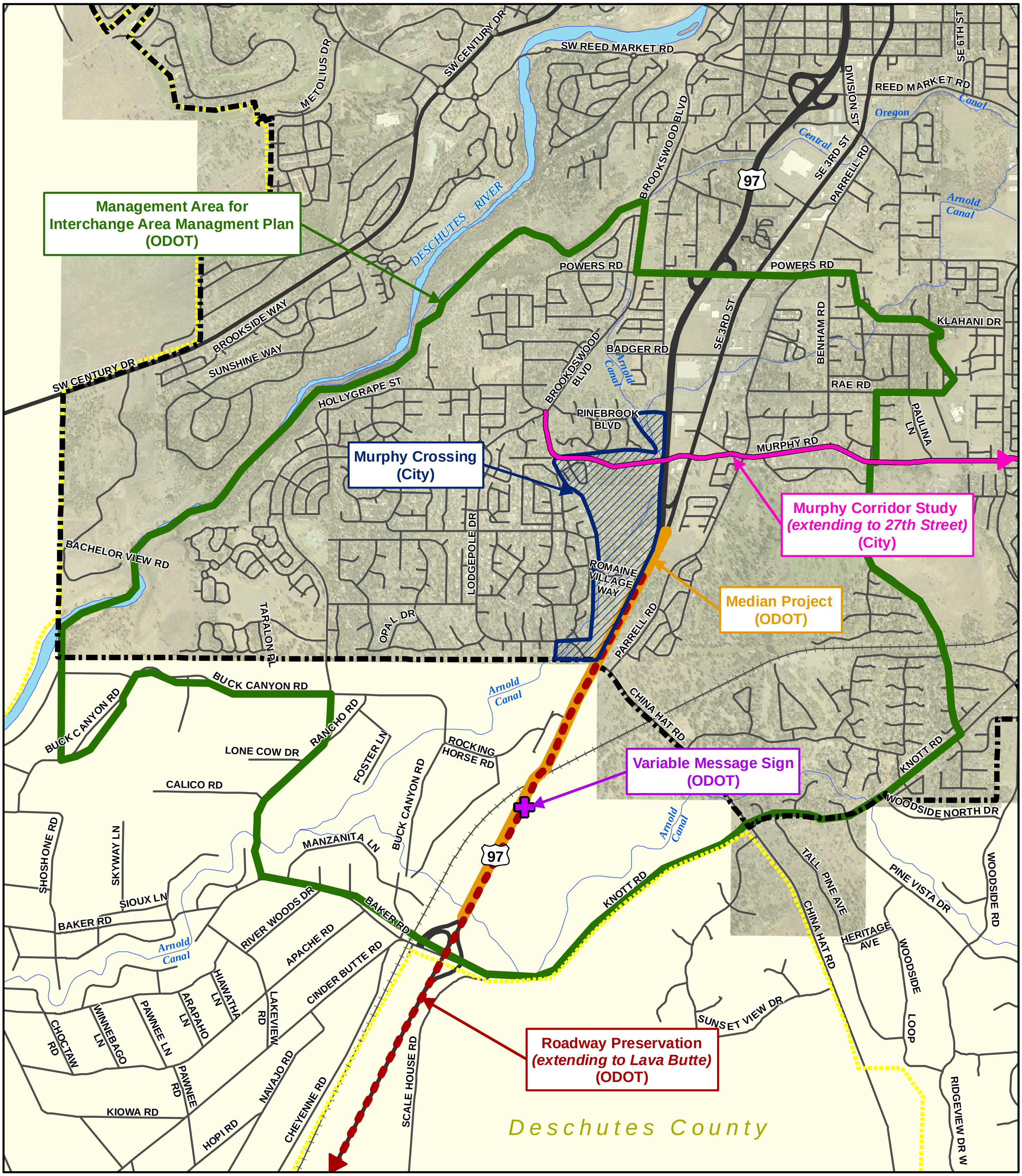
Route 1 and Route 2 are proposed to be in operation Monday through Friday from 6:15 AM to 6:15 PM, and will be on a 30 minute schedule. On Saturday these lines will operate on an hourly schedule between 7:15 AM to 5:15 PM.

Planned Projects

ODOT staff are planning two safety projects that may be combined into a single project. The projects are described below. These projects will develop an access management strategy that will include the South Bend Parkway Refinement Study and any other current land use and access management decision making in the vicinity.

5.4 U.S. 97 Median Project – ODOT

The draft U.S. 97 Median Project proposal is to install a median barrier that would extend between MP 141.0 and MP 142.5, from the existing barrier on U.S. 97 (current median barrier ends just north of the Burlington Northern Santa Fe Railroad over crossing), to the vicinity of the signal at the Third Street intersection (please refer to **Figure 4**) as appropriate.



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DAVID EVANS AND ASSOCIATES INC.

Legend

Urban Growth Boundary (UGB)
Metropolitan Planning Organization (MPO) Boundary

Transportation	*Water Features*	*Planning and Projects in Southern Bend*
State Route	River	Murphy Corridor Study (City)
Other Roads	Canal	Murphy Crossing Project (City)
Railroad		IAMP Management Area (ODOT)
		Median Project (ODOT)
		Roadway Preservation (ODOT)
		Variable Message Sign (ODOT)

South Parkway
Murphy Interchange IAMP

Figure 4

Summary of Planned and Programmed Projects

The purpose of this project is to reduce the number of accidents occurring along this roadway section. For the years 2002-2004, 20 accidents were reported between MP 141.0 and 142.5. Of these reported accidents, ten were coded as angle, three rear end, three fixed object, two side-swipe, and two involved hitting an animal head-on in the left turn refuge.

5.5 U.S. 97 Roadway Preservation Project – ODOT

The proposed U.S. 97 Roadway Preservation Project would grind out and inlay the existing travel lanes and overlay the entire roadway section between mile post 142.0 and MP 146.50 (see **Figure 4**). This roadway section is currently rutting, cracking and raveling. As stated above, this project has been packaged with the U.S. 97 median extension, and it would be preferable to do both projects as one; however, this project could be completed separately.

The proposed preservation project is being submitted as a safety project. The draft scoring narrative indicates that in 2003, the segment had a Safety Investment Program (SIP) category of 4 and a SPIS value of 38.8, which is in the top 15% for the State of Oregon. At the High Desert Museum entrance (MP 145), there has been a concentration of accidents that appear to be related to movements in/out of the entrance.

ODOT staff has recommended this project for STIP Year 2008. At this time, no definitive schedule has been developed for the construction project.

6. Conclusion

6.1 Intersection Operation

Most intersections in the study area operate with acceptable volume to capacity (v/c) ratios, Level of Service (LOS), and queuing lengths. Three intersections do not meet at least one of the acceptable standards:

- **Bend Parkway (U.S. 97) at Powers Road:** The operational analysis indicates this intersection is operating at v/c ratio of 0.95 (which exceeds the OHP standards), and has an eastbound queue that at times blocks the southbound off ramp from the Bend Parkway to Powers Road.
- **Bend Parkway (U.S. 97) at Third Street:** The operational analysis indicates this intersection is also exceeding the OHP standard, with a v/c ratio of 0.91.
- **Ponderosa Road at U.S. 97:** The eastbound approach to U.S. 97 operates at a v/c ratio greater than 1.0. The volumes on the approach are small, but the majority of the traffic wants to turn left or cross U.S. 97, and due to the traffic volume on U.S. 97 the waits are long for Ponderosa Road.

6.2 Signal Warrants

Two of the unsignalized intersections in the study area meet the Manual on Uniform Traffic Control Devices (MUTCD) for signal warrants:

- **U.S. 97 at Ponderosa Road/China Hat Road:** This intersection meets both Signal Warrants 1 and 2; however, long term proposals for this intersection include converting the intersection to right-in/right-out with acceleration lanes, or constructing an overpass of U.S. 97.
- **Third Street at Pinebrook Boulevard:** This intersection also meets Warrant 1 and Warrant 2 as described in the MUTCD. Currently the spacing between Pinebrook Boulevard and Murphy Road is less than 400 ft and may not meet spacing requirements. With the proposal for Murphy Road to be relocated to the south away from Pinebrook Boulevard, it is proposed this location be reassessed at this time.

6.3 Safety Summary

The intersection crash rates along the U.S. 97 Parkway and along Third Street indicated the intersection rates are below the 1.0 crash rate, which is a rate at which a location is potentially problematic and a candidate for further investigation.

Segment crash rates indicate the U.S. 97 Parkway from Powers Road to the Third Street intersection has a crash rate of 1.26 which exceeds the 0.78 comparable state average for U.S. 97. The proposed Build Alternative H-Modified, Option 1 (as defined in the South Bend Parkway Refinement Study) would significantly reduce the crashes along the Parkway. For the section of U.S. 97 south of the Third Street intersection, ODOT staff have prepared a proposal for an approximate $4.5 million preservation/safety project that would reduce accidents along this section.