Polson Area Transportation Plan

Existing Intersection Levels of Service

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2.1 Existing Intersection Levels of Service

Roadway systems are ultimately controlled by the function of major intersections within a developed area. Intersection failure directly reduces the number of vehicles that can be accommodated during the peak hours which have the highest demand and the roadway capacity of a corridor. As a result of this strong impact on corridor function, intersection improvements can be a very cost-effective means of increasing a corridor's traffic capacity. In some circumstances, corridor expansion projects may be able to be delayed with correct intersection improvements. Due to the substantial portion of total expense for roadway construction projects used for design, construction, mobilization, and adjacent area rehabilitation, a careful analysis must be made of the expected service life from intersection-only improvements. If adequate design life is achieved with only improvements to the intersection, then a corridor expansion is not the most efficient solution. With that in mind, it is important to determine how well the major intersections are functioning by determining their Level of Service (LOS).

Level of Service (LOS) for an intersection is a qualitative measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. It provides a scale that is intended to match the perception by motorists of the operation of the intersection. LOS provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersections with each other. The LOS scale represents the full range of operating conditions. The scale is based on the ability of an intersection to accommodate the amount of traffic using it. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates substantial vehicle delay and traffic congestion. The LOS analysis was conducted according to the procedures outlined in the Transportation Research Board's Highway Capacity Manual – Special Report 209 using the Highway Capacity Software, version 4.1f.

In order to calculate the LOS, 16 intersections were counted during the summer and fall of 2010. These intersections included 5 signalized intersections and 11 unsignalized intersections in the Polson area. Each intersection was counted between 7:00 a.m. to 9:00 a.m. and 4:00 p.m. and 6:00 p.m., to ensure that the intersection's peak volumes were represented. Based upon this data, the operational characteristics of each intersection were obtained.

2.1.1 Signalized Intersections

For signalized intersections, recent research has determined that average control delay per vehicle is the best available measure of LOS. Control delay takes into account uniform delay, incremental delay, and initial queue delay. The amount of control delay that a vehicle experiences is approximately equal to the time elapsed from when a vehicle joins a queue at the intersection (or arrives at the stop line when there is no queue) until the vehicle departs from the stopped position at the head of the queue. The control delay is primarily a function of volume, capacity, cycle length, green ratio, and the pattern of vehicle arrivals.

The following table identifies the relationship between LOS and average control delay per vehicle. The procedures used to evaluate signalized intersections use detailed information on geometry, lane use, signal timing, peak hour volumes, arrival types and other parameters. This information is then used to calculate delays and determine the capacity of each intersection. Generally, an intersection is determined to be functioning adequately if operating at LOS C or better, at all times. **Table 2-1** shows the LOS by control delay for signalized intersections.

Table 2-1
Level of Service Criteria (Signalized Intersections)

LOS	Control Delay per Vehicle (sec)
A	< 10
B	10 to 20
C	20 to 35
D	35 to 50
E	50 to 80
F	> 80

Source: The Transportation Research Board's *Highway Capacity Manual*

Using these techniques and the data collected in the summer and fall of 2010, the LOS for the signalized intersections was calculated. **Table 2-2** shows the AM and PM peak hour LOS for each individual leg of the intersections, as well as the intersections as a whole. The intersection LOS is shown graphically in **Figure 2-3**.

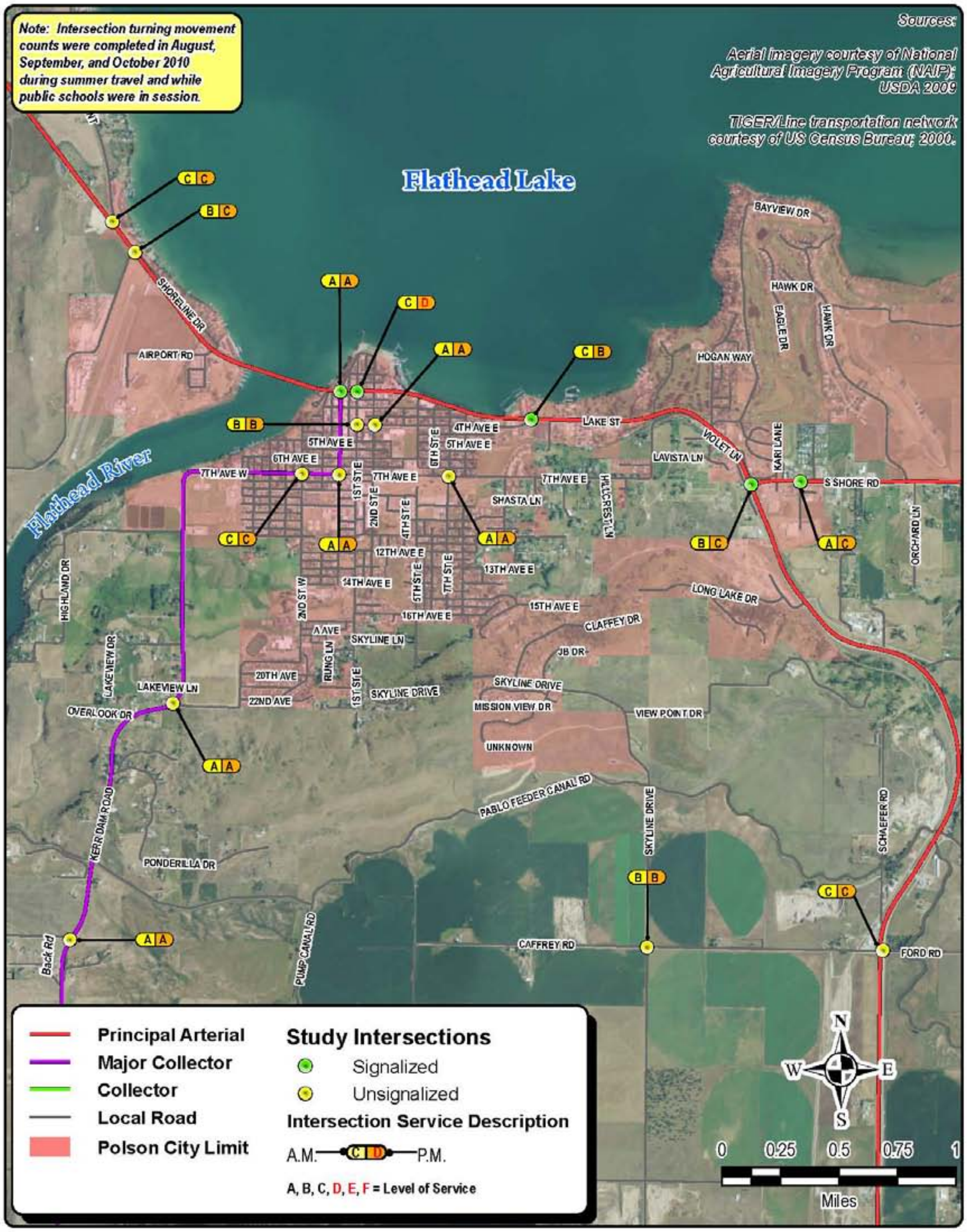

Figure 2-3

Intersection Level of Service
Polson Area Transportation Plan

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Table 2-2
Existing (2010) Level of Service for Signalized Intersections

Intersection	AM Peak Hour					PM Peak Hour				
	EB	WB	NB	SB	INT	EB	WB	NB	SB	INT
US 93 & South Shore Road (MT 35)	-	C	A	B	B	-	C	B	C	C
US 93 (3rd Avenue East) & 4th Avenue East	A	A	F	D	C	A	A	F	D	B
US 93 (2nd Avenue East) & 1st Street East	C	C	C	B	C	C	C	D	C	D
US 93 (2nd Avenue East) & Main Street*	A	A	*N/A*	E	A	A	A	*N/A*	E	A
South Shore Road (MT 35) & Heritage Lane	A	A	E	-	A	A	A	F	-	C

(Abbreviations used are as follows: EB = eastbound; WB = westbound; NB = northbound; SB = southbound; INT = intersections as a whole; N/A = not applicable). * Main Street NB approach under construction during time of data collection.

2.1.2 Unsignalized Intersections

Level of service for unsignalized intersections is based on the delay experienced by each movement within the intersection, rather than on the overall stopped delay per vehicle at the intersection. This difference from the method used for signalized intersections is necessary since the operating characteristics of a stop-controlled intersection are substantially different. Driver expectations and perceptions are entirely different. For two-way stop controlled intersections, the through traffic on the major (uncontrolled) roadway experiences no delay at the intersection. Conversely, vehicles turning left from the minor roadway experience more delay than other movements and at times can experience substantial delay. Vehicles on the minor roadway, which are turning right or going across the major roadway, experience less delay than those turning left from the same approach. Due to this situation, the LOS assigned to a two-way stop controlled intersection is based on the average delay for vehicles on the minor roadway approach.

LOS for all-way stop controlled intersections are also based on delay experienced by the vehicles at the intersection. Since there is no uncontrolled roadway, the highest delay could be experienced by any of the approaching roadways. Therefore, the LOS is based on the approach with the highest delay as shown in **Table 2-3**. This table shows the LOS criteria for both the all-way and two-way stop controlled intersections.

Table 2-3
Level of Service Criteria (Unsignalized Intersections)

Level of Service	Delay (seconds/vehicle)
A	< 10
B	10 to 15
C	15 to 25
D	25 to 35
E	35 to 50
F	> 50

Source: The Transportation Research Board's *Highway Capacity Manual*

Using the above guidelines, the data collected in the summer and fall of 2010 and calculation techniques for two-way stop controls and all-way stop controls, the LOS was calculated for 11 intersections. **Table 2-4** shows the detailed results of the performance level turning movement breakout for each unsignalized intersection.

Table 2-4
Existing (2010) Level of Service for Unsignalized Intersections

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	v/c	Delay	LOS	v/c
US 93 & Rocky Point Road						
Eastbound Left/Thru	7.6	A	0.01	8.3	A	0.00
Southbound Left/Right	16.3	C	0.33	15.6	C	0.20
US 93 & Irvine Flats Road						
Eastbound Left/Thru/Right	7.7	A	0.01	8.2	A	0.01
Westbound Left/Thru/Right	8.6	A	0.02	8.0	A	0.01
Northbound Left/Thru/Right	11.8	B	0.02	13.4	B	0.08
Southbound Left/Thru/Right	13.9	B	0.02	18.8	C	0.17

US 93 & Caffrey Road						
Eastbound Left/Thru/Right	12.1	B	0.15	12.6	B	0.17
Westbound Left/Thru/Right	23.6	C	0.04	18.5	C	0.03
Northbound Left	8.3	A	0.11	8.6	A	0.00
Southbound Left	8.2	A	0.00	8.8	A	0.07
4th Avenue East & 1st Street East *						
Eastbound Left/Thru/Right	8.59	A	-	8.82	A	-
Westbound Left/Thru/Right	9.62	A	-	9.92	A	-
Northbound Left/Thru/Right	10.84	B	-	11.30	B	-
Southbound Left/Thru/Right	10.11	B	-	10.95	B	-
4th Avenue East & 2nd Street East *						
Eastbound Left/Thru/Right	8.31	A	-	8.04	A	-
Westbound Left/Thru/Right	8.25	A	-	7.87	A	-
Northbound Left/Thru/Right	7.87	A	-	8.05	A	-
Southbound Left/Thru/Right	8.38	A	-	7.90	A	-
7th Avenue & Main Street *						
Eastbound Left/Thru/Right	8.45	A	-	8.85	A	-
Westbound Left/Thru/Right	8.73	A	-	9.37	A	-
Northbound Left/Thru/Right	8.00	A	-	8.51	A	-
*Southbound Left/Thru/Right ** *	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
7th Avenue West & 2nd Street West						
Eastbound Left/Thru/Right	7.4	A	0.00	7.6	A	0.00
Westbound Left/Thru/Right	8.3	A	0.21	7.8	A	0.11
Northbound Left/Thru/Right	13.0	B	0.24	13.3	B	0.35

Southbound Left/Thru/Right	24.8	C	0.12	18.4	C	0.11
7th Avenue East & 7th Street East *						
Eastbound Left/Thru/Right	8.22	A	-	9.04	A	-
Westbound Left/Thru/Right	8.10	A	-	8.60	A	-
Northbound Left/Thru/Right	8.18	A	-	8.60	A	-
Southbound Left/Thru/Right	7.84	A	-	8.67	A	-
Skyline Drive & Caffrey Road						
Eastbound Left/Thru/Right	11.3	B	0.01	10.3	B	0.02
Westbound Left/Thru/Right	9.2	A	0.13	9.2	A	0.10
Northbound Left/Thru/Right	7.3	A	0.01	7.3	A	0.01
Southbound Left/Thru/Right	7.4	A	0.04	7.3	A	0.03
Kerr Dam Road (Secondary 354) & Grenier Lane						
Westbound Left/Thru/Right	9.4	A	0.02	9.5	A	0.05
Southbound Left/Thru/Right	7.6	A	0.01	7.4	A	0.01
Northbound Left/Thru/Right	7.3	A	0.00	7.4	A	0.00
Kerr Dam Road (Secondary 354) & Back Road						
Eastbound Left/Thru/Right	9.5	A	0.06	9.4	A	0.03
Southbound Left/Thru/Right	7.4	A	0.00	7.3	A	0.00
Northbound Left/Thru/Right	7.3	A	0.01	7.4	A	0.01

(Abbreviations used are as follows: N/A = not applicable). * HCM methodology does not compute v/c ratios for four–way stop controlled intersections. ** Main Street SB approach under construction during time of data collection.

The existing conditions LOS study in the Polson area shows that one signalized intersection is currently functioning at LOS D or lower. The intersection indicates a potential opportunity for closer examination and further intersection improvement measures to mitigate “operational” conditions. This intersection is shown in **Table 2-5**.

Table 2-5
Existing Intersections Functioning at a LOS D or Lower

Intersection		AM Peak	PM Peak
US 93 (2nd Avenue East) & 1st Street East	S	C	D

S=Signalized

2.2 Percentage of Truck Traffic

Truck traffic within the study area is a concern with the public and local government officials. Based on a data review of the turning movement counts at each of the sixteen intersections studied, Table 2-6 shows the percentage of truck traffic for the intersection as a whole during the AM and PM traffic counts.

Table 2-6
Truck Traffic Percentages

Intersection		AM %	PM %
US 93 & South Shore Road	S	6.6%	3.7%
US 93 (3rd Avenue East) & 4th Avenue East	S	5.8%	3.1%
US 93 (2nd Avenue East) & 1st Street East	S	5.0%	3.5%
US 93 (2nd Avenue East) & Main Street *	S	3.8%	3.7%
South Shore Road (MT 35) & Heritage Lane	S	7.4%	3.2%
US 93 & Rocky Point Road	U-1W	4.3%	4.0%
US 93 & Irvine Flats Road	U-1W	4.9%	5.2%
US 93 & Caffrey Road	U-2W	6.2%	4.4%
4th Avenue East & 1st Street East	U-4W	2.6%	2.0%
4th Avenue East & 2nd Street East	U-4W	0.6%	0.2%
7th Avenue & Main Street *	U-4W	2.7%	0.9%
7th Avenue West & 2nd Street West	U-2W	3.7%	1.4%
7th Avenue East & 7th Street East	U-4W	2.7%	1.9%
Skyline Drive & Caffrey Road	U-2W	12.3%	12.4%

Kerr Dam Road & Grenier Lane	U-1W	5.0%	5.1%
Kerr Dam Road & Back Road	U-1W	9.7%	6.3%

S=Signalized; U-1W=Unsignalized one-way stop controlled; U-2W=Unsignalized two-way stop controlled; U-4W=Unsignalized four-way stop controlled. *Main Street under construction during data collection.

2.3 References

American Association of State Highway and Transportation Officials (AASHTO), 2001. *A Policy on Geometric Design of Highways and Streets, Fourth Edition, Chapter 1,* Washington D.C.

American Association of State Highway and Transportation Officials (AASHTO), 2001. *AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT < 400), Chapter 2,* Washington D.C.

Federal Highway Administration (FHWA). *Manual on Uniform Traffic Control Devices 2003 Edition – Chapter 2B Regulatory Signs,* Washington D.C.

Montana Department of Transportation, January 2008. *A Guide to Functional Classifications, Highway Systems and Other Route Designations in Montana*, Helena, Montana.

Transportation Research Board - National Research Council. 2000. *Highway Capacity Manual (HCM2000) - Chapter 9 Analytical Procedures Overview,* Washington D.C.

Robert Peccia & Associates, Inc. April 2009. *Greater Bozeman Area Transportation Plan (2007 Update) - Chapter 2,* Bozeman, Montana.