

Date: September 30, 2015

Project #: 18460

To: Wade Salyards, PE (Montana Department of Transportation)

From: Brett Korporaal and Andy Daleiden, PE

Project: Airport Rd/Main St – Billings, CM 1099(102), UPN 8718000

Subject: Existing and Future Transportation Conditions

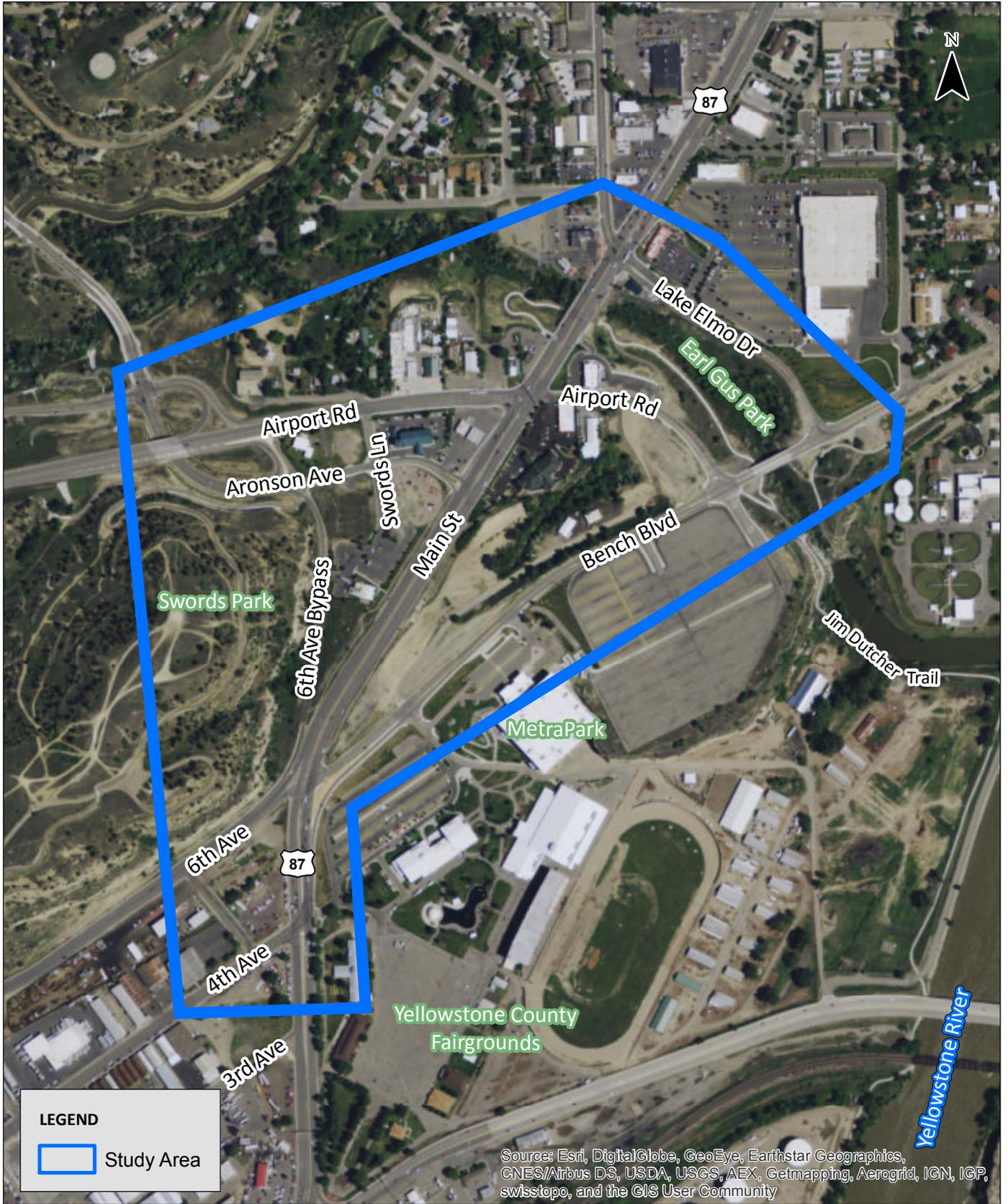
## Introduction

This memorandum summarizes the existing and future transportation system conditions within the study area of the Airport Road and Main Street transportation study in Billings, MT. This memorandum documents the current facilities in place and their operational and safety performance of all travel modes within the study area. The existing conditions analysis establishes the baseline conditions of the current transportation system for comparison in the future conditions analysis. The future conditions analysis addresses programmed facility improvements, growth within the region, and the anticipated operational performance under year 2040 within the study area. The future conditions analysis provides a basis for comparing future alternatives in the next study phase. This memorandum includes the following items:

- Introduction - Pages 1 to 5
- Transportation system inventory – Pages 6 to 10
- Existing conditions – Pages 11 to 25
- Future conditions – Pages 25 to 30
- Summary – Pages 31 to 33

## STUDY AREA

The Airport Road and Main Street intersection is located two miles northeast of downtown Billings, just north of MetraPark. The intersection's location is a critical junction for commuter, regional, and freight trips along the Airport Road and Main Street corridors. Designated as principal arterials, the two corridors connect recreational, residential neighborhoods (Heights West and East), low density commercial, and light industrial uses with downtown Billings and Interstate 90. The intersection is located on the Camino Real International Trade Corridor that connects Canada, United States, and Mexico. Figure 1 highlights the study area.

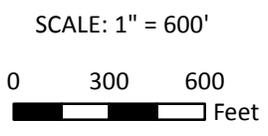


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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**STUDY AREA  
BILLINGS, MONTANA**



**FIGURE  
1**

## PAST PLANS AND STUDIES

Several relevant past plans and studies were reviewed to understand the context of previous work completed in the study area, and to ensure that future intersection alternatives are consistent with any planned projects and the community's vision for the respective corridors. The key findings relevant to the study area from the five studies are outlined below:

### MetraPark Egress Improvements Study (Reference 1)

This study was completed in April 2013 for the Yellowstone County Commission. The study identifies improvement recommendations to the overall circulation plan for the MetraPark, specifically ingress/egress changes to access on Main Street between the 4<sup>th</sup> Avenue and 6<sup>th</sup> Avenue and on Bench Boulevard along the MetraPark frontage.

### Traffic Report 6<sup>th</sup> Ave N/Bench-Blgs, Phase 2 (Reference 2)

This study was completed in November 2012 for the MDT. The study evaluates several alternative intersection improvements at the 4<sup>th</sup> Avenue and 6<sup>th</sup> Avenue intersections with Bench Boulevard and Main Street. The study recommends the following improvements:

- **Main Street and 6th Avenue North/Bench Boulevard** – The short term recommendation is a no build option. The long term recommendation is the 4th Avenue North Flyover, but the timing of this improvement should be revisited once the Billings Bypass is constructed and more is known on the development potential within the EBURD and Hospitality Corridor.
- **Main Street and 1st Avenue North/US 87** – The short term recommendation is the no build option. The long term recommendation is a multilane roundabout, but the timing of this improvement should be revisited once the Billings Bypass is constructed and more is known on the development potential within the EBURD and Hospitality Corridor.
- **Airport Road and Main Avenue** – No specific improvements were recommended in the study. However, it was noted that capacity improvements would be needed in the future, as the intersection is projected to operate at a LOS F in 2020 without the Billings Bypass and at LOS F in 2033 with the Billings Bypass in place.

### Hospitality Corridor Planning Study (Reference 3)

This study was completed in September 2013 for the City of Billings. The study provides a vision to integrate vehicular and non-vehicular needs within the Highway 87/Main Street/Exposition Drive corridor. The study includes recommendations for street cross-sections, intersection improvements, and pedestrian enhancements in the study area.

## 2014 Billings Urban Area Long Range Transportation Plan (Reference 4)

This plan was completed in August 2014 for the City of Billings / Yellowstone County Metropolitan Planning Organization. The plan identifies several transportation projects within the study area, including:

- **Roadway, Intersection, and Congestion Management:** Airport/Main improvements (illustrative), Main Street and 4th Avenue North pavement preservation (committed), Main Street signal timing (recommended)
- **Pedestrian:** Aronson Avenue sidewalks (illustrative), Main Street (US 87) pedestrian easement (recommended), MetraPark pedestrian overpass (recommended)
- **Bicycle:** Airport Road bike lanes (illustrative), Lake Elmo Drive bike lanes (illustrative), 4th Avenue bike lanes (illustrative), 6th Avenue bike lanes (illustrative)
- **Trails:** Swords Park/6th Avenue North Connector (committed), Alkali Creek Trail (committed)

## East Billings Urban Renewal District (EBURD) Master Plan (Reference 5)

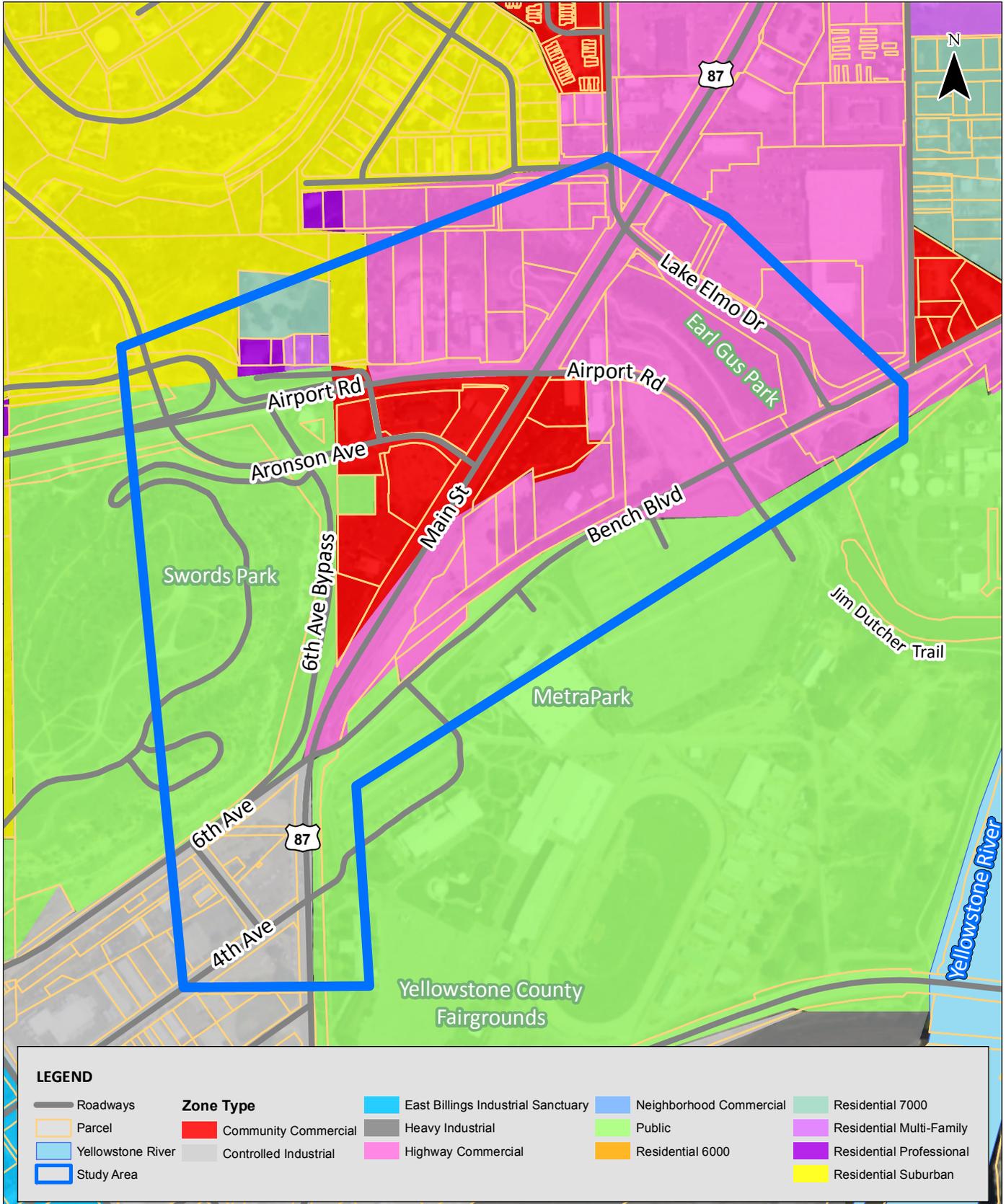
This plan was completed in July 2009 for the Big Sky Economic Development Authority. This plan defined some prototypical streetscape standards, including guidance on lane width, presence of street trees, and other modal facilities.

## LAND USE AND ZONING

The project area is located mostly within the city limits of Billings, MT; however, the MetraPark area located south of Bench Boulevard and east of Main Street is owned by Yellowstone County. The existing zoning within the study area is a mix of industrial, public, highway and community commercial, and residential.

Figure 2 illustrates the existing zoning for the study area.

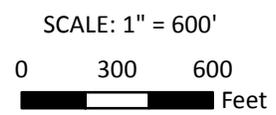
There are several restaurants, gas stations, and hotels near the intersection of Airport Road and Main Street. The southeast region of the study area is occupied by MetraPark and the Yellowstone County Fairgrounds. This entertainment and trade center facility hosts a wide variety of events (e.g. concerts, rodeos, sporting games, trade shows) throughout the year. The northern region of the study area is occupied by commercial and residential uses. The southwest region of the study area includes the Swords Rimrock Park, which has multiuse trails and points of interest. To the north of the study area, Main Street has several major commercial uses (e.g. Target, Walmart) that serve the Billings community.



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**EXISTING ZONING  
BILLINGS, MONTANA**



**FIGURE  
2**

# Transportation System Inventory

The transportation system inventory identifies site conditions and the current geometric characteristics of roadways within the study area. The information presented herein is based on field visits and inventories of the area conducted in April 2015.

## ROADWAY FACILITIES

Major roadways in the study area were identified and catalogued. Table 1 provides a summary of the roadway facilities being studied.

**Table 1. Existing Roadway Characteristics within Study Area**

Roadway	Functional Classification <sup>1</sup>	# of Travel Lanes	Posted Speed (mph)	Pedestrian Facilities	Bicycle Facilities <sup>2</sup>	Average Daily Traffic (ADT) <sup>3</sup>	AM Peak/PM Peak <sup>4</sup>
4 <sup>th</sup> Avenue North	Principal Arterial	3 Lanes	35	Yes	No	14,000	535/1,675
6 <sup>th</sup> Avenue Bypass	Principal Arterial	1 Lane	35	Partial	Primary Bike Route	4,800	760/200
6 <sup>th</sup> Avenue North	Principal Arterial	4 Lanes	35	Yes	Arterial Bike Route	13,800	2,170/935
Alkali Creek Road	Principal Arterial	2 Lanes	25	Partial	Primary Bike Route	3,400	380/220
Airport Road	Principal Arterial	4 - 6 Lanes	45 - 50	Partial	Arterial Bike Route	11,800 - 13,000	1,015/1,610
Aronson Avenue	Principal Arterial	2 Lanes	25	Partial	No	3,100	310/645
Bench Boulevard	Principal Arterial	2 Lanes	35	Partial	Partial	6,500	960/1,110
Main Street	Principal Arterial	6 Lanes	35	Yes	No	38,000 - 49,300	3,060/4,090
Lake Elmo Drive	Collector / Principal Arterial	2 Lanes	25	Partial	Primary Bike Route	6,600	700/865
Swords Lane	Local Street	2 Lanes	25	Partial	No	800	45/75

Notes: <sup>1</sup> Roadway functional classification was derived from the 2014 Billings Urban Area Long Range Transportation Plan; <sup>2</sup> There are no bike lanes on any roadways within the study area, bike routes were highlighted by the City of Billings Parks and Recreation; <sup>3</sup> ADT counts are from the 2014 Billings Urbanized Area Traffic Count Map provided by the City of Billings or estimated based on the peak hour counts; and <sup>4</sup> AM and PM Peak hour counts are from turning movement counts collected in April 2015 and shown on Figures 6 and 7.

4<sup>th</sup> Avenue North is a one-way, principal arterial in the eastbound direction. The roadway provides a connection from Central Billings to Main Street. Bus routes 14P (Alkali), 16P (Main), 17P (Bench), and 18M (Heights) use 4<sup>th</sup> Avenue North to access communities to the east of downtown.

6<sup>th</sup> Avenue Bypass is a one lane, principal arterial that provides a one-way connection for vehicles traveling from Aronson Avenue and the Heights neighborhoods to 6<sup>th</sup> Avenue North. Bus Route 15P (Hilltop) uses the Bypass to connect with 6<sup>th</sup> Avenue.

6<sup>th</sup> Avenue North is a one-way, four lane, principal arterial in the westbound direction. The roadway begins at the Main Street/Bench Boulevard/6<sup>th</sup> Avenue intersection and provides westbound vehicles

a connection into Central Billings. Bus routes 14P (Alkali) and 15P (Hilltop) use 6<sup>th</sup> Avenue North to connect with downtown Billings.

*Alkali Creek Road* is a two-lane, principal arterial located to the northwest of the Airport Road/Main Street intersection. The roadway provides connections to local roads via Airport Road and Aronson Avenue within the Heights neighborhood north of Billings Logan International Airport.

*Airport Road* is a principal arterial that begins at the Airport Road/Main Street intersection and connects MetraPark and Main Street with the Billings Logan International Airport and Montana State Highway 3. No transit service is provided along Airport Road.

*Aronson Avenue* serves as a two-lane, principal arterial that connects Main Street to the Heights neighborhood located to the north of the study area.

*Bench Boulevard* is a two-lane, principal arterial that provides a north-south parallel route to Main Street. This roadway connects both commercial and residential uses in the north area of Billings, as well as serves as the main access to MetraPark and its parking facilities.

*Main Street* serves as a six-lane, principal arterial that provides a continuous, major north-south roadway outside the City limits into Central Billings. Bus routes 14P (Alakli), 15P (Hilltop), 16P (Main), 17P (Bench), and 18M (Heights) utilize Main Street to operate their route.

*Lake Elmo Drive* is a two-lane, collector and principal arterial that runs parallel to Main Street on the west side. This roadway provides a connection from the Heights neighborhood to Main Street. *Swords Lane* is a two-lane, local road that provides access to some residential parcels, commercial uses, and to Aronson Avenue.

Figure 3 illustrates the existing roadway's functional classification, pedestrian facilities, multi-use trails, and MET fixed-route bus stops within the study area.

## PEDESTRIAN AND BICYCLE FACILITIES

Figure 3 highlights the location of sidewalks along the roadways. Main Street, 4<sup>th</sup> Avenue North, and 6<sup>th</sup> Avenue North were the only roadways with sidewalks on both sides of the road. An asphalt path was recently constructed along the 6<sup>th</sup> Avenue Bypass and Swords Lane. The remaining roadways maintain partial and/or intermittent sidewalks.

No bike lanes are provided on any of the roadways within the study area. However, the City of Billings has designated several roadways within the study area as "Arterial Bike Routes" or "Primary Bike Routes," identified in Table 1.



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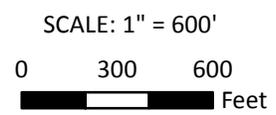
**LEGEND**

- Principal Arterial
- Minor Arterial
- Collector
- Local Road
- Sidewalks
- Multi-Use Trails
- Study Area
- MET Bus Stops

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



**EXISTING  
ROADWAY FACILITIES  
BILLINGS, MONTANA**



**FIGURE  
3**

Within the study area, Earl Gus Park and Swords Park provide multi-use paths for both pedestrians and bicyclists. These paths are separated and protected from nearby roadways. As shown on Figure 3, Earl Gus Park is located between Lake Elmo Drive, Airport Road, Main Street, and Bench Boulevard. The park includes grade separated facilities to access the Jim Dutcher Trail, which runs parallel to Bench Boulevard and the Yellowstone River. Swords Park is located west of the 6<sup>th</sup> Avenue Bypass and includes several trails for hiking and biking with views overlooking the Rimrocks and the City of Billings.

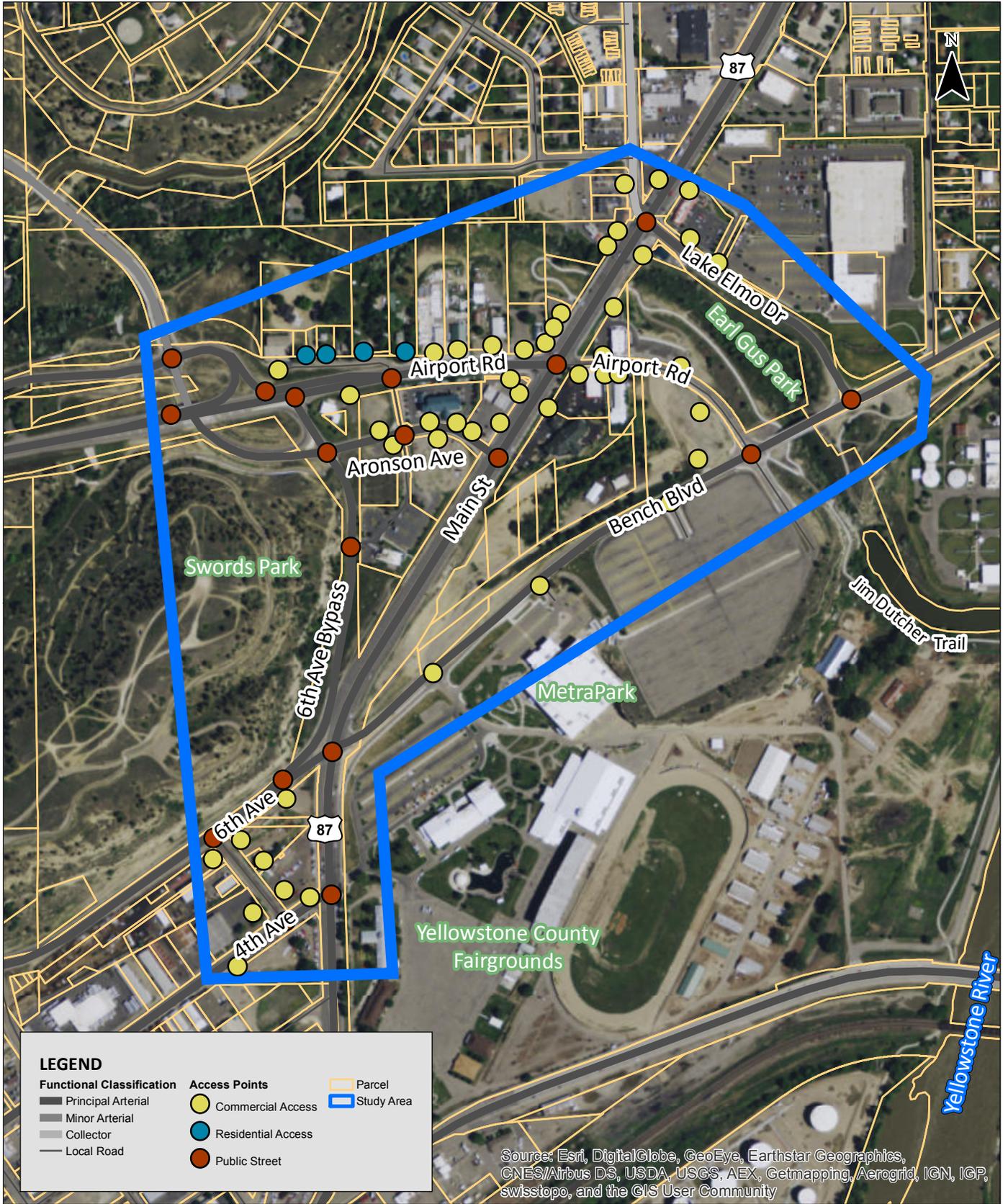
## TRANSIT FACILITIES

Billings Metropolitan Transit (MET) is the public transportation agency providing fixed-route and paratransit bus services throughout Billings. There are five fixed-route bus routes providing service throughout the study area. These routes include: 14P (Alakli), 15P (Hiltop), 16P (Main), 17P (Bench), and 18M (Heights), all providing weekday service during the a.m. and p.m. peak periods with headways varying between 60 and 80 minutes. Weekend service is provided by bus route 18P (Heights) with headways varying between 60 and 80 minutes beginning at 8:40 a.m. This route runs on Saturday only, with no bus service provided on Sundays. The bus operations include a flag-down service, but there are a few common locations where buses stop in the study area, as shown in Figure 3.

## PUBLIC AND PRIVATE ACCESSES

A field inventory of the existing residential and commercial accesses and public street connections was conducted within the study area. Figure 4 illustrates the location of each approach. There are a total of 68 accesses, of which 46 are commercial accesses, 18 public street connections, and 4 residential driveways within the study area. There are no residential driveways located on Main Street or Airport Road. All four residential driveways are located on Swords Lane, north of Airport Road.

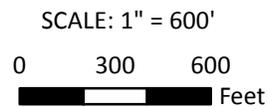
The majority of accesses are in the vicinity of the Airport Road/Main Street intersection and the Lake Elmo Drive/Main Street intersection. Main Street has 10 commercial accesses between Aronson Avenue and Lake Elmo Drive. Airport Road has 12 commercial accesses between Bench Boulevard and 6<sup>th</sup> Avenue Bypass.



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**EXISTING APPROACHES  
PUBLIC & PRIVATE  
BILLINGS, MONTANA**



**FIGURE  
4**

# Existing Conditions

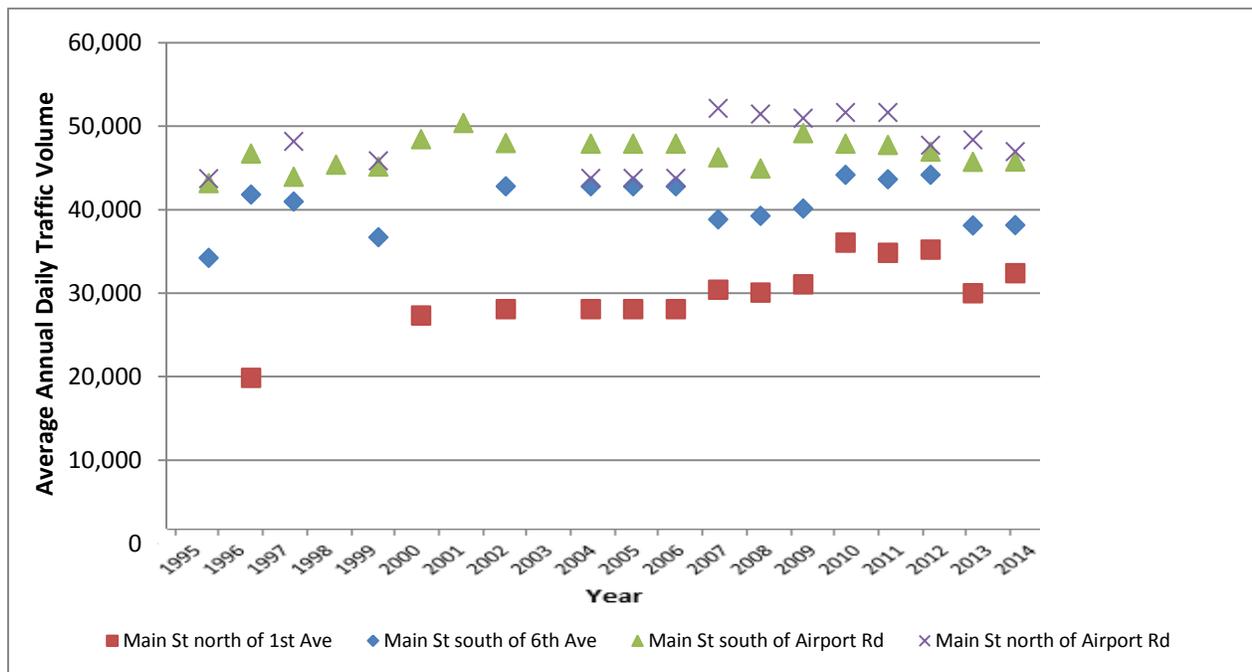
This section summarizes the existing traffic operations and safety analysis within the study area.

## OPERATIONS ANALYSIS

### Daily Traffic Volumes on Main Street

Montana Department of Transportation (MDT) provided average annual daily traffic (AADT) volumes along Main Street for the past 20 years (1995 - 2014). The AADT along Main Street includes two-way traffic volumes between 1<sup>st</sup> Avenue and Lake Elmo Drive. In 2014, AADT along Main Street varied from 46,900 north of Lake Elmo Drive to 38,100 north of 1<sup>st</sup> Avenue. Exhibit 1 presents a graphical representation of the range of AADT on Main Street for the past 20 years. When averaging the segment’s AADT over 20 years, the annual growth rate is approximately 1%. *Attachment A includes the AADT worksheets provided by MDT along Main Street from 1995 – 2015.*

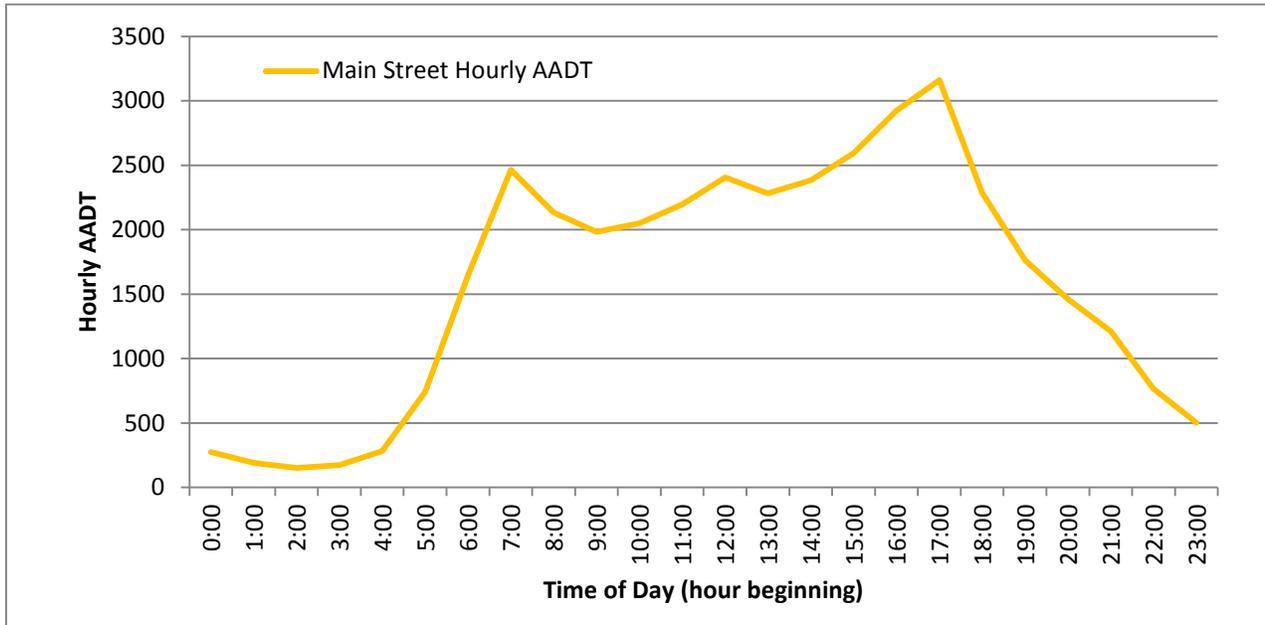
**Exhibit 1. 20 Year AADT on Main Street**



Notes: There was no AADT data recorded or estimated in 2003.

Exhibit 2 summarizes a weekday, 24-hour profile of the AADT volumes on Main Street just north of 1<sup>st</sup> Avenue. Main Street has a distinct a.m. peak that occurs between 7:00 a.m. and 8:00 a.m. and a p.m. peak that occurs between 5:00 p.m. and 6:00 p.m. The weekday p.m. peak hour is approximately 23 percent greater than the weekday a.m. peak hour.

**Exhibit 2. Hourly AADT Profile at Main Street North of 1st Avenue**



**Heavy Vehicle Patterns and Activity**

Airport Road and Main Street are located on the Camino Real International Trade Corridor that connects Canada, United States, and Mexico. Table 2 summarizes the heavy vehicle percentages by direction on Main Street and Airport Road during the weekday a.m. and p.m. peak hours. The weekday a.m. peak hour has the highest percentage of heavy vehicles in the study area.

**Table 2. Heavy Vehicle Percentages along Study Roadways**

Roadway	Peak Hour	Heavy Vehicle Percentages			
		Northbound	Southbound	Eastbound	Westbound
Airport Road (west of Main Street)	AM Peak	-	-	7.1%	6.8%
	PM Peak	-	-	3.6%	3.0%
Main Street (north of Airport Road)	AM Peak	8.3%	3.8%	-	-
	PM Peak	3.2%	3.8%	-	-
Main Street (between 6th Avenue and Airport Road)	AM Peak	12.7%	4.8%	-	-
	PM Peak	2.3%	5.2%	-	-

The Airport Road/Main Street intersection has the highest percentage of heavy vehicles among the study intersections, accounting for 5.6% and 3.5% of all vehicles during the weekday a.m. and p.m. peak hours, respectively. The northbound left (42%) from Main Street onto Airport Road and eastbound right (26%) from Airport Road onto Main Street are the movements with the highest heavy vehicle percentages at the intersection.

## Pedestrian and Bicyclist Activity

Turning movement counts and pedestrian/bicyclist counts were collected at each study intersection in April 2015. The majority of pedestrian and bicyclist activity occurred at the Airport Road/Main Street intersection and along Bench Boulevard in the vicinity of Earl Gus Park. Table 3 provides directional pedestrian and bicycle activity where recorded at the study intersections.

There was relatively minimal bicycle activity throughout the study area. Many bicyclists utilize the multiuse trails within the study area, as they are separated and provide fairly good connectivity from the neighborhoods to downtown Billings.

**Table 3. Pedestrian and Bicycle Activity**

Intersection	Peak Hour	Northern Crossing		Southern Crossing		Eastern Crossing		Western Crossing		Total
		Ped	Bike	Ped	Bike	Ped	Bike	Ped	Bike	
Lake Elmo Dr/Main St	AM Peak	2	-	-	1	-	1	1	1	6
	PM Peak	-	-	-	-	1	1	1	-	3
Airport Rd/Main St	AM Peak	-	-	1	-	2	-	4	1	8
	PM Peak	-	-	5	1	-	1	4	-	11
Lake Elmo Dr/Bench Blvd	AM Peak	-	-	7	-	-	-	-	-	7
	PM Peak	2	-	12	-	1	-	-	-	15
Airport Rd/Bench Blvd	AM Peak	-	2	4	-	-	-	3	-	9
	PM Peak	1	-	1	-	1	-	-	1	4
Aronson Ave/6th Ave Bypass	AM Peak	-	-	2	-	-	-	-	-	2
	PM Peak	-	1	4	3	-	-	-	-	8
Aronson Ave/Main St	AM Peak	-	-	-	-	-	-	3	1	4
	PM Peak	-	-	-	-	-	-	6	-	6
6th Ave/Main St	AM Peak	-	-	-	-	-	1	1	-	2
	PM Peak	-	-	-	-	-	-	-	-	0
4th St/Main St	AM Peak	-	1	1	1	1	-	-	-	4
	PM Peak	-	-	3	-	-	-	1	-	4

## Intersection Peak Hour Operations Analysis

Turning movement counts were collected on a typical mid-week day in April 2015 during the a.m. peak period (7:00 a.m. to 9:00 a.m.) and p.m. peak period (4:00 p.m. to 6:00 p.m.) at each of the study intersections. Additionally, turning movement counts were collected during an event at the Rimrock Auto Arena at MetraPark. The event was a Pro Bull Riding Rodeo on Friday, April 17, 2015. Turning movement counts were collected between 4:00 p.m. and 12:00 a.m. to identify event traffic patterns at nearby study intersections. *Attachment B includes the turning movement count data sheets at the study intersections for the weekday a.m. and p.m. peak time periods.*

The operational analysis was performed using the following assumptions:

- Synchro 8 was used to model the existing roadway network and analyze the weekday a.m. and p.m. peak hour traffic conditions.
- Weekday AM and PM turning movement counts (collected in April 2015)
- Pedestrian and bicycle counts (collected in April 2015)
- Lane geometry, posted speeds, and storage lengths (field collected in April 2015; used GoogleEarth to confirm some measurements)
- A 1700 passenger cars/per hour/per lane saturation flow rate was used based on field data collected on King Avenue in Billings, as part of the King Avenue Signal Timing project.
- Peak hour factor was calculated from the April 2015 turning movement counts
- Signal timing and phase diagrams were obtained from MDT for the traffic signals on Main Street and City of Billings for the Bench Boulevard/Airport Road intersection; The Main Street corridor operates in coordination with a cycle length of 130 and 150 seconds during the weekday a.m. and p.m. peak hours, respectively.
- The Highway Capacity Manual (HCM) 2000 (Reference 6) and Synchro 8's SIMTraffic methodology were used in the analysis. The HCM 2000 methodology was used for all of the signalized and stop-controlled intersections as it produced consistent results with our field observations in comparison to using the HCM 2010, except for the stop-controlled intersections of Aronson Avenue/6<sup>th</sup> Avenue Bypass and Aronson Avenue/Main Street. At the Aronson Avenue/6<sup>th</sup> Avenue Bypass intersection, the lane geometry and stop-controlled operations are not accommodated in the HCM. At the Aronson Avenue/Main Street intersection, the northbound left-turn movement was observed to maneuver when the northbound left-turn at the Airport Road/Main Street signalized intersection received the green arrow. The macroscopic nature of the HCM model is unable to capture this operational benefit from an upstream traffic signal. Therefore, Synchro 8's SimTraffic, a microsimulation tool was used to report the operational results at these two intersections. HCM 2010 was used to analyze the merge condition at the Airport Road/Alkali Creek Road on-ramp (Reference 7).
- Intersection performance measures reported in this study include, but are not limited to, level of service (LOS), volume-to-capacity ratio (V/C), delay, and 95<sup>th</sup> percentile queue lengths. MDT has adopted level-of-service standards for facilities, detailed in Chapter 3 of the MDT Road Design Manual. For a Principal Urban Arterial, the desirable LOS is LOS "B" or LOS "C" per the MDT Road Design Manual (Reference 8). In urban conditions, a LOS "D" or LOS "E" and a volume-to-capacity ratio of less than 0.90 are often acceptable. The LOS "B" and LOS "C" criteria are more pertinent for freeways and two-lane highways versus the urban arterial conditions within the study area.

Figure 5 presents the existing lane configuration and traffic control devices at the study intersections. Figure 6 and Figure 7 summarize the operational analysis at the study intersections during the weekday a.m. and p.m. peak hours. *Attachment C includes the existing conditions operational results from Synchro 8 during the weekday a.m. and p.m. peak hours.*

As shown in Figures 6 and 7, most of the study intersections currently operate at a level of service C or better during the weekday a.m. and p.m. peak hours. However, the following intersections are identified as either not meeting the LOS C criteria or have a volume-to-capacity ratio of greater than 0.90:

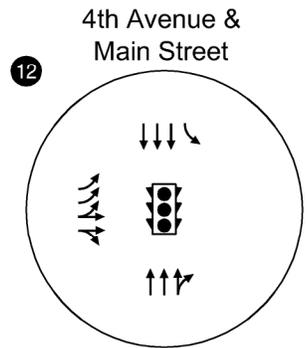
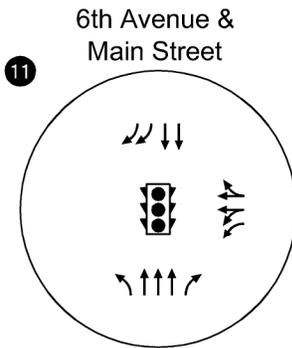
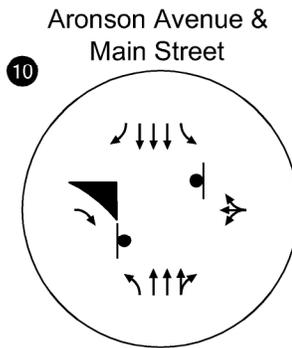
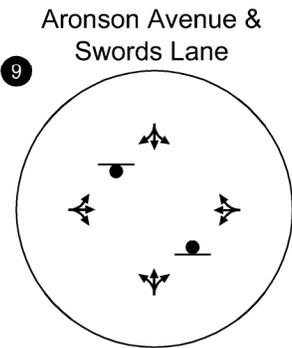
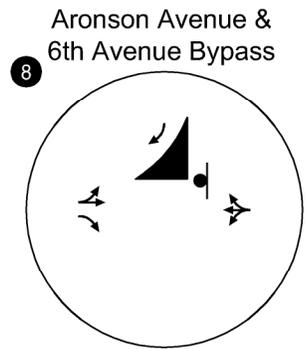
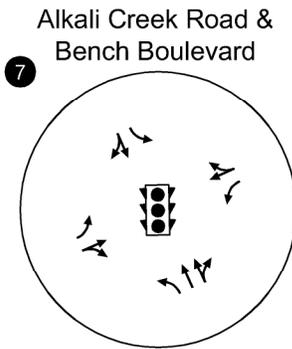
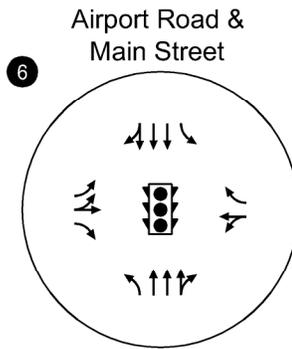
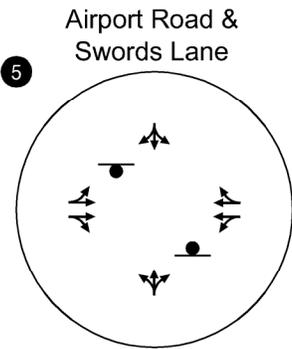
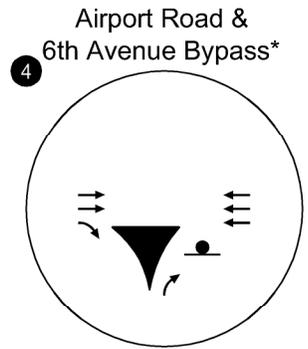
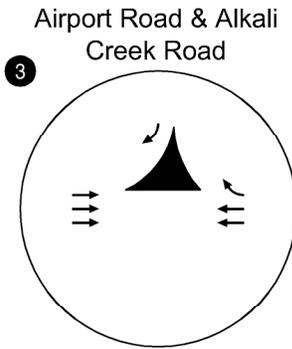
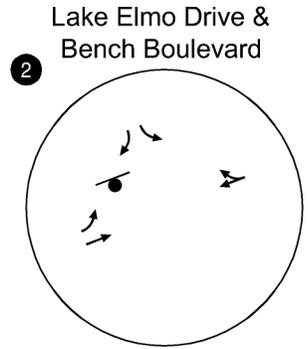
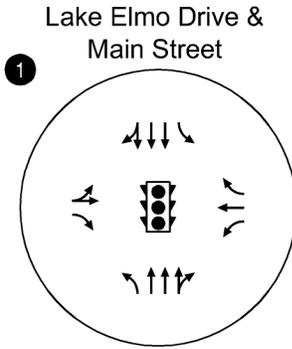
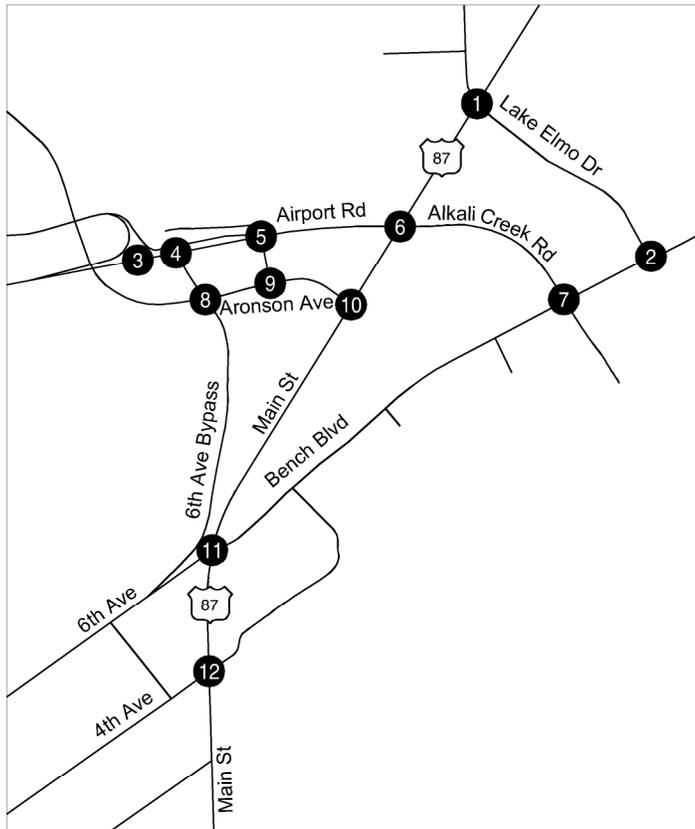
- Main Street/Lake Elmo Drive (AM v/c = 0.97)
- Main Street/Airport Road (AM v/c = 0.92, PM LOS D and v/c = 0.92)
- Main Street/Aronson Avenue (PM LOS = D for northbound left-turn)
- Main Street/6<sup>th</sup> Avenue (AM v/c = 1.00, PM v/c = 0.97)
- Main Street/4<sup>th</sup> Avenue (PM LOS D and v/c = 0.96)

As observed in the field, the main Street corridor between 4<sup>th</sup> Avenue and Lake Elmo Drive is operating near capacity during the weekday a.m. and p.m. peak hour.

Queue lengths were evaluated at the signalized intersections along the Main Street corridor to identify if any deficiencies in queue spillback occur during the weekday a.m. and p.m. peak hours. The 95<sup>th</sup> percentile queue lengths are calculated using Synchro 8 and represents the worst-case queue that occurs 5% of the time.

Figure 8 illustrates the 95<sup>th</sup> percentile critical queue lengths at the study intersections during the weekday a.m. and p.m. peak hours. The following are results from the analysis and observations from the field visit:

- **Lake Elmo Drive/Main Street** – The 95<sup>th</sup> percentile queue length for the eastbound right exceeds the storage length during the weekday a.m. and p.m. peak hours. There is currently an exclusive right-turn lane with a storage length of 100 feet, which is inadequate to accommodate the right-turn traffic volume. Additionally, during the weekday a.m. peak period, vehicles making that right-turn have limited opportunity to make a right-turn on red due to the heavy throughput on Main Street. Vehicle queues for the southbound through movement reach their maximum length during the weekday a.m. peak period, extending roughly 500 feet from the intersection.
- **Airport Road/Main Street** - The eastbound left turn experiences high delay and at times long vehicle queues during the weekday p.m. peak hour. The split-phasing for the eastbound and westbound movements limits the green time for the eastbound left turn. During the weekday a.m. peak hour, vehicle queues in the southbound through direction were observed to spill back to the Lake Elmo Drive intersection.



\* The third westbound through lane serves as a right-turn lane at the downstream intersection.

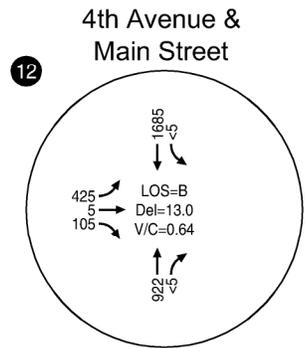
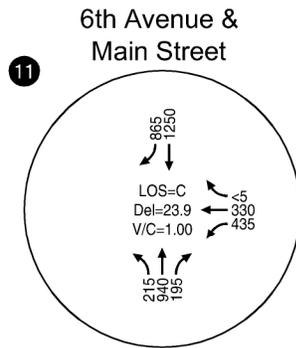
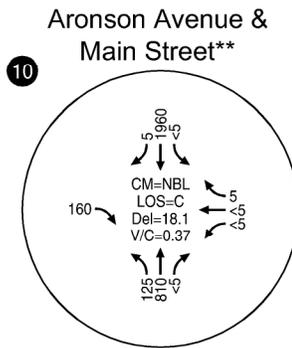
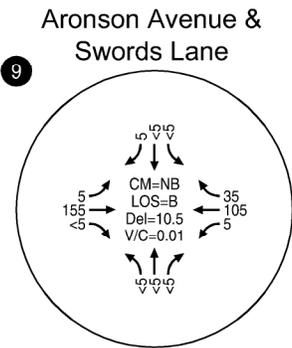
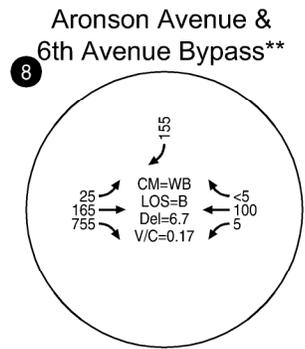
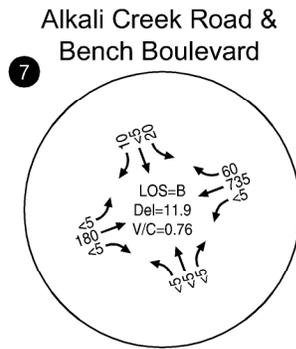
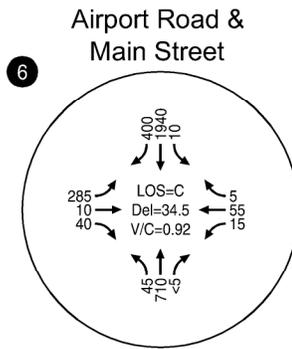
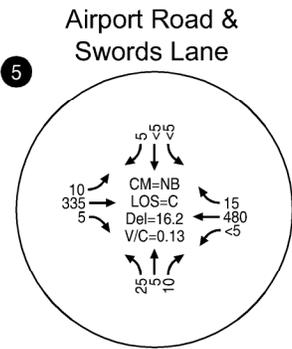
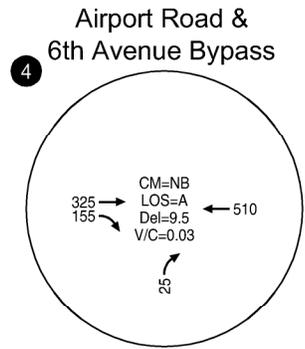
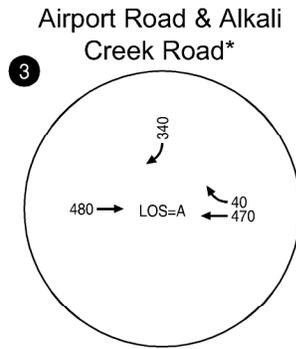
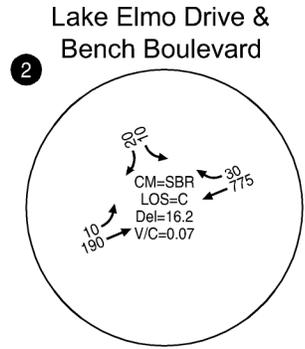
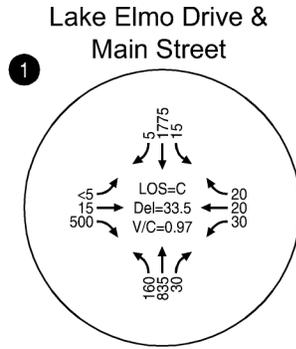
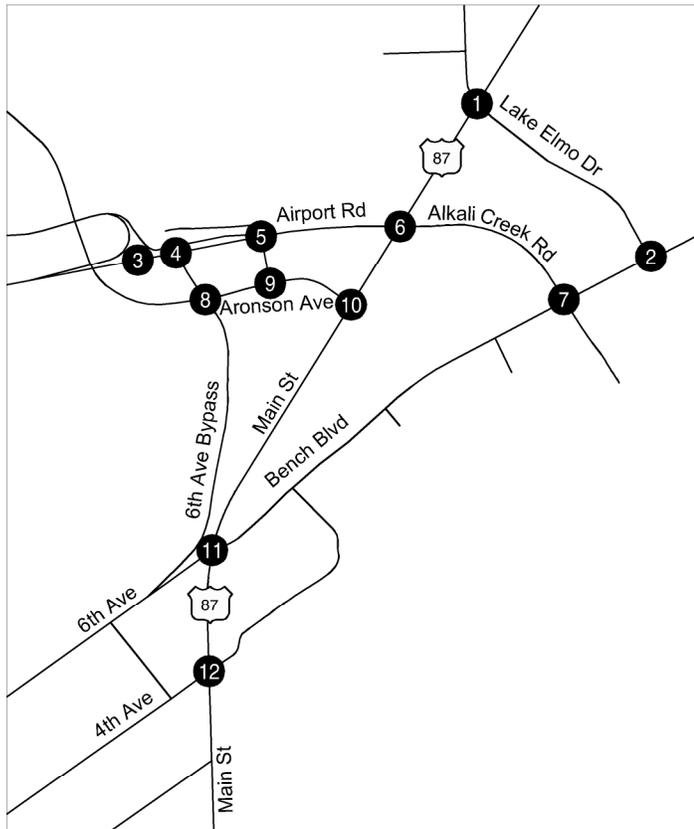


EXISTING  
LANE CONFIGURATIONS AND  
TRAFFIC CONTROL DEVICES  
BILLINGS, MONTANA

- LEGEND
- STOP SIGN
  - TRAFFIC SIGNAL

FIGURE  
5

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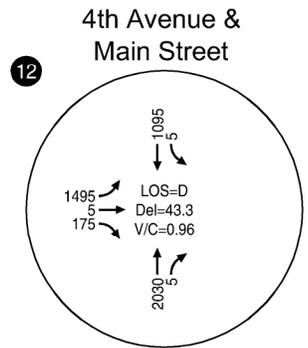
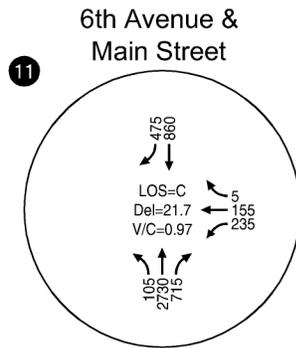
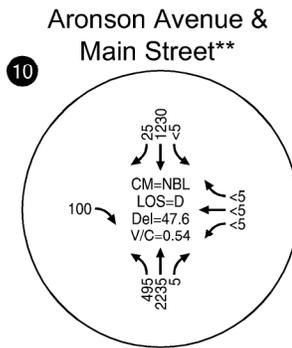
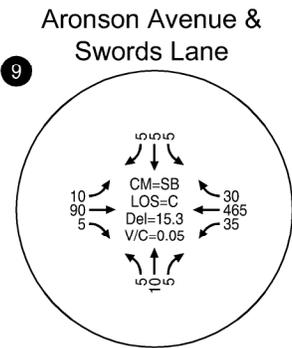
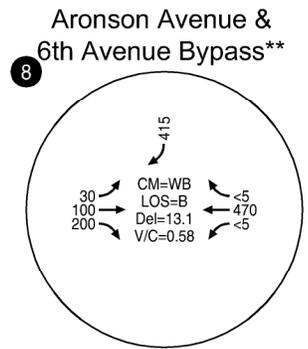
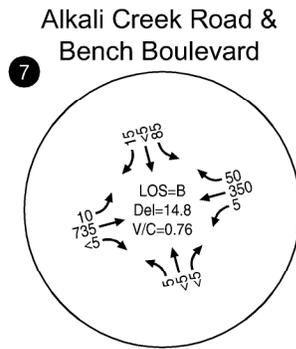
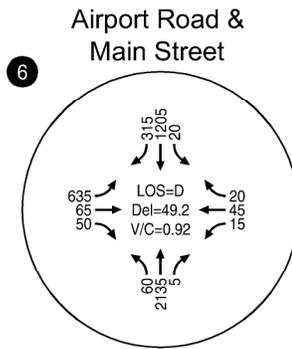
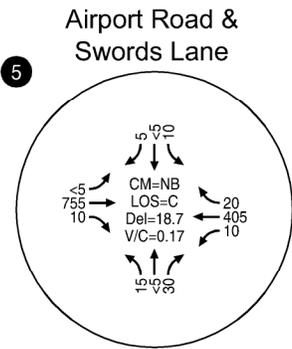
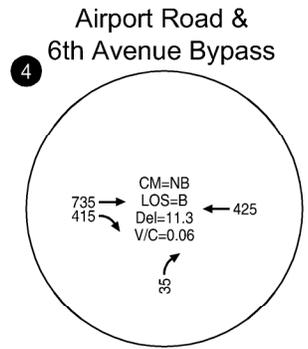
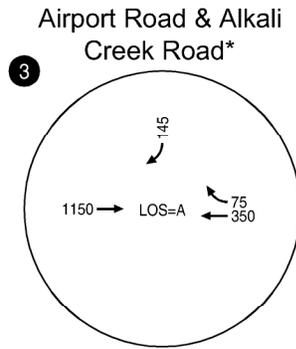
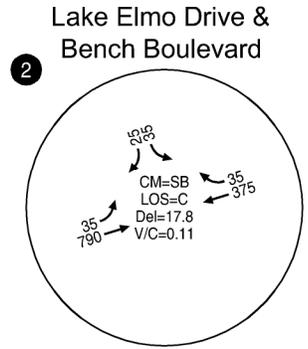
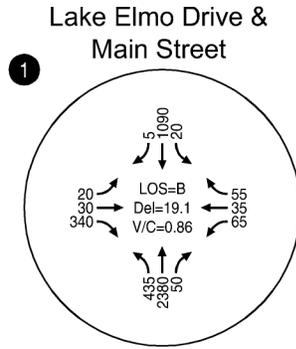
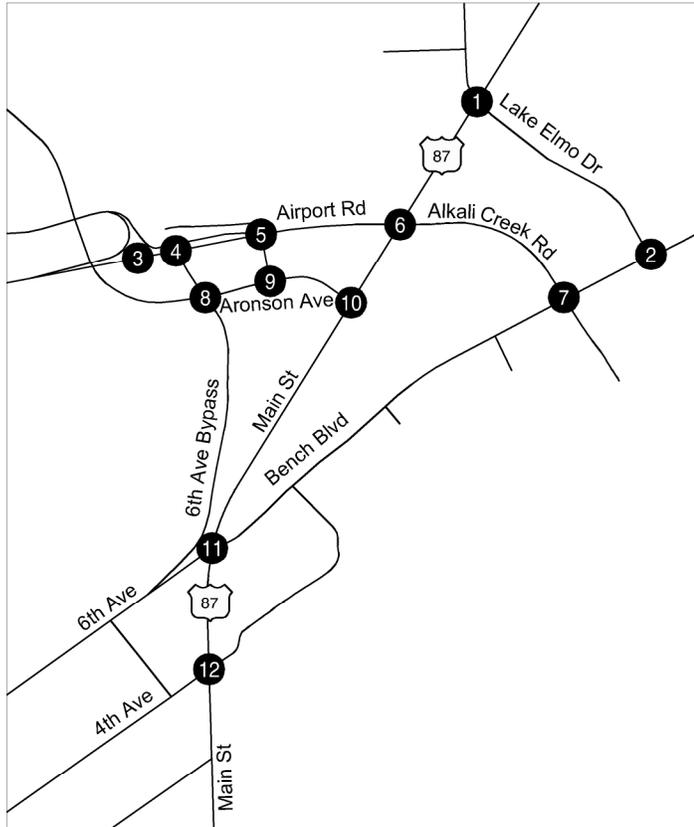
\* HCM 2000 Methodology does not support intersection's traffic control device. Operation results were determined using HCS 2010 Merge Segment Methodology.  
 \*\* HCM 2000 Methodology does not support intersection's lane configuration. Operation results were determined using Synchro's SimTraffic analysis.



**EXISTING CONDITIONS  
AM PEAK HOUR  
BILLINGS, MONTANA**

**LEGEND**  
 CM = CRITICAL MOVEMENT (UN SIGNALIZED)  
 LOS = INTERSECTION LEVEL OF SERVICE / CRITICAL MOVEMENT LEVEL OF SERVICE (UN SIGNALIZED)  
 Del = INTERSECTION AVERAGE CONTROL DELAY / CRITICAL MOVEMENT CONTROL DELAY (UN SIGNALIZED)  
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

**FIGURE  
6**



\* HCM 2000 Methodology does not support intersection's traffic control device. Operation results were determined using HCS 2010 Merge Segment Methodology.  
 \*\* HCM 2000 Methodology does not support intersection's lane configuration. Operation results were determined using Synchro's SimTraffic analysis.

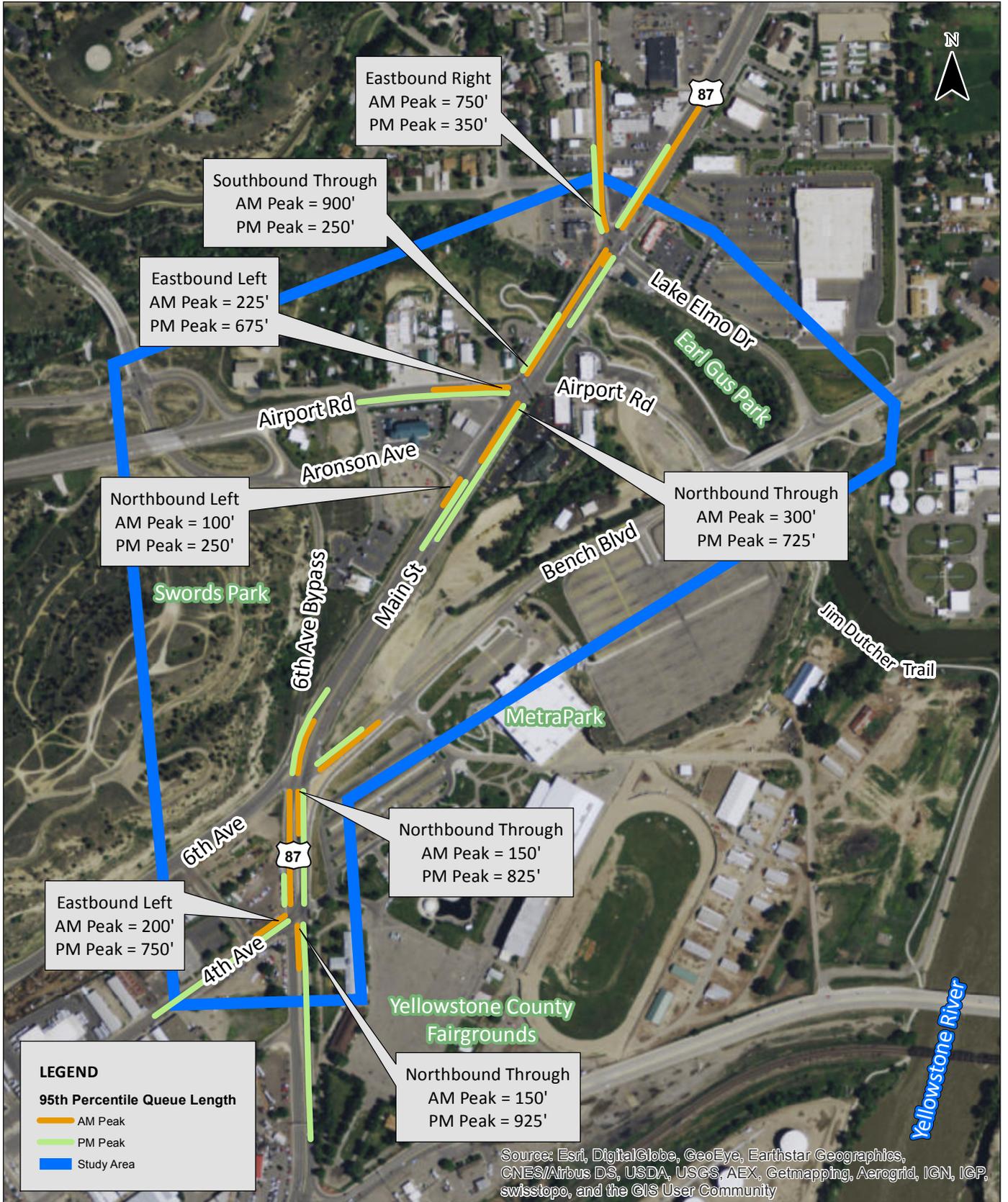


**EXISTING CONDITIONS  
PM PEAK HOUR  
BILLINGS, MONTANA**

**LEGEND**  
 CM = CRITICAL MOVEMENT (UN SIGNALIZED)  
 LOS = INTERSECTION LEVEL OF SERVICE / CRITICAL MOVEMENT LEVEL OF SERVICE (UN SIGNALIZED)  
 Del = INTERSECTION AVERAGE CONTROL DELAY / CRITICAL MOVEMENT CONTROL DELAY (UN SIGNALIZED)  
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

**FIGURE  
7**

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**95th PERCENTILE CRITICAL QUEUE LENGTHS BILLINGS, MONTANA**

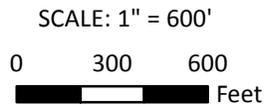


FIGURE 8

There is currently no southbound right-turn lane, so vehicles making the right-turn on to Airport Road must wait until the southbound through movement gets a green indication. Vehicle queues in the northbound direction varied based on time of day, but were longest during the weekday p.m. peak hour. The northbound vehicle queues were observed to spillback to or past the Aronson Drive/Main Street intersection. Vehicle queues for the northbound left movement never exceeded the storage length provided in either of the peak periods as the majority of vehicles making a left off of Main Street in the northbound direction use Aronson Avenue as an alternate route.

- **Aronson Avenue/Main Street** – The unsignalized intersection of Aronson Avenue/Main Street experiences a high volume of northbound left turns (495 in the p.m. peak hour). This movement was observed to fill the storage length turn lane and on occasion, spill back into the through lanes on Main Street.
- **6<sup>th</sup> Avenue/Main Street/Bench Boulevard** - The northbound left turn is at capacity during the weekday a.m. peak hour, which results in queues exceeding the storage lane. During the weekday p.m. peak hour, the queue length of the northbound through movement was observed to spillback past the 4<sup>th</sup> Avenue/Main Street intersection, resulting in a lack of progression for vehicles trying to make a left from 4<sup>th</sup> Avenue onto Main Street.
- **4<sup>th</sup> Avenue/Main Street** - The eastbound left turn experiences long delays and queues during the weekday p.m. peak hour. This movement often slows or stops during its phase to join the platoon of vehicles headed in the northbound direction along Main Street. When the eastbound left turn's phase turns green, vehicles must wait for the northbound through queue on Main Street to clear before entering the intersection, resulting in an underutilized phase at the 4<sup>th</sup> Avenue/Main Street intersection. In addition, the southbound through queue length reaches storage capacity during the weekday a.m. peak hour. Spillback into the 6<sup>th</sup> Avenue intersection was not observed; however, at times southbound through queues at 4<sup>th</sup> Avenue did inhibit westbound left turns from Bench Boulevard from being able to turn onto Main Street and head south.

## Event Traffic Conditions

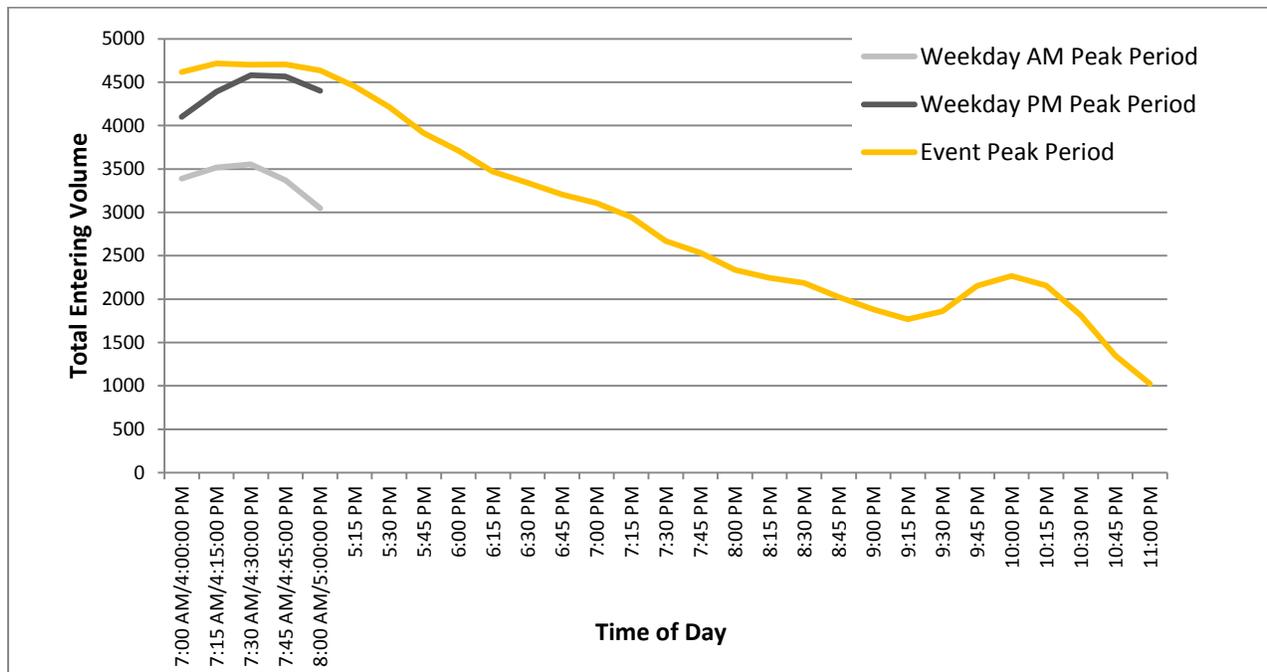
Turning movement counts were collected at each of the study intersections on Friday, April 17, 2015 from 4:00 p.m. to 12:00 a.m. Counts were collected to analyze the impact of event traffic on roadways and intersections within the study area. The Rimrock Auto Area at MetraPark has a capacity of 12,000 seats and was host to the Professional Bull Riding Rodeo from 8:00 p.m. to 10:00 p.m. on that evening.

Event counts during the Friday p.m. peak period were higher than the non-event weekday p.m. peak hour conditions. At the Airport Road/Main Street intersection, the total entering volume was approximately 3.3% higher during the event than the non-event condition, which is not a significant change. However, event counts indicate turning movement counts onto Airport Road in the

eastbound direction increased 61% during the Friday p.m. peak hour. Other than the Friday p.m. peak hour containing a higher percentage of vehicles turning onto eastbound Airport Road, peak characteristics under event conditions were generally the same as the non-event, weekday p.m. peak hour conditions.

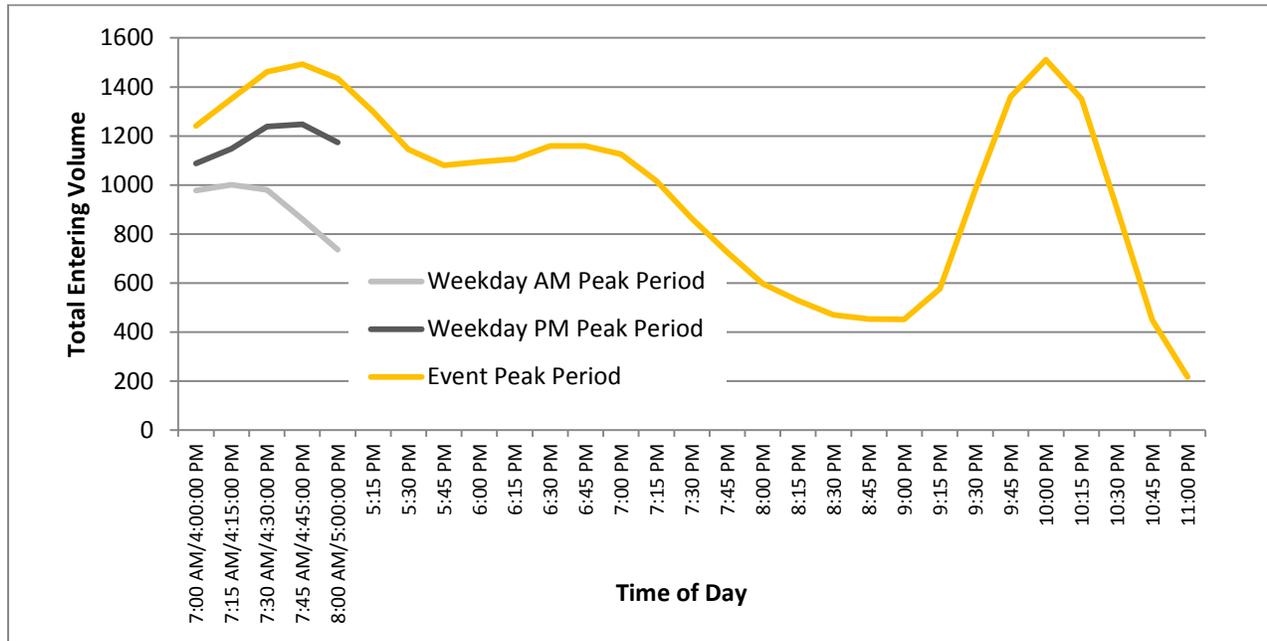
After the event completed, traffic increased at the intersections between 10:00 p.m. and 11:00 p.m. The eastbound approach at the Airport Road/Main Street intersection accounted for approximately 28% of the total entering volume at the intersection, in comparison to 2% during non-event conditions. Exhibit 3 compares the total entering volumes between event and non-event conditions at Airport Road/Main Street.

**Exhibit 3. Total Entering Volume Comparison of Event and Non-Event Traffic at the Airport Road/Main Street Intersection**



The Bench Boulevard/Airport Road intersection serves as the main exit for vehicles leaving the arena. Exhibit 4 compares the total entering volumes between event and non-event conditions at Bench Boulevard/Airport Road. After the event completed, traffic increased by approximately 21% at the intersection between 10:00 p.m. and 11:00 p.m. The westbound approach accounted for approximately 64% of the total entering volume at the intersection, in comparison to less than 1% during non-event conditions.

**Exhibit 4. Total Entering Volume Comparison of Event and Non-Event Traffic at the Bench Boulevard/Airport Road Intersection**



Overall, the peak hour totals of event traffic were within the range of the traffic volumes counted during the midweek p.m. peak hour. However, specific approaches at the intersections experience a significant increase in volume when the event lets out. At this time, no additional traffic operations analysis was completed at the study intersections under an event condition. However, a sensitivity check and discussion about event conditions is planned for the different alternatives, as the study moves into the development and evaluation of the alternatives. *Attachment D contains the turning movement counts collected during the event peak period.*

**CRASH HISTORY**

Crash data from the previous five years (2010 – 2014) was obtained from MDT and was used to evaluate crash trends within the study area. Crash data was summarized at each of the study intersections. Overall, there were 383 crashes, including 1 fatality over a 5-year period in the study area. Injury related crashes accounted for 36% of all reported crashes. There were no crashes reported at the unsignalized intersection of Aronson Avenue/Swords Lane or the signalized intersection of Bench Boulevard/Airport Road. Table 4 presents the severity of total reported crashes, as well as a crash rate for each intersection which is the ratio of crashes per million entering vehicles at each of the study intersections.

The crash rate is a useful tool to measure the relative safety at a particular intersection, as well as how it compares to the average intersection along a specific corridor or roadway network. Oftentimes, a crash rate is used to prioritize locations for safety improvements. An intersection or

roadway crash rate greater than 1.00 is an indication that a particular crash type may warrant additional analysis to potentially implement a mitigation to improve safety at the intersection or along the roadway.

**Table 4. Crash Summary (2010 - 2014) at the Study Intersections**

Int. ID	Study Intersection	PDO	Injury	Fatal	Total	Crashes per Million Vehicles Entering
1	Lake Elmo Drive/Main Street	96	51	0	147	1.78
2	Lake Elmo Drive/Bench Boulevard	1	0	0	1	0.04
3	Airport Road/Alkali Creek Road	1	1	0	2	0.06
4	Airport Road/6th Avenue Bypass	0	2	0	2	0.07
5	Airport Road/Swords Lane	4	1	0	5	0.22
6	Airport Road/Main Street	67	44	0	111	1.33
7	Airport Road/Bench Boulevard	0	0	0	0	0.00
8	Aronson Avenue/6th Avenue Bypass	2	0	0	2	0.09
9	Aronson Avenue/Swords Lane	0	0	0	0	0.00
10	Aronson Avenue/Main Street	5	3	0	8	0.40
11	6th Avenue/Main Street	34	15	1	50	0.58
12	4th Avenue/Main Street	34	21	0	55	0.62
-	<b>Total</b>	<b>244</b>	<b>138</b>	<b>1</b>	<b>383</b>	-

Notes: Crash data provided by Montana Department of Transportation for years 2010 – 2014.

The Lake Elmo Drive/Main Street and Airport Road/Main Street intersections have crash rates greater than 1.00. Both intersections have the two highest totals of reported crashes. Rear-end crashes accounted for approximately two-thirds of the reported crashes at both intersections, which is a common crash type at signalized intersections.

The highest crash types among all study intersections were rear-end crashes and right angle crashes, accounting for 61% and 14% of total crashes, respectively. Exhibit 5 presents the percentage of crash types among all reported crashes. Nearly 25% of crashes occurred during the weekday p.m. peak period (4:00 p.m. – 6:00 p.m.). No crash trends were identified within specific months of the year. However, 21% of crashes occurred on wet/snowy/icy pavement.

**Exhibit 5. Crash Types of Reported Crashes at All Study Intersections**

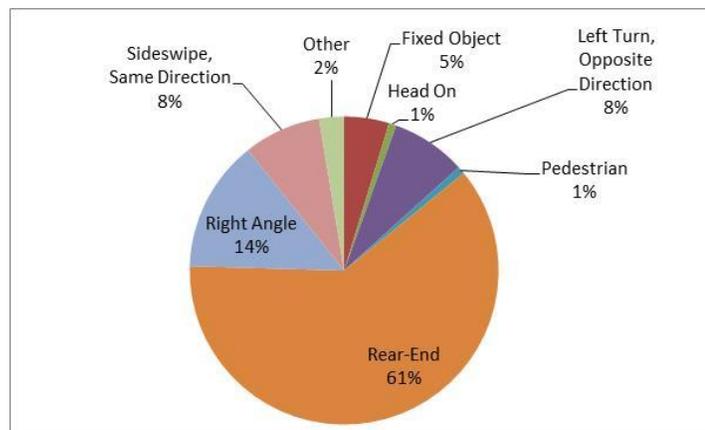


Table 5 summarizes the crash type by year at the two highest crash rate intersections. Similar to the other study intersections, rear-end crashes exceeded 60% at both of these intersections.

**Table 5. Airport Road/Main Street and Lake Elmo Drive/Main Street Crash Summary**

Crash Type	Year					Total	Percentage
	2010	2011	2012	2013	2014		
<b>Airport Road &amp; Main Street Intersection</b>							
Fixed Object	2	1	1	1	1	6	5%
Head On	0	0	1	0	1	2	2%
Left Turn, Opposite Direction	2	2	2	0	4	10	9%
Pedestrian	0	0	0	1	0	1	2%
Rear-End	16	20	13	10	11	70	63%
Right Angle	2	4	3	4	0	13	12%
Sideswipe, Same Direction	1	2	2	3	1	9	8%
Totals	23	29	22	19	18	111	100%
<b>Lake Elmo Drive &amp; Main Street Intersection</b>							
Fixed Object	1	1	0	1	0	3	2%
Left Turn, Opposite Direction	0	7	2	4	4	17	12%
Other	0	0	0	1	1	2	1%
Pedestrian	0	0	0	0	1	1	1%
Rear-End	27	18	9	26	22	102	69%
Right Angle	0	3	5	2	4	14	10%
Right Turn, Same Direction	0	0	0	0	1	1	1%
Sideswipe, Opposite Direction	2	1	1	1	2	7	5%
Totals	30	30	17	35	35	147	100%

In addition to the intersection crashes, there were a total of 44 reported crashes that occurred on the individual segments on Main Street between 4<sup>th</sup> Street and Lake Elmo Drive. The highest crash types were rear-end and side-swipe. *Historical crash data is available through MDT and is included within the project file.*

## ENVIRONMENTAL SCAN

The purpose of the environmental scan was to identify potential environmental constraints within the study area to inform the development and evaluation of alternatives during the concept phase, and for future insights as this project moves into final design. **This environmental scan is not meant to be used as or substituted for a comprehensive environmental investigation.** If improvement options are forwarded from this study into project development, an analysis for compliance with the National and Montana Environmental Policy Acts (NEPA and MEPA) will be completed as part of the Montana Department of Transportation (MDT) project development process. Information provided in this

study may be forwarded into the NEPA/MEPA process at that time. *Attachment E includes the complete environmental scan document.*

## ACCESS MANAGEMENT

This section describes existing access spacing along the Main Street and Airport Road corridors in comparison to MDT access control spacing guidelines from the MDT Road Design Manual and Montana Right-of-Way Operations Manual (Reference 9).

MDT's access spacing guidelines for roadways classified as National Highway System (NHS), undivided and divided, and in a developed area are:

- Undivided (Airport Road – 45 mph): Signal spacing is  $\frac{1}{4}$  mile. Minimum unsignalized access spacing is 325 to 375 feet.
- Divided (Main Street – 35 mph): Signal spacing is  $\frac{1}{4}$  mile. Median opening spacing is  $\frac{1}{4}$  mile for full movement and  $\frac{1}{8}$  mile for directional only. Minimum unsignalized access spacing is 250 feet.

*Attachment F includes the Recommended Montana Access Guidelines figure from the Montana Right-of-Way Operations Manual.*

As shown in Figure 4, there are several commercial accesses located near the Airport Road and Main Street intersection. In general, the roadway segments near the Airport Road and Main Street intersection do not currently meet the MDT access control spacing guidelines presented above.

As this study moves forward into the next phase, additional research will be conducted regarding access control and the access deeds in place for the parcels near the Airport Road and Main Street intersection. Additionally, access consideration will be included in the evaluation and assessment of the different intersection alternatives in the next phase of the study.

## Year 2040 Future Conditions

Future conditions reflect traffic conditions in year 2040, which documents programmed facility improvements, growth within the region, and the anticipated operational performance within the study area. This section provides a basis for comparing to future alternatives in the next study phase.

## PROGRAMMED TRANSPORTATION IMPROVEMENTS

Several facility improvements in the study area, listed below are identified in the Billings Urban-Area LRTP as committed and/or recommended within the fiscally-constrained plan.

- **Roadway, Intersection, and Congestion Management:** Airport/Main improvements (illustrative), Main Street and 4<sup>th</sup> Avenue North pavement preservation (committed), Main Street-Billings pavement preservation (committed), Main Street signal timing (recommended)
- **Pedestrian:** Aronson Avenue sidewalks (illustrative), Main Street (US 87) pedestrian easement (recommended), MetraPark pedestrian overpass (recommended)
- **Bicycle:** Airport Road bike lanes (illustrative), Lake Elmo Drive bike lanes (illustrative), 4<sup>th</sup> Avenue bike lanes (illustrative), 6<sup>th</sup> Avenue bike lanes (illustrative)
- **Trails:** Swords Park/6<sup>th</sup> Avenue North Connector (committed), Alkali Creek Trail (committed)

There are no design plans for these improvements. Most of the improvements are focused on improving the pedestrian and bicycle connectivity in the area. These improvements are not included in the analysis for the purposes of establishing a base future year 2040 condition.

However, there are two committed projects that have a significant impact on the projected traffic volumes on Main Street and in the study area.

- The **Billings Bypass Arterial project**, located to the northeast of the study area is a committed project that will be moving into the design phase in 2015. This project provides a new 3-lane connection between Old Highway 312 and Highway 87 (Main Street) in Billings to the Johnson Lane interchange in Lockwood.
- The **Inner Belt Loop project**, located to the northwest of the study area is a committed project that will provide a new 2-lane connection between Wicks Lane/Skyview Drive to Zimmerman Trail.

These two projects, along with several other regional transportation improvement projects are included in the regional travel demand model.

## YEAR 2040 TRAFFIC VOLUMES

The MDT travel demand model for the Billings Urban Area/Yellowstone County was used to develop year 2040 traffic volume forecasts on the roadway links and intersections within the study area. The methodology included the following steps:

- **Verify model input** - The 2035 travel demand model inputs were reviewed to identify any potential changes to roadway connections, number of travel lanes, and speed. The recommended changes to the 2035 travel demand model were coordinated with MDT Planning to update and rerun the travel demand model output.
- **Check reasonableness of model output** - The year 2035 daily traffic volumes from the travel demand model were reviewed and compared with the year 2035 daily traffic

volumes included in the 2035 Billings Urban-Area LRTP model run. Additionally, the directional daily volumes were obtained from MDT for each of the roadway segments in the study area. Once the data looked reasonable, the year 2035 daily traffic volumes were used to develop year 2040 turning movement counts at the study intersections during the weekday a.m. and p.m. peak hours.

- **Develop future year 2040 turning movement counts** – MDT provided year 2010 and 2035 daily, directional traffic volumes from the travel demand model for the roadway links within the study area. The year 2010 daily volumes, year 2035 daily volumes, and year 2015 turning movement counts (actual count data) were used to estimate year 2040 turning movement counts.
  - The year 2010 and 2035 daily, directional link volumes were adjusted to obtain weekday a.m. and p.m. peak hour link, directional volumes.
  - The incremental annual change between year 2010 and year 2035 directional link volumes was calculated and added for 25 years to the actual year 2015 traffic count, peak hour, directional link volumes to obtain year 2040 directional link volumes. *Note: Using the actual peak hour count data along with the incremental change from the two model year link volumes provides a more accurate representation of the year 2040 link volumes when compared to just using the model output.*
  - The year 2010 peak hour, directional link volumes, year 2040 peak hour, directional link volumes, and year 2015 turning movement counts (actual count data) were used to estimate year 2040 turning movement counts during the weekday a.m. and p.m. peak hours. The ratio and difference methodology from *NCHRP Report 765 – Analytical Travel Forecasting Approaches for Project-Level Planning and Design (incorporates the methodology from NCHRP 255)* was applied using these three data sets to estimate the year 2040 turning movement counts at the study intersections (Reference 10). *Attachment G includes the travel demand model output and analysis worksheets.*
- The year 2040 turning movement counts and years 2035 and 2040 peak hour link volumes were reviewed for consistency and reasonableness, and compared with recent studies and plans for this area, including Billings Urban Area LRTP, Billings Bypass EIS, and Traffic Report 6th Ave N/Bench-Blgs, Phase 2. Once confirmed, the year 2040 turning movement counts were added to the traffic operational model in Synchro to perform an operations analysis during the year 2040 traffic conditions, weekday a.m. and p.m. peak hours.

Table 6 summarizes the link volumes within study area and percent change between the year 2015 and 2040 daily traffic volumes.

**Table 6. Year 2015 and Year 2040 Daily Traffic Volumes and Growth Change**

Roadway Segment	Location on Roadway	Year 2015 Daily Volume	Year 2040 Daily Volume	Annual Growth
Main Street	North of Lake Elmo Drive	43,000	56,200	1.1%
Main Street	North of Airport Road	52,200	66,800	1.0%
Main Street	South of Airport Road	49,300	70,600	1.4%
Main Street	South of 6 <sup>th</sup> Avenue	56,000	81,300	1.5%
Main Street	South of 4 <sup>th</sup> Avenue	39,800	63,000	1.9%
Airport Road	West of Main Street	14,100	21,900	1.8%
Airport Road	West of Aronson Avenue	19,800	35,200	2.3%
Airport Road	East of Main Street	2,000	6,100	4.5%
Lake Elmo Drive	West of Main Street	10,400	15,200	1.5%
Lake Elmo Drive	East of Main Street	3,100	6,000	2.7%
Bench Boulevard	South of Airport Road	13,400	21,300	1.9%
Bench Boulevard	North of Airport Road	14,800	26,300	2.3%
6 <sup>th</sup> Avenue	West of Main Street	11,300	15,400	1.2%
4 <sup>th</sup> Avenue	West of Main Street	20,200	33,600	2.1%

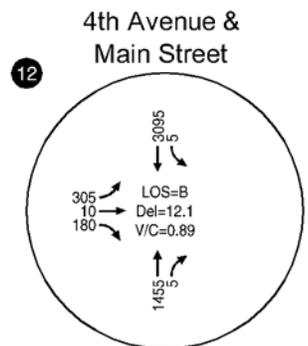
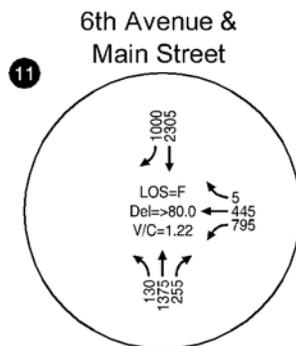
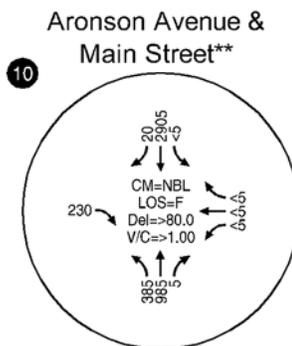
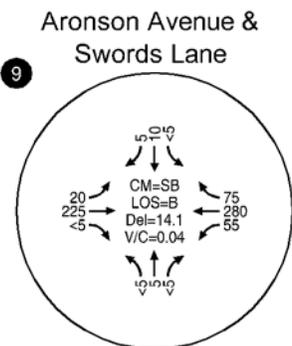
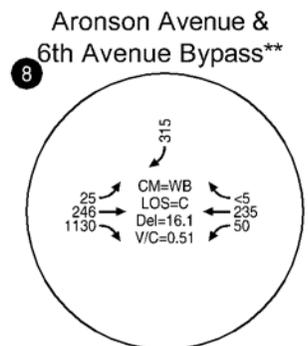
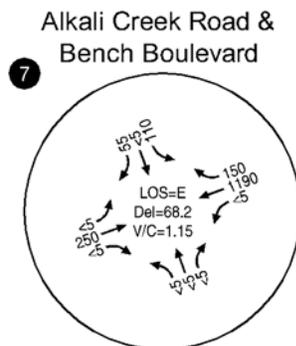
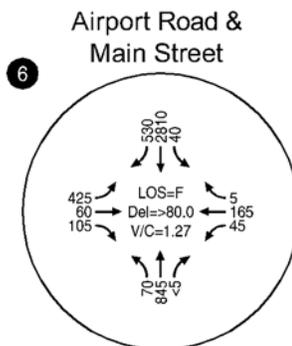
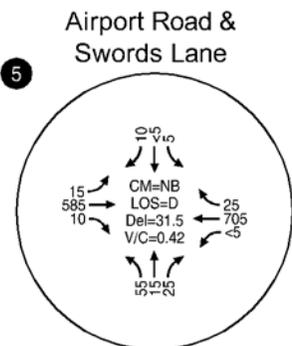
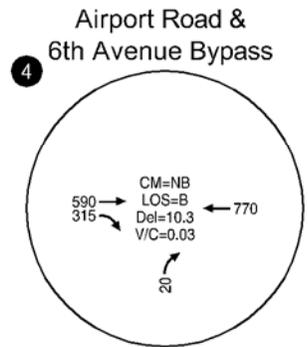
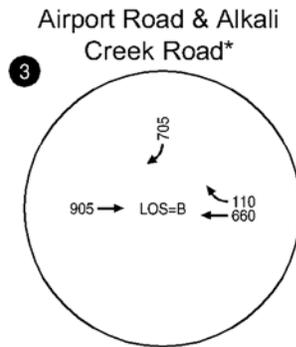
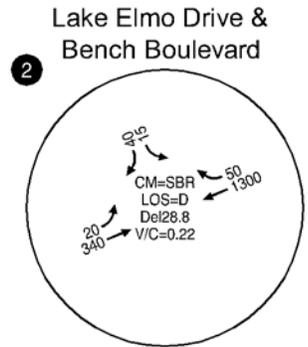
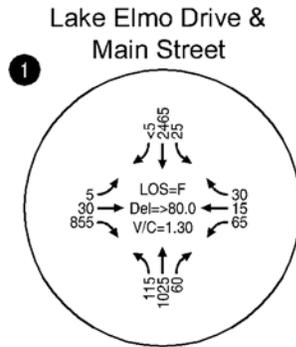
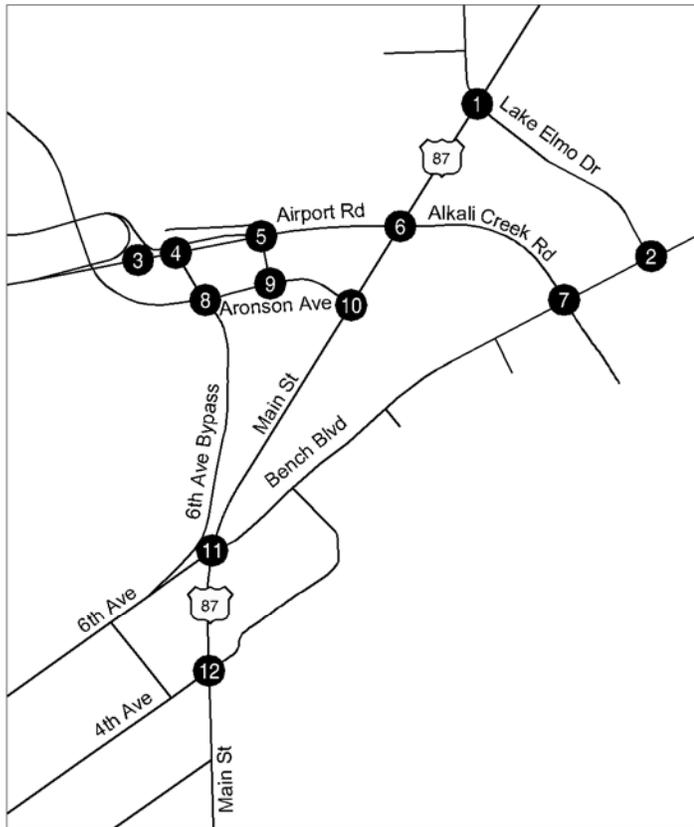
As shown in Table 6 the average annual growth is approximately 1.4% percent on Main Street and 2.1% percent on Airport Road. Main Street is projected to carry approximately 56,000 to 81,000 daily traffic volumes with the Billings Bypass Arterial in place. Airport Road is projected to carry approximately 22,000 to 35,000 daily traffic volumes with the Billings Bypass Arterial in place. Figures 9 and 10 illustrate the year 2040 traffic volumes during the weekday a.m. and p.m. peak hours, respectively.

## OPERATIONAL ANALYSIS

An operational analysis was performed at the study intersections using the same methodology and assumptions under existing conditions with the exception of the following:

- At the signalized intersections, the phase splits were optimized to account for the change in traffic volumes. Cycle lengths were not adjusted at this time, but will be optimized as part of the alternatives analysis in the next phase of the study.
- Future year 2040 traffic volumes were used for the weekday a.m. and p.m. peak hours.
- A peak hour factor of 1.0 was used for this planning-level analysis.

The operational analysis results are shown in Figures 9 and 10. As shown in the operational analysis, all of the signalized intersections and most of the unsignalized intersections are projected to operate at LOS E or worse and a volume-to-capacity ratio of greater than 1.0 under year 2040 weekday a.m. and p.m. peak hour traffic conditions. The operational analysis is consistent with the findings from the Billings Urban Area LRTP and Traffic Report 6th Ave N/Bench-Blgs, Phase 2. *Attachment H includes the Year 2040 Weekday AM and PM Peak Hour Level of Service Worksheets.*



\* HCM 2000 Methodology does not support intersection's traffic control device. Operation results were determined using HCS 2010 Merge Segment Methodology.  
 \*\* Synchro's SimTraffic analysis could not properly determine delay at the intersection because of queue spillback. Intersection has reached or is exceeding vehicle capacity.

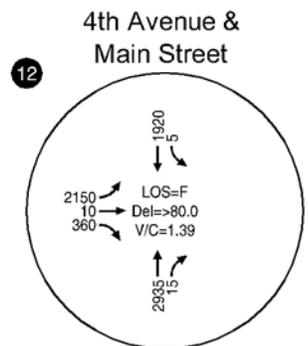
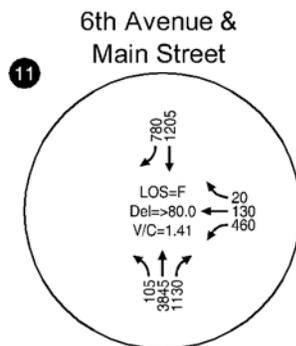
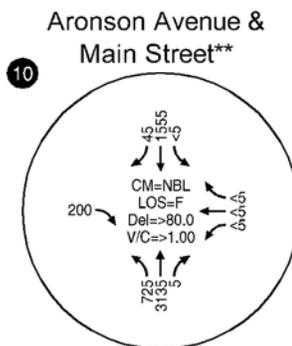
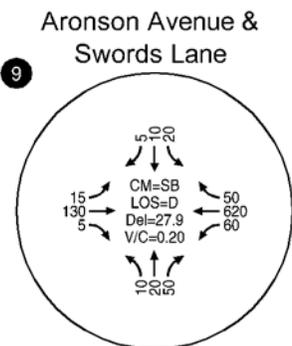
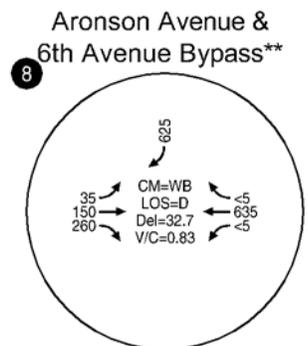
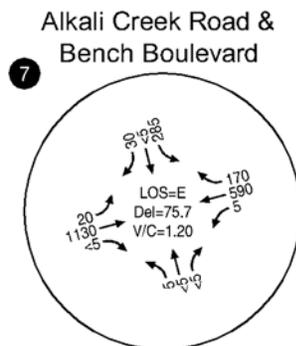
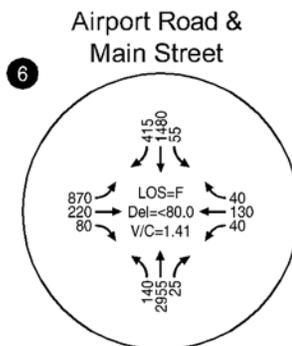
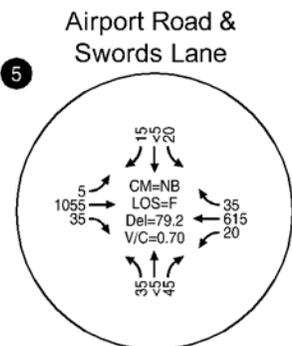
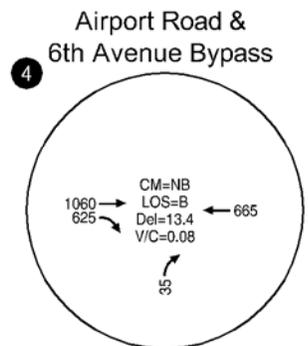
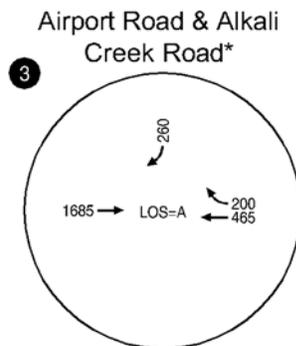
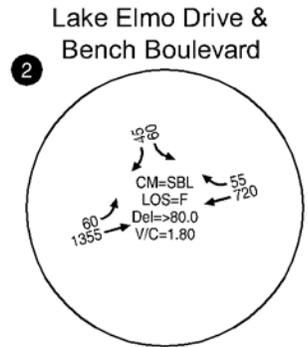
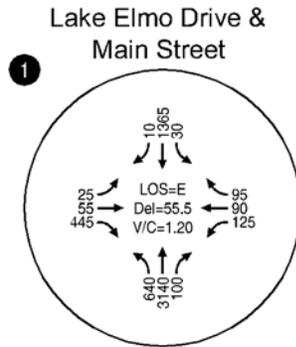
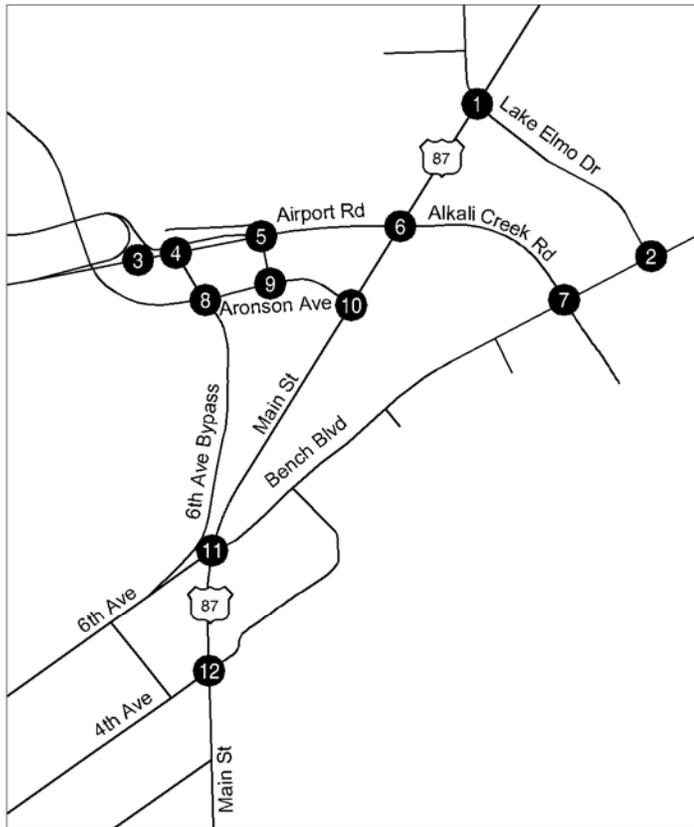


**FUTURE CONDITIONS  
YEAR 2040 AM PEAK HOUR  
BILLINGS, MONTANA**

**LEGEND**  
 CM = CRITICAL MOVEMENT (UN SIGNALIZED)  
 LOS = INTERSECTION LEVEL OF SERVICE / CRITICAL MOVEMENT LEVEL OF SERVICE (UN SIGNALIZED)  
 Del = INTERSECTION AVERAGE CONTROL DELAY / CRITICAL MOVEMENT CONTROL DELAY (UN SIGNALIZED)  
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

**FIGURE  
9**

H:\proj\16460 - Airport Road & Main Street - Billings\dwgs\figs\16460\_Final\Figures.dwg M: 1/23/2016 7:36am - Nonpoint Layout Tab: FutureAM



\* HCM 2000 Methodology does not support intersection's traffic control device. Operation results were determined using HCS 2010 Merge Segment Methodology.  
 \*\* Synchro's SimTraffic analysis could not properly determine delay at the intersection because of queue spillback. Intersection has reached or is exceeding vehicle capacity.



**FUTURE CONDITIONS  
YEAR 2040 PM PEAK HOUR  
BILLINGS, MONTANA**

**LEGEND**  
 CM = CRITICAL MOVEMENT (UN SIGNALIZED)  
 LOS = INTERSECTION LEVEL OF SERVICE / CRITICAL MOVEMENT LEVEL OF SERVICE (UN SIGNALIZED)  
 Del = INTERSECTION AVERAGE CONTROL DELAY / CRITICAL MOVEMENT CONTROL DELAY (UN SIGNALIZED)  
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

**FIGURE  
10**

## Summary

The key findings from the existing and future conditions analysis are highlighted below.

### EXISTING CONDITIONS

- The AADT on Main Street ranges from 38,000 to the north of 1<sup>st</sup> Avenue to 48,000 to the north of Lake Elmo Drive.
- The Airport Road/Main Street intersection has a total entering volume of 4,570 vehicles during the weekday p.m. peak hour, which is approaching the threshold between large signalized intersections and alternative intersection forms (e.g., displaced left-turns, quadrants, median u-turns). The critical movements are the eastbound left turn (285 AM, 635 PM), southbound right-turn (400 AM, 315 PM), northbound through (710 AM, 2,135 PM), and southbound through (1,940 AM, 1,205 PM) during the weekday a.m. and p.m. peak hours.
- The Airport Road and Main Street corridors are located on a major freight route, El Camino Real Trade Corridor. The Airport Road/Main Street intersection has the highest percentage of heavy vehicles in the study area, ranging between 3.5% and 5.6% during the weekday a.m. and p.m. peak hours, respectively. The northbound left (42%) from Main Street onto Airport Road and eastbound right (26%) from Airport Road onto Main Street are the movements with the highest heavy vehicle percentages.
- Most of the study intersections currently operate at a level of service C or better during the weekday a.m. and p.m. peak hours. However, the following intersections exceed the the LOS C criteria or have a volume-to-capacity ratio of greater than 0.90:
  - Main Street/Lake Elmo Drive (AM v/c = 0.97)
  - Main Street/Airport Road (AM v/c = 0.93, PM LOS D and v/c = 0.93)
  - Main Street/Aronson Avenue (PM LOS = D for northbound left-turn)
  - Main Street/6<sup>th</sup> Avenue (AM v/c = 1.00, PM v/c = 0.97)
  - Main Street/4<sup>th</sup> Avenue (PM LOS D and v/c = 0.96)
- As observed in the field and presented in the operations analysis, the Main Street corridor between 4<sup>th</sup> Avenue and Lake Elmo Drive is operating near capacity during the weekday a.m. and p.m. peak hours.
- The MetraPark is a major activity center that is host to a variety of concerts, sports events, and other event types during the year. Overall, the total intersection peak hour event traffic volumes are within the range of the non-event traffic volumes. However, specific approaches at the study intersections experience a significant increase in volume when an

event lets out. A sensitivity check and discussion about event conditions is planned as the study moves into the development and evaluation of the alternatives.

- Over the past five years (2010 – 2014), there were 383 reported crashes, including 1 fatality at the study area intersections and roadway segments. The highest crash types at the study intersections were rear-end crashes and right angle crashes, accounting for 61% and 14% of total crashes, respectively.
- The Lake Elmo Drive/Main Street and Airport Road/Main Street intersections have crash rates greater than 1.00. Both intersections have the two highest totals of reported crashes. Rear-end crashes accounted for approximately two-thirds of the reported crashes at both intersections.
- Based on the environmental scan, the study area includes the following key items for further assessment with the alternatives development and evaluation phase of the study and future design phase: three Section 4(f) properties: Swords Park, Earl Guss Park, and MetraPark; three historical properties: Black Otter Trail, Boothill Cemetery, and Larry’s Overlook; two inactive and three active hazardous materials sites; three listed endangered species and two candidate species; and a classified surface water with Alkali Creek.
- There are a total of 68 accesses, of which 46 are commercial accesses, 18 public street connections, and 4 residential driveways within the study area. The majority of accesses are in the vicinity of the Airport Road/Main Street intersection and the Lake Elmo Drive/Main Street intersection. Main Street has 10 commercial accesses between Aronson Avenue and Lake Elmo Drive. Airport Road has 12 commercial accesses between Bench Boulevard and 6<sup>th</sup> Avenue Bypass. The MDT access spacing guidelines for Airport Road and Main Street are not met in the vicinity of the Airport Road and Main Street intersection.

## FUTURE CONDITIONS

- The Billings Bypass Arterial and Inner Belt Loop are committed projects with a significant impact on the projected year 2040 traffic volumes on Main Street and Airport Road.
- The annual growth between year 2015 and 2040 is approximately 1.4% percent along Main Street and approximately 2.1% percent along Airport Road.
- Main Street is projected to carry approximately 56,000 to 81,000 daily traffic volumes with the Billings Bypass Arterial in place. Airport Road is projected to carry approximately 22,000 to 35,000 daily traffic volumes with the Billings Bypass Arterial in place
- All of the signalized intersections and most of the unsignalized intersections are projected to operate at LOS E or worse and a volume-to-capacity ratio of greater than 1.0 under year 2040 traffic conditions, weekday a.m. and p.m. peak hour conditions. The operational analysis is consistent with the findings from the Billings Urban Area LRTP and Traffic Report 6th Ave N/Bench-Blgs, Phase 2.

If you have any questions, please contact Andy Daleiden via email at [adaleiden@kittelso.com](mailto:adaleiden@kittelso.com) or by phone at 208.338.2683.

## References

1. Marvin & Associates. *Final Report for MetraPark Egress Improvements*, Yellowstone County Commissioners, April 2013.
2. Sanderson Stewart. *Traffic Report: 6<sup>th</sup> Ave N/Bench-Blgs, Phase 2*, Montana Department of Transportation, November 2012.
3. Fehr & Peers. *City of Billings Hospitality Corridor and Planning Study, Final Report*, City of Billings, September 2013.
4. Kittelson & Associates, Inc. *2014 Billings Urban Area Long Range Transportation Plan*, Billings Yellowstone County Metropolitan Planning Organization. August 2014.
5. EDAW/AECOM. *East Billings Urban Renewal District Master Plan*, Big Sky Economic Development Authority, July 2009.
6. Transportation Research Board. *Highway Capacity Manual 2000*. 2000.
7. Transportation Research Board. *Highway Capacity Manual 2010*. 2010.
8. Montana Department of Transportation. *Road Design Manual*, Montana Department of Transportation, Helena, Montana, July 2008.
9. Montana Department of Transportation. *Montana Right-of-Way Operations Manual*, Montana Department of Transportation, Helena, Montana, March 2007.
10. Transportation Research Board. *NCHRP Report 765 – Analytical Travel Forecasting Approaches for Project-Level Planning and Design*. 2014.

Attachment A AADT Worksheets (Main St.)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-010  
 Tech: RM

Location ID: 56-4A-10  
 Functional Class: Principal Arterial - Urb  
 Traffic Factor Group: UPA  
 Main (US-87/ P-16), N of 1st Av N

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	32,390	30,000	35,200	34,840	36,050	31,050	30,060	30,420	28,080	28,080	28,080		28,080		27,330					19,830
Source	A	A	M	A	A	A	A	A	L	L	L		L		L					L

**HOURLY FULL DETAIL**

Date	Bin	Road	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	TOTAL
07/10	Volume	N	138	110	86	79	125	257	554	798	866	874	915	1,041	1,150	1,106	1,198	1,373	1,615	1,898	1,271	965	831	681	424	274	18,629
07/10	Volume	S	137	81	66	96	157	485	1,090	1,666	1,267	1,109	1,134	1,154	1,255	1,177	1,186	1,220	1,308	1,263	1,016	800	632	532	343	229	19,403
07/10	Volume	T	275	191	152	175	282	742	1,644	2,464	2,133	1,983	2,049	2,195	2,405	2,283	2,384	2,593	2,923	3,161	2,287	1,765	1,463	1,213	767	503	38,032

**RAW BIN DETAIL**

Date	Bin	Road	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	TOTAL
07/09	Volume	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	1156	1366	1620	1859	1325	946	854	627	412	258	10423
07/09	Volume	S	N	N	N	N	N	N	N	N	N	N	N	N	N	N	1215	1226	1280	1247	997	825	619	534	316	203	8462
07/10	Volume	S	141	80	60	82	158	543	1141	1723	1267	1109	1134	1154	1255	1177	1186	1214	1335	1279	1034	775	644	530	369	255	19645
07/10	Volume	N	131	100	86	82	116	247	545	798	913	874	915	1041	1150	1106	1198	1379	1609	1936	1216	983	808	735	435	289	18692
07/11	Volume	S	132	82	72	109	155	427	1038	1609	1188	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	4812
07/11	Volume	N	145	120	86	75	134	267	563	798	818	907	N	N	N	N	N	N	N	N	N	N	N	N	N	N	3913

FACTOR USED: 0.852 ACF: 0.910 UPA, SDOWF: 0.936 UPA

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-011  
 Tech:

Location ID: 56-4A-11  
 Functional Class: Principal Arterial - Urb  
 Traffic Factor Group: UPA  
 Main (US-87/ P-16), S of 6th Av N

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	38,140	38,100	44,170	43,620	44,160	40,110	39,250	38,810	42,810	42,810	42,810		42,810			36,690		40,960	41,820	34,230
Source	E	A	M	A	A	A	A	A	L	L	L		L			L		L	L	L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

No Factor stats were found

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-012  
 Tech: Estimate-PJ

Location ID: 56-4A-12  
 Functional Class: Principal Arterial - Urb  
 Traffic Factor Group: UPA  
 Main (US-87/ P-16), S of Airport Rd (U-1014)

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	45,760	45,710	46,930	47,730	47,890	49,160	44,930	46,270	47,910	47,910	47,910		47,970	50,380	48,434	45,160	45,390	43,950	46,700	43,180
Source	M	A	M	A	A	A	A	A	L	L	L		L	L	L	L	L	L	L	L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-013  
 Tech: RMMiovision

Location ID: 56-4A-13

Functional Class: Principal Arterial - Urb

Traffic Factor Group: UPA

Main (US-87/P-16) btwn Airport Rd and Lake Elmo Dr

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	46,930	48,360	47,700	51,640	51,640	50,950	51,430	52,150	43,750	43,750	43,750					45,830		48,170		43,701
Source	M	A	M	E	A	A	A	A	L	L	L					L		L		L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-246  
 Tech: City of Billings

Location ID: 56-4A-246  
 Functional Class: Principal Arterial - Urb  
 Traffic Factor Group: UPA  
 4th Av N (U-1018), SW of Exposition Dr

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	11,345	13,490	13,290	14,210	14,210	14,680	11,750	12,390	12,350	12,350	12,350		11,592	10,867			11,632		13,713	12,281
Source	M	E	M	E	E	M	E	E	L	L	L		L	L			L		L	L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-247  
 Tech: City of Billings

Location ID: 56-4A-247  
 Functional Class: Principal Arterial - Urb  
 Traffic Factor Group: UPA  
 6th Av N (U-1029), SW of Main

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	12,883	15,830	15,600	15,350	15,350	15,860	12,650	13,340	13,300	13,300	13,300		12,903		9,835		11,374		13,913	
Source	M	E	M	E	E	M	E	E	L	L	L		L		L		L		L	

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-265  
 Tech: RMMiovision

Location ID: 56-4A-265  
 Functional Class: Minor Arterial - Urb  
 Traffic Factor Group: UMC  
 Airport Rd, btwn Main and Alkali Crk Rd

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	11,530	11,610	12,290	11,950	11,320	10,700	10,490	10,830	11,200	11,180	10,470			9,112		9,150		6,671		8,234
Source	M	E	M	M	E	E	E	E	L	L	L			L		L		L		L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-266  
 Tech:

Location ID: 56-4A-266  
 Functional Class: Collector - Urb  
 Traffic Factor Group: UMC  
 Alkali Crk Rd, btwn Black Pine and Airport Rd

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	3,690	3,632	3,900	3,930	7,220	6,820	6,690	6,900	7,130	6,140				6,141		5,434		5,242		6,265
Source	E	M	E	M	E	E	E	E	M	M				L		L		L		L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

No Factor stats were found

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-292  
 Tech:

Location ID: 56-4A-292  
 Functional Class: Collector - Urb  
 Traffic Factor Group: UMC  
 Lake Elmo Dr, N of Emerald Dr

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	6,290	6,182	6,530	6,590	7,210	6,810	6,680	6,890	7,120	7,120		6,670		5,728		5,395		5,607		5,637
Source	E	M	E	M	E	E	E	E	M	M		M		L		L		L		L

No Records For Hourly Full Detail

No Volume Records For Raw Bin Detail

No Factor stats were found

\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)



**Short Term Profile -Volume Only**

For Year: 2014  
 Yellowstone County  
 Station 4A-299  
 Tech: City of Billings

Location ID: 56-4A-299  
 Functional Class: Collector - Urb  
 Traffic Factor Group: UMC  
 Bench Blvd, SE of Main (at guardrail)

(STPV)

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
AADT	2,642	2,220	2,350	2,370	2,380	3,210	3,150	3,250	3,360	2,560	2,560		2,764	2,118			1,368		1,526	1,827
Source	M	E	E	E	M	E	E	E	L	L	L		L	L			L		L	L

No Records For Hourly Full Detail

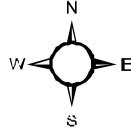
No Volume Records For Raw Bin Detail

AADT FOR THIS SITE HAS BEEN MANUALLY ENTERED

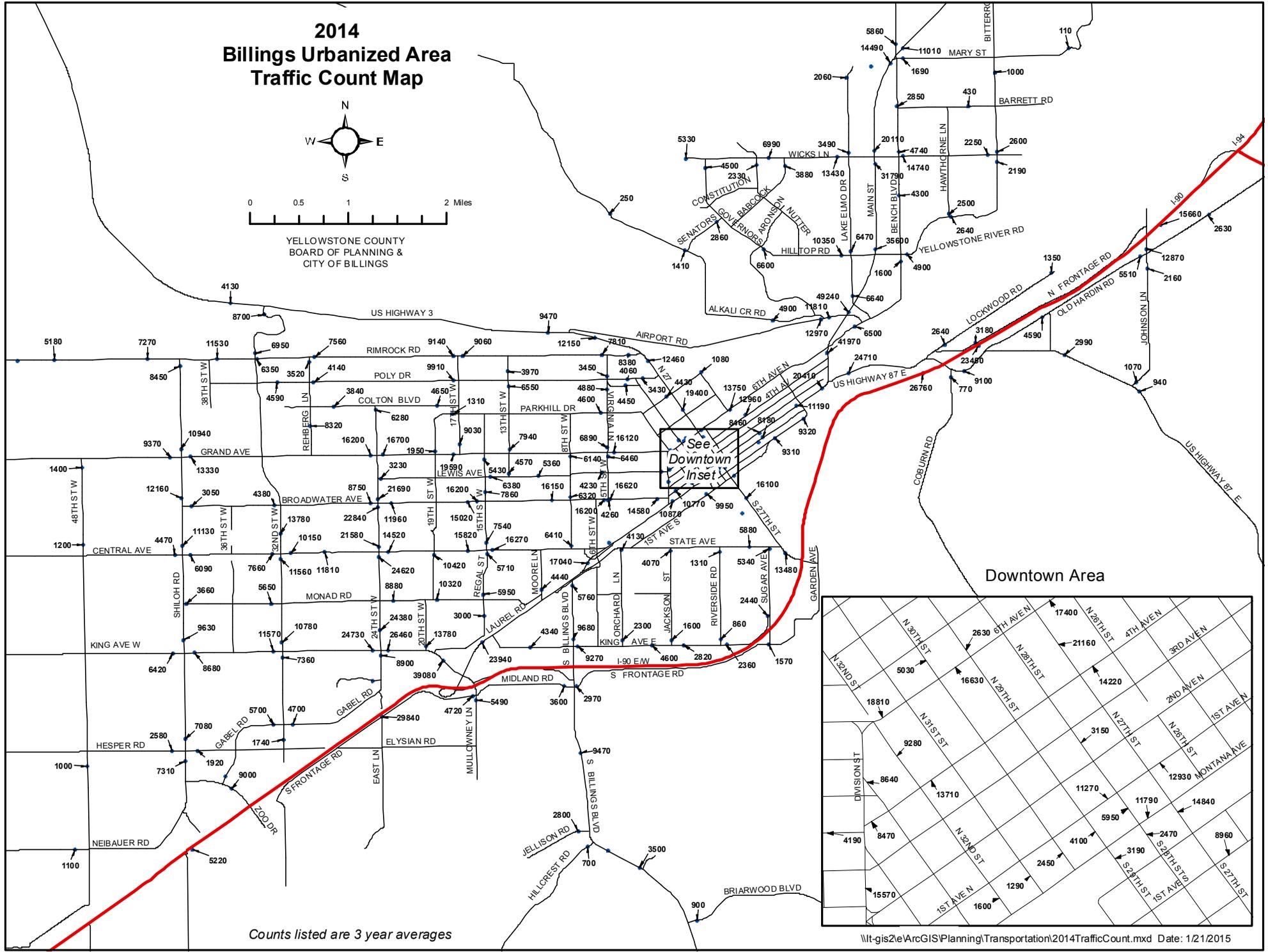
\* NOTES-- None

Source Legend: A (Actual) , E (Estimate) , M (Manually Entered), L (Legacy), C (Unknown)

# 2014 Billings Urbanized Area Traffic Count Map

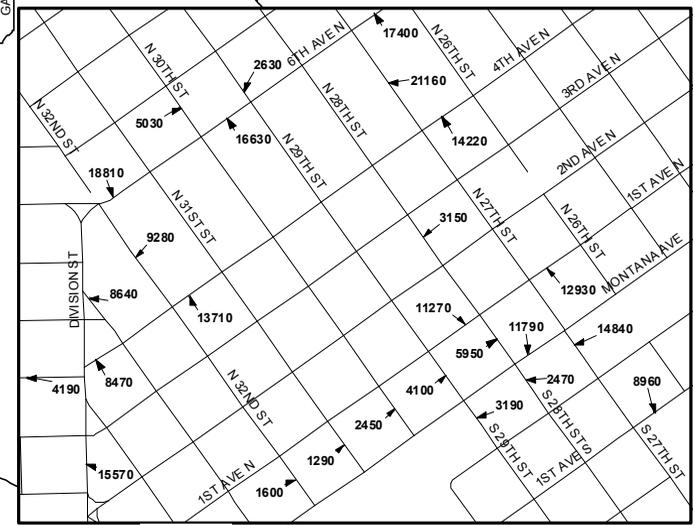


YELLOWSTONE COUNTY  
BOARD OF PLANNING &  
CITY OF BILLINGS



See  
Downtown  
Inset

## Downtown Area



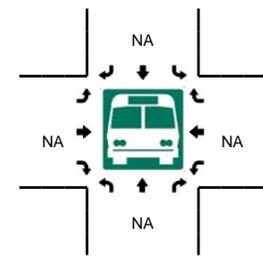
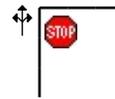
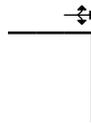
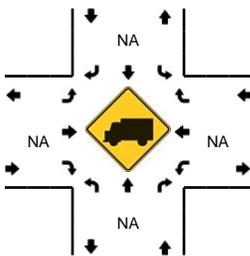
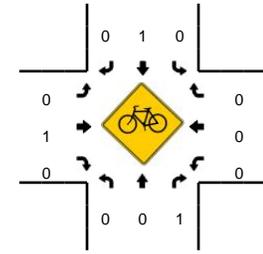
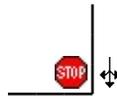
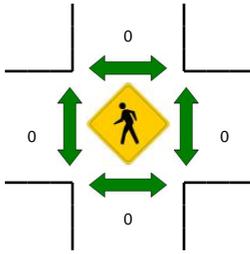
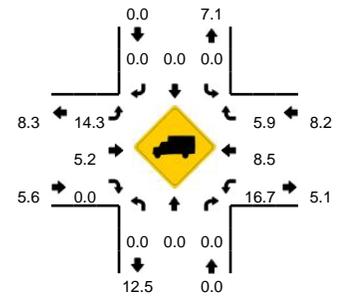
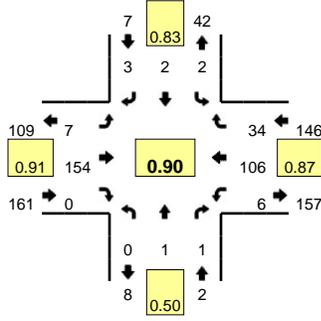
Counts listed are 3 year averages

Attachment B Weekday A.M. and P.M.  
Turning Movement Counts

**LOCATION:** Swords Ln -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173201  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**



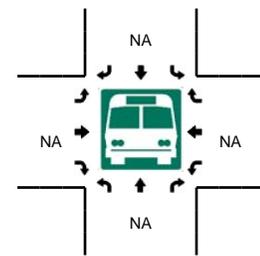
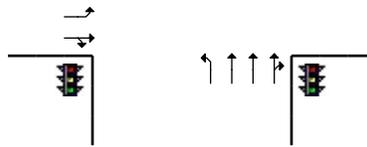
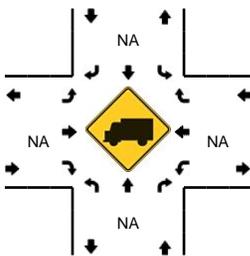
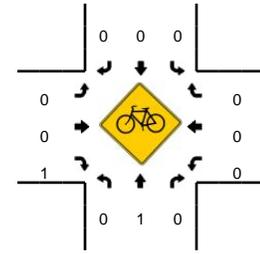
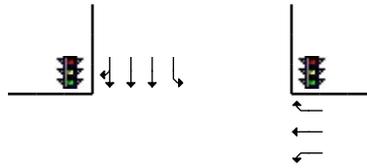
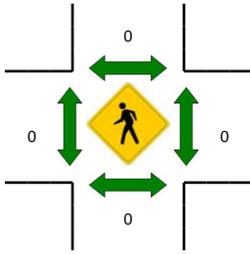
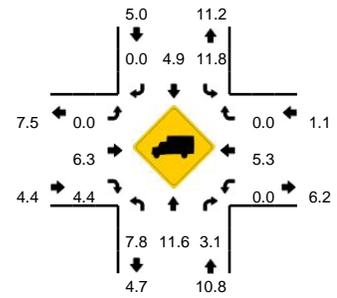
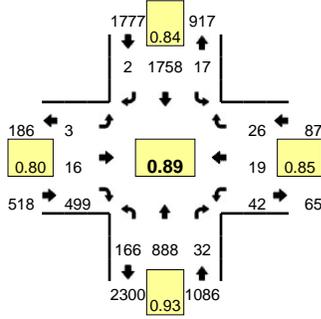
15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	1	1	0	0	0	0	0	2	36	0	0	1	18	7	0	66	
7:15 AM	0	1	0	0	1	0	1	0	0	40	0	0	1	20	5	0	69	
7:30 AM	0	0	1	0	0	0	1	0	0	46	0	0	0	33	7	0	88	
7:45 AM	0	0	0	0	1	1	0	0	5	38	0	0	0	28	14	0	87	310
8:00 AM	0	0	0	0	0	1	1	0	2	30	0	0	5	25	8	0	72	316
8:15 AM	0	1	0	0	1	1	1	0	4	36	1	0	2	14	7	0	68	315
8:30 AM	0	1	0	0	2	0	1	0	0	19	0	0	1	27	9	0	60	287
8:45 AM	0	0	0	0	0	0	1	1	0	13	0	0	0	20	3	0	38	238
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	4	0	0	0	4	0	0	184	0	0	0	132	28	0	352	
Heavy Trucks	0	0	0		0	0	0		0	4	0		0	8	0		12	
Pedestrians		0				0				0				0			0	
Bicycles	0	0	0		0	1	0		0	0	0		0	0	0		1	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- Lake Elmo Dr  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173223  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



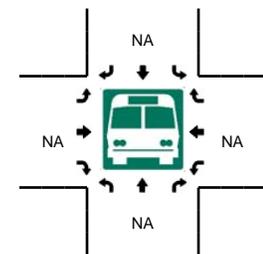
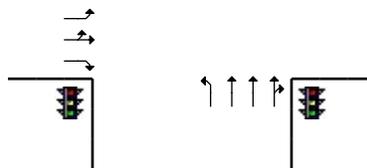
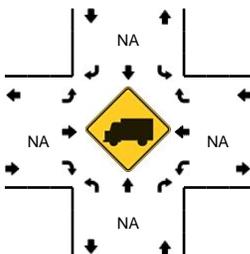
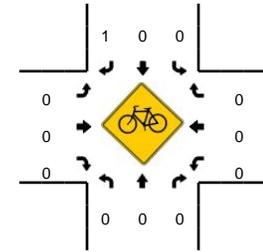
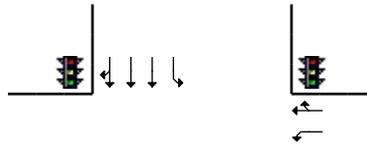
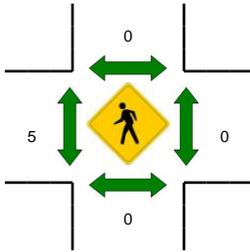
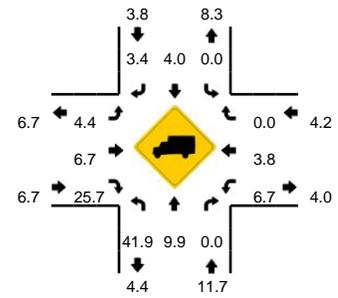
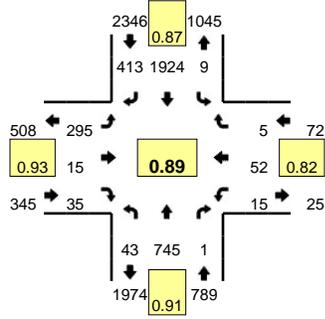
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Lake Elmo Dr (Eastbound)				Lake Elmo Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	31	133	8	0	6	320	1	0	1	1	109	0	7	3	8	0	628	
7:15 AM	27	174	6	0	4	381	2	0	0	3	109	0	5	5	1	0	717	
7:30 AM	32	222	6	0	2	530	1	0	0	4	124	0	6	6	4	0	937	
7:45 AM	53	233	9	0	7	493	0	0	1	5	155	0	7	4	8	0	975	3257
8:00 AM	46	207	8	0	3	373	0	0	1	2	110	0	13	3	6	0	772	3401
8:15 AM	34	226	9	1	5	362	1	0	1	5	110	0	16	6	8	0	784	3468
8:30 AM	46	212	10	0	5	340	1	0	0	4	118	0	21	3	3	0	763	3294
8:45 AM	38	233	8	1	4	226	2	0	1	6	98	0	12	4	7	0	640	2959
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	212	932	36	0	28	1972	0	0	4	20	620	0	28	16	32	0	3900	
Heavy Trucks	16	92	0		4	68	0		0	0	20		0	0	0		200	
Pedestrians	0	0	0		0	0	0		0	0	0		0	0	0		0	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- E Airport Rd/Alkali Creek Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173221  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**

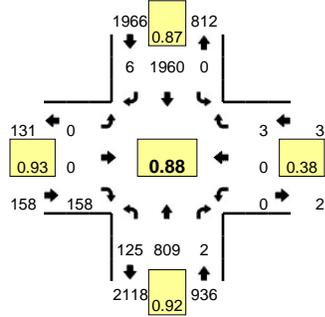


15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				E Airport Rd/Alkali Creek Rd (Eastbound)				E Airport Rd/Alkali Creek Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	14	126	0	0	4	374	69	0	53	1	12	0	0	7	1	0	661	
7:15 AM	7	150	0	0	2	413	87	1	58	0	17	0	3	14	0	0	752	
7:30 AM	7	184	0	0	4	557	115	0	78	4	11	0	4	12	2	0	978	
7:45 AM	14	201	0	0	1	564	102	0	81	2	10	0	5	17	1	0	998	3389
8:00 AM	17	176	0	0	3	404	97	0	66	5	4	0	3	14	0	0	789	3517
8:15 AM	5	184	1	0	1	399	99	0	70	4	10	0	3	9	2	0	787	3552
8:30 AM	9	207	2	0	1	406	84	0	51	6	8	0	1	17	3	0	795	3369
8:45 AM	14	215	0	0	3	291	61	0	65	6	8	0	0	11	4	0	678	3049
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	56	804	0	0	4	2256	408	0	324	8	40	0	20	68	4	0	3992	
Heavy Trucks	24	68	0	0	0	60	16	0	8	0	4	0	4	4	0	0	188	
Pedestrians	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

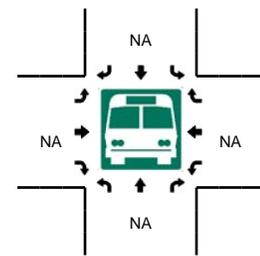
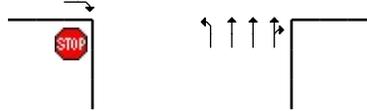
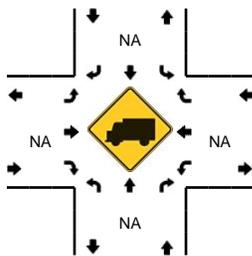
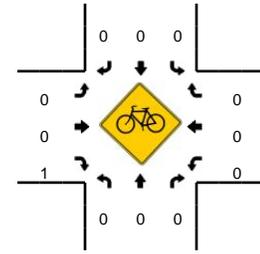
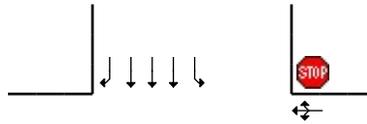
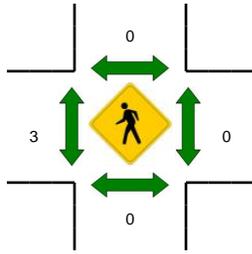
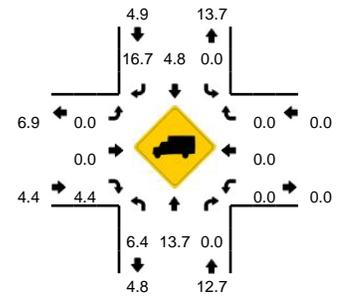
Comments:

**LOCATION:** Main St (Hwy 87) -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173219  
**DATE:** Thu, Apr 16 2015



**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	21	143	0	0	0	379	1	0	0	0	39	0	0	1	0	0	584	
7:15 AM	20	183	0	0	0	433	0	0	0	0	40	0	0	0	1	0	677	
7:30 AM	33	203	0	0	0	561	2	0	0	0	45	0	0	0	0	0	844	
7:45 AM	38	224	1	0	0	566	1	0	0	0	44	0	0	0	0	0	874	2979
8:00 AM	34	199	1	0	0	400	3	0	0	0	29	0	0	0	2	0	668	3063
8:15 AM	24	199	1	0	0	402	1	0	0	0	38	0	0	0	0	0	665	3051
8:30 AM	24	226	0	0	0	403	7	0	0	0	25	0	0	0	0	0	685	2892
8:45 AM	23	230	0	0	0	292	0	0	0	0	20	0	0	0	0	0	565	2583
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	152	896	4	0	0	2264	4	0	0	0	176	0	0	0	0	0		3496
Heavy Trucks	8	112	0	0	0	88	0	0	0	0	0	0	0	0	0	0	208	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Comments:



7409 SW Tech Center Dr, Ste B150

Tigard, OR 97223  
971-223-0003

[www.qualitycounts.net](http://www.qualitycounts.net)

Site Code: 13173217

Location: Main St (Hwy 87) & 6th Ave N/Bench Blvd

Date: 4/16/2015

Peak Hour: 7:20 AM - 8:20 AM

Peak 15-minutes: 7:40 AM - 7:55 AM

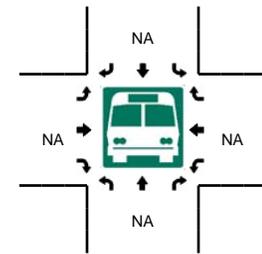
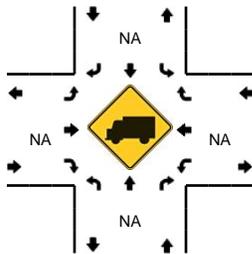
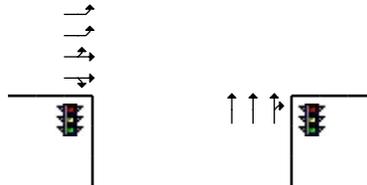
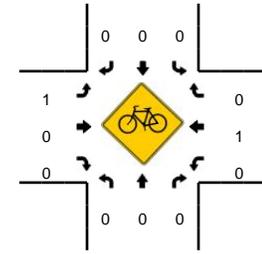
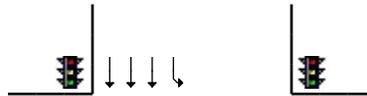
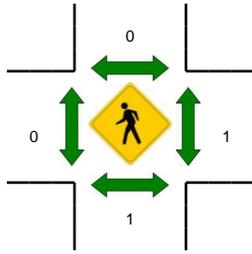
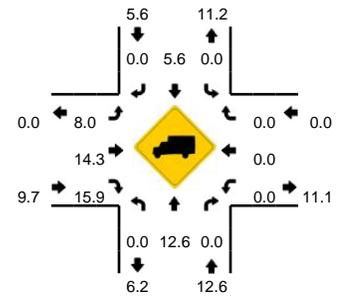
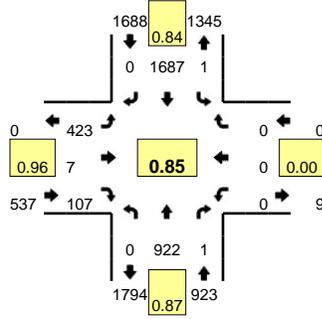
Peak Hour Factor: 0.823

	6th Ave Bypass (Southbound)					Main St (Hwy 87) (Southbound)					Bench Blvd (Westbound)					Main St (Hwy 87) (Northbound)					6th Ave N (Eastbound)					Interval Totals	Hourly Totals	15-minute Totals
	U- Turns	Right to 6th Ave N	Thru to Main St (Hwy 87)	Left to Bench Blvd	Left to Main St (Hwy 87)	U- Turns	Right to 6th Ave Bypass	Right	Thru	Left	U- Turns	Right	Right to 6th Ave Bypass	Thru	Left	U- Turns	Right	Thru	Thru to 6th Ave Bypass	Left	U- Turns	Right	Thru	Left	Left to 6th Ave Bypass			
7:00 AM	0	26	0	0	0	0	0	43	65	0	0	0	0	12	16	0	13	60	0	9	0	0	0	0	0	244		
7:05 AM	0	38	0	0	0	0	0	48	109	0	0	0	0	22	24	0	14	53	0	14	0	0	0	0	0	322		
7:10 AM	0	40	0	0	0	0	0	65	95	0	0	0	0	14	32	0	13	62	0	18	0	0	0	0	0	339		905
7:15 AM	0	51	0	0	0	0	0	49	97	0	0	0	0	32	30	0	10	61	0	9	0	0	0	0	0	339		1000
7:20 AM	0	52	0	0	0	0	0	74	86	0	0	0	0	27	41	0	8	69	0	25	0	0	0	0	0	382		1060
7:25 AM	0	58	0	0	0	0	0	67	94	0	0	0	0	13	38	0	10	71	0	14	0	0	0	0	0	365		1086
7:30 AM	0	56	0	0	0	0	0	62	88	0	0	0	0	34	43	0	10	76	0	15	0	0	0	0	0	384		1131
7:35 AM	0	61	0	0	0	0	0	69	114	0	0	0	0	37	49	0	12	74	0	25	0	0	0	0	0	441		1190
7:40 AM	0	81	0	0	0	0	0	103	148	0	0	0	0	26	28	0	22	92	0	19	0	0	0	0	0	519		1344
7:45 AM	0	74	0	0	0	0	0	87	138	0	0	0	0	33	51	0	5	86	0	21	0	0	0	0	0	495		1455
7:50 AM	0	82	0	0	0	0	0	78	110	0	0	0	0	36	60	0	22	73	0	18	0	0	0	0	0	479		1493
7:55 AM	0	67	0	0	0	0	0	81	126	0	0	0	0	27	26	0	22	90	0	20	0	0	0	0	0	459	4768	1433
8:00 AM	0	58	0	0	0	0	0	63	88	0	0	0	0	18	21	0	26	97	0	6	0	0	0	0	0	377	4901	1315
8:05 AM	0	49	0	0	0	0	0	53	71	0	0	1	0	36	21	0	16	62	0	18	0	0	0	0	0	327	4906	1163
8:10 AM	0	46	0	0	0	0	0	75	85	0	0	0	0	12	19	0	19	75	0	12	0	0	0	0	0	343	4910	1047
8:15 AM	0	39	0	0	0	0	0	67	85	0	0	0	0	12	15	0	30	81	0	16	0	0	0	0	0	345	4916	1015
8:20 AM	0	51	0	0	0	0	0	48	80	0	0	0	0	27	26	0	18	66	0	9	0	0	0	0	0	325	4859	1013
8:25 AM	0	40	0	0	0	0	0	60	99	0	0	0	0	13	16	0	17	81	0	11	0	0	0	0	0	337	4831	1007
8:30 AM	0	25	0	0	0	0	0	73	82	0	0	0	0	14	22	0	13	91	0	14	0	0	0	0	0	334	4781	996
8:35 AM	0	16	0	0	0	0	0	59	83	0	0	0	0	15	25	0	15	69	0	15	0	0	0	0	0	297	4637	968
8:40 AM	0	28	0	0	0	0	0	59	76	0	0	0	0	12	19	0	12	81	0	12	0	0	0	0	0	299	4417	930
8:45 AM	0	30	0	0	0	0	0	43	82	0	0	0	0	9	17	0	12	71	0	12	0	0	0	0	0	276	4198	872
8:50 AM	0	28	0	0	0	0	0	46	61	0	0	1	0	9	20	0	14	83	0	11	0	0	0	0	0	273	3992	848
8:55 AM	0	22	0	0	0	0	0	40	56	0	0	0	0	9	23	0	16	91	0	6	0	0	0	0	0	263	3796	812
Totals	0	1118	0	0	0	0	0	1512	2218	0	0	2	0	499	682	0	369	1815	0	349	0	0	0	0	0			

**LOCATION:** Main St (Hwy 87) -- 4th Ave N  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173215  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



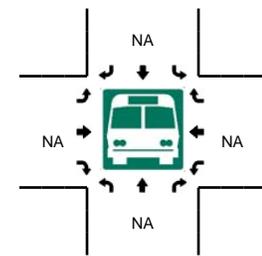
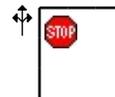
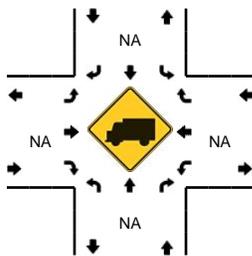
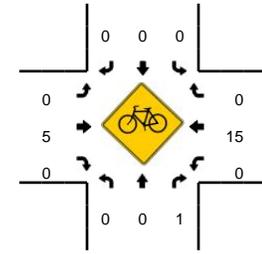
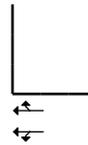
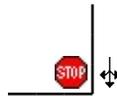
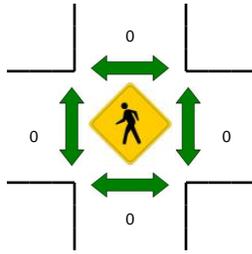
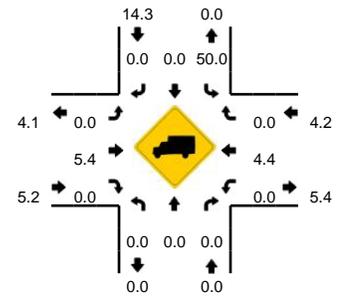
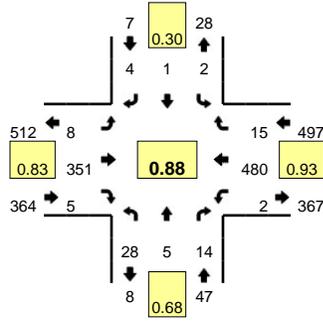
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				4th Ave N (Eastbound)				4th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	175	2	0	0	351	0	0	72	2	22	0	0	0	0	0	624	
7:15 AM	0	189	1	0	0	395	0	0	91	5	25	0	0	0	0	0	706	
7:30 AM	0	247	0	0	0	470	0	0	103	2	25	0	0	0	0	0	847	
7:45 AM	0	266	0	0	1	510	0	0	107	0	38	0	0	0	0	0	922	3099
8:00 AM	0	220	0	0	0	312	0	0	122	0	19	0	0	0	0	0	673	3148
8:15 AM	0	194	0	0	0	303	0	0	115	0	16	0	0	0	0	0	628	3070
8:30 AM	0	203	3	0	0	308	0	1	118	0	21	0	0	0	0	0	654	2877
8:45 AM	0	183	5	0	0	256	0	0	96	2	18	0	0	0	0	0	560	2515
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	1064	0	0	4	2040	0	0	428	0	152	0	0	0	0	0	3688	
Heavy Trucks	0	128	0	0	0	76	0	0	36	0	28	0	0	0	0	0	268	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Swords Ln -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173213  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



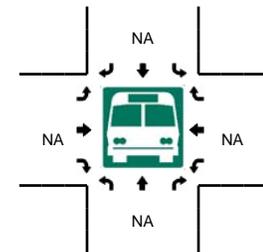
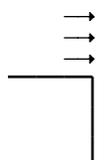
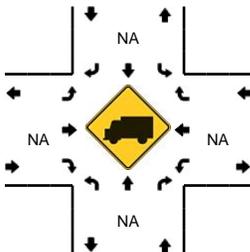
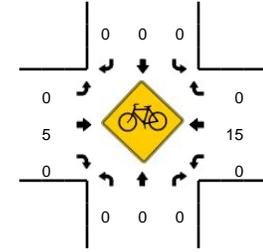
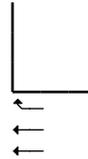
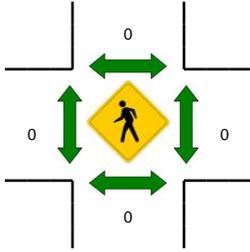
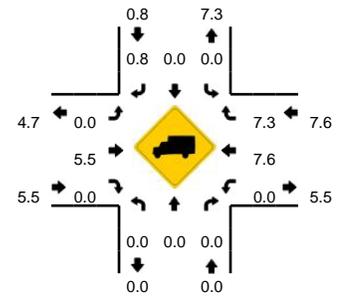
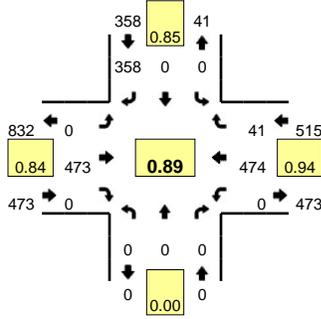
15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	4	0	6	0	0	0	0	0	0	63	0	0	0	89	0	0	162	
7:15 AM	2	0	4	0	1	0	1	0	1	68	2	0	0	110	0	0	189	
7:30 AM	5	0	2	0	1	1	3	0	3	97	0	0	0	128	2	0	242	
7:45 AM	12	2	4	0	0	0	0	0	4	104	2	0	0	120	13	0	261	854
8:00 AM	5	3	2	0	0	0	0	0	0	66	1	0	1	121	0	0	199	891
8:15 AM	6	0	6	0	1	0	1	0	1	84	2	0	1	111	0	0	213	915
8:30 AM	4	0	5	0	1	0	20	0	0	57	2	0	0	113	0	0	202	875
8:45 AM	3	0	2	0	0	0	2	0	0	71	1	0	1	83	0	0	163	777
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	48	8	16	0	0	0	0	0	16	416	8	0	0	480	52	0	1044	
Heavy Trucks	0	0	0		0	0	0		0	12	0		0	28	0		40	
Pedestrians		0				0				0				0			0	
Bicycles		0	1			0	0			0	0			5	0		6	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Alkali Creek Rd -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173211  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



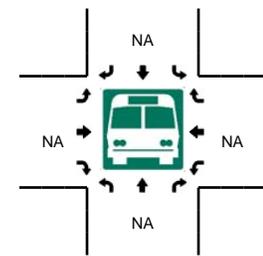
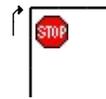
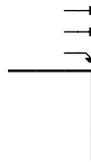
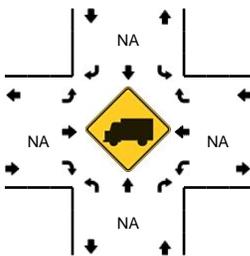
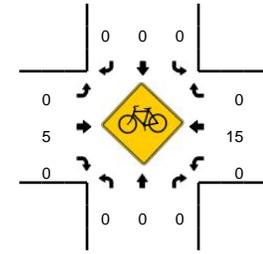
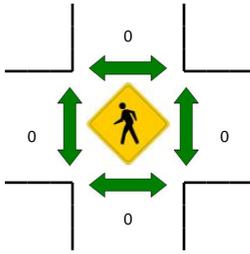
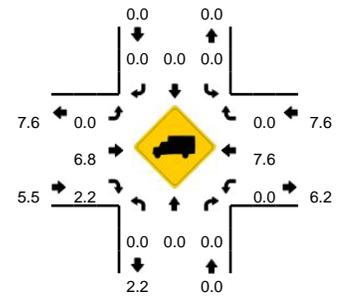
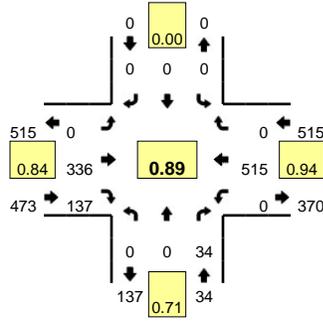
15-Min Count Period Beginning At	Alkali Creek Rd (Northbound)				Alkali Creek Rd (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	0	0	0	0	42	0	0	80	0	0	0	91	5	0	218	
7:15 AM	0	0	0	0	0	0	63	0	0	104	0	0	0	107	5	0	279	
7:30 AM	0	0	0	0	0	0	105	0	0	138	0	0	0	128	8	0	379	
7:45 AM	0	0	0	0	0	0	104	0	0	143	0	0	0	122	11	0	380	1256
8:00 AM	0	0	0	0	0	0	70	0	0	93	0	0	0	111	17	0	291	1329
8:15 AM	0	0	0	0	0	0	79	0	0	99	0	0	0	113	5	0	296	1346
8:30 AM	0	0	0	0	0	0	51	0	0	82	0	0	0	109	28	0	270	1237
8:45 AM	0	0	0	0	0	0	38	0	0	87	0	0	0	79	9	0	213	1070
<b>Peak 15-Min Flowrates</b>	<b>Northbound</b>				<b>Southbound</b>				<b>Eastbound</b>				<b>Westbound</b>				<b>Total</b>	
All Vehicles	0	0	0	0	0	0	416	0	0	572	0	0	0	488	44	0	1520	
Heavy Trucks	0	0	0	0	0	0	4	0	0	20	0	0	0	56	0	0	80	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** 6th Ave Bypass -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173209  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**



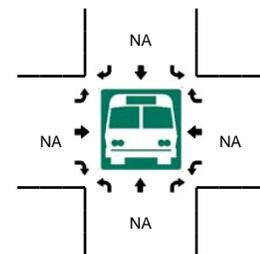
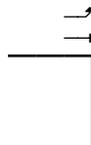
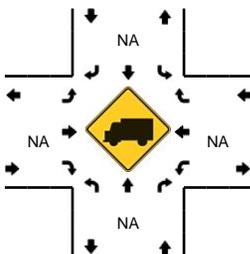
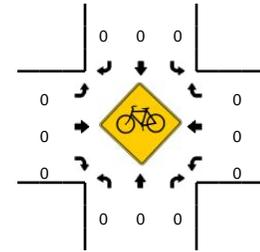
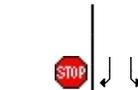
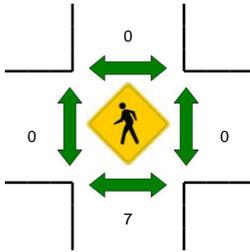
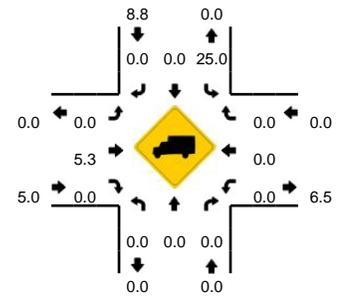
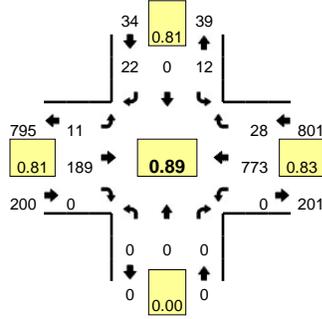
15-Min Count Period Beginning At	6th Ave Bypass (Northbound)				6th Ave Bypass (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	3	0	0	0	0	0	0	59	21	0	0	96	0	0	179	
7:15 AM	0	0	4	0	0	0	0	0	0	67	37	0	0	112	0	0	220	
7:30 AM	0	0	7	0	0	0	0	0	0	95	43	0	0	136	0	0	281	
7:45 AM	0	0	10	0	0	0	0	0	0	100	43	0	0	133	0	0	286	966
8:00 AM	0	0	5	0	0	0	0	0	0	62	31	0	0	128	0	0	226	1013
8:15 AM	0	0	12	0	0	0	0	0	0	79	20	0	0	118	0	0	229	1022
8:30 AM	0	0	4	0	0	0	0	0	0	57	25	0	0	137	0	0	223	964
8:45 AM	0	0	3	0	0	0	0	0	0	69	18	0	0	88	0	0	178	856
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	40	0	0	0	0	0	0	400	172	0	0	532	0	0	1144	
Heavy Trucks	0	0	0	0	0	0	0	0	0	12	8	0	0	56	0	0	76	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Lake Elmo Dr -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173207  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**



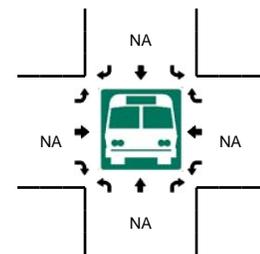
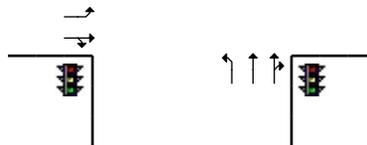
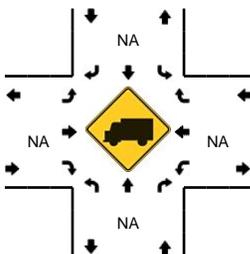
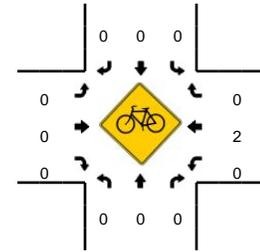
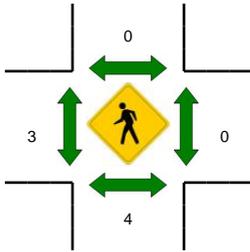
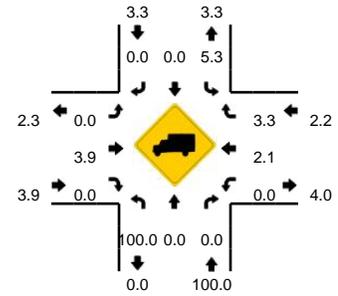
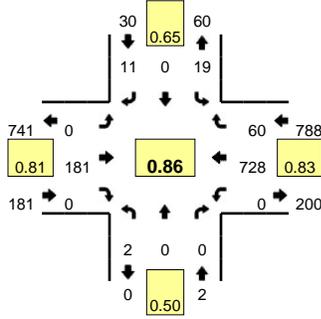
15-Min Count Period Beginning At	Lake Elmo Dr (Northbound)				Lake Elmo Dr (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	0	0	1	0	4	0	0	41	0	0	0	145	4	0	195	
7:15 AM	0	0	0	0	4	0	3	0	1	35	0	0	0	185	2	0	230	
7:30 AM	0	0	0	0	2	0	3	0	3	44	0	0	0	236	4	0	292	
7:45 AM	0	0	0	0	4	0	6	0	4	42	0	0	0	210	14	0	280	997
8:00 AM	0	0	0	0	2	0	10	0	3	68	0	0	0	142	8	0	233	1035
8:15 AM	0	0	0	0	3	0	6	0	7	66	0	0	0	112	5	0	199	1004
8:30 AM	0	0	0	0	4	0	4	0	4	37	0	0	0	116	5	0	170	882
8:45 AM	0	0	0	0	4	0	4	0	1	51	0	0	0	81	3	0	144	746
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	8	0	12	0	12	176	0	0	0	944	16	0	1168	
Heavy Trucks	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0	8	
Pedestrians		8				0				0				0			8	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Alkali Creek Rd -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173205  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**



15-Min Count Period Beginning At	Alkali Creek Rd (Northbound)				Alkali Creek Rd (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	2	0	0	0	2	0	0	0	0	40	0	0	0	136	12	0	192	
7:15 AM	2	0	0	0	4	0	3	0	0	29	0	0	0	175	11	0	224	
7:30 AM	0	0	0	0	6	0	3	0	0	41	0	0	0	226	14	0	290	
7:45 AM	0	0	0	0	3	0	3	0	0	45	0	0	0	202	18	0	271	977
8:00 AM	0	0	0	0	6	0	2	0	0	66	0	0	0	125	17	0	216	1001
8:15 AM	0	0	0	0	6	0	1	0	0	68	0	0	0	113	15	0	203	980
8:30 AM	0	0	1	0	5	0	4	0	0	36	0	0	0	104	21	0	171	861
8:45 AM	0	0	0	0	8	0	7	0	1	45	0	0	0	77	8	0	146	736
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	24	0	12	0	0	164	0	0	0	904	56	0	1160	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	28	4	0	32	
Pedestrians		16				0				12				0			28	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																	0	
Stopped Buses																		

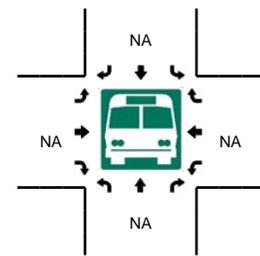
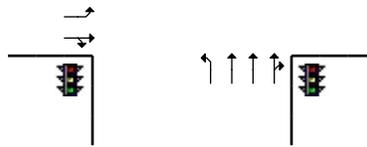
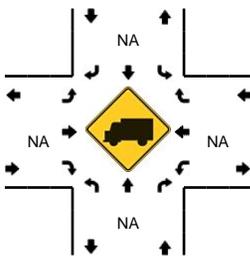
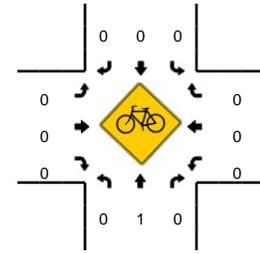
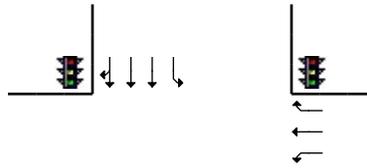
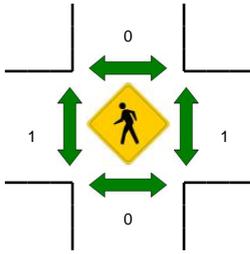
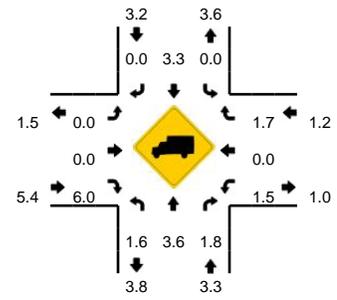
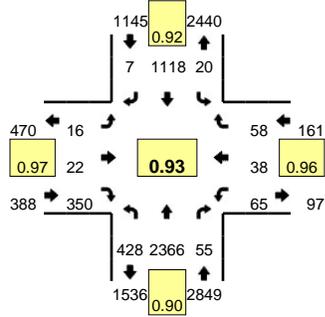
Comments:



**LOCATION:** Main St (Hwy 87) -- Lake Elmo Dr  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173224  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



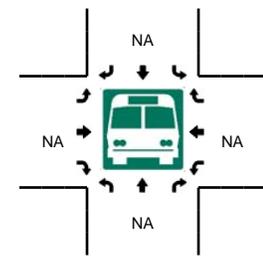
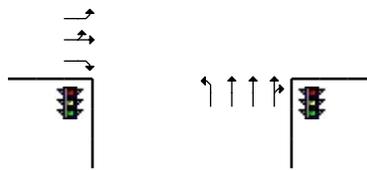
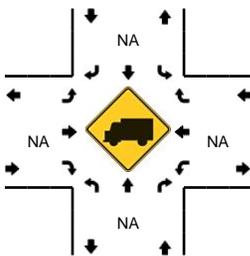
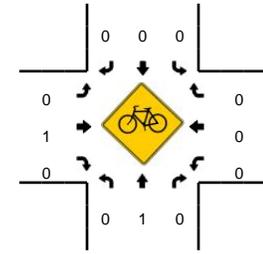
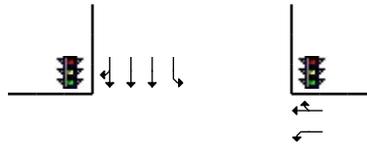
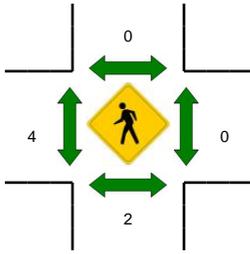
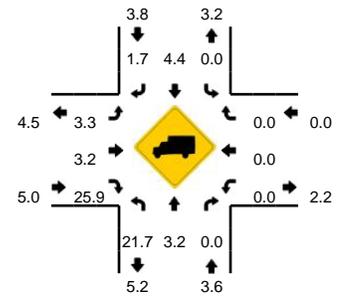
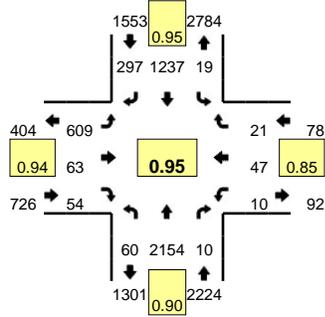
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Lake Elmo Dr (Eastbound)				Lake Elmo Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	86	437	11	0	4	242	4	1	4	4	78	0	22	7	4	0	904	
4:15 PM	97	509	13	0	5	278	3	1	5	5	92	0	20	10	12	0	1050	
4:30 PM	93	524	14	1	6	302	2	0	3	3	93	0	16	10	13	0	1080	
4:45 PM	94	556	14	1	1	253	0	0	4	6	84	0	15	10	14	0	1052	4086
5:00 PM	122	630	8	0	8	277	3	0	5	3	94	0	19	10	12	0	1191	4373
5:15 PM	116	656	19	1	5	286	2	0	4	10	79	0	15	8	19	0	1220	4543
5:30 PM	102	536	8	0	4	274	2	0	7	12	85	0	17	7	9	0	1063	4526
5:45 PM	101	455	16	0	6	242	1	0	5	5	77	0	19	11	12	0	950	4424
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	464	2624	76	4	20	1144	8	0	16	40	316	0	60	32	76	0	4880	
Heavy Trucks	8	92	4		0	48	0		0	0	28		0	0	0		180	
Pedestrians		0				0				0				0				0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		0
Stopped Buses																		0

Comments:

**LOCATION:** Main St (Hwy 87) -- E Airport Rd/Alkali Creek Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173222  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 5:00 PM -- 5:15 PM**



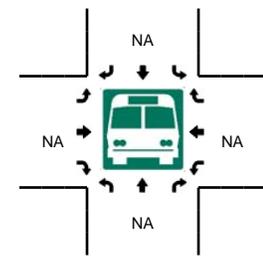
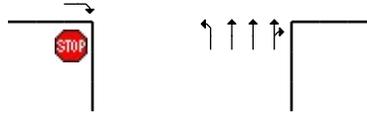
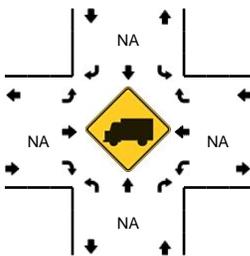
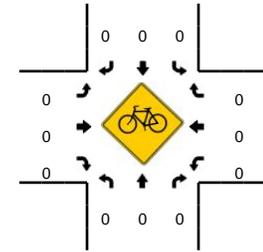
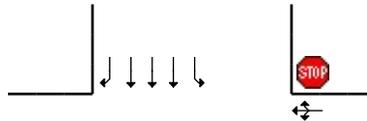
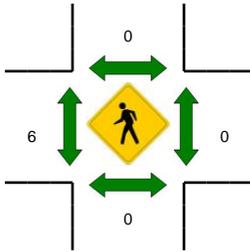
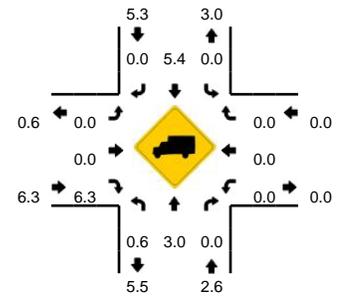
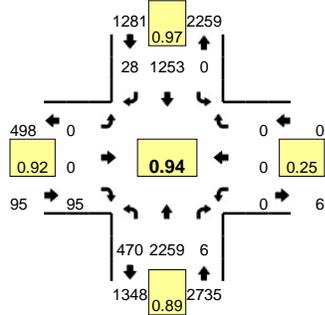
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				E Airport Rd/Alkali Creek Rd (Eastbound)				E Airport Rd/Alkali Creek Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	15	407	2	0	4	263	59	0	128	12	11	0	1	10	8	0	920	
4:15 PM	17	444	1	0	5	297	74	0	126	13	7	0	5	10	6	0	1005	
4:30 PM	12	495	4	0	5	329	61	0	127	17	15	0	1	13	6	0	1085	
4:45 PM	17	474	1	0	5	297	83	0	163	12	23	0	6	7	4	0	1092	4102
5:00 PM	11	588	4	0	2	329	81	0	148	13	9	0	1	18	5	0	1209	4391
5:15 PM	20	597	1	0	7	282	72	0	171	21	7	0	2	9	6	0	1195	4581
5:30 PM	11	474	1	0	6	298	78	0	151	19	12	0	6	11	3	0	1070	4566
5:45 PM	10	422	1	0	4	264	66	0	125	13	5	0	6	10	1	0	927	4401
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	44	2352	16	0	8	1316	324	0	592	52	36	0	4	72	20	0	4836	
Heavy Trucks	4	48	0		0	60	4		20	0	12		0	0	0		148	
Pedestrians	0	0	0		0	0	0		0	8	0		0	0	0		8	
Bicycles	0	0	0		0	0	0		0	1	0		0	0	0		1	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173220  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 5:00 PM -- 5:15 PM**



15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	90	418	2	2	0	269	2	0	0	0	17	0	0	0	0	0	800	
4:15 PM	88	468	4	0	0	307	10	0	0	0	20	0	0	0	1	0	898	
4:30 PM	100	524	3	0	0	322	11	0	0	0	18	0	0	0	0	0	978	
4:45 PM	101	508	1	0	0	316	6	0	0	0	19	0	0	0	0	0	951	3627
5:00 PM	129	598	2	0	0	333	5	0	0	0	28	0	0	0	0	0	1095	3922
5:15 PM	140	629	0	0	0	282	6	0	0	0	30	0	0	0	0	0	1087	4111
5:30 PM	123	499	3	0	0	300	10	0	0	0	24	0	0	0	0	0	959	4092
5:45 PM	92	424	5	0	0	268	4	0	0	0	28	0	0	0	1	0	822	3963
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	516	2392	8	0	0	1332	20	0	0	0	112	0	0	0	0	0	4380	
Heavy Trucks	4	40	0		0	72	0		0	0	0		0	0	0		116	
Pedestrians		0				0				4				0			4	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

Comments:



7409 SW Tech Center Dr, Ste B150

Tigard, OR 97223  
971-223-0003

[www.qualitycounts.net](http://www.qualitycounts.net)

Site Code: 13173218

Location: Main St (Hwy 87) & 6th Ave N/Bench Blvd

Date: 4/16/2015

Peak Hour: 4:30 PM - 5:30 PM

Peak 15-minutes: 5:05 PM - 5:15 PM

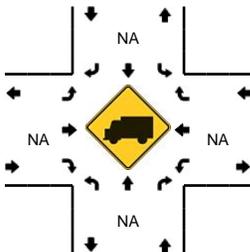
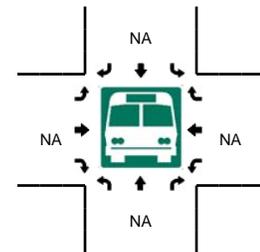
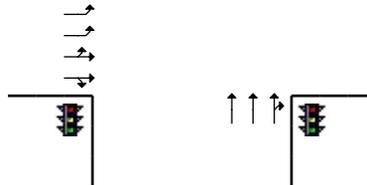
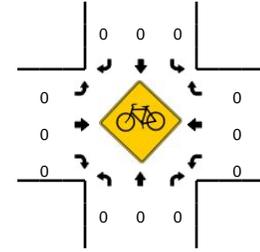
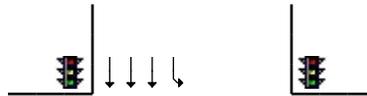
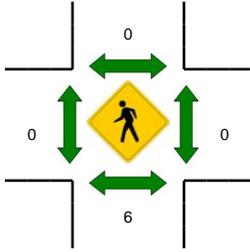
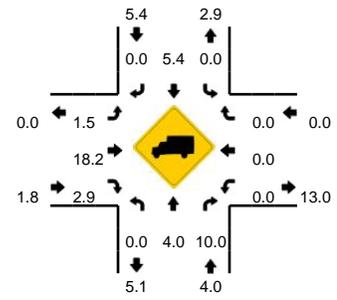
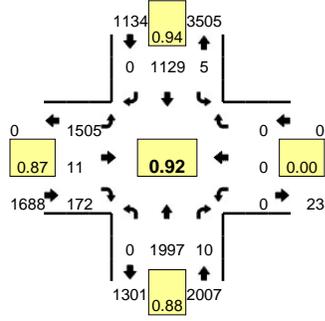
Peak Hour Factor: 0.884

	6th Ave Bypass (Southbound)					Main St (Hwy 87) (Southbound)					Bench Blvd (Westbound)					Main St (Hwy 87) (Northbound)					6th Ave N (Eastbound)					Interval Totals	Hourly Totals	15-minute Totals
	U- Turns	Right to 6th Ave N	Thru to Main St (Hwy 87)	Left to Bench Blvd	Left to Main St (Hwy 87)	U- Turns	Right to 6th Ave Bypass	Right	Thru	Left	U- Turns	Right	Right to 6th Ave Bypass	Thru	Left	U- Turns	Right	Thru	Thru to 6th Ave Bypass	Left	U- Turns	Right	Thru	Left	Left to 6th Ave Bypass			
4:00 PM	0	15	0	0	0	0	0	43	67	0	0	3	0	19	21	0	32	161	0	7	0	0	0	0	0	368		
4:05 PM	0	12	0	0	0	0	0	31	59	0	0	1	0	10	19	0	40	166	0	10	0	0	0	0	0	348		
4:10 PM	0	14	0	0	0	0	0	37	65	0	0	0	0	19	17	0	53	171	0	8	0	0	0	0	0	384		1100
4:15 PM	0	13	0	0	0	0	0	46	66	0	0	3	0	10	20	0	45	184	0	12	0	0	0	0	0	399		1131
4:20 PM	0	19	0	0	0	0	0	37	67	0	0	0	0	8	16	0	38	217	0	11	0	0	0	0	0	413		1196
4:25 PM	0	18	0	0	0	0	0	49	64	0	0	0	0	9	15	0	48	159	0	7	0	0	0	0	0	369		1181
4:30 PM	0	13	0	0	0	0	0	42	76	0	0	0	0	11	17	0	47	207	0	9	0	0	0	0	0	422		1204
4:35 PM	0	9	0	0	0	0	0	50	71	0	0	0	0	7	26	0	52	190	0	7	0	0	0	0	0	412		1203
4:40 PM	0	16	0	0	0	0	0	42	76	0	0	0	0	14	22	0	48	217	0	4	0	0	0	0	0	439		1273
4:45 PM	0	13	0	0	0	0	0	35	78	0	0	0	0	18	22	0	61	215	0	6	0	0	0	0	0	448		1299
4:50 PM	0	25	0	0	0	0	0	32	64	0	0	0	0	14	19	0	49	193	0	9	0	0	0	0	0	405		1292
4:55 PM	0	17	0	0	0	0	0	42	65	0	0	0	0	17	25	0	54	196	0	7	0	0	0	0	0	423	4830	1276
5:00 PM	0	13	0	0	0	0	0	42	65	0	0	0	0	12	24	0	56	220	0	6	0	0	0	0	0	438	4900	1266
5:05 PM	0	19	0	0	0	0	0	38	92	0	0	0	0	14	24	0	69	264	0	5	0	0	0	0	0	525	5077	1386
5:10 PM	0	20	0	0	0	0	0	44	85	0	0	0	0	13	17	0	65	257	0	11	0	0	0	0	0	512	5205	1475
5:15 PM	0	21	0	0	0	0	0	34	84	0	0	0	0	12	17	0	66	268	0	7	0	0	0	0	0	509	5315	1546
5:20 PM	0	14	0	0	0	0	0	34	71	0	0	2	0	11	17	0	78	250	0	6	0	0	0	0	0	483	5385	1504
5:25 PM	0	12	0	0	0	0	0	39	65	0	0	0	0	6	16	0	62	242	0	8	0	0	0	0	0	450	5466	1442
5:30 PM	0	11	0	0	0	0	0	33	61	0	0	0	0	12	26	0	62	205	0	10	0	0	0	0	0	420	5464	1353
5:35 PM	0	17	0	0	0	0	0	54	62	0	0	0	0	10	12	0	43	195	0	9	0	0	0	0	0	402	5454	1272
5:40 PM	0	20	0	0	0	0	0	46	64	0	0	1	0	16	15	0	49	221	0	4	0	0	0	0	0	436	5451	1258
5:45 PM	0	28	0	0	0	0	0	32	80	0	0	0	0	16	17	0	56	182	0	9	0	0	0	0	0	420	5423	1258
5:50 PM	0	18	0	0	0	0	0	44	50	0	0	0	0	9	16	0	41	180	0	7	0	0	0	0	0	365	5383	1221
5:55 PM	0	8	0	0	0	0	0	30	58	0	0	0	0	11	24	0	30	147	0	6	0	0	0	0	0	314	5274	1099
Totals	0	385	0	0	0	0	0	956	1655	0	0	10	0	298	464	0	1244	4907	0	185	0	0	0	0	0			

**LOCATION:** Main St (Hwy 87) -- 4th Ave N  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173216  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



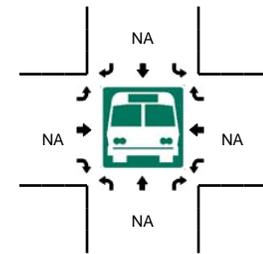
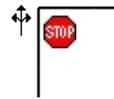
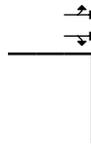
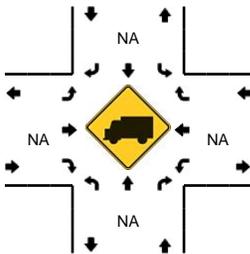
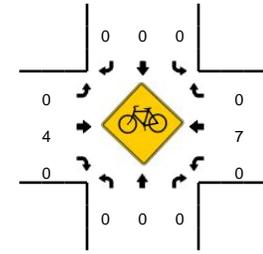
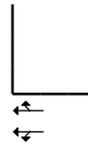
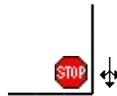
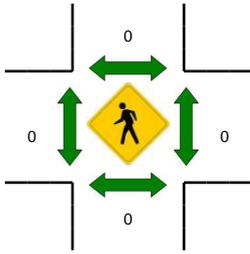
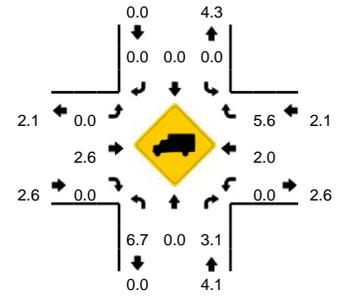
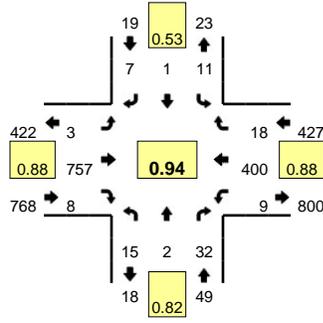
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				4th Ave N (Eastbound)				4th Ave N (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	379	4	0	0	235	0	0	279	0	43	0	0	0	0	0	940	
4:15 PM	0	437	2	0	1	248	0	0	237	3	47	0	0	0	0	0	975	
4:30 PM	0	455	6	0	0	278	0	3	327	5	33	0	0	0	0	0	1107	
4:45 PM	0	462	2	0	1	276	0	0	326	2	51	0	0	0	0	0	1120	4142
5:00 PM	0	503	2	0	0	302	0	0	443	2	38	0	0	0	0	0	1290	4492
5:15 PM	0	577	0	0	1	273	0	0	409	2	50	0	0	0	0	0	1312	4829
5:30 PM	0	486	2	0	1	242	0	0	317	0	36	0	0	0	0	0	1084	4806
5:45 PM	0	417	1	0	1	241	0	0	235	2	36	0	0	0	0	0	933	4619
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	2308	0	0	4	1092	0	0	1636	8	200	0	0	0	0	0	5248	
Heavy Trucks	0	80	0		0	48	0		28	4	8		0	0	0		168	
Pedestrians		4				0				0				0			4	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																	0	
Stopped Buses																		

Comments:

**LOCATION:** Swords Ln -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173214  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



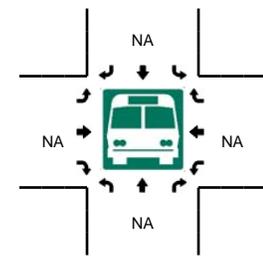
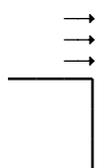
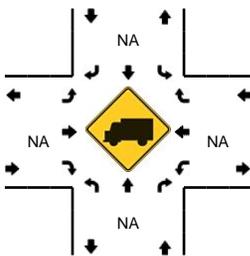
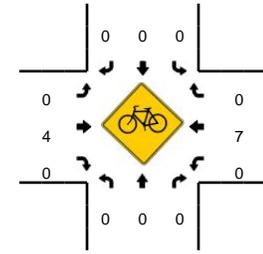
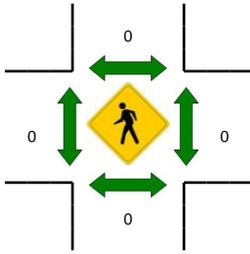
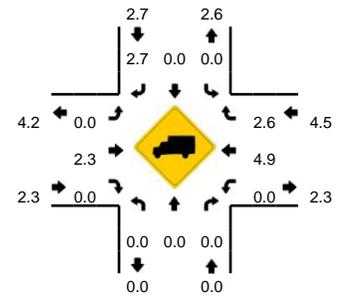
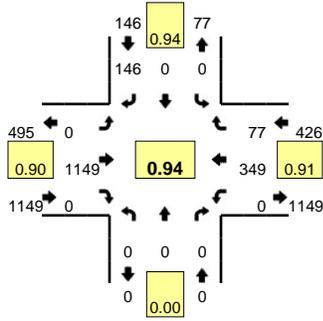
15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	3	0	3	0	0	1	0	0	0	138	2	0	0	85	0	0	232	
4:15 PM	8	0	3	0	0	0	0	0	0	136	2	0	3	100	0	0	252	
4:30 PM	12	1	7	0	0	0	0	0	0	168	5	0	0	82	2	0	277	
4:45 PM	2	0	4	0	4	1	4	0	2	192	1	0	1	103	6	0	320	1081
5:00 PM	2	1	7	0	2	0	1	0	1	175	4	0	5	114	2	0	314	1163
5:15 PM	6	1	8	0	1	0	2	0	0	218	1	0	1	89	8	0	335	1246
5:30 PM	5	0	13	0	4	0	0	0	0	172	2	0	2	94	2	0	294	1263
5:45 PM	9	1	6	0	2	0	1	0	1	125	0	0	0	84	1	0	230	1173
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	24	4	32	0	4	0	8	0	0	872	4	0	4	356	32	0	1340	
Heavy Trucks	0	0	0		0	0	0		0	20	0		0	12	0		32	
Pedestrians		0				0				0				0			0	
Bicycles	0	0	0		0	0	0		0	1	0		0	1	0		2	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Alkali Creek Rd -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173212  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



15-Min Count Period Beginning At	Alkali Creek Rd (Northbound)				Alkali Creek Rd (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	0	0	33	0	0	199	0	0	0	75	17	0	324	
4:15 PM	0	0	0	0	0	0	36	0	0	223	0	0	0	87	18	0	364	
4:30 PM	0	0	0	0	0	0	32	0	0	243	0	0	0	85	9	0	369	
4:45 PM	0	0	0	0	0	0	29	0	0	255	0	0	0	92	17	0	393	1450
5:00 PM	0	0	0	0	0	0	38	0	0	297	0	0	0	93	24	0	452	1578
5:15 PM	0	0	0	0	0	0	39	0	0	320	0	0	0	79	21	0	459	1673
5:30 PM	0	0	0	0	0	0	40	0	0	277	0	0	0	85	15	0	417	1721
5:45 PM	0	0	0	0	0	0	34	0	0	188	0	0	0	77	18	0	317	1645
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	0	0	156	0	0	1280	0	0	0	316	84	0	1836	
Heavy Trucks	0	0	0	0	0	0	0	0	0	32	0	0	0	12	8	0	52	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	
Railroad																		
Stopped Buses																		

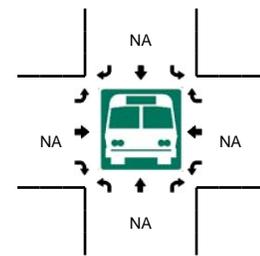
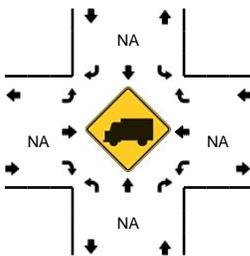
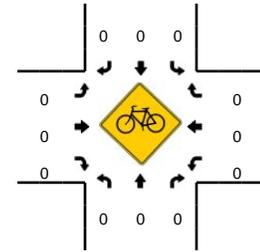
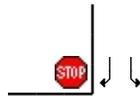
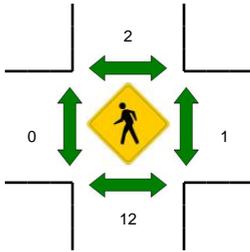
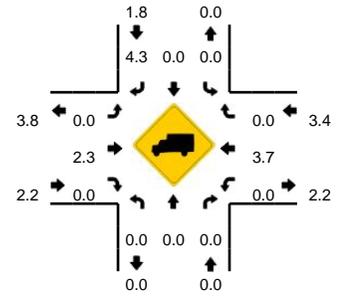
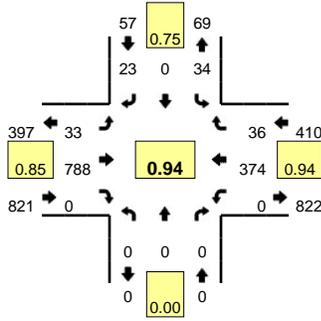
Comments:



**LOCATION:** Lake Elmo Dr -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173208  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



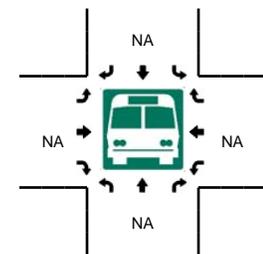
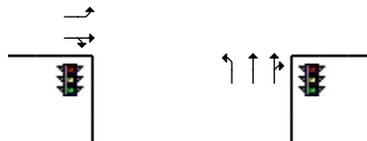
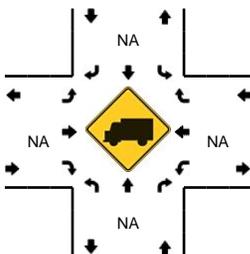
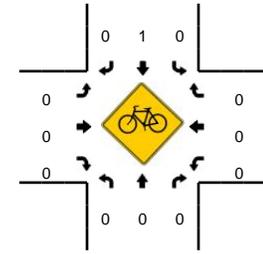
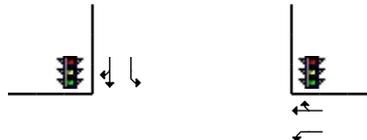
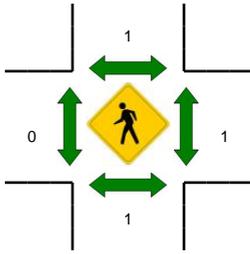
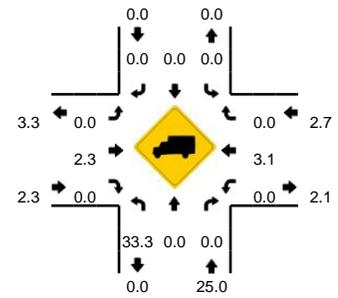
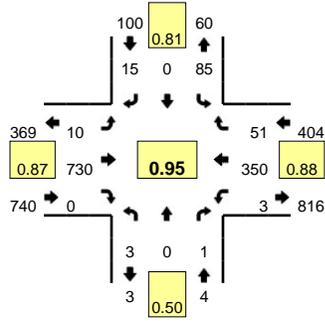
15-Min Count Period Beginning At	Lake Elmo Dr (Northbound)				Lake Elmo Dr (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	7	0	8	0	6	135	0	0	0	112	4	0	272	
4:15 PM	0	0	0	0	5	0	4	0	3	148	0	0	0	79	15	0	254	
4:30 PM	0	0	0	0	7	0	3	0	4	152	0	0	0	100	13	0	279	
4:45 PM	0	0	0	0	7	0	8	0	14	182	0	0	0	107	6	0	324	1129
5:00 PM	0	0	0	0	6	0	3	0	11	190	0	0	0	105	10	0	325	1182
5:15 PM	0	0	0	0	8	0	6	0	4	237	0	0	0	79	9	0	343	1271
5:30 PM	0	0	0	0	13	0	6	0	4	179	0	0	0	83	11	0	296	1288
5:45 PM	0	0	0	0	4	0	3	0	7	140	0	0	0	91	12	0	257	1221
<b>Peak 15-Min Flowrates</b>	<b>Northbound</b>				<b>Southbound</b>				<b>Eastbound</b>				<b>Westbound</b>				<b>Total</b>	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	32	0	24	0	16	948	0	0	0	316	36	0	1372	
Heavy Trucks	0	0	0	0	0	0	0	0	0	20	0	0	0	4	0	0	24	
Pedestrians		12				0				0				0			12	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																	0	
Stopped Buses																		

Comments:

**LOCATION:** Alkali Creek Rd -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173206  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**

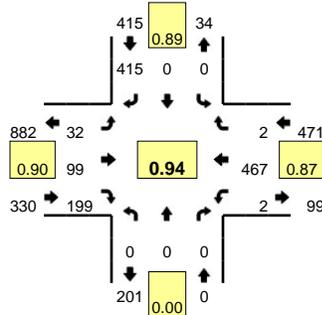


15-Min Count Period Beginning At	Alkali Creek Rd (Northbound)				Alkali Creek Rd (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	14	0	1	0	1	125	0	0	0	103	16	0	260	
4:15 PM	1	0	0	0	17	0	0	0	2	132	0	0	0	70	14	0	236	
4:30 PM	0	0	0	0	15	0	5	0	2	148	0	0	0	86	14	0	270	
4:45 PM	1	0	0	0	18	0	4	0	1	177	0	1	1	105	14	0	322	1088
5:00 PM	0	0	0	0	18	0	3	0	6	183	0	0	1	92	16	0	319	1147
5:15 PM	1	0	1	0	27	0	4	0	2	210	0	0	1	73	9	0	328	1239
5:30 PM	1	0	0	0	22	0	4	0	0	160	0	0	0	80	12	0	279	1248
5:45 PM	0	0	1	0	18	0	0	0	5	127	0	0	0	84	12	0	247	1173
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	4	0	4	0	108	0	16	0	8	840	0	0	4	292	36	0	1312	
Heavy Trucks	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	16	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

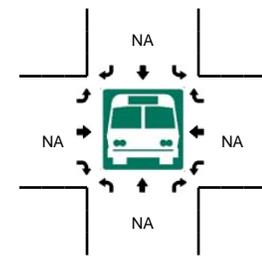
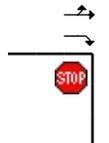
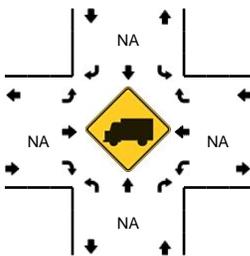
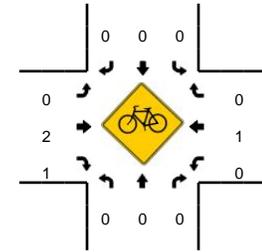
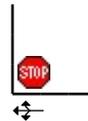
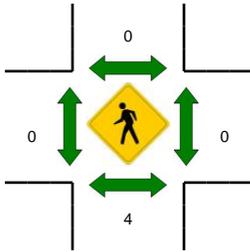
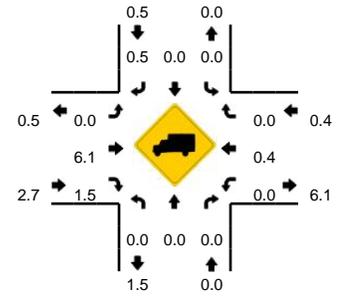
Comments:

**LOCATION:** 6th Ave Bypass -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173204  
**DATE:** Thu, Apr 16 2015



**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:00 PM -- 5:15 PM**



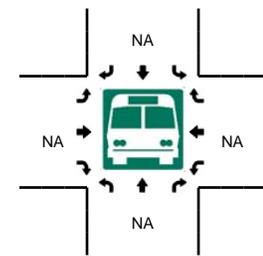
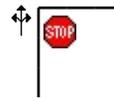
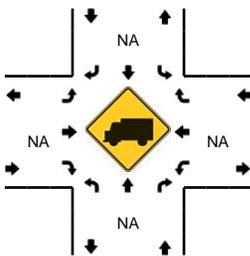
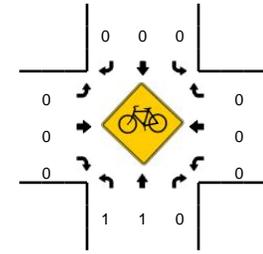
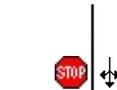
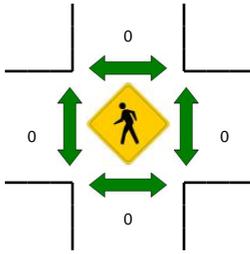
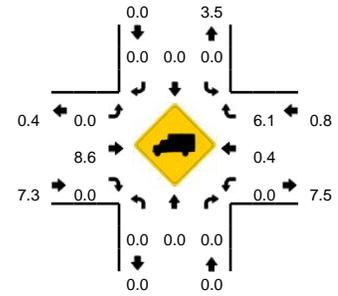
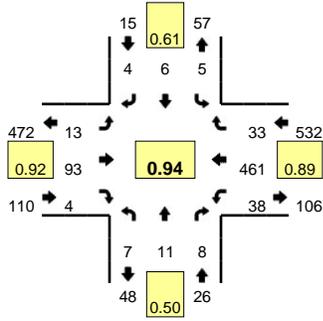
15-Min Count Period Beginning At	6th Ave Bypass (Northbound)				6th Ave Bypass (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	0	0	59	0	2	15	39	0	2	86	1	0	204	
4:15 PM	0	0	0	0	0	0	82	0	1	20	41	0	2	90	0	0	236	
4:30 PM	0	0	0	0	0	0	74	0	9	19	36	0	0	86	1	0	225	
4:45 PM	0	0	0	0	0	0	84	0	15	19	58	0	0	100	1	0	277	942
5:00 PM	0	0	0	0	0	0	117	0	3	30	50	0	2	119	1	0	322	1060
5:15 PM	0	0	0	0	0	0	110	0	12	21	44	0	0	135	0	0	322	1146
5:30 PM	0	0	0	0	0	0	104	0	2	29	47	0	0	113	0	0	295	1216
5:45 PM	0	0	0	0	0	0	66	0	3	29	51	0	1	86	2	0	238	1177
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	0	0	468	0	12	120	200	0	8	476	4	0	1288	
Heavy Trucks	0	0	0	0	0	0	4	0	0	0	8	0	0	0	0	0	12	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Swords Ln -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173202  
**DATE:** Thu, Apr 16 2015

**Peak-Hour: 5:00 PM -- 6:00 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	2	2	1	0	0	1	2	0	0	14	0	0	2	88	3	0	115	
4:15 PM	1	0	1	0	2	2	0	0	5	15	3	0	8	92	6	0	135	
4:30 PM	0	1	2	0	0	4	0	0	3	15	0	0	14	92	15	0	146	
4:45 PM	2	2	2	0	2	0	0	0	1	18	0	0	7	96	3	0	133	529
5:00 PM	1	1	0	0	1	3	3	0	2	27	1	0	8	123	8	0	178	592
5:15 PM	1	2	2	0	0	2	1	0	1	23	0	0	7	133	10	0	182	639
5:30 PM	1	3	2	0	4	0	0	0	6	21	2	0	14	113	8	0	174	667
5:45 PM	4	5	4	0	0	1	0	0	4	22	1	0	9	92	7	0	149	683
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	4	8	8	0	0	8	4	0	4	92	0	0	28	532	40	0	728	
Heavy Trucks	0	0	0	0	0	0	0	0	0	16	0	0	0	4	0	0	20	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Comments:

Attachment C Existing Conditions Synchro  
LOS Worksheets

									
Lane Group	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	18	572	36	21	22	182	994	18	2046
v/c Ratio	0.13	1.11	0.32	0.15	0.10	0.42	0.30	0.06	0.81
Control Delay	52.4	109.9	59.8	52.9	1.2	40.7	0.8	5.9	26.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8
Total Delay	52.4	109.9	59.8	52.9	1.2	40.7	0.8	5.9	39.1
Queue Length 50th (ft)	15	~542	30	17	0	92	1	3	487
Queue Length 95th (ft)	34	#730	56	38	1	#179	62	10	522
Internal Link Dist (ft)	1611			243			606		2740
Turn Bay Length (ft)	100				260				285
Base Capacity (vph)	330	517	268	339	225	438	3366	318	2513
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	1	0	0	0	0	0	0	489
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.05	1.11	0.13	0.06	0.10	0.42	0.30	0.06	1.01

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

1: Main St (Hwy 87) & Lake Elmo Dr

Existing Year 2015 AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	2	14	498	31	18	19	158	836	29	16	1777	3	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.91		1.00	0.91		
Frbp, ped/bikes		1.00	1.00	1.00	1.00	0.99	1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00		1.00	1.00		
Flt Protected		0.99	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1591	1389	1615	1604	1426	1509	4135		1524	4462		
Flt Permitted		0.97	1.00	0.75	1.00	1.00	0.05	1.00		0.28	1.00		
Satd. Flow (perm)		1560	1389	1268	1604	1426	83	4135		443	4462		
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	
Adj. Flow (vph)	2	16	572	36	21	22	182	961	33	18	2043	3	
RTOR Reduction (vph)	0	0	10	0	0	20	0	2	0	0	0	0	
Lane Group Flow (vph)	0	18	562	36	21	2	182	992	0	18	2046	0	
Confl. Peds. (#/hr)	2					2	1					1	
Confl. Bikes (#/hr)									1			1	
Heavy Vehicles (%)	0%	7%	4%	0%	6%	0%	7%	12%	0%	6%	4%	0%	
Turn Type	Perm	NA	pm+ov	Perm	NA	pm+ov	pm+pt	NA		pm+pt	NA		
Protected Phases		8	5		4	1	5	2		1	6		
Permitted Phases	8		8	4		4	2			6			
Actuated Green, G (s)		10.5	43.9	10.5	10.5	14.1	110.2	102.1		75.9	72.3		
Effective Green, g (s)		10.5	43.9	10.5	10.5	14.1	110.2	102.1		75.9	72.3		
Actuated g/C Ratio		0.08	0.34	0.08	0.08	0.11	0.85	0.79		0.58	0.56		
Clearance Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		
Lane Grp Cap (vph)		126	517	102	129	204	436	3247		288	2481		
v/s Ratio Prot			c0.28		0.01	0.00	0.11	0.24		0.00	c0.46		
v/s Ratio Perm		0.01	0.13	0.03		0.00	0.25			0.03			
v/c Ratio		0.14	1.09	0.35	0.16	0.01	0.42	0.31		0.06	0.82		
Uniform Delay, d1		55.6	43.0	56.5	55.7	51.7	27.8	3.9		11.7	23.7		
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.48	0.13		1.00	1.00		
Incremental Delay, d2		0.5	65.3	2.1	0.6	0.0	0.6	0.2		0.1	3.3		
Delay (s)		56.1	108.4	58.6	56.3	51.8	41.8	0.7		11.8	26.9		
Level of Service		E	F	E	E	D	D	A		B	C		
Approach Delay (s)		106.8			56.1			7.1			26.8		
Approach LOS		F			E			A			C		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			33.5		HCM 2000 Level of Service						C		
HCM 2000 Volume to Capacity ratio			0.97										
Actuated Cycle Length (s)			130.0		Sum of lost time (s)					13.8			
Intersection Capacity Utilization			87.7%		ICU Level of Service					E			
Analysis Period (min)			15										

c Critical Lane Group

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000  
 2: Bench Blvd & Lake Elmo Dr

Existing Year 2015 AM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↑	↔		↔	↔
Volume (veh/h)	11	189	773	28	12	22
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	12	212	869	31	13	25
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None TWLTL					
Median storage (veh)	2					
Upstream signal (ft)	504					
pX, platoon unblocked						
vC, conflicting volume	900				1121	884
vC1, stage 1 conf vol					884	
vC2, stage 2 conf vol					237	
vCu, unblocked vol	900				1121	884
tC, single (s)	4.1				6.6	6.2
tC, 2 stage (s)					5.6	
tF (s)	2.2				3.7	3.3
p0 queue free %	98				96	93
cM capacity (veh/h)	763				348	347
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	12	212	900	13	25	
Volume Left	12	0	0	13	0	
Volume Right	0	0	31	0	25	
cSH	763	1700	1700	348	347	
Volume to Capacity	0.02	0.12	0.53	0.04	0.07	
Queue Length 95th (ft)	1	0	0	3	6	
Control Delay (s)	9.8	0.0	0.0	15.7	16.2	
Lane LOS	A			C	C	
Approach Delay (s)	0.5		0.0	16.0		
Approach LOS				C		
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			57.4%	ICU Level of Service	B	
Analysis Period (min)			15			

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000  
 4: 6th Ave Bypass & E Airport Rd

Existing Year 2015 AM Peak Hour



Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	↑↑	↗		↑↑↑		↗	
Volume (veh/h)	324	154	0	509	0	26	
Sign Control	Free		Free		Stop		
Grade	0%		0%		0%		
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	
Hourly flow rate (vph)	364	173	0	572	0	29	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None		None				
Median storage (veh)							
Upstream signal (ft)	1202						
pX, platoon unblocked							
vC, conflicting volume			537		555	182	
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			537		555	182	
tC, single (s)			4.1		6.8	6.9	
tC, 2 stage (s)							
tF (s)			2.2		3.5	3.3	
p0 queue free %			100		100	97	
cM capacity (veh/h)			1041		467	836	
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	182	182	173	191	191	191	29
Volume Left	0	0	0	0	0	0	0
Volume Right	0	0	173	0	0	0	29
cSH	1700	1700	1700	1700	1700	1700	836
Volume to Capacity	0.11	0.11	0.10	0.11	0.11	0.11	0.03
Queue Length 95th (ft)	0	0	0	0	0	0	3
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	9.5
Lane LOS							A
Approach Delay (s)	0.0		0.0				9.5
Approach LOS							A
Intersection Summary							
Average Delay			0.2				
Intersection Capacity Utilization			20.0%		ICU Level of Service		A
Analysis Period (min)			15				

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

5: Swords Ln & E Airport Rd

Existing Year 2015 AM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations		↑↑			↑↑			↕			↕		
Volume (veh/h)	8	335	5	1	479	15	24	5	12	2	1	4	
Sign Control		Free			Free			Stop			Stop		
Grade		0%			0%			0%			0%		
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Hourly flow rate (vph)	9	394	6	1	564	18	28	6	14	2	1	5	
Pedestrians													
Lane Width (ft)													
Walking Speed (ft/s)													
Percent Blockage													
Right turn flare (veh)													
Median type	None			None									
Median storage (veh)													
Upstream signal (ft)	728												
pX, platoon unblocked													
vC, conflicting volume	581			400			705	999	200	808	994	291	
vC1, stage 1 conf vol													
vC2, stage 2 conf vol													
vCu, unblocked vol	581			400			705	999	200	808	994	291	
tC, single (s)	4.1			4.1			7.5	6.5	7.1	8.5	6.5	6.9	
tC, 2 stage (s)													
tF (s)	2.2			2.2			3.5	4.0	3.4	4.0	4.0	3.3	
p0 queue free %	99			100			91	98	98	99	100	99	
cM capacity (veh/h)	1003			1170			321	243	789	194	245	712	
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1							
Volume Total	206	203	283	299	48	8							
Volume Left	9	0	1	0	28	2							
Volume Right	0	6	0	18	14	5							
cSH	1003	1700	1170	1700	371	349							
Volume to Capacity	0.01	0.12	0.00	0.18	0.13	0.02							
Queue Length 95th (ft)	1	0	0	0	11	2							
Control Delay (s)	0.5	0.0	0.0	0.0	16.2	15.6							
Lane LOS	A		A		C	C							
Approach Delay (s)	0.2		0.0		16.2	15.6							
Approach LOS					C	C							
<b>Intersection Summary</b>													
Average Delay			1.0										
Intersection Capacity Utilization			28.6%		ICU Level of Service			A					
Analysis Period (min)			15										

									
Lane Group	EBL	EBT	EBR	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	167	167	48	82	3	51	809	12	2658
v/c Ratio	0.77	0.77	0.19	0.64	0.01	0.59	0.30	0.03	1.00
Control Delay	75.2	74.8	2.3	81.0	0.0	46.0	24.0	4.2	29.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Total Delay	75.2	74.8	2.3	81.0	0.0	46.0	24.0	4.2	31.5
Queue Length 50th (ft)	143	143	0	68	0	28	232	2	~877
Queue Length 95th (ft)	214	214	3	#188	0	#68	272	m2	m#879
Internal Link Dist (ft)		648		878			417		606
Turn Bay Length (ft)			445			165		175	
Base Capacity (vph)	275	276	299	128	200	86	2671	394	2658
Starvation Cap Reductn	0	0	0	0	0	0	0	0	21
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.61	0.16	0.64	0.01	0.59	0.30	0.03	1.01

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

6: Main St (Hwy 87) & E Airport Rd/Alkali Creek Rd

Existing Year 2015 AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	283	11	42	15	57	3	45	711	1	11	1938	401
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91		1.00	0.91	
Frbp, ped/bikes	1.00	1.00	0.99		1.00	1.00	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	0.97	
Flt Protected	0.95	0.96	1.00		0.99	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1461	1466	1198		1596	1445	1154	4219		1614	4376	
Flt Permitted	0.95	0.96	1.00		0.99	1.00	0.05	1.00		0.32	1.00	
Satd. Flow (perm)	1461	1466	1198		1596	1445	61	4219		547	4376	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	322	12	48	17	65	3	51	808	1	12	2202	456
RTOR Reduction (vph)	0	0	41	0	0	3	0	0	0	0	24	0
Lane Group Flow (vph)	167	167	7	0	82	0	51	809	0	12	2634	0
Confl. Peds. (#/hr)			1	1			4		2	2		4
Heavy Vehicles (%)	5%	9%	19%	7%	5%	0%	40%	10%	0%	0%	3%	3%
Turn Type	Split	NA	Perm	Split	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3	2			6		
Actuated Green, G (s)	19.4	19.4	19.4		10.5	10.5	84.0	79.6		79.6	77.4	
Effective Green, g (s)	19.4	19.4	19.4		10.5	10.5	84.0	79.6		79.6	77.4	
Actuated g/C Ratio	0.15	0.15	0.15		0.08	0.08	0.65	0.61		0.61	0.60	
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	218	218	178		128	116	76	2583		352	2605	
v/s Ratio Prot	c0.11	0.11			c0.05		c0.02	0.19		0.00	c0.60	
v/s Ratio Perm			0.01			0.00	0.41			0.02		
v/c Ratio	0.77	0.77	0.04		0.64	0.00	0.67	0.31		0.03	1.01	
Uniform Delay, d1	53.1	53.1	47.3		57.9	54.9	25.7	12.1		9.9	26.3	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.14	2.08		0.55	0.63	
Incremental Delay, d2	14.8	14.8	0.1		10.5	0.0	18.8	0.3		0.0	15.0	
Delay (s)	67.9	67.9	47.4		68.4	54.9	48.0	25.4		5.5	31.6	
Level of Service	E	E	D		E	D	D	C		A	C	
Approach Delay (s)		65.3			67.9			26.7			31.5	
Approach LOS		E			E			C			C	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			34.5									HCM 2000 Level of Service C
HCM 2000 Volume to Capacity ratio			0.92									
Actuated Cycle Length (s)			130.0									Sum of lost time (s) 18.3
Intersection Capacity Utilization			75.6%									ICU Level of Service D
Analysis Period (min)			15									
c Critical Lane Group												



Lane Group	EBL	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	1	211	924	2	2	22	14
v/c Ratio	0.00	0.15	0.66	0.02	0.00	0.12	0.07
Control Delay	5.0	4.3	12.3	27.0	0.0	28.1	17.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.0	4.3	12.3	27.0	0.0	28.1	17.6
Queue Length 50th (ft)	0	0	0	1	0	6	0
Queue Length 95th (ft)	2	97	#895	6	0	29	16
Internal Link Dist (ft)		337	424		177		878
Turn Bay Length (ft)	90					100	
Base Capacity (vph)	356	1445	1432	93	1582	178	562
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.00	0.15	0.65	0.02	0.00	0.12	0.02

**Intersection Summary**

# 95th percentile volume exceeds capacity, queue may be longer.  
 Queue shown is maximum after two cycles.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

7: Alkali Creek Rd & Bench Blvd

Existing Year 2015 AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	181	1	0	734	61	2	1	1	19	1	11
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.0	6.0			6.0		4.0	5.0		4.0	5.0	
Lane Util. Factor	1.00	1.00			1.00		1.00	0.95		1.00	1.00	
Frbp, ped/bikes	1.00	1.00			1.00		1.00	1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00			0.99		1.00	0.93		1.00	0.86	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1615	1634			1645		804	2988		1538	1430	
Flt Permitted	0.19	1.00			1.00		0.91	1.00		0.91	1.00	
Satd. Flow (perm)	329	1634			1645		769	2988		1472	1430	
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	1	210	1	0	853	71	2	1	1	22	1	13
RTOR Reduction (vph)	0	0	0	0	2	0	0	2	0	0	12	0
Lane Group Flow (vph)	1	211	0	0	922	0	2	0	0	22	2	0
Confl. Peds. (#/hr)			4	4			3					3
Confl. Bikes (#/hr)						2						
Heavy Vehicles (%)	0%	4%	0%	0%	2%	3%	100%	0%	0%	5%	0%	0%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	59.6	59.6			55.1		4.9	4.4		4.9	4.4	
Effective Green, g (s)	59.6	59.6			55.1		4.9	4.4		4.9	4.4	
Actuated g/C Ratio	0.75	0.75			0.69		0.06	0.06		0.06	0.06	
Clearance Time (s)	4.0	6.0			6.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	254	1224			1140		47	165		91	79	
v/s Ratio Prot	0.00	c0.13			c0.56		0.00	0.00		c0.00	0.00	
v/s Ratio Perm	0.00						0.00			c0.01		
v/c Ratio	0.00	0.17			0.81		0.04	0.00		0.24	0.02	
Uniform Delay, d1	6.0	2.9			8.5		35.1	35.5		35.5	35.5	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	0.1			4.3		0.4	0.0		1.4	0.1	
Delay (s)	6.0	2.9			12.8		35.5	35.5		36.9	35.6	
Level of Service	A	A			B		D	D		D	D	
Approach Delay (s)		2.9			12.8			35.5			36.4	
Approach LOS		A			B			D			D	

Intersection Summary

HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	79.5	Sum of lost time (s)	19.0
Intersection Capacity Utilization	65.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

9: Swords Ln & Aronson Ave

Existing Year 2015 AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	157	1	6	106	34	1	1	1	2	2	3
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	8	174	1	7	118	38	1	1	1	2	2	3
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None			None								
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	156			176			345	359	175	342	341	137
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	156			176			345	359	175	342	341	137
tC, single (s)	4.2			4.3			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.4			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			99			100	100	100	100	100	100
cM capacity (veh/h)	1354			1315			604	564	874	609	578	917
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>WB 1</b>	<b>NB 1</b>	<b>SB 1</b>								
Volume Total	183	162	3	8								
Volume Left	8	7	1	2								
Volume Right	1	38	1	3								
cSH	1354	1315	656	699								
Volume to Capacity	0.01	0.01	0.01	0.01								
Queue Length 95th (ft)	0	0	0	1								
Control Delay (s)	0.4	0.4	10.5	10.2								
Lane LOS	A	A	B	B								
Approach Delay (s)	0.4	0.4	10.5	10.2								
Approach LOS			B	B								
<b>Intersection Summary</b>												
Average Delay			0.7									
Intersection Capacity Utilization			22.2%	ICU Level of Service	A							
Analysis Period (min)			15									



Lane Group	WBL	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	292	611	252	1104	227	1473	1019
v/c Ratio	0.86	0.86	1.05	0.48	0.16	0.87	0.41
Control Delay	71.1	60.8	110.3	12.6	0.2	13.4	0.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Total Delay	71.1	60.8	110.3	12.6	0.2	13.5	0.2
Queue Length 50th (ft)	256	268	~189	121	0	352	0
Queue Length 95th (ft)	#372	319	#328	132	0	m358	m0
Internal Link Dist (ft)		463		526		572	
Turn Bay Length (ft)			105		335		
Base Capacity (vph)	360	749	241	2289	1403	1684	2463
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	7	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.81	0.82	1.05	0.48	0.16	0.88	0.41

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

11: Main St (Hwy 87) & 6th Ave

Existing Year 2015 AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	436	331	1	214	938	193	0	1252	866
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)				4.5	4.5		4.5	4.8	4.0		4.8	4.0
Lane Util. Factor				0.91	0.91		1.00	0.91	1.00		0.95	0.88
Frb, ped/bikes				1.00	1.00		1.00	1.00	1.00		1.00	0.99
Flpb, ped/bikes				1.00	1.00		1.00	1.00	1.00		1.00	1.00
Frt				1.00	1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected				0.95	0.98		0.95	1.00	1.00		1.00	1.00
Satd. Flow (prot)				1441	2998		1553	4181	1403		3076	2463
Flt Permitted				0.95	0.98		0.08	1.00	1.00		1.00	1.00
Satd. Flow (perm)				1441	2998		129	4181	1403		3076	2463
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	0	0	513	389	1	252	1104	227	0	1473	1019
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	292	611	0	252	1104	227	0	1473	1019
Confl. Peds. (#/hr)							1					1
Heavy Vehicles (%)	0%	0%	0%	2%	1%	0%	4%	11%	3%	0%	5%	2%
Turn Type				Split	NA		pm+pt	NA	Free		NA	Free
Protected Phases				4	4		1	2			2	
Permitted Phases							2		Free			Free
Actuated Green, G (s)				30.7	30.7		85.5	71.2	130.0		71.2	130.0
Effective Green, g (s)				30.7	30.7		85.5	71.2	130.0		71.2	130.0
Actuated g/C Ratio				0.24	0.24		0.66	0.55	1.00		0.55	1.00
Clearance Time (s)				4.5	4.5		4.5	4.8			4.8	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				340	707		241	2289	1403		1684	2463
v/s Ratio Prot				0.20	c0.20		c0.11	0.26			0.48	
v/s Ratio Perm							c0.57		0.16			0.41
v/c Ratio				0.86	0.86		1.05	0.48	0.16		0.87	0.41
Uniform Delay, d1				47.6	47.6		38.1	18.1	0.0		25.5	0.0
Progression Factor				1.00	1.00		1.38	0.65	1.00		0.38	1.00
Incremental Delay, d2				18.9	10.7		69.0	0.7	0.2		3.3	0.2
Delay (s)				66.4	58.4		121.5	12.5	0.2		12.9	0.2
Level of Service				E	E		F	B	A		B	A
Approach Delay (s)		0.0			61.0			28.1			7.7	
Approach LOS		A			E			C			A	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			23.9	HCM 2000 Level of Service				C				
HCM 2000 Volume to Capacity ratio			1.00									
Actuated Cycle Length (s)			130.0	Sum of lost time (s)				13.8				
Intersection Capacity Utilization			79.7%	ICU Level of Service				D				
Analysis Period (min)			15									
c Critical Lane Group												

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000  
 12: Main St (Hwy 87) & 4th Ave N

Existing Year 2015 AM Peak Hour

					
Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Group Flow (vph)	334	298	1086	1	1985
v/c Ratio	0.69	0.66	0.36	0.00	0.62
Control Delay	56.1	54.2	7.5	3.0	4.1
Queue Delay	0.0	0.0	0.0	0.0	0.5
Total Delay	56.1	54.2	7.5	3.0	4.6
Queue Length 50th (ft)	155	135	105	0	86
Queue Length 95th (ft)	179	159	164	m0	317
Internal Link Dist (ft)		1812	1281		526
Turn Bay Length (ft)				165	
Base Capacity (vph)	1009	936	2999	296	3197
Starvation Cap Reductn	0	0	0	0	658
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.33	0.32	0.36	0.00	0.78

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

12: Main St (Hwy 87) & 4th Ave N

Existing Year 2015 AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	423	7	107	0	0	0	0	922	1	1	1687	0
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	5.0	5.0						5.6		5.6	5.6	
Lane Util. Factor	0.86	0.86						0.91		1.00	0.91	
Frbp, ped/bikes	1.00	0.99						1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00						1.00		1.00	1.00	
Frt	1.00	0.94						1.00		1.00	1.00	
Flt Protected	0.95	0.97						1.00		0.95	1.00	
Satd. Flow (prot)	2572	2376						4107		1614	4378	
Flt Permitted	0.95	0.97						1.00		0.24	1.00	
Satd. Flow (perm)	2572	2376						4107		407	4378	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	498	8	126	0	0	0	0	1085	1	1	1985	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	334	293	0	0	0	0	0	1086	0	1	1985	0
Confl. Peds. (#/hr)			1	1						1	1	
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	8%	14%	16%	0%	0%	0%	0%	13%	0%	0%	6%	0%
Turn Type	Perm	NA						NA		Perm	NA	
Protected Phases		4						2			2	
Permitted Phases	4									2		
Actuated Green, G (s)	24.5	24.5						94.9		94.9	94.9	
Effective Green, g (s)	24.5	24.5						94.9		94.9	94.9	
Actuated g/C Ratio	0.19	0.19						0.73		0.73	0.73	
Clearance Time (s)	5.0	5.0						5.6		5.6	5.6	
Vehicle Extension (s)	3.0	3.0						0.2		0.2	0.2	
Lane Grp Cap (vph)	484	447						2998		297	3195	
v/s Ratio Prot								0.26			c0.45	
v/s Ratio Perm	c0.13	0.12								0.00		
v/c Ratio	0.69	0.66						0.36		0.00	0.62	
Uniform Delay, d1	49.2	48.8						6.4		4.8	8.7	
Progression Factor	1.00	1.00						1.00		0.40	0.38	
Incremental Delay, d2	4.2	3.5						0.3		0.0	0.4	
Delay (s)	53.4	52.3						6.8		1.9	3.7	
Level of Service	D	D						A		A	A	
Approach Delay (s)		52.9			0.0			6.8			3.7	
Approach LOS		D			A			A			A	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			13.0		HCM 2000 Level of Service					B		
HCM 2000 Volume to Capacity ratio			0.64									
Actuated Cycle Length (s)			130.0		Sum of lost time (s)				10.6			
Intersection Capacity Utilization			54.9%		ICU Level of Service				A			
Analysis Period (min)			15									

c Critical Lane Group

Summary of All Intervals

Run Number	1	10	2	3	4	5	6
Start Time	7:05	7:05	7:05	7:05	7:05	7:05	7:05
End Time	8:15	8:15	8:15	8:15	8:15	8:15	8:15
Total Time (min)	70	70	70	70	70	70	70
Time Recorded (min)	60	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1	1
Vehs Entered	6553	6708	6649	6788	6720	6760	6645
Vehs Exited	6622	6719	6656	6774	6771	6739	6670
Starting Vehs	345	335	301	307	332	312	318
Ending Vehs	276	324	294	321	281	333	293
Travel Distance (mi)	6837	6995	6860	7010	6959	7033	6890
Travel Time (hr)	311.8	311.8	319.8	314.7	318.3	319.2	308.8
Total Delay (hr)	99.2	94.6	106.3	96.8	101.9	100.1	94.9
Total Stops	6470	6545	6714	6461	6802	6924	6529
Fuel Used (gal)	248.5	250.9	250.9	252.2	252.7	253.1	248.3

Summary of All Intervals

Run Number	Billings\synchro\Task 003 Existing and Future Conditions\Existing\18460_ExistingAM	Avg
Start Time	7:05	7:05
End Time	8:15	8:15
Total Time (min)	70	70
Time Recorded (min)	60	60
# of Intervals	2	2
# of Recorded Intervals	1	1
Vehs Entered	6895	6716
Vehs Exited	6875	6728
Starting Vehs	310	319
Ending Vehs	330	303
Travel Distance (mi)	7146	6968
Travel Time (hr)	343.7	318.2
Total Delay (hr)	121.1	101.5
Total Stops	7609	6744
Fuel Used (gal)	263.0	252.6

Interval #0 Information Seeding

Start Time	7:05
End Time	7:15
Total Time (min)	10
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

**Interval #1 Information Recording**

Start Time	7:15
End Time	8:15
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	1	10	2	3	4	5	6
Vehs Entered	6553	6708	6649	6788	6720	6760	6645
Vehs Exited	6622	6719	6656	6774	6771	6739	6670
Starting Vehs	345	335	301	307	332	312	318
Ending Vehs	276	324	294	321	281	333	293
Travel Distance (mi)	6837	6995	6860	7010	6959	7033	6890
Travel Time (hr)	311.8	311.8	319.8	314.7	318.3	319.2	308.8
Total Delay (hr)	99.2	94.6	106.3	96.8	101.9	100.1	94.9
Total Stops	6470	6545	6714	6461	6802	6924	6529
Fuel Used (gal)	248.5	250.9	250.9	252.2	252.7	253.1	248.3

**Interval #1 Information Recording**

Start Time	7:15
End Time	8:15
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	Billings\synchro\Task 003 Existing and Future Conditions\Existing\18460_ExistingAM	Avg
Vehs Entered	6895	6716
Vehs Exited	6875	6728
Starting Vehs	310	319
Ending Vehs	330	303
Travel Distance (mi)	7146	6968
Travel Time (hr)	343.7	318.2
Total Delay (hr)	121.1	101.5
Total Stops	7609	6744
Fuel Used (gal)	263.0	252.6

8: 6th Ave Bypass & Aronson Ave Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	SBR	All
Denied Delay (hr)	0.0	0.1	0.8	0.0	0.0	0.0	0.9
Denied Del/Veh (s)	2.2	2.4	3.6	0.0	0.0	0.0	2.6
Total Delay (hr)	0.0	0.0	0.9	0.0	0.2	0.1	1.1
Total Del/Veh (s)	0.4	0.5	4.1	5.9	6.7	1.4	3.4

10: Main St (Hwy 87) & Aronson Ave Performance by movement

Movement	EBT	EBR	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.1	0.0	0.0	0.0		0.0	0.2	0.0
Total Delay (hr)	0.0	0.3	0.0	0.6	0.2	0.0	0.0	1.6	0.0	2.8
Total Del/Veh (s)	0.6	6.0	4.5	18.1	1.0	0.3		2.9	3.8	3.2

Total Zone Performance

Denied Delay (hr)	0.9
Denied Del/Veh (s)	3.2
Total Delay (hr)	3.9
Total Del/Veh (s)	135.6

Intersection: 8: 6th Ave Bypass & Aronson Ave

Movement	EB	WB
Directions Served	R	LTR
Maximum Queue (ft)	63	86
Average Queue (ft)	4	40
95th Queue (ft)	32	70
Link Distance (ft)		294
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)	400	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 10: Main St (Hwy 87) & Aronson Ave

Movement	EB	WB	NB	SB	SB	SB
Directions Served	R	LTR	L	L	T	T
Maximum Queue (ft)	135	29	133	2	11	12
Average Queue (ft)	52	3	42	0	1	0
95th Queue (ft)	112	18	100	2	9	7
Link Distance (ft)	317	75			359	359
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)			290	60		
Storage Blk Time (%)						
Queuing Penalty (veh)						

Zone Summary

Zone wide Queuing Penalty: 0
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RAMPS AND RAMP JUNCTIONS WORKSHEET									
General Information					Site Information				
Analyst		Brett Korporaal			Freeway/Dir of Travel		Airport Rd		
Agency or Company		Kittelson & Associates, Inc.			Junction		Alkali Creek Rd		
Date Performed		7/29/2015			Jurisdiction		MDT		
Analysis Time Period		AM Peak Hour			Analysis Year		Existing Year - 2015		
Project Description Airport Rd/Main St - Billings									
Inputs									
Upstream Adj Ramp		Freeway Number of Lanes, N			2		Downstream Adj Ramp		
<input type="checkbox"/> Yes <input type="checkbox"/> On		Ramp Number of Lanes, N			1		<input type="checkbox"/> Yes <input type="checkbox"/> On		
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off		Acceleration Lane Length, L <sub>A</sub>			750		<input checked="" type="checkbox"/> No <input type="checkbox"/> Off		
L <sub>up</sub> = ft		Deceleration Lane Length L <sub>D</sub>					L <sub>down</sub> = ft		
V <sub>u</sub> = veh/h		Freeway Volume, V <sub>F</sub>			468		V <sub>D</sub> = veh/h		
		Ramp Volume, V <sub>R</sub>			342				
		Freeway Free-Flow Speed, S <sub>FF</sub>			55.0				
		Ramp Free-Flow Speed, S <sub>FR</sub>			25.0				
Conversion to pc/h Under Base Conditions									
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f <sub>HV</sub>	f <sub>p</sub>	v = V/PHF x f <sub>HV</sub> x f <sub>p</sub>	
Freeway	468	0.87	Rolling	5	0	0.930	1.00	578	
Ramp	342	0.87	Rolling	5	0	0.930	1.00	423	
UpStream									
DownStream									
Merge Areas					Diverge Areas				
Estimation of v <sub>12</sub>					Estimation of v <sub>12</sub>				
$V_{12} = V_F (P_{FM})$ (Equation 13-6 or 13-7) P <sub>FM</sub> = 1.000 using Equation (Exhibit 13-6) V <sub>12</sub> = 578 pc/h V <sub>3</sub> or V <sub>av34</sub> = 0 pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					$V_{12} = V_R + (V_F - V_R)P_{FD}$ (Equation 13-12 or 13-13) P <sub>FD</sub> = using Equation (Exhibit 13-7) V <sub>12</sub> = pc/h V <sub>3</sub> or V <sub>av34</sub> = pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)				
Capacity Checks					Capacity Checks				
	Actual	Capacity		LOS F?		Actual	Capacity		LOS F?
V <sub>FO</sub>	1001	Exhibit 13-8		No	V <sub>F</sub>		Exhibit 13-8		
					V <sub>FO</sub> = V <sub>F</sub> - V <sub>R</sub>		Exhibit 13-8		
					V <sub>R</sub>		Exhibit 13-10		
Flow Entering Merge Influence Area					Flow Entering Diverge Influence Area				
	Actual	Max Desirable		Violation?		Actual	Max Desirable		Violation?
V <sub>R12</sub>	1001	Exhibit 13-8	4600:All	No	V <sub>12</sub>		Exhibit 13-8		
Level of Service Determination (if not F)					Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$ D <sub>R</sub> = 8.4 (pc/mi/ln) LOS = A (Exhibit 13-2)					$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D <sub>R</sub> = (pc/mi/ln) LOS = (Exhibit 13-2)				
Speed Determination					Speed Determination				
M <sub>S</sub> = 0.294 (Exhibit 13-11) S <sub>R</sub> = 51.2 mph (Exhibit 13-11) S <sub>0</sub> = N/A mph (Exhibit 13-11) S = 51.2 mph (Exhibit 13-13)					D <sub>S</sub> = (Exhibit 13-12) S <sub>R</sub> = mph (Exhibit 13-12) S <sub>0</sub> = mph (Exhibit 13-12) S = mph (Exhibit 13-13)				

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

1: Main St (Hwy 87) & Lake Elmo Dr

Existing Year 2015 PM Peak Hour

									
Lane Group	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	55	368	71	38	58	469	2610	19	1180
v/c Ratio	0.39	0.72	0.63	0.24	0.21	0.84	0.74	0.17	0.46
Control Delay	70.2	43.7	87.9	64.1	19.8	43.4	6.1	17.1	21.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0
Total Delay	70.2	43.7	87.9	64.1	19.8	43.5	6.3	17.1	21.4
Queue Length 50th (ft)	52	282	68	35	10	304	231	4	238
Queue Length 95th (ft)	96	326	119	71	50	m328	m236	14	362
Internal Link Dist (ft)	1438			243		606		2068	
Turn Bay Length (ft)					100		260		285
Base Capacity (vph)	251	592	202	289	270	631	3538	109	2566
Starvation Cap Reductn	0	0	0	0	0	3	254	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.22	0.62	0.35	0.13	0.21	0.75	0.79	0.17	0.46

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

1: Main St (Hwy 87) & Lake Elmo Dr

Existing Year 2015 PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	20	31	342	66	35	54	436	2378	49	18	1090	7	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.91		1.00	0.91		
Frbp, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00		1.00	1.00		
Flt Protected		0.98	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1667	1363	1568	1700	1417	1583	4491		1615	4458		
Flt Permitted		0.87	1.00	0.72	1.00	1.00	0.18	1.00		0.05	1.00		
Satd. Flow (perm)		1482	1363	1190	1700	1417	296	4491		81	4458		
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	
Adj. Flow (vph)	22	33	368	71	38	58	469	2557	53	19	1172	8	
RTOR Reduction (vph)	0	0	21	0	0	40	0	1	0	0	0	0	
Lane Group Flow (vph)	0	55	347	71	38	18	469	2609	0	19	1180	0	
Confl. Peds. (#/hr)							1		1	1		1	
Confl. Bikes (#/hr)									1				
Heavy Vehicles (%)	0%	0%	6%	3%	0%	2%	2%	3%	2%	0%	4%	0%	
Turn Type	Perm	NA	pm+ov	Perm	NA	pm+ov	pm+pt	NA		pm+pt	NA		
Protected Phases		8	5		4	1	5	2		1	6		
Permitted Phases	8		8	4		4	2			6			
Actuated Green, G (s)		14.3	49.9	14.3	14.3	19.0	126.4	117.2		91.0	86.3		
Effective Green, g (s)		14.3	49.9	14.3	14.3	19.0	126.4	117.2		91.0	86.3		
Actuated g/C Ratio		0.10	0.33	0.10	0.10	0.13	0.84	0.78		0.61	0.58		
Clearance Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		
Lane Grp Cap (vph)		141	494	113	162	221	554	3508		97	2564		
v/s Ratio Prot			c0.17		0.02	0.00	c0.20	0.58		0.01	0.26		
v/s Ratio Perm		0.04	0.09	0.06		0.01	c0.51			0.11			
v/c Ratio		0.39	0.70	0.63	0.23	0.08	0.85	0.74		0.20	0.46		
Uniform Delay, d1		63.8	43.6	65.3	62.8	57.8	25.6	8.6		15.8	18.4		
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.70	0.57		1.00	1.00		
Incremental Delay, d2		1.8	4.5	10.4	0.7	0.2	5.9	0.7		1.0	0.6		
Delay (s)		65.5	48.1	75.7	63.5	58.0	49.5	5.6		16.8	19.0		
Level of Service		E	D	E	E	E	D	A		B	B		
Approach Delay (s)		50.3			66.8			12.3			19.0		
Approach LOS		D			E			B			B		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			19.1		HCM 2000 Level of Service						B		
HCM 2000 Volume to Capacity ratio			0.86										
Actuated Cycle Length (s)			150.0		Sum of lost time (s)						13.8		
Intersection Capacity Utilization			78.2%		ICU Level of Service						D		
Analysis Period (min)			15										

c Critical Lane Group

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000  
 2: Bench Blvd & Lake Elmo Dr

Existing Year 2015 PM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	33	788	374	36	34	23
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	35	838	398	38	36	24
Pedestrians			1		2	
Lane Width (ft)			12.0		12.0	
Walking Speed (ft/s)			4.0		4.0	
Percent Blockage			0		0	
Right turn flare (veh)						
Median type		None	TWLTL			
Median storage (veh)			2			
Upstream signal (ft)		504				
pX, platoon unblocked					0.61	
vC, conflicting volume	438				1329	419
vC1, stage 1 conf vol					419	
vC2, stage 2 conf vol					910	
vCu, unblocked vol	438				1219	419
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	97				89	96
cM capacity (veh/h)	1131				317	629
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	35	838	436	36	24	
Volume Left	35	0	0	36	0	
Volume Right	0	0	38	0	24	
cSH	1131	1700	1700	317	629	
Volume to Capacity	0.03	0.49	0.26	0.11	0.04	
Queue Length 95th (ft)	2	0	0	10	3	
Control Delay (s)	8.3	0.0	0.0	17.8	11.0	
Lane LOS	A			C	B	
Approach Delay (s)	0.3		0.0	15.1		
Approach LOS				C		
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization			56.4%		ICU Level of Service	B
Analysis Period (min)			15			

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000  
 4: 6th Ave Bypass & E Airport Rd

Existing Year 2015 PM Peak Hour



Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	↑↑	↗		↑↑↑		↗	
Volume (veh/h)	736	415	0	426	0	34	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	
Hourly flow rate (vph)	800	451	0	463	0	37	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None		None				
Median storage (veh)							
Upstream signal (ft)	1202						
pX, platoon unblocked							
vC, conflicting volume			1251		954	400	
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			1251		954	400	
tC, single (s)			4.1		6.8	6.9	
tC, 2 stage (s)							
tF (s)			2.2		3.5	3.3	
p0 queue free %			100		100	94	
cM capacity (veh/h)			563		260	605	
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	400	400	451	154	154	154	37
Volume Left	0	0	0	0	0	0	0
Volume Right	0	0	451	0	0	0	37
cSH	1700	1700	1700	1700	1700	1700	605
Volume to Capacity	0.24	0.24	0.27	0.09	0.09	0.09	0.06
Queue Length 95th (ft)	0	0	0	0	0	0	5
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	11.3
Lane LOS							B
Approach Delay (s)	0.0	0.0					11.3
Approach LOS							B
Intersection Summary							
Average Delay			0.2				
Intersection Capacity Utilization			32.7%	ICU Level of Service		A	
Analysis Period (min)			15				

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

5: Swords Ln & E Airport Rd

Existing Year 2015 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 			 			 	
Volume (veh/h)	3	757	8	9	404	18	15	2	32	11	1	7
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	3	805	9	10	430	19	16	2	34	12	1	7
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)					728							
pX, platoon unblocked												
vC, conflicting volume	449			814			1058	1284	407	903	1279	224
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	449			814			1058	1284	407	903	1279	224
tC, single (s)	4.1			4.1			7.6	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			91	99	94	95	99	99
cM capacity (veh/h)	1122			822			168	164	591	217	165	785
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1						
Volume Total	406	411	224	234	52	20						
Volume Left	3	0	10	0	16	12						
Volume Right	0	9	0	19	34	7						
cSH	1122	1700	822	1700	315	290						
Volume to Capacity	0.00	0.24	0.01	0.14	0.17	0.07						
Queue Length 95th (ft)	0	0	1	0	15	6						
Control Delay (s)	0.1	0.0	0.5	0.0	18.7	18.4						
Lane LOS	A		A		C	C						
Approach Delay (s)	0.0		0.3		18.7	18.4						
Approach LOS					C	C						
<b>Intersection Summary</b>												
Average Delay			1.1									
Intersection Capacity Utilization			36.1%		ICU Level of Service				A			
Analysis Period (min)			15									



Lane Group	EBL	EBT	EBR	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	370	372	54	64	19	63	2276	21	1617
v/c Ratio	1.11	1.10	0.15	1.07	0.12	0.39	0.84	0.19	0.65
Control Delay	135.8	132.3	0.9	200.5	1.6	15.5	39.2	16.7	15.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	135.8	132.3	0.9	200.5	1.6	15.5	39.2	16.7	15.6
Queue Length 50th (ft)	~434	~434	0	~68	0	30	717	6	233
Queue Length 95th (ft)	#654	#651	0	#172	0	m30	m715	m17	241
Internal Link Dist (ft)		648		878			417		606
Turn Bay Length (ft)			445			165		175	
Base Capacity (vph)	332	337	358	60	159	305	2720	200	2503
Starvation Cap Reductn	0	0	0	0	0	0	0	0	18
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.11	1.10	0.15	1.07	0.12	0.21	0.84	0.10	0.65

**Intersection Summary**

- ~ Volume exceeds capacity, queue is theoretically infinite.  
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

6: Main St (Hwy 87) & E Airport Rd/Alkali Creek Rd

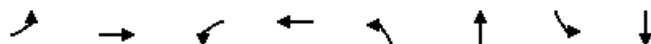
Existing Year 2015 PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	633	65	51	15	45	18	59	2133	7	20	1206	314
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91		1.00	0.91	
Frbp, ped/bikes	1.00	1.00	0.98		1.00	1.00	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	0.97	
Flt Protected	0.95	0.96	1.00		0.99	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1490	1509	1218		1650	1445	1442	4504		1615	4292	
Flt Permitted	0.95	0.96	1.00		0.99	1.00	0.10	1.00		0.05	1.00	
Satd. Flow (perm)	1490	1509	1218		1650	1445	145	4504		79	4292	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	673	69	54	16	48	19	63	2269	7	21	1283	334
RTOR Reduction (vph)	0	0	42	0	0	18	0	0	0	0	24	0
Lane Group Flow (vph)	370	372	12	0	64	1	63	2276	0	21	1593	0
Confl. Peds. (#/hr)			5	5			4					4
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	3%	2%	16%	7%	0%	0%	12%	3%	0%	0%	5%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3	2			6		
Actuated Green, G (s)	33.5	33.5	33.5		5.5	5.5	95.7	88.8		89.7	85.8	
Effective Green, g (s)	33.5	33.5	33.5		5.5	5.5	95.7	88.8		89.7	85.8	
Actuated g/C Ratio	0.22	0.22	0.22		0.04	0.04	0.64	0.59		0.60	0.57	
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	332	337	272		60	52	152	2666		87	2455	
v/s Ratio Prot	c0.25	0.25			c0.04		c0.02	c0.51		0.01	0.37	
v/s Ratio Perm			0.01			0.00	0.25			0.14		
v/c Ratio	1.11	1.10	0.04		1.07	0.01	0.41	0.85		0.24	0.65	
Uniform Delay, d1	58.2	58.2	45.7		72.2	69.6	14.4	25.2		20.0	21.8	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.53	1.55		1.37	0.68	
Incremental Delay, d2	83.9	79.9	0.1		135.9	0.1	0.2	0.4		1.3	1.2	
Delay (s)	142.2	138.2	45.8		208.2	69.7	22.2	39.6		28.8	16.0	
Level of Service	F	F	D		F	E	C	D		C	B	
Approach Delay (s)		133.8			176.5			39.1			16.2	
Approach LOS		F			F			D			B	

Intersection Summary

HCM 2000 Control Delay	49.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.3
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	11	775	3	422	3	2	89	17
v/c Ratio	0.02	0.68	0.01	0.38	0.02	0.00	0.35	0.07
Control Delay	5.3	14.8	5.7	8.9	24.0	0.0	26.9	14.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.3	14.8	5.7	8.9	24.0	0.0	26.9	14.9
Queue Length 50th (ft)	1	111	0	42	1	0	21	0
Queue Length 95th (ft)	10	#727	4	263	8	0	86	19
Internal Link Dist (ft)		337		424		177		878
Turn Bay Length (ft)	90		80				100	
Base Capacity (vph)	633	1509	362	1469	164	1699	253	776
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.51	0.01	0.29	0.02	0.00	0.35	0.02

**Intersection Summary**

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

7: Alkali Creek Rd & Bench Blvd

Existing Year 2015 PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	735	1	3	350	51	3	1	1	85	1	15
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	5.0		4.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	1.00	
Frbp, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.98		1.00	0.93		1.00	0.86	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1615	1666		1615	1622		1214	2956		1614	1428	
Flt Permitted	0.48	1.00		0.22	1.00		1.00	1.00		0.62	1.00	
Satd. Flow (perm)	817	1666		370	1622		1278	2956		1045	1428	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	774	1	3	368	54	3	1	1	89	1	16
RTOR Reduction (vph)	0	0	0	0	4	0	0	2	0	0	14	0
Lane Group Flow (vph)	11	775	0	3	418	0	3	0	0	89	3	0
Confl. Peds. (#/hr)	1		1	1		1			1	1		
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	0%	2%	0%	0%	3%	0%	33%	0%	0%	0%	0%	0%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	36.0	35.6		36.0	35.6		2.9	2.5		12.1	7.7	
Effective Green, g (s)	36.0	35.6		36.0	35.6		2.9	2.5		12.1	7.7	
Actuated g/C Ratio	0.57	0.56		0.57	0.56		0.05	0.04		0.19	0.12	
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	471	939		218	915		58	117		250	174	
v/s Ratio Prot	c0.00	c0.47		0.00	0.26		0.00	0.00		c0.03	0.00	
v/s Ratio Perm	0.01			0.01			0.00			c0.04		
v/c Ratio	0.02	0.83		0.01	0.46		0.05	0.00		0.36	0.02	
Uniform Delay, d1	5.9	11.2		7.6	8.1		28.8	29.1		21.9	24.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	6.0		0.0	0.4		0.4	0.0		0.9	0.0	
Delay (s)	5.9	17.2		7.6	8.4		29.2	29.1		22.7	24.4	
Level of Service	A	B		A	A		C	C		C	C	
Approach Delay (s)		17.0			8.4			29.1			23.0	
Approach LOS		B			A			C			C	

Intersection Summary

HCM 2000 Control Delay	14.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	63.1	Sum of lost time (s)	19.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

9: Swords Ln & Aronson Ave

Existing Year 2015 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	89	3	36	465	29	5	8	6	7	5	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	97	3	39	505	32	5	9	7	8	5	4
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None			None								
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	537			100			727	735	98	730	721	521
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	537			100			727	735	98	730	721	521
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			97			98	97	99	98	98	99
cM capacity (veh/h)	1041			1505			326	337	963	322	343	559
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	111	576	21	17								
Volume Left	11	39	5	8								
Volume Right	3	32	7	4								
cSH	1041	1505	419	368								
Volume to Capacity	0.01	0.03	0.05	0.05								
Queue Length 95th (ft)	1	2	4	4								
Control Delay (s)	0.9	0.8	14.0	15.3								
Lane LOS	A	A	B	C								
Approach Delay (s)	0.9	0.8	14.0	15.3								
Approach LOS			B	C								
<b>Intersection Summary</b>												
Average Delay			1.5									
Intersection Capacity Utilization			48.2%	ICU Level of Service	A							
Analysis Period (min)			15									



Lane Group	WBL	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	155	318	125	3288	860	1034	571
v/c Ratio	0.76	0.75	0.34	1.01	0.61	0.46	0.23
Control Delay	85.0	72.6	4.7	31.2	1.1	2.1	0.2
Queue Delay	0.0	0.0	0.0	36.4	0.0	0.0	0.0
Total Delay	85.0	72.6	4.7	67.6	1.1	2.1	0.2
Queue Length 50th (ft)	162	165	22	~1249	0	37	0
Queue Length 95th (ft)	225	198	m27	812	m0	38	0
Internal Link Dist (ft)		463		526		572	
Turn Bay Length (ft)			105		335		
Base Capacity (vph)	242	506	363	3265	1417	2250	2469
Starvation Cap Reductn	0	0	0	275	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.64	0.63	0.34	1.10	0.61	0.46	0.23

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

11: Main St (Hwy 87) & 6th Ave N

Existing Year 2015 PM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	0	0	0	234	155	3	104	2729	714	0	858	474	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)				4.5	4.5		4.5	4.8	4.0		4.8	4.0	
Lane Util. Factor				0.91	0.91		1.00	0.91	1.00		0.95	0.88	
Flt				1.00	1.00		1.00	1.00	0.85		1.00	0.85	
Flt Protected				0.95	0.98		0.95	1.00	1.00		1.00	1.00	
Satd. Flow (prot)				1427	2975		1599	4506	1417		3106	2469	
Flt Permitted				0.95	0.98		0.24	1.00	1.00		1.00	1.00	
Satd. Flow (perm)				1427	2975		410	4506	1417		3106	2469	
Peak-hour factor, PHF	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	
Adj. Flow (vph)	0	0	0	282	187	4	125	3288	860	0	1034	571	
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	0	
Lane Group Flow (vph)	0	0	0	155	317	0	125	3288	860	0	1034	571	
Heavy Vehicles (%)	0%	0%	0%	3%	1%	0%	1%	3%	2%	0%	4%	3%	
Turn Type				Split	NA		pm+pt	NA	Free		NA	Free	
Protected Phases				4	4		1	2			2		
Permitted Phases							2		Free			Free	
Actuated Green, G (s)				21.4	21.4		114.8	108.7	150.0		108.7	150.0	
Effective Green, g (s)				21.4	21.4		114.8	108.7	150.0		108.7	150.0	
Actuated g/C Ratio				0.14	0.14		0.77	0.72	1.00		0.72	1.00	
Clearance Time (s)				4.5	4.5		4.5	4.8			4.8		
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0		
Lane Grp Cap (vph)				203	424		362	3265	1417		2250	2469	
v/s Ratio Prot				c0.11	0.11		0.01	c0.73			0.33		
v/s Ratio Perm							0.25		c0.61			0.23	
v/c Ratio				0.76	0.75		0.35	1.01	0.61		0.46	0.23	
Uniform Delay, d1				61.9	61.7		5.3	20.6	0.0		8.5	0.0	
Progression Factor				1.00	1.00		0.85	0.83	1.00		0.17	1.00	
Incremental Delay, d2				15.6	7.1		0.3	13.3	1.1		0.6	0.2	
Delay (s)				77.5	68.8		4.8	30.5	1.1		2.1	0.2	
Level of Service				E	E		A	C	A		A	A	
Approach Delay (s)		0.0			71.6			23.8			1.4		
Approach LOS		A			E			C			A		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			21.7	HCM 2000 Level of Service						C			
HCM 2000 Volume to Capacity ratio			0.97										
Actuated Cycle Length (s)			150.0	Sum of lost time (s)					13.8				
Intersection Capacity Utilization			75.0%	ICU Level of Service					D				
Analysis Period (min)			15										

c Critical Lane Group



Lane Group	EBL	EBT	NBT	SBL	SBT
Lane Group Flow (vph)	1089	733	2211	3	1188
v/c Ratio	0.92	0.64	0.99	0.07	0.54
Control Delay	54.1	34.8	53.7	21.3	20.8
Queue Delay	5.4	0.1	39.7	0.0	0.0
Total Delay	59.5	34.9	93.4	21.3	20.8
Queue Length 50th (ft)	575	306	776	1	250
Queue Length 95th (ft)	#736	386	#909	m2	295
Internal Link Dist (ft)		1371	1162		526
Turn Bay Length (ft)				165	
Base Capacity (vph)	1191	1167	2234	44	2213
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	72	36	391	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.97	0.65	1.20	0.07	0.54

**Intersection Summary**

- # 95th percentile volume exceeds capacity, queue may be longer.  
 Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

Airport Rd & Main St - Billings, CM 1099(102), UPN 8718000

12: Main St (Hwy 87) & 4th Ave N

Existing Year 2015 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1495	6	175	0	0	0	0	2028	6	3	1093	0
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	5.0	5.0						5.6		5.6	5.6	
Lane Util. Factor	0.86	0.86						0.91		1.00	0.91	
Frbp, ped/bikes	1.00	1.00						1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00						1.00		1.00	1.00	
Frt	1.00	0.96						1.00		1.00	1.00	
Flt Protected	0.95	0.96						1.00		0.95	1.00	
Satd. Flow (prot)	2750	2649						4461		1615	4420	
Flt Permitted	0.95	0.96						1.00		0.05	1.00	
Satd. Flow (perm)	2750	2649						4461		91	4420	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1625	7	190	0	0	0	0	2204	7	3	1188	0
RTOR Reduction (vph)	0	19	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	1089	714	0	0	0	0	0	2211	0	3	1188	0
Confl. Peds. (#/hr)			3	3				1				1
Heavy Vehicles (%)	1%	17%	4%	0%	0%	0%	0%	4%	0%	0%	5%	0%
Turn Type	Perm	NA						NA		Perm	NA	
Protected Phases		4						2			2	
Permitted Phases	4									2		
Actuated Green, G (s)	64.3	64.3						75.1		75.1	75.1	
Effective Green, g (s)	64.3	64.3						75.1		75.1	75.1	
Actuated g/C Ratio	0.43	0.43						0.50		0.50	0.50	
Clearance Time (s)	5.0	5.0						5.6		5.6	5.6	
Vehicle Extension (s)	3.0	3.0						0.2		0.2	0.2	
Lane Grp Cap (vph)	1178	1135						2233		45	2212	
v/s Ratio Prot								c0.50			0.27	
v/s Ratio Perm	c0.40	0.27								0.03		
v/c Ratio	0.92	0.63						0.99		0.07	0.54	
Uniform Delay, d1	40.6	33.5						37.1		19.3	25.6	
Progression Factor	1.00	1.00						1.00		0.87	0.77	
Incremental Delay, d2	12.0	1.1						16.9		2.5	0.8	
Delay (s)	52.6	34.6						53.9		19.4	20.5	
Level of Service	D	C						D		B	C	
Approach Delay (s)		45.4			0.0			53.9			20.5	
Approach LOS		D			A			D			C	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			43.3					HCM 2000 Level of Service			D	
HCM 2000 Volume to Capacity ratio			0.96									
Actuated Cycle Length (s)			150.0					Sum of lost time (s)		10.6		
Intersection Capacity Utilization			84.6%					ICU Level of Service		E		
Analysis Period (min)			15									
c Critical Lane Group												

Summary of All Intervals

Run Number	1	10	2	3	4	5	6
Start Time	4:35	4:35	4:35	4:35	4:35	4:35	4:35
End Time	5:45	5:45	5:45	5:45	5:45	5:45	5:45
Total Time (min)	70	70	70	70	70	70	70
Time Recorded (min)	60	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1	1
Vehs Entered	7894	7949	7939	7740	7307	7908	7942
Vehs Exited	7837	7906	7908	7371	6930	7637	7869
Starting Vehs	425	445	435	401	417	378	407
Ending Vehs	482	488	466	770	794	649	480
Travel Distance (mi)	8056	8084	8100	7565	7102	7926	8097
Travel Time (hr)	434.3	449.2	437.2	497.8	655.2	466.8	436.6
Total Delay (hr)	183.9	197.7	184.8	262.8	435.2	220.7	184.4
Total Stops	11266	11625	11030	11563	11311	11914	11339
Fuel Used (gal)	305.5	309.2	307.7	305.5	330.9	307.9	306.6

Summary of All Intervals

Run Number	Billings\synchro\Task 003 Existing and Future Conditions\Existing\18460_ExistingPM	Avg
Start Time	4:35	4:35
End Time	5:45	5:45
Total Time (min)	70	70
Time Recorded (min)	60	60
# of Intervals	2	2
# of Recorded Intervals	1	1
Vehs Entered	7789	7818
Vehs Exited	7409	7641
Starting Vehs	379	403
Ending Vehs	759	588
Travel Distance (mi)	7638	7848
Travel Time (hr)	514.3	475.0
Total Delay (hr)	277.2	231.0
Total Stops	11940	11442
Fuel Used (gal)	313.2	309.1

Interval #0 Information Seeding

Start Time	4:35
End Time	4:45
Total Time (min)	10
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

**Interval #1 Information Recording**

Start Time	4:45
End Time	5:45
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	1	10	2	3	4	5	6
Vehs Entered	7894	7949	7939	7740	7307	7908	7942
Vehs Exited	7837	7906	7908	7371	6930	7637	7869
Starting Vehs	425	445	435	401	417	378	407
Ending Vehs	482	488	466	770	794	649	480
Travel Distance (mi)	8056	8084	8100	7565	7102	7926	8097
Travel Time (hr)	434.3	449.2	437.2	497.8	655.2	466.8	436.6
Total Delay (hr)	183.9	197.7	184.8	262.8	435.2	220.7	184.4
Total Stops	11266	11625	11030	11563	11311	11914	11339
Fuel Used (gal)	305.5	309.2	307.7	305.5	330.9	307.9	306.6

**Interval #1 Information Recording**

Start Time	4:45
End Time	5:45
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	Billings\synchro\Task 003 Existing and Future Conditions\Existing\18460_ExistingPM	Avg
Vehs Entered	7789	7818
Vehs Exited	7409	7641
Starting Vehs	379	403
Ending Vehs	759	588
Travel Distance (mi)	7638	7848
Travel Time (hr)	514.3	475.0
Total Delay (hr)	277.2	231.0
Total Stops	11940	11442
Fuel Used (gal)	313.2	309.1

8: Aronson Ave & 6th Ave Bypass Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBR	All
Denied Delay (hr)	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.4
Denied Del/Veh (s)	2.1	1.7	5.2	0.0	0.0	0.0	0.0	1.1
Total Delay (hr)	0.1	0.5	0.1	0.0	1.4	0.0	0.2	2.4
Total Del/Veh (s)	16.3	17.7	1.6	9.7	11.8	13.1	1.8	7.3

10: Main St (Hwy 87) & Aronson Ave Performance by movement

Movement	EBT	EBR	WBR	NBL	NBT	NBR	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.0	0.1	0.6	0.1	0.0	0.0	0.0	0.1
Total Delay (hr)	0.0	0.1	0.0	6.0	4.0	0.0	0.8	0.1	11.1
Total Del/Veh (s)	0.8	5.1	23.7	47.6	6.7	3.7	2.4	17.4	10.0

Total Zone Performance

Denied Delay (hr)	0.5
Denied Del/Veh (s)	4.9
Total Delay (hr)	13.5
Total Del/Veh (s)	654.7

Intersection: 8: Aronson Ave & 6th Ave Bypass

Movement	EB	EB	WB
Directions Served	LT	R	LTR
Maximum Queue (ft)	105	43	230
Average Queue (ft)	19	3	99
95th Queue (ft)	167	64	190
Link Distance (ft)	542		294
Upstream Blk Time (%)	1		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)		400	
Storage Blk Time (%)	2		
Queuing Penalty (veh)	4		

Intersection: 10: Main St (Hwy 87) & Aronson Ave

Movement	EB	WB	NB	NB	NB	NB	B29	B29	B29	SB	SB	SB
Directions Served	R	LTR	L	T	T	TR	T	T	T	T	T	T
Maximum Queue (ft)	174	18	348	555	482	414	290	284	239	31	32	45
Average Queue (ft)	25	1	203	137	95	68	60	53	35	1	2	2
95th Queue (ft)	105	9	356	584	437	315	327	307	241	32	37	42
Link Distance (ft)	317	75		748	748	748	489	489	489	359	359	359
Upstream Blk Time (%)	0			10	3	0	8	5	1		0	
Queuing Penalty (veh)	0			92	23	2	72	50	10		0	
Storage Bay Dist (ft)			290									
Storage Blk Time (%)			13									1
Queuing Penalty (veh)			97									0

Intersection: 10: Main St (Hwy 87) & Aronson Ave

Movement	SB
Directions Served	R
Maximum Queue (ft)	35
Average Queue (ft)	4
95th Queue (ft)	28
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	100
Storage Blk Time (%)	0
Queuing Penalty (veh)	0

Zone Summary

Zone wide Queuing Penalty: 349

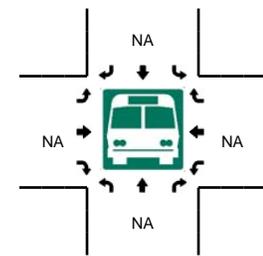
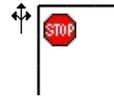
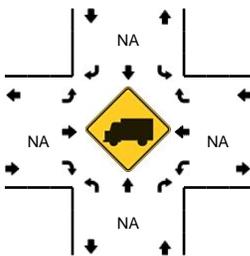
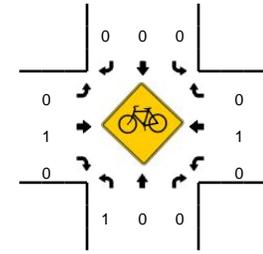
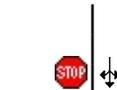
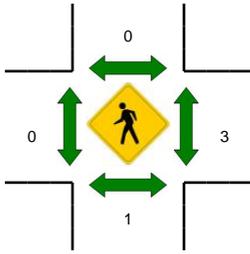
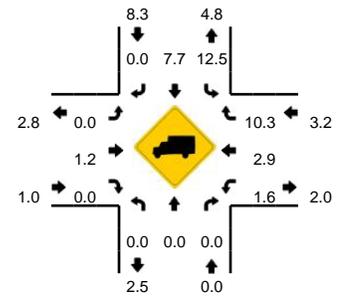
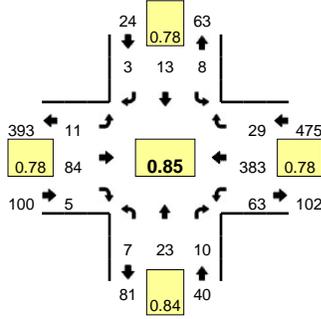
RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Information					Site Information					
Analyst	Brett Korporaal		Freeway/Dir of Travel	Airport Rd		Agency or Company	Kittelson & Associates, Inc.		Junction	Alkali Creek Rd
Date Performed	7/29/2015		Jurisdiction	MDT		Analysis Time Period	PM Peak Hour		Analysis Year	Existing Year - 2015
Project Description Airport Rd/Main St - Billings										
Inputs										
Upstream Adj Ramp	Freeway Number of Lanes, N		2		Downstream Adj Ramp					
<input type="checkbox"/> Yes <input type="checkbox"/> On	Ramp Number of Lanes, N		1		<input type="checkbox"/> Yes <input type="checkbox"/> On					
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off	Acceleration Lane Length, L <sub>A</sub>		750		<input checked="" type="checkbox"/> No <input type="checkbox"/> Off					
L <sub>up</sub> = ft	Deceleration Lane Length L <sub>D</sub>				L <sub>down</sub> = ft					
V <sub>u</sub> = veh/h	Freeway Volume, V <sub>F</sub>		349		V <sub>D</sub> = veh/h					
	Ramp Volume, V <sub>R</sub>		146							
	Freeway Free-Flow Speed, S <sub>FF</sub>		55.0							
	Ramp Free-Flow Speed, S <sub>FR</sub>		25.0							
Conversion to pc/h Under Base Conditions										
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f <sub>HV</sub>	f <sub>p</sub>	v = V/PHF x f <sub>HV</sub> x f <sub>p</sub>		
Freeway	349	0.94	Rolling	5	0	0.930	1.00	399		
Ramp	146	0.94	Rolling	5	0	0.930	1.00	167		
UpStream										
DownStream										
Merge Areas					Diverge Areas					
Estimation of v <sub>12</sub>					Estimation of v <sub>12</sub>					
$V_{12} = V_F (P_{FM})$ (Equation 13-6 or 13-7) P <sub>FM</sub> = 1.000 using Equation (Exhibit 13-6) V <sub>12</sub> = 399 pc/h V <sub>3</sub> or V <sub>av34</sub> = 0 pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					$V_{12} = V_R + (V_F - V_R)P_{FD}$ (Equation 13-12 or 13-13) P <sub>FD</sub> = using Equation (Exhibit 13-7) V <sub>12</sub> = pc/h V <sub>3</sub> or V <sub>av34</sub> = pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					
Capacity Checks					Capacity Checks					
	Actual	Capacity		LOS F?		Actual	Capacity		LOS F?	
V <sub>FO</sub>	566	Exhibit 13-8		No	V <sub>F</sub>		Exhibit 13-8			
					V <sub>FO</sub> = V <sub>F</sub> - V <sub>R</sub>		Exhibit 13-8			
					V <sub>R</sub>		Exhibit 13-10			
Flow Entering Merge Influence Area					Flow Entering Diverge Influence Area					
	Actual	Max Desirable		Violation?		Actual	Max Desirable		Violation?	
V <sub>R12</sub>	566	Exhibit 13-8	4600:All	No	V <sub>12</sub>		Exhibit 13-8			
Level of Service Determination (if not F)					Level of Service Determination (if not F)					
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$ D <sub>R</sub> = 5.1 (pc/mi/ln) LOS = A (Exhibit 13-2)					$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D <sub>R</sub> = (pc/mi/ln) LOS = (Exhibit 13-2)					
Speed Determination					Speed Determination					
M <sub>S</sub> =	0.290 (Exhibit 13-11)				D <sub>S</sub> =	(Exhibit 13-12)				
S <sub>R</sub> =	51.2 mph (Exhibit 13-11)				S <sub>R</sub> =	mph (Exhibit 13-12)				
S <sub>0</sub> =	N/A mph (Exhibit 13-11)				S <sub>0</sub> =	mph (Exhibit 13-12)				
S =	51.2 mph (Exhibit 13-13)				S =	mph (Exhibit 13-13)				

Attachment D Event Turning Movement  
Counts

**LOCATION:** Swords Ln -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173225  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 5:00 PM -- 6:00 PM**  
**Peak 15-Min: 5:00 PM -- 5:15 PM**



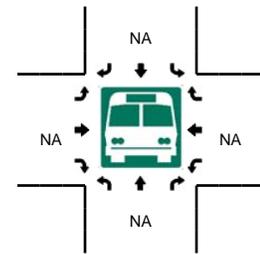
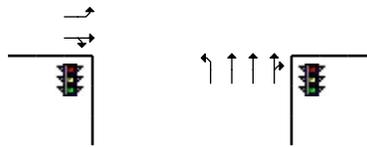
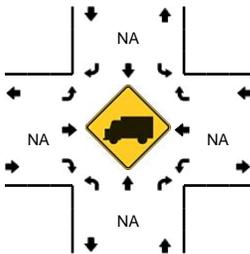
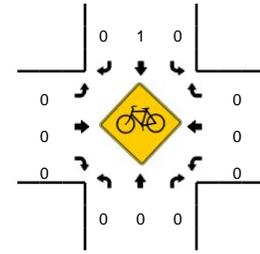
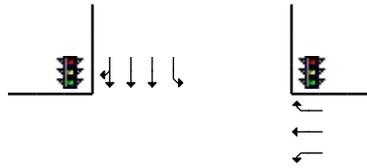
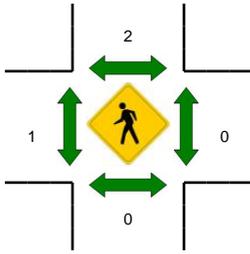
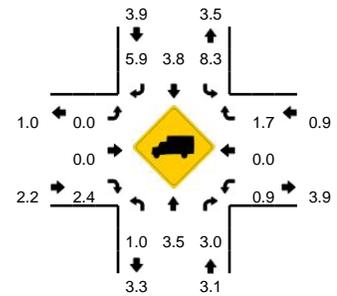
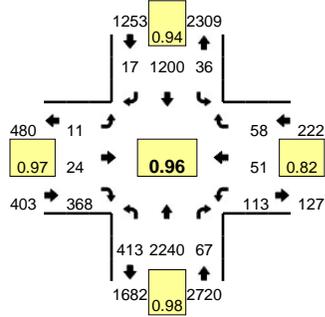
15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	2	0	2	1	0	0	6	18	0	0	4	85	10	0	128	
4:15 PM	2	2	0	0	3	2	0	0	1	24	0	0	3	81	14	0	132	
4:30 PM	0	3	2	0	2	3	1	1	2	30	1	0	8	80	9	0	142	
4:45 PM	1	4	1	0	1	3	2	0	3	16	0	0	19	87	7	0	144	546
5:00 PM	1	1	4	0	2	3	0	0	5	15	2	0	15	127	12	0	187	605
5:15 PM	4	4	4	0	2	3	2	0	0	25	1	0	11	89	7	0	152	625
5:30 PM	0	5	1	0	2	4	0	0	1	25	2	0	15	86	6	0	147	630
5:45 PM	2	13	1	0	2	3	1	0	5	19	0	0	22	81	4	0	153	639
6:00 PM	6	15	4	0	4	2	1	0	11	25	1	0	19	68	9	0	165	617
6:15 PM	3	10	2	0	2	2	0	0	2	21	3	0	16	63	6	0	130	595
6:30 PM	2	12	2	0	6	2	0	0	3	17	2	0	9	38	5	0	98	546
6:45 PM	5	7	4	0	3	5	1	0	4	18	4	0	10	57	8	0	126	519
7:00 PM	0	11	11	0	4	2	1	0	3	18	1	0	14	46	11	0	122	476
7:15 PM	3	10	6	0	2	1	0	0	6	14	1	0	13	40	7	0	103	449
7:30 PM	1	13	10	0	2	1	1	0	2	22	2	0	10	47	4	0	115	466
7:45 PM	2	5	1	0	0	0	1	0	3	19	1	0	8	31	8	0	79	419
8:00 PM	4	2	3	1	1	0	1	0	4	11	0	0	9	39	3	0	78	375
8:15 PM	1	6	0	0	1	0	1	0	3	9	2	0	5	46	4	0	78	350
8:30 PM	3	12	3	0	1	0	0	0	3	11	2	0	12	33	2	0	82	317
8:45 PM	3	8	7	0	1	2	0	0	5	10	2	0	4	34	0	0	76	314
9:00 PM	6	5	3	0	1	1	0	0	3	6	3	0	6	40	5	0	79	315
9:15 PM	0	4	2	0	1	1	0	0	4	4	0	0	3	40	1	0	60	297
9:30 PM	2	4	0	0	0	1	0	0	0	6	1	0	4	50	2	0	70	285
9:45 PM	0	3	2	0	0	0	0	0	4	3	0	0	5	27	2	0	46	255
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	4	4	16	0	8	12	0	0	20	60	8	0	60	508	48	0	748	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	16	4	0	20	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- Lake Elmo Dr  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173236  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



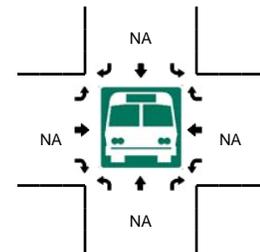
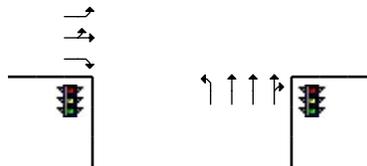
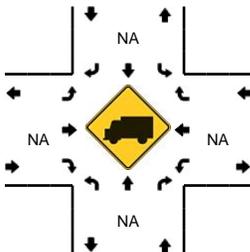
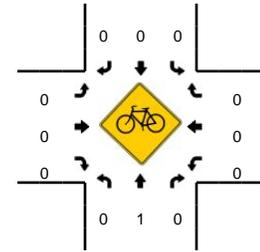
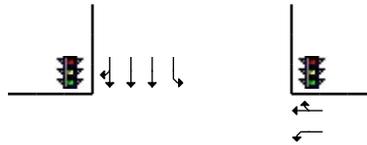
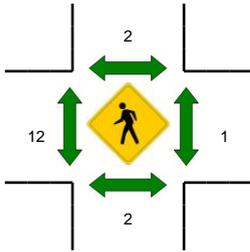
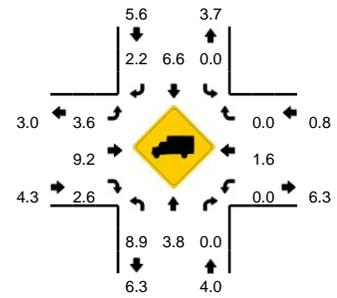
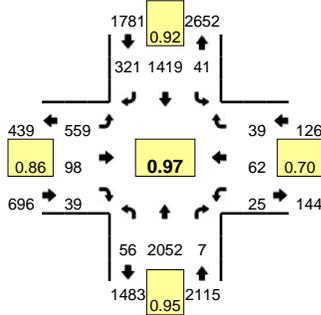
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Lake Elmo Dr (Eastbound)				Lake Elmo Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	96	485	21	0	10	284	2	0	5	7	94	0	32	11	13	0	1060	
4:15 PM	101	553	13	0	7	332	1	1	9	5	97	0	28	9	17	0	1173	
4:30 PM	99	502	17	1	8	293	3	1	1	4	109	0	29	10	14	0	1091	
4:45 PM	86	555	17	0	11	302	6	0	2	9	100	0	21	8	13	0	1130	4454
5:00 PM	113	565	15	0	11	285	4	0	3	7	97	0	30	12	12	0	1154	4548
5:15 PM	119	551	20	0	10	326	1	0	2	4	92	0	31	19	19	0	1194	4569
5:30 PM	94	569	15	1	4	287	6	0	4	4	79	0	31	12	14	0	1120	4598
5:45 PM	89	468	14	0	9	345	0	0	3	3	38	0	26	9	10	0	1014	4482
6:00 PM	83	469	22	1	13	328	3	0	3	5	46	0	18	10	16	0	1017	4345
6:15 PM	79	446	22	0	13	316	2	1	1	2	45	0	19	10	10	0	966	4117
6:30 PM	55	341	18	0	11	262	4	0	5	9	87	0	14	10	11	0	827	3824
6:45 PM	79	334	21	1	24	250	0	0	6	8	87	0	19	6	12	0	847	3657
7:00 PM	63	297	17	1	27	232	2	0	3	6	67	0	20	7	11	0	753	3393
7:15 PM	70	321	17	0	19	228	0	0	5	10	73	0	25	9	9	0	786	3213
7:30 PM	56	293	9	0	16	208	0	1	7	9	45	0	16	8	13	0	681	3067
7:45 PM	54	293	9	0	25	199	1	0	3	12	61	0	23	8	10	0	698	2918
8:00 PM	41	282	16	0	10	193	4	0	1	8	47	0	20	14	13	0	649	2814
8:15 PM	62	260	12	1	9	147	1	0	6	8	38	0	19	4	16	0	583	2611
8:30 PM	48	233	11	0	7	176	3	0	1	2	50	0	20	6	9	0	566	2496
8:45 PM	58	216	13	0	5	170	1	0	2	5	46	0	24	4	9	0	553	2351
9:00 PM	59	216	3	2	8	159	0	0	0	2	32	0	10	6	9	0	506	2208
9:15 PM	55	214	15	1	3	131	2	0	0	4	33	0	18	4	8	0	488	2113
9:30 PM	42	159	8	1	8	123	1	0	1	0	27	0	7	7	14	0	398	1945
9:45 PM	40	173	11	2	2	109	4	0	4	3	20	0	16	6	6	0	396	1788
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	476	2204	80	0	40	1304	4	0	8	16	368	0	124	76	76	0	4776	
Heavy Trucks	8	92	4		4	48	0		0	0	4		0	0	0		160	
Pedestrians		0				0				4				0				4
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0			0
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- E Airport Rd/Alkali Creek Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173235  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:15 PM -- 5:15 PM**  
**Peak 15-Min: 4:15 PM -- 4:30 PM**



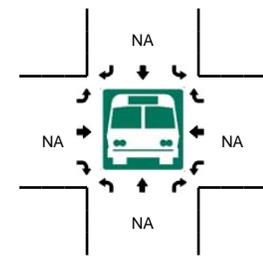
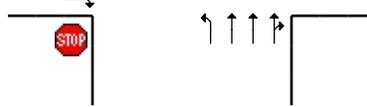
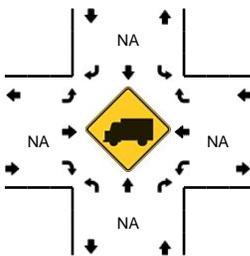
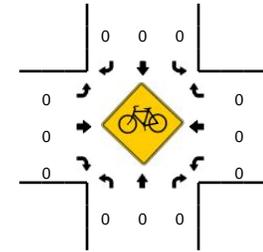
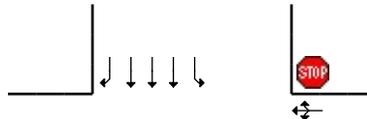
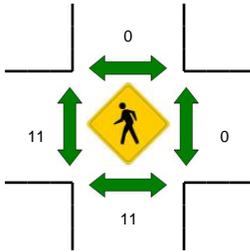
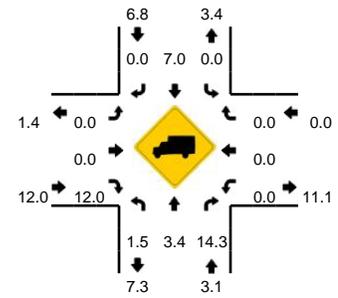
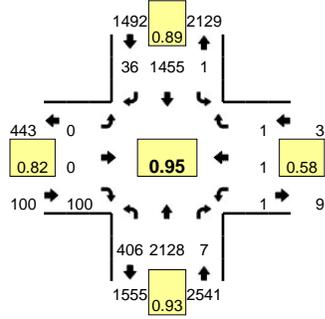
15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				E Airport Rd/Alkali Creek Rd (Eastbound)				E Airport Rd/Alkali Creek Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	25	502	3	0	11	298	74	0	143	23	14	0	9	9	9	0	1120	
4:15 PM	10	521	3	0	4	394	87	0	146	18	13	0	10	12	3	0	1221	
4:30 PM	14	473	2	0	16	355	74	0	141	26	13	0	3	17	13	0	1147	
4:45 PM	7	514	1	0	8	334	76	1	130	25	5	0	5	14	11	0	1131	4619
5:00 PM	25	544	1	0	11	336	84	1	142	29	8	0	7	19	12	0	1219	4718
5:15 PM	12	499	5	1	5	326	110	0	165	39	7	0	2	19	16	0	1206	4703
5:30 PM	21	535	0	0	11	301	75	0	145	29	5	0	3	17	7	0	1149	4705
5:45 PM	14	445	1	0	15	328	75	0	124	23	9	0	8	8	12	0	1062	4636
6:00 PM	13	425	2	0	10	320	67	1	138	24	11	0	7	9	7	0	1034	4451
6:15 PM	15	390	2	0	10	296	74	1	124	27	6	0	7	4	13	0	969	4214
6:30 PM	13	304	9	0	10	298	66	1	87	26	4	0	5	10	15	0	848	3913
6:45 PM	16	321	6	0	18	262	72	0	100	36	14	0	1	3	10	0	859	3710
7:00 PM	11	282	8	0	28	246	39	0	92	47	13	0	7	6	13	0	792	3468
7:15 PM	10	312	18	0	32	241	52	1	86	58	8	0	8	9	6	0	841	3340
7:30 PM	4	261	11	1	36	197	29	1	97	43	10	0	7	5	12	0	714	3206
7:45 PM	9	280	7	0	28	223	49	0	76	47	12	0	8	8	11	0	758	3105
8:00 PM	4	246	7	0	16	198	39	0	76	19	5	0	5	7	10	0	632	2945
8:15 PM	7	234	3	0	10	161	35	0	71	12	7	0	8	7	10	0	565	2669
8:30 PM	8	223	1	0	7	191	44	0	66	15	7	0	2	4	13	0	581	2536
8:45 PM	4	214	4	0	6	208	34	2	59	9	9	0	4	2	5	0	560	2338
9:00 PM	4	211	1	0	5	174	31	1	61	12	8	0	11	11	8	0	538	2244
9:15 PM	2	206	2	0	9	159	24	0	68	12	11	0	5	2	7	0	507	2186
9:30 PM	6	169	1	0	3	133	26	0	45	7	1	0	5	13	12	0	421	2026
9:45 PM	4	183	4	0	4	114	37	0	40	8	5	0	5	5	8	0	417	1883
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	40	2084	12	0	16	1576	348	0	584	72	52	0	40	48	12	0	4884	
Heavy Trucks	4	96	0		0	124	4		12	0	4		0	0	0		244	
Pedestrians		0				4				28				0			32	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Main St (Hwy 87) -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173234  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:15 PM -- 5:15 PM**  
**Peak 15-Min: 5:00 PM -- 5:15 PM**



15-Min Count Period Beginning At	Main St (Hwy 87) (Northbound)				Main St (Hwy 87) (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	92	535	7	0	0	294	4	0	0	0	26	0	0	0	0	0	958	
4:15 PM	86	519	6	0	0	410	8	0	0	0	27	0	0	0	0	0	1056	
4:30 PM	87	496	1	0	0	365	6	0	0	0	39	0	0	0	0	0	994	
4:45 PM	101	534	0	0	0	338	10	0	0	0	16	0	0	0	0	1	1000	4008
5:00 PM	132	579	0	0	1	342	12	0	0	0	18	0	0	1	1	0	1086	4136
5:15 PM	103	520	1	0	2	332	6	0	0	0	26	0	0	0	1	0	991	4071
5:30 PM	98	565	2	0	1	299	12	0	0	0	27	0	0	0	2	1	1007	4084
5:45 PM	83	447	4	0	1	346	13	0	0	0	26	0	0	0	0	0	920	4004
6:00 PM	82	450	2	0	0	323	13	0	0	0	31	0	0	0	0	0	901	3819
6:15 PM	71	398	1	0	1	301	9	0	0	0	29	0	0	0	1	1	812	3640
6:30 PM	42	338	5	0	1	298	9	0	0	0	25	0	0	0	1	0	719	3352
6:45 PM	61	356	2	0	0	269	11	0	0	0	23	0	0	0	2	0	724	3156
7:00 PM	44	289	3	0	0	250	11	1	0	0	34	0	1	0	1	0	634	2889
7:15 PM	44	348	2	0	0	254	12	0	0	0	29	0	0	0	0	0	689	2766
7:30 PM	51	284	3	0	1	215	10	0	0	0	38	0	0	0	0	0	602	2649
7:45 PM	38	306	1	0	0	226	10	0	0	0	23	0	0	0	0	1	605	2530
8:00 PM	41	270	1	0	1	199	11	0	0	0	18	0	0	0	0	0	541	2437
8:15 PM	47	254	1	0	0	165	7	0	0	0	10	0	0	1	0	0	485	2233
8:30 PM	37	218	2	0	0	192	7	0	0	0	11	0	0	0	0	0	467	2098
8:45 PM	33	219	1	0	0	217	11	0	0	0	14	0	0	0	0	0	495	1988
9:00 PM	39	212	1	0	0	185	8	0	0	0	14	0	0	1	0	0	460	1907
9:15 PM	25	210	0	0	2	164	4	0	0	0	10	0	0	0	0	1	416	1838
9:30 PM	51	179	0	0	0	140	6	0	0	0	10	0	0	0	0	0	386	1757
9:45 PM	29	193	0	0	0	121	3	0	0	0	7	0	0	0	0	0	353	1615
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	528	2316	0	0	4	1368	48	0	0	0	72	0	0	4	4	0	4344	
Heavy Trucks	4	52	0	0	0	76	0	0	0	0	4	0	0	0	0	0	136	
Pedestrians		16				0					16						32	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

Comments:



7409 SW Tech Center Dr, Ste B150  
 Tigard, OR 97223  
 971-223-0003  
[www.qualitycounts.net](http://www.qualitycounts.net)

Site Code: 13173233  
 Location: Main St (Hwy 87) & 6th Ave N/Bench Blvd  
 Date: 4/17/2015

Peak Hour: 4:15 PM - 5:15 PM  
 Peak 15-minutes: 5:00 PM - 5:15 PM  
 Peak Hour Factor: 0.931

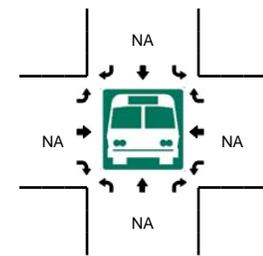
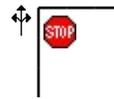
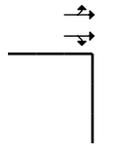
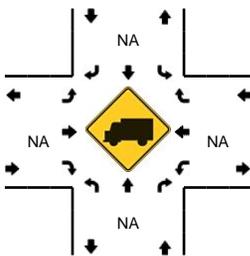
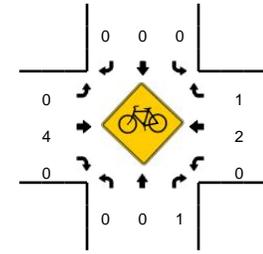
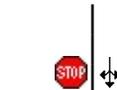
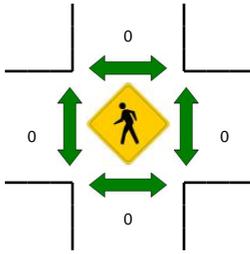
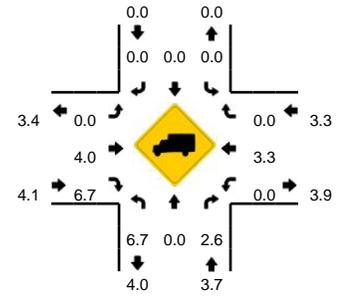
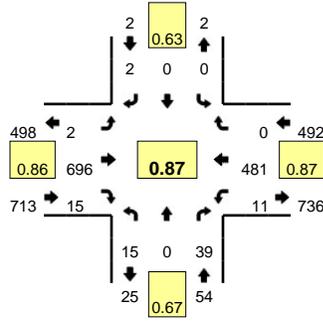
	6th Ave Bypass (Southbound)					Main St (Hwy 87) (Southbound)					Bench Blvd (Westbound)					Main St (Hwy 87) (Northbound)					6th Ave N (Eastbound)					Interval Totals	Hourly Totals
	U-Turns	Right to 6th Ave N	Thru to Main St (Hwy 87)	Left to Bench Blvd	Left to Main St (Hwy 87)	U-Turns	Right to 6th Ave Bypass	Right	Thru	Left	U-Turns	Right	Right to 6th Ave Bypass	Thru	Left	U-Turns	Right	Thru	Thru to 6th Ave Bypass	Left	U-Turns	Right	Thru	Left	Left to 6th Ave Bypass		
4:00 PM	0	32	0	0	0	0	0	123	214	0	0	2	0	52	79	0	129	616	0	16	0	0	0	0	0	1263	
4:15 PM	0	31	0	0	0	0	0	153	276	0	0	6	0	54	80	0	153	596	0	19	0	0	0	0	0	1368	
4:30 PM	0	53	0	0	0	0	0	129	280	0	0	6	0	57	82	0	138	576	0	21	0	0	0	0	0	1342	
4:45 PM	0	45	0	0	0	0	0	129	215	0	0	5	0	53	97	0	131	647	0	15	0	0	0	0	0	1337	5310
5:00 PM	0	53	0	0	0	0	0	122	233	0	0	7	0	63	96	0	188	704	0	19	0	0	0	0	0	1485	5532
5:15 PM	0	50	0	0	0	0	0	105	250	0	0	4	0	48	101	0	163	622	0	12	0	0	0	0	0	1355	5519
5:30 PM	0	57	0	0	0	0	0	96	240	0	0	5	0	40	73	0	138	658	0	17	0	0	0	0	0	1324	5501
5:45 PM	0	41	0	0	0	0	0	122	230	0	0	4	0	37	52	0	94	545	0	14	0	0	0	0	0	1139	5303
6:00 PM	0	34	0	0	0	0	0	122	237	0	0	6	0	44	66	0	88	533	0	13	0	0	0	0	0	1143	4961
6:15 PM	0	43	0	0	0	0	0	118	220	0	0	6	0	42	51	0	112	464	0	0	0	0	0	0	0	1056	4662
6:30 PM	0	32	0	0	0	0	0	129	191	0	0	5	0	40	61	0	93	387	0	4	0	0	0	0	0	942	4280
6:45 PM	0	40	0	0	0	0	0	87	205	0	0	6	0	20	41	0	144	405	0	13	0	0	0	0	0	961	4102
7:00 PM	0	33	0	0	0	0	0	96	182	0	0	1	0	23	52	0	113	343	0	12	0	0	0	0	0	855	3814
7:15 PM	0	18	0	0	0	0	0	97	179	0	0	1	0	21	47	0	166	382	0	4	0	0	0	0	0	915	3673
7:30 PM	0	24	0	0	0	0	0	76	177	0	0	2	0	19	37	0	152	328	0	12	0	0	0	0	0	827	3558
7:45 PM	0	17	0	0	0	0	0	78	159	0	0	8	0	23	54	0	130	345	0	16	0	0	0	0	0	830	3427
8:00 PM	0	22	0	0	0	0	0	86	144	0	0	0	0	15	30	0	78	301	0	17	0	0	0	0	0	693	3265
8:15 PM	0	19	0	0	0	0	0	64	111	0	0	3	0	33	38	0	85	300	0	7	0	0	0	0	0	660	3010
8:30 PM	0	30	0	0	0	0	0	75	135	0	0	1	0	20	35	1	56	257	0	8	0	0	0	0	0	618	2801
8:45 PM	0	19	0	0	0	0	0	76	147	0	0	1	0	16	30	0	57	247	0	13	0	0	0	0	0	606	2577
9:00 PM	0	11	0	0	0	0	0	66	133	0	0	1	0	20	27	0	41	248	0	13	0	0	0	0	0	560	2444
9:15 PM	0	8	0	0	0	0	0	65	114	0	0	1	0	15	24	0	47	243	0	11	0	0	0	0	0	528	2312
9:30 PM	0	9	0	0	0	0	0	69	93	0	0	5	0	13	34	0	39	224	0	13	0	0	0	0	0	499	2193



**LOCATION:** Swords Ln -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173231  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



15-Min Count Period Beginning At	Swords Ln (Northbound)				Swords Ln (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	7	1	9	0	1	0	1	0	1	166	3	0	1	101	0	0	291	
4:15 PM	13	0	4	0	0	0	0	0	0	174	3	0	2	106	0	2	304	
4:30 PM	4	1	11	0	0	0	1	0	1	173	2	0	5	99	0	0	297	
4:45 PM	5	0	8	0	0	0	0	0	0	148	5	0	1	99	0	0	266	1158
5:00 PM	5	0	13	0	0	0	0	0	0	178	3	0	2	125	0	1	327	1194
5:15 PM	1	0	9	0	0	0	0	0	0	204	5	0	3	139	0	0	361	1251
5:30 PM	4	0	9	0	0	0	2	0	2	166	2	0	4	118	0	0	307	1261
5:45 PM	3	0	19	0	0	0	0	0	0	134	3	0	3	90	1	1	254	1249
6:00 PM	10	0	25	0	0	0	0	0	0	149	3	0	4	92	0	0	283	1205
6:15 PM	4	0	13	0	0	1	1	0	0	129	2	0	1	88	0	0	239	1083
6:30 PM	0	0	20	0	0	0	1	0	0	107	1	0	7	92	1	0	229	1005
6:45 PM	5	1	13	0	1	0	0	0	0	139	8	0	1	95	1	0	264	1015
7:00 PM	2	0	21	0	0	1	0	0	0	137	4	0	2	65	0	0	232	964
7:15 PM	2	0	21	0	1	0	0	0	0	138	1	0	3	67	0	0	233	958
7:30 PM	1	0	18	0	0	0	0	0	0	119	3	1	1	43	0	0	186	915
7:45 PM	5	0	11	0	0	0	0	0	0	119	0	0	1	64	1	0	201	852
8:00 PM	2	0	7	0	1	0	1	0	1	95	1	0	1	53	0	0	162	782
8:15 PM	2	1	9	0	0	0	0	0	0	80	1	0	1	47	0	0	141	690
8:30 PM	4	0	14	0	1	0	0	0	0	73	0	0	1	56	1	0	150	654
8:45 PM	1	0	11	0	0	0	1	0	1	63	3	0	0	43	0	0	123	576
9:00 PM	2	0	11	0	0	0	0	0	0	71	1	0	1	45	1	0	132	546
9:15 PM	0	0	8	0	0	0	0	0	0	86	0	0	2	28	0	0	124	529
9:30 PM	1	0	5	0	0	0	0	0	0	42	0	0	1	46	0	0	95	474
9:45 PM	2	0	7	0	0	0	0	0	0	50	0	0	0	46	0	0	105	456
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	4	0	36	0	0	0	0	0	0	816	20	0	12	556	0	0	1444	
Heavy Trucks	0	0	4	0	0	0	0	0	0	40	4	0	0	20	0	0	68	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
Railroad																		
Stopped Buses																		

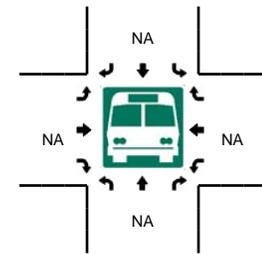
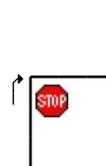
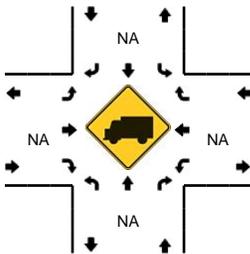
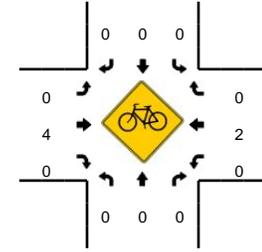
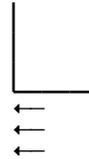
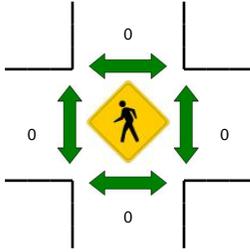
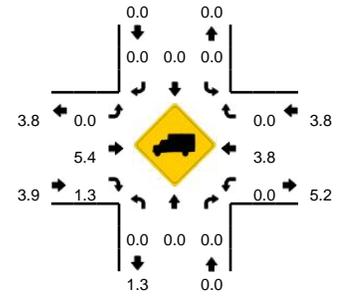
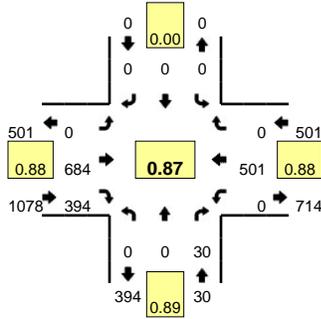
Comments:



**LOCATION:** 6th Ave Bypass -- E Airport Rd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173229  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



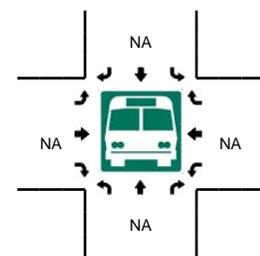
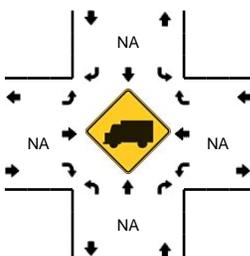
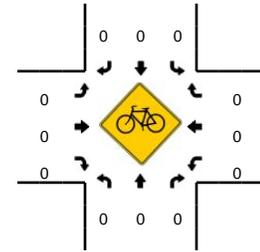
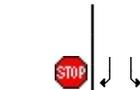
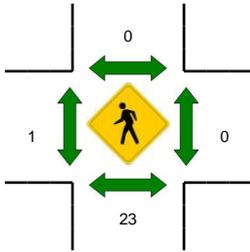
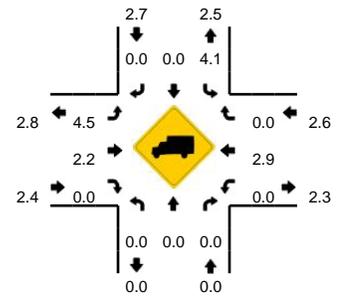
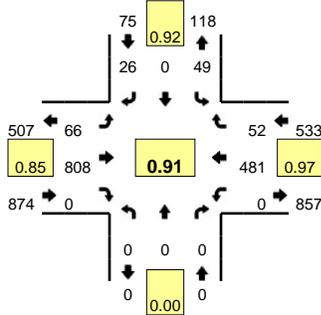
15-Min Count Period Beginning At	6th Ave Bypass (Northbound)				6th Ave Bypass (Southbound)				E Airport Rd (Eastbound)				E Airport Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	12	0	0	0	0	0	0	162	42	0	0	108	0	0	324	
4:15 PM	0	0	9	0	0	0	0	0	0	166	79	0	0	117	0	0	371	
4:30 PM	0	0	6	0	0	0	0	0	0	171	86	0	0	111	0	0	374	
4:45 PM	0	0	6	0	0	0	0	0	0	146	91	0	0	110	0	0	353	1422
5:00 PM	0	0	6	0	0	0	0	0	0	180	102	0	0	128	0	0	416	1514
5:15 PM	0	0	12	0	0	0	0	0	0	193	116	0	0	142	0	0	463	1606
5:30 PM	0	0	6	0	0	0	0	0	0	165	85	0	0	121	0	0	377	1609
5:45 PM	0	0	4	0	0	0	0	0	0	130	65	0	0	92	0	0	291	1547
6:00 PM	0	0	9	0	0	0	0	0	0	145	70	0	0	105	0	0	329	1460
6:15 PM	0	0	4	0	0	0	0	0	0	130	69	0	0	89	0	0	292	1289
6:30 PM	0	0	3	0	0	0	0	0	0	104	50	0	0	98	0	0	255	1167
6:45 PM	0	0	7	0	0	0	0	0	0	138	57	0	0	98	0	0	300	1176
7:00 PM	0	0	11	0	0	0	0	0	0	131	20	0	0	67	0	0	229	1076
7:15 PM	0	0	11	0	0	0	0	0	0	128	49	0	0	63	0	0	251	1035
7:30 PM	0	0	8	0	0	0	0	0	0	117	36	0	0	52	0	0	213	993
7:45 PM	0	0	9	0	0	0	0	0	0	113	26	0	0	64	0	0	212	905
8:00 PM	0	0	6	0	0	0	0	0	0	86	43	0	0	59	0	0	194	870
8:15 PM	0	0	5	0	0	0	0	0	0	79	30	0	0	49	0	0	163	782
8:30 PM	0	0	2	0	0	0	0	0	0	68	38	0	0	60	0	0	168	737
8:45 PM	0	0	6	0	0	0	0	0	0	65	31	0	0	45	0	0	147	672
9:00 PM	0	0	2	0	0	0	0	0	0	70	29	0	0	47	0	0	148	626
9:15 PM	0	0	1	0	0	0	0	0	0	79	42	0	0	28	0	0	150	613
9:30 PM	0	0	0	0	0	0	0	0	0	42	21	0	0	47	0	0	110	555
9:45 PM	0	0	1	0	0	0	0	0	0	51	24	0	0	48	0	0	124	532
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	48	0	0	0	0	0	0	772	464	0	0	568	0	0	1852	
Heavy Trucks	0	0	0	0	0	0	0	0	0	48	0	0	0	20	0	0	68	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Comments:

**LOCATION:** Lake Elmo Dr -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173228  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



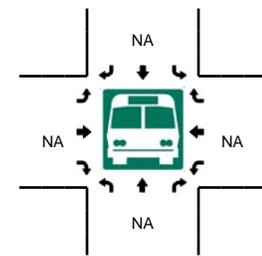
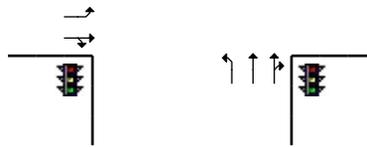
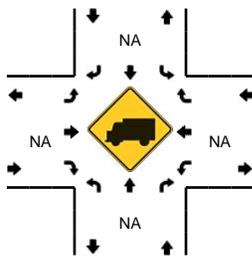
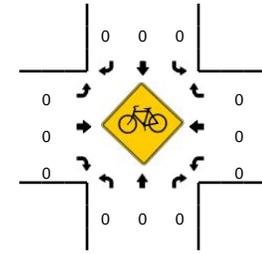
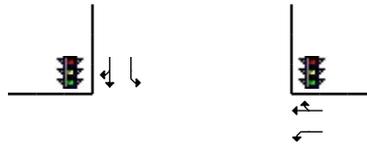
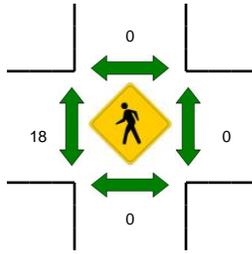
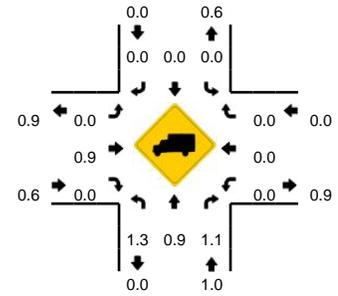
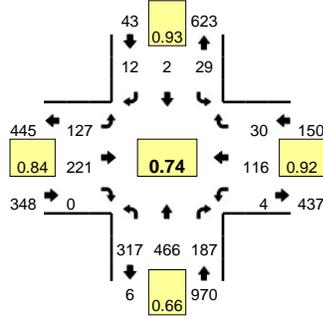
15-Min Count Period Beginning At	Lake Elmo Dr (Northbound)				Lake Elmo Dr (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	16	0	5	0	8	141	0	0	0	121	16	0	307	
4:15 PM	0	0	0	0	10	0	6	0	8	161	0	0	0	122	12	0	319	
4:30 PM	0	0	0	0	13	0	8	0	9	156	0	0	0	121	11	0	318	
4:45 PM	0	0	0	0	13	0	6	0	7	165	0	0	0	121	19	0	331	1275
5:00 PM	0	0	0	0	14	0	4	0	17	230	0	0	0	120	14	0	399	1367
5:15 PM	0	0	0	0	12	0	5	0	27	231	0	0	0	126	7	0	408	1456
5:30 PM	0	0	0	0	10	0	11	0	15	182	0	0	0	114	12	0	344	1482
5:45 PM	0	0	0	0	10	0	4	0	12	127	0	0	0	97	13	0	263	1414
6:00 PM	0	0	0	0	12	0	10	0	12	111	0	0	0	112	5	0	262	1277
6:15 PM	0	0	0	0	13	0	15	0	7	109	0	0	0	102	10	0	256	1125
6:30 PM	0	0	0	0	9	0	15	0	6	95	0	0	0	127	8	0	260	1041
6:45 PM	0	0	0	0	15	0	29	0	6	100	0	0	0	95	11	0	256	1034
7:00 PM	0	0	0	0	11	0	33	0	7	83	0	0	0	87	11	0	232	1004
7:15 PM	0	0	0	0	16	0	33	0	5	76	0	0	0	104	9	0	243	991
7:30 PM	0	0	0	0	5	0	39	0	3	61	0	0	0	78	18	0	204	935
7:45 PM	0	0	0	0	8	0	31	0	4	70	0	0	0	73	11	0	197	876
8:00 PM	0	0	0	0	9	0	10	0	6	70	0	0	0	56	4	0	155	799
8:15 PM	0	0	0	0	7	0	10	0	9	71	0	0	0	61	11	0	169	725
8:30 PM	0	0	0	0	11	0	6	0	0	62	0	0	0	57	4	0	140	661
8:45 PM	0	0	0	0	5	0	6	0	1	56	0	0	0	43	6	0	117	581
9:00 PM	0	0	0	0	5	0	2	0	1	49	0	0	0	43	5	0	105	531
9:15 PM	0	0	0	0	1	0	3	0	2	53	0	0	0	30	0	0	89	451
9:30 PM	0	0	0	0	2	0	4	0	4	48	0	0	0	41	5	0	104	415
9:45 PM	0	0	0	0	4	0	4	0	4	48	0	0	0	40	2	0	102	400
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	48	0	20	0	108	924	0	0	0	504	28	0	1632	
Heavy Trucks	0	0	0	0	0	0	0	0	4	20	0	0	0	12	0	0	36	
Pedestrians		20				0				0				0			20	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** Alkali Creek Rd -- Bench Blvd  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173227  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 10:00 PM -- 11:00 PM**  
**Peak 15-Min: 10:15 PM -- 10:30 PM**



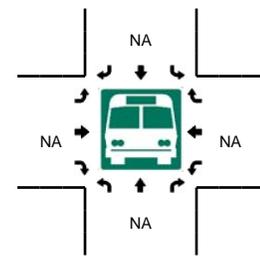
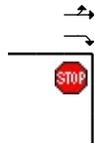
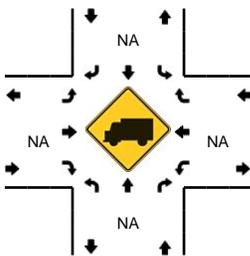
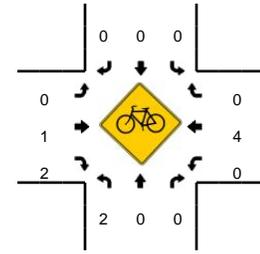
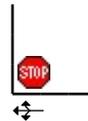
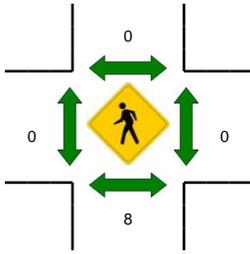
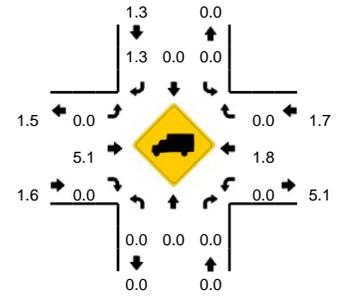
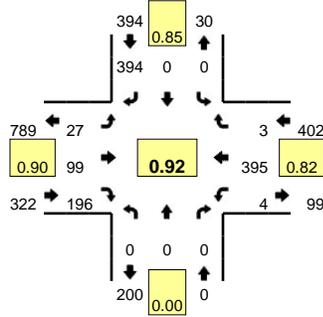
15-Min Count Period Beginning At	Alkali Creek Rd (Northbound)				Alkali Creek Rd (Southbound)				Bench Blvd (Eastbound)				Bench Blvd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 PM	0	0	0	0	17	5	8	0	6	110	0	0	6	110	9	0	271	1300
6:15 PM	1	1	0	0	11	13	17	0	4	100	1	0	13	91	12	0	264	1145
6:30 PM	0	1	1	0	11	17	13	0	7	87	0	0	15	113	12	0	277	1080
6:45 PM	3	5	1	0	17	31	12	0	2	89	1	0	30	82	9	0	282	1094
7:00 PM	0	4	0	0	29	52	13	0	5	59	1	0	37	76	7	0	283	1106
7:15 PM	2	3	1	0	14	69	13	0	4	68	1	0	56	75	11	0	317	1159
7:30 PM	2	1	1	0	14	71	11	0	6	47	12	0	48	56	8	0	277	1159
7:45 PM	2	0	1	0	18	42	12	0	4	54	7	0	33	68	8	0	249	1126
8:00 PM	0	1	2	0	10	17	8	0	3	64	1	0	8	50	10	0	174	1017
8:15 PM	0	0	0	0	10	4	8	0	1	71	0	0	5	54	11	0	164	864
8:30 PM	0	1	0	0	10	4	4	0	2	52	3	0	2	54	7	0	139	726
8:45 PM	3	0	0	0	7	4	2	0	1	54	0	0	2	41	6	0	120	597
9:00 PM	1	4	0	0	7	1	1	0	5	42	0	0	2	34	9	0	106	529
9:15 PM	5	3	0	0	12	2	2	0	2	45	1	0	1	27	5	0	105	470
9:30 PM	9	11	3	0	9	0	2	0	4	39	0	0	0	32	13	0	122	453
9:45 PM	16	6	5	0	9	0	1	0	0	38	1	0	0	36	7	0	119	452
10:00 PM	31	51	15	0	6	1	2	0	7	46	0	0	2	52	17	0	230	576
10:15 PM	113	167	75	0	10	0	7	0	39	64	0	0	1	27	5	0	508	979
10:30 PM	116	180	71	0	5	1	3	0	45	61	0	0	0	18	2	0	502	1359
10:45 PM	57	68	26	0	8	0	0	0	36	50	0	0	1	19	6	0	271	1511
11:00 PM	4	3	3	0	4	1	0	0	4	33	0	0	0	14	4	0	70	1351
11:15 PM	3	3	3	0	5	1	3	0	0	26	0	0	0	13	5	0	62	905
11:30 PM	3	1	0	0	4	0	0	0	2	20	0	0	0	14	2	0	46	449
11:45 PM	0	0	1	0	5	0	0	0	0	18	0	0	1	12	2	0	39	217
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	452	668	300	0	40	0	28	0	156	256	0	0	4	108	20	0	2032	
Heavy Trucks	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
Pedestrians		0			0					64				0			64	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

**LOCATION:** 6th Ave Bypass -- Aronson Ave  
**CITY/STATE:** Billings, MT

**QC JOB #:** 13173226  
**DATE:** Fri, Apr 17 2015

**Peak-Hour: 4:45 PM -- 5:45 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**



15-Min Count Period Beginning At	6th Ave Bypass (Northbound)				6th Ave Bypass (Southbound)				Aronson Ave (Eastbound)				Aronson Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	0	0	42	0	9	22	33	0	1	80	3	0	190	
4:15 PM	0	0	0	0	0	0	79	0	7	24	33	0	1	80	2	0	226	
4:30 PM	0	0	0	0	0	0	86	0	6	32	48	0	1	80	0	0	253	
4:45 PM	0	0	0	0	0	0	91	0	5	22	44	0	1	94	1	0	258	927
5:00 PM	0	0	0	0	0	0	102	0	6	21	47	0	1	122	0	0	299	1036
5:15 PM	0	0	0	0	0	0	116	0	11	27	50	0	1	99	1	0	305	1115
5:30 PM	0	0	0	0	0	0	85	0	5	29	55	0	1	80	1	0	256	1118
5:45 PM	0	0	0	0	0	0	65	0	4	25	38	0	1	78	0	0	211	1071
6:00 PM	0	0	0	0	0	0	70	0	8	32	33	0	2	74	1	0	220	992
6:15 PM	0	0	0	0	0	0	69	0	4	27	41	0	0	63	0	0	204	891
6:30 PM	0	0	0	0	0	0	50	0	3	21	31	0	0	38	0	0	143	778
6:45 PM	0	0	0	0	0	0	57	0	7	25	43	0	1	61	0	1	195	762
7:00 PM	0	0	0	0	0	0	20	0	11	20	30	0	0	44	0	1	126	668
7:15 PM	0	0	0	0	0	0	49	0	10	21	18	0	0	44	1	0	143	607
7:30 PM	0	0	0	0	0	0	36	0	7	27	21	0	2	43	1	0	137	601
7:45 PM	0	0	0	0	0	0	26	0	9	23	18	0	1	32	0	0	109	515
8:00 PM	0	0	0	0	0	0	43	0	6	14	21	0	0	43	0	0	127	516
8:15 PM	0	0	0	0	0	0	30	0	4	14	19	0	0	48	1	0	116	489
8:30 PM	0	0	0	0	0	0	38	0	2	18	22	0	1	34	0	0	115	467
8:45 PM	0	0	0	0	0	0	31	0	6	14	15	0	0	37	0	0	103	461
9:00 PM	0	0	0	0	0	0	29	0	2	11	13	0	0	46	0	0	101	435
9:15 PM	0	0	0	0	0	0	42	0	1	7	7	0	0	40	0	0	97	416
9:30 PM	0	0	0	0	0	0	21	0	0	7	9	0	0	52	0	0	89	390
9:45 PM	0	0	0	0	0	0	24	0	1	7	14	0	0	28	0	0	74	361
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	0	0	464	0	44	108	200	0	4	396	4	0	1220	
Heavy Trucks	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	
Pedestrians		4				0				0				0			4	
Bicycles	1	0	0		0	0	0		0	0	0		0	0	0		1	
Railroad																		
Stopped Buses																		

Comments:

## Attachment E Environmental Scan

Date: September 30, 2015

Project #: 18460

To: Wade Salyards, PE (Montana Department of Transportation)

From: Brett Korporaal, Jacqueline Gulczynski, and Andy Daleiden, PE

Project: Airport Rd/Main St – Billings, CM 1099(102), UPN 8718000

Subject: Environmental Scan

The purpose of this memorandum is to identify potential environmental constraints within the study area to inform the development and evaluation of alternatives during the concept phase, and for future insights as this project moves into final design. **This environmental scan is not meant to be used as or substituted for a comprehensive environmental investigation.** If improvement options are forwarded from this study into project development, an analysis for compliance with the National and Montana Environmental Policy Acts (NEPA and MEPA) will be completed as part of the Montana Department of Transportation (MDT) project development process. Information provided in this report may be forwarded into the NEPA/MEPA process at that time. Detailed findings of the environmental scan are documented in this memorandum, which includes the following:

- Introduction
- Land Use and Zoning
- Parks and Recreation Areas
- Cultural and historical Resources
- Socioeconomics and Environmental Justice
- Known/Suspected Hazardous Materials
- Air Quality
- Threatened/Endangered Species
- Soil and Geology
- Noise
- Wetlands
- Surface Water, Groundwater, and Floodplains
- Permits Required

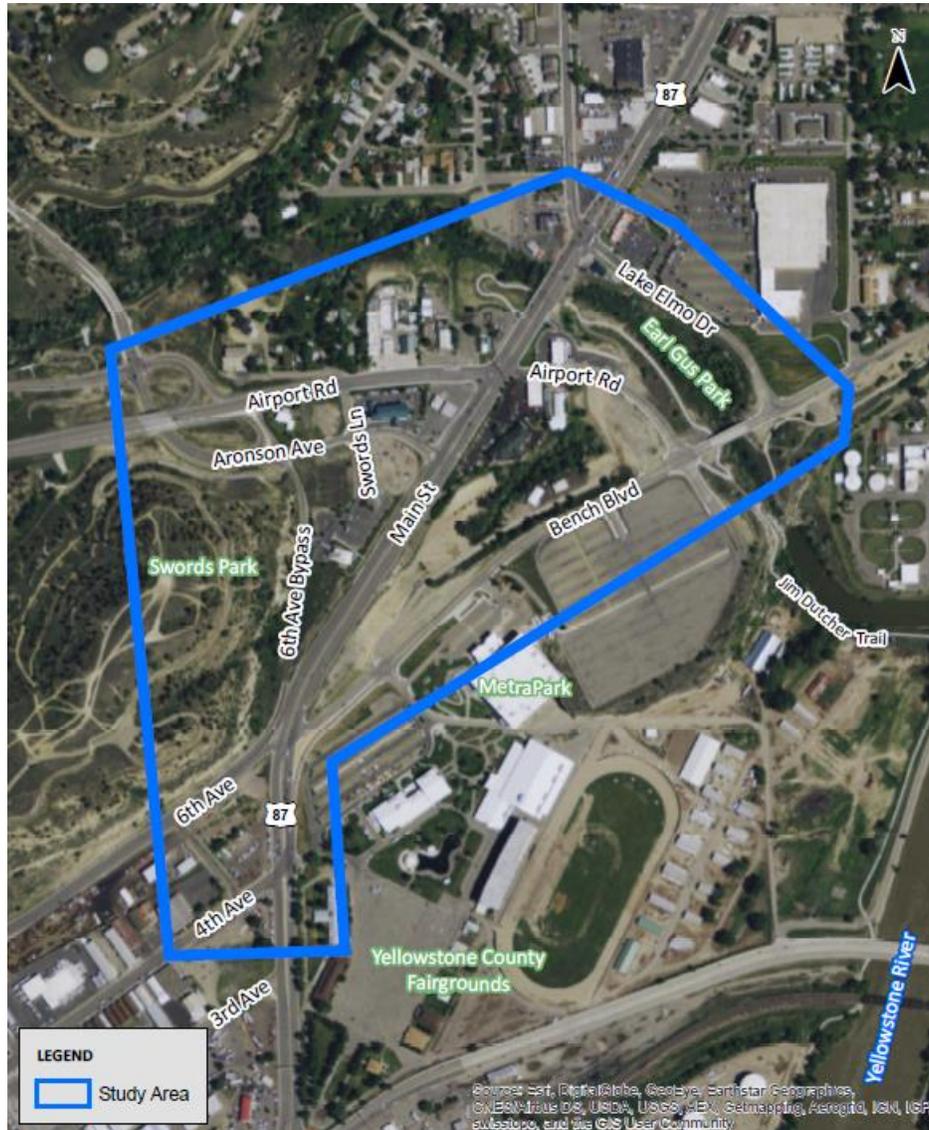
## Introduction

MDT has kicked off a transportation study for the Airport Road and Main Street intersection in Billings, MT. This study will investigate transportation alternatives to improve operations and safety for all users in the study area. This project consists of two phases. Phase 1 is the transportation study to identify the proposed project for design and construction, Phase 2 would include design and construction of the project.

The Airport Road and Main Street intersection is located 2 miles northeast of downtown Billings, just north of Rimrock Auto Arena at MetraPark. The intersection's location is a critical junction for freight

routes along Airport Road and Main Street corridors. The intersection is located on the Camino Real International Trade Corridor that connects Canada, United States, and Mexico. In addition to carrying high volumes of freight vehicles, Main Street and Airport Road serve as principal arterials that connect recreation, residential neighborhoods (Heights West and East), low density commercial, and light industrial land uses with downtown Billings and Interstate 90. Exhibit 1 highlights the study area.

### Exhibit 1. Study Area

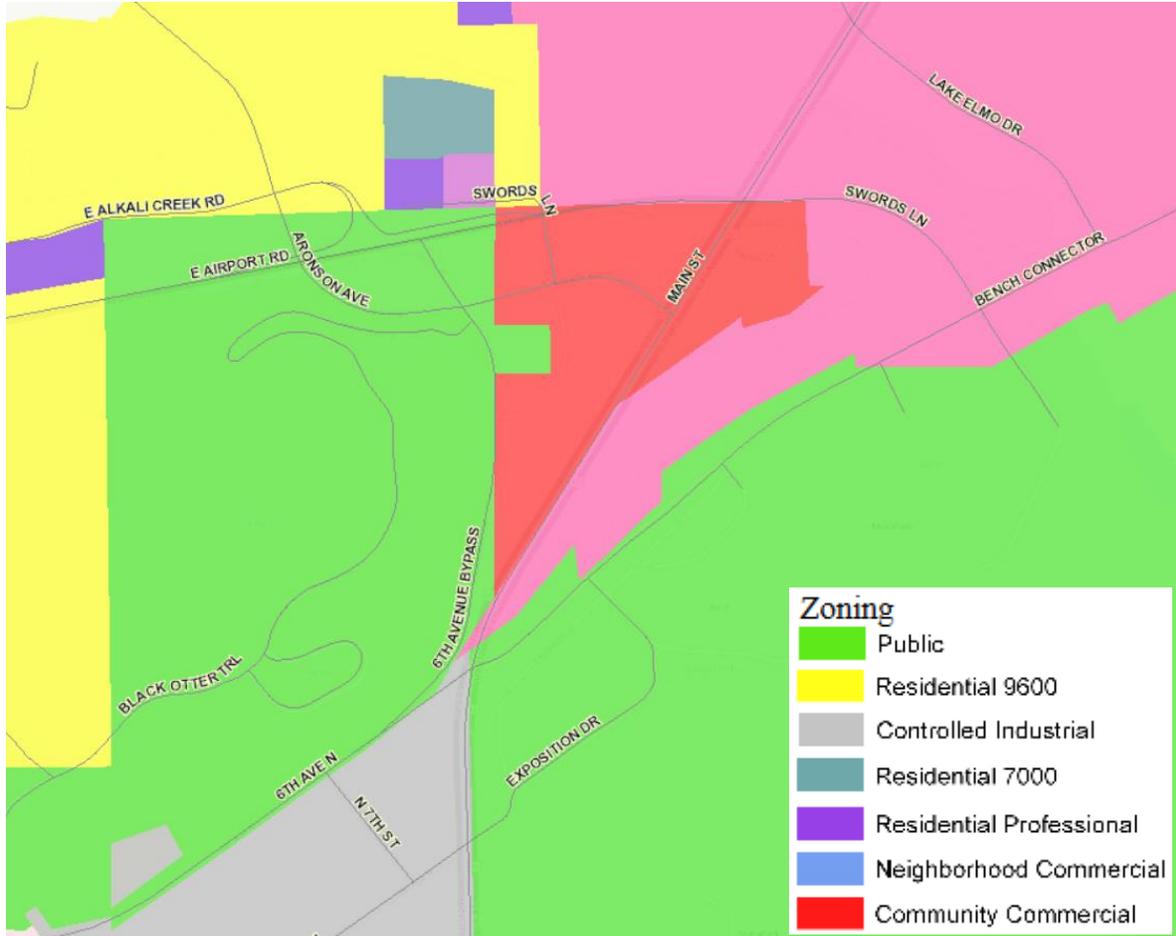


## Land Use and Zoning

The majority of the study area is located within the city limits of Billings, MT; however, MetraPark and the Yellowstone County Fairgrounds are both owned by the County. The existing zoning within the

study area is a mix of industrial, public, highway and community commercial, and residential. Exhibit 2 illustrates the existing zoning for the study area (Reference 1).

### Exhibit 2. Existing Land Use and Zoning



Source: Yellowstone County; <http://www.co.yellowstone.mt.gov/mapping/webgis.asp>, June 2015.

There are several restaurants, gas stations, and hotels near the intersection of Airport Road and Main Street. The southeast region of the study area is occupied by MetraPark and the Yellowstone County Fairgrounds. This entertainment and trade center facility hosts a wide variety of events (e.g. concerts, rodeos, sporting games, trade shows) throughout the year. The northern region of the study area is occupied by commercial and residential uses. The southwest region of the study area includes the Swords Rimrock Park, which has a mix of multiuse trails and points of interest.

## Parks and Recreation Areas

Exhibit 3 illustrates the location of parks and recreation areas in the study area.

Swords Park, owned by the City of Billings is a 60-acre natural area park located in the southwest region of the study area. The park provides trails for hiking and biking as well as views of downtown Billings and the Yellowstone River. The entrance to Swords Park is serviced by Aronson Avenue on the west side of the study area. Swords Park is a Section 4(f) property (Reference – Billings-Airport Road Environmental Assessment, MT (009); CN 4743, October 2005). For reference, Section 4(f) properties are publicly owned parks, recreation areas, or wildlife and waterfowl refuges of national, state, or local significance, and historic resources eligible for listing on the National Register of Historic Places or are locally significant.

### Exhibit 3. Existing Parks and Recreation Areas



Source: Google Maps (2015). [Airport Rd/Main St, Billings, Montana] [Street Map]. Retrieved from <https://www.google.com/maps/place/Billings,+Mt/@45.8012038,-108.4796361,1092m/data=!3m1!1e3!4m2!3m1!1s0x53486f8888fa9d97:0x373556d4f179b550!6m1!1e1>.

Earl Guss Park, owned by Yellowstone County, is located in the northeast region of the study area. The park provides open space in an urban setting. The Alkali Creek Trails traverses through the park providing another area for hiking and biking and viewing wildlife. Earl Guss Park is a Section 4(f) property (Reference – Bench Boulevard-Billings, MT 1036(1) Categorical Exclusion Concurrence Request, September 27, 2010.).

MetraPark, owned by Yellowstone County, is an entertainment and trade center hosting events throughout the year. It contains an arena, exhibition buildings, grandstand with entertainment and athletic facilities, and an extensive network of paved circulation roads, access roads, and parking areas. The building and parking lot are located in the southeast region of the study area. MetraPark is a Section 4(f) property (Reference – Bench Boulevard-Billings, MT 1036(1) Categorical Exclusion Concurrence Request, September 27, 2010.).

The National Land and Water Conservation Fund Act (LWCFA), or Section 6(f) was created to help protect and preserve outdoor recreational assets. “Section 6(f) of the Land and Water Conservation Act requires that the conversion of lands or facilities acquired with Land and Water Conservation Act funds be coordinated with the Department of Interior.” (Reference 2) According to the LWCFA, the study area does not contain land that receives funding from the Land and Water Conservation Act.

## Cultural and Historic Resources

Three historical sites are located in the study area and described in Table 1. *Attachment A includes the full list of historical sites in Billings, Montana.*

**Table 1. Historical Properties**

Property	Address	City	Listing Date	Smithsonian Number	National Register Reference Number	Site Type
<b>Black Otter Trail</b>	Black Otter Trail	Billings	1/5/2007	24YL1551	06001224	Trail/Road
<b>Boothill Cemetery</b>	North of Billings	Billings	4/17/1979	24YL0755	79001428	Cemetery
<b>Larry's Overlook</b>	SE Quadrant of Airport Rd/Main St Intersection	Billings	3/21/2003	24YL608	-	Rock Shelter and Pictographs

Source: National Register of Historic Places in Montana.

Two of the nationally registered historical properties are located within close proximity to the Airport Road/Main Street intersection. The Boothill Cemetery is located approximately two tenths of a mile southwest of the intersection, while Larry’s Overlook is located in the southeast quadrant of the intersection.

There are also two cultural buildings in the study area: Rainbow Dance School and MetraPark. Rainbow Dance School is located on Swords Lane, in an isolated location. MetraPark is an entertainment and trade center facility located on Main Street in the southeast region of the study area.

## Socioeconomics and Environmental Justice

Table 2, on the next page, shows data from the 2010 U.S. Census Bureau population, housing, income, and poverty data for the City of Billings, Yellowstone County, and State.

The population of Billings is 89,847 which accounts for approximately 70 percent of the County’s population. Billings has less housing units per person than Yellowstone County. This may indicate more single family homes in the city in comparison to the county. Both the median income and per capita income are fairly consistent throughout the state, county, and city. The poverty line for the City and County are lower than the State. *Attachment B includes the U.S. Census data.*

There are a small number of single family homes in the study area. Most of the homes appear to be on the northwest section of the study area.

**Table 2. Socioeconomic Characteristics for Montana, Yellowstone County, and City of Billings**

Area	Population	Housing Units	Median Household Income	Per Capita Income	Persons Below Poverty Line (%)
Montana	989,415	485,771	\$46,230	\$25,373	15.2
Yellowstone County	147,975	64,883	\$51,342	\$27,761	12.3
City of Billings	104,170	46,317	\$46,317	\$27,544	14.1

Source: U.S. Census Bureau, Washington D.C., 2010.

Table 3 provides the demographic data provided by the U.S. Census Bureau for Montana, Yellowstone County, and the City of Billings.

**Table 3. Demographic Data for Montana, Yellowstone County, and City of Billings**

Area	White	Black/ African American	American Indian & Alaskan Indian	Asian	Native Hawaiian or other Pacific Islander	Hispanic or Latino
Montana	89.5%	0.6%	6.5%	0.8%	0.1%	3.3%
Yellowstone County	91.5%	0.8%	4.3%	0.7%	0.1%	5.1%
City of Billings	89.6%	0.8%	4.4%	0.7%	0.1%	5.2%

Source: U.S. Census Bureau, Washington D.C., 2010.

## Known/Suspected Hazardous Materials

The Environmental Protection Agency (EPA) has created a map that is used to determine possible hazardous material locations throughout the country. There were five facilities within the study area that were identified by the EPA. Table 4 summarizes these facilities which are also detailed in Montana’s Department of Environmental Quality *Hazardous Waste Handlers Report*. Out of the five identified sites, only three remain active. *Attachment C includes detailed information on these potentially hazardous sites, documented in the Hazardous Waste Handlers Report.*

**Table 4. EPA Identified Potential Hazardous Materials**

Name	Address	Description	Status
Knife River Billings - Sword Park Trail	Top of Rimrock, Billing MT	ICIS-NPDES NON-MAJOR	Inactive
CMG Construction - Alkali Creek Multi Use Path	Main St along Alkali Creek, Billings, MT	ICIS-NPDES NON-MAJOR	Inactive
Rehbein Enterprises - Aronson Bypass Trail at Swords Park	Alkali Creek Rd & Aronson Ave, Billings, MT	ICIS-NPDES NON-MAJOR	Active
Conocophillips Co Glacier Dist Office	Hwy 87 E, Billings, MT	Petroleum Stations, Pipeline Transportation of Petroleum Products	Active
Pacific Recycling Billings	777 4 <sup>th</sup> Ave. Billings, MT	Recyclable Materials Wholesaler, Scrap and Waste Materials	Active

Source: Montana Department of Environmental Quality, Hazardous Waste Handlers Report, May 31, 2015.

The Montana Department of Environmental Quality (MDEQ) maintains a database of both active and closed Underground Storage Tanks (UST) and Leaking Underground Storage Tanks (LUST) across the state. The study area includes three (3) underground storage tank sites, which are located on the southwest corner of Airport Road and Main Street (236 Main St. Billings, MT). All of the tanks are active and referenced by facility ID 5608904. The tanks were last inspected on February 27, 2015.

There are hazardous waste handlers identified within the study area. According to the location indicated in the MDEQ database, the sites are Conocophillips Co Glacier District Office and Pacific Recycling Billings. Both locations are located in the southern area of the study area. Pacific Recycling Billings is located on 4<sup>th</sup> Street and Conocophillips is located on the corner of 4<sup>th</sup> Street and Main Street.

## Air Quality

The EPA establishes regulatory requirements and various ambient air quality standards. Between the years 1978-2002 Billings was classified as a nonattainment area for Carbon Monoxide (CO) by the EPA (Reference 3). Nonattainment areas are those that have air quality worse than the National Ambient

Air Quality Standards (NAAQS). According to the Billings Urban Area Long Range Transportation Plan (LRTP), the City of Billings is currently listed as a “limited maintenance plan” attainment area for CO, and is therefore meeting the NAAQS standards for CO. However, the City of Billings is classified as a nonattainment area for Sulfur Dioxide (SO<sub>2</sub>) according to the 2010 Sulfur Dioxide Standards created by the EPA (Reference 4). While the City has been actively working to lift the nonattainment and referencing the consistent decrease in SO<sub>2</sub> levels, the EPA has not complied. The city claims the high levels of SO<sub>2</sub> are because of there are 7 main industrial sources of SO<sub>2</sub> in the county. The nonattainment requires the city to have stricter control. If federal funds are used for design and/or construction, an air quality screening analysis and documentation process may be required to address air quality for the proposed project.

Construction of the proposed alternatives may cause short-term impacts to air quality in the study area. Dust created from demolition, clearing and grubbing, cut-and-fill operations, and road construction can all cause PM<sub>10</sub> emissions. Heavy duty diesel engines used during construction can cause Fine Particulate Matter (PM<sub>2.5</sub>), CO, and Greenhouse Gas emissions.

## Threatened/Endangered Species

The U.S. Fish & Wildlife Service (USFWS) has identified the species listed in Table 5 as endangered, threatened, protected, and candidate species of plants and wildlife in Yellowstone County.

**Table 5. Threatened and Endangered Species in Yellowstone County**

Species (Scientific Name)	Status
Black-footed Ferret ( <i>Mustela nigripes</i> )	Listed Endangered
Whooping Crane ( <i>Grus americana</i> )	Listed Endangered
Red Knot ( <i>Calidris canutus rufa</i> )	Listed Threatened
Greater Sage-Grouse ( <i>Centrocercus urophasianus</i> )	Candidate
Sprague’s Pipit ( <i>Anthus spragueii</i> )	Candidate

Source: United States Department of the Interior – Fish and Wildlife Services, Endangered Species Act, April 2015.

## Soil and Geology

A soils report from the U.S. Geological Survey Web Soil Survey database shown in Exhibit 4 reveals the soil types in the project area. There are a large variety of soils and none are classified as Prime or Unique Farmland within the project area. Prime Farmland is defined by the Department of Agriculture as “land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas” (Reference 5). Attachment D includes a list of the soil types within the study area.



## Wetlands

The study area includes multiple natural water sources. Alkali Creek flows through Earl Gus Park and into the Yellowstone River. Exhibit 5 illustrates the creek and wetlands areas within the study area.

**Exhibit 5. Natural Heritage Map Viewer of Wetlands within the Study Area**



Source: Montana Natural Heritage Program, <http://mtnhp.org/mapviewer/?t=8>.

## Surface Water, Groundwater, and Floodplains

Exhibit 6 illustrates that several small ponds are located throughout the study area; however, the only classified surface water in the area is Alkali Creek.

**Exhibit 6. Floodplain for Study Area**



Source: Yellowstone County; <http://www.co.yellowstone.mt.gov/mapping/webgis.asp>, June 2015.

Billings is positioned on the alluvial valley of the Yellowstone River. The river flows just east of the project area. The alluvial deposits are generally the source of groundwater for the city. Most of the wells in the city range from 10 to 20 feet deep. Since the project area is in close proximity to the river, the water table is high. Groundwater recharge for alluvial valley comes from precipitation, irrigation, and irrigation from canal leakage (Reference 8).

The Federal Emergency Management Agency (FEMA) released the Executive Order 11988: Floodplain Management in 1977. It requires “federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.” The order requires agencies to avoid building in floodplains unless absolutely necessary. The floodplain for the study area is illustrated in Exhibit 6. *Attachment E contains the full Executive Order 11988: Floodplain Management.*

## Permits Required

This project is currently in the study phase. Therefore, no permits are required at this time. However, future construction of the selected alternative is likely to require several permits, including a floodplain permit for Yellowstone County, Clean Water Act 404 permit from the USACE, and Air Quality and Hazardous Material permits from the MDEQ. The final permit list will be based on the type of project, project timing, source of funding, and other items that might require additional permitting.

If you have any questions, please contact Andy Daleiden via email at [adaleiden@kittelson.com](mailto:adaleiden@kittelson.com) or by phone at 208.338.2683.

## References

1. "Yellowstone County WebGIS." Montana GIS Department, 2009-2014. Web. <<http://www.co.yellowstone.mt.gov/mapping/webgis.asp>>.
2. "Land and Water Conservation Fund." 69 (2008): n. pag. National Park Service. PDF.
3. "Primary National Ambient Air Quality." (2011): n. pag. Environmental Protection Agency, 22 June 2010. PDF.
4. "Summary Nonattainment Area Population Exposure Report | Green Book | US EPA." *Green Book*. Environmental Protection Agency, 30 Jan. 2015. Web. <<http://www.epa.gov/airquality/greenbook/popexp.html>>.
5. "Prime Farmlands." Natural Resources Conservation Services, n.d. Web. <[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/full/pr/soils/cid/nrcs141p2\\_037285](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/full/pr/soils/cid/nrcs141p2_037285)>.
6. "Recent Earthquake Near Billings, Montana, United States." *Earthquakes in Billings, Montana, United States*. U.S. Geological Survey, n.d. Web. <<http://earthquaketrack.com/us-mt-billings/recent>>.
7. Montana Department of Transportation. *Traffic Noise Analysis and Abatement Policy*. Helena: Environmental Service Bureau, 27 Apr. 2011. PDF.
8. Mulder, Rick, and Christian Schmidt. "Groundwater, Surface Water, and Sediment Monitoring for Pesticides and Nitrate in Billings, Montana." (n.d.): n. pag. Montana Department of Agriculture, Apr. 2011. Web.

Attachment A City of Billings' Historical Sites

<b>Property Name</b>	<b>Address</b>	<b>City</b>	<b>Listing Date</b>	<b>Smithsonian Number</b>	<b>NR reference number</b>	<b>Property Type</b>	<b>Associated Multiple Properties Document</b>
<b>Acme Building</b>	109-111 N Broadway	Billings	11/9/2005	24YL1620	05001279	Building	
<b>Armour Cold Storage</b>	1 S Broadway	Billings	7/7/2004	24YL1583	04000670	Building	
<b>Babcock Theatre Building</b>	2nd Ave North and Broadway	Billings	4/9/2013	24YL1880	13000153	Building	
<b>Billings Chamber of Commerce</b>	303 N 27th St	Billings	1/20/1972	24YL0259	72000739	Building	
<b>Billings Historic District</b>	Roughly bounded by N. 23rd and N. 25th Sts. 1st and Montana Aves.	Billings	3/13/1979	24YL0752	09001427	District	
<b>Billings Old Town Historic District</b>	Generally bounded by Montana Ave on the N; S 26th on the E; 1st Ave S on the S; and S 30th St on the W	Billings	9/16/2010	24YL1856	10000753	District	
<b>Billings Townsite Historic District (Boundary Increase)</b>	2600(2528),2604-2606,2608,2610-2614, and 2624 Montana Ave.	Billings	4/21/2006	24YL0752	06000333	District	
<b>Billings West Side School</b>	415 Broadwater Ave	Billings	3/20/2002	24YL0196	02000214	Building	
<b>Black Otter Trail</b>	Black Otter Trail	Billings	1/5/2007	24YL1580	06001224	District	
<b>Boothill Cemetery</b>	N of Billings	Billings	4/17/1979	24YL0755	79001428	District	

<b>Dude Rancher Lodge</b>	415 N. 29th St.	Billings	7/22/2010	24YL1732	10000489	Building	
<b>Electric Building</b>	113-115 Broadway	Billings	3/1/2002	24YL1539	02000105	Building	
<b>Fire House No 2</b>	201 E. 30th St	Billings	2/29/1980	24YL0261	80002436	Building	
<b>Garfield School</b>	3212 1st Ave. South	Billings	10/3/2012	24YL1612	12000830	Building	
<b>Hoskins Basin Archeological District</b>	Address Restricted	Billings	11/20/1974	24YL1031	47001100	District	
<b>L&amp;L Building</b>	2624 Minnesota Ave.	Billings	12/19/2008	24YL0699	08001227	Building	
<b>Masonic Temple</b>	2806 Third Ave N	Billings	4/17/1986	24YL0260	86000847	Building	
<b>Moss, Preston B., House</b>	Address Restricted	Billings	4/30/1982	24YL0263	82003181	Building	
<b>North, Austin, House</b>	622 N 29th St.	Billings	11/23/1977	24YL0258	77000822	Building	
<b>Northern Hotel</b>	19 North Broadway	Billings	6/12/2103	24YL1849	13000369	Building	
<b>O'Donnell, D., House</b>	105 Clark Ave	Billings	11/23/1977	24YL0265	77000823	Building	
<b>Oliver Building</b>	2702 Montana Ave.	Billings	12/19/2008	24YL0700	08001228	Building	
<b>Parmly Billings Memorial Library</b>	2822 Montana Ave	Billings	10/26/1972	24YL0075	72000740	Building	
<b>Pictograph Cave</b>	7 mi SE of Billings in Indian Caves Park	Billings	10/15/1966	24YL0001	66000439	District	NHL
<b>Prescott Commons</b>	Rimrock Rd	Billings	4/30/1982	24YL0264	82003182	Building	
<b>Ruth, Harold and Marion, Residence</b>	111 Emerald Drive	Billings	6/21/07	24YL1630	07000578	Building	

<b>US Post Office and Courthouse</b>	2602 First Ave N.	Billings	3/14/1986	24YL0754	86000678	Building	US Post Offices in Montana 1900—1941
<b>Yegen, Christian, House</b>	208 S 35th St.	Billings	10/1/1979	24YL0262	79003779	Building	
<b>Yegen, Peter, House</b>	209 S 35th St.	Billings	4/16/1980	24YL0266	80002437	Building	

# MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM

Form No. 1

## Locational Information

---

**1.1 Smithsonian Number:** 24YL608      **1.2 Field Designation:** Larry's Overlook      **1.3 County:** Yellowstone

**1.4 Township/Range/Section:** T1N, R26E, Section 27, SW ¼ SW ¼ NW ¼ SE ¼

**1.5 UTM Coordinates:** Zone 12, 696151mE, 5075043mN

**1.6 Property Type/Types:** Rock shelter and pictographs.

**1.7 Recording Status:** Mapped, photographed (2003). Reportedly tested (1972).

**1.8 Administrative Surface Ownership:** Unknown

**1.9 Mineral Ownership:**

**1.10 Project Name:** 6<sup>th</sup> Ave – Bench Boulevard

**1.11 General Narrative Description of Property:**

The site consists of a shallow sandstone overhang along a cliff face along the north bank of Alkali Creek approximately 1/3 mile upstream from its confluence with the Yellowstone River. The site reportedly contains two pictographs and a petroglyph (Loendorf 1972). These have faded over the past thirty years, now visible only as red stains on the cliff wall. The course of Alkali Creek has shifted closer to the rock shelter, the floor of which now is quite marshy.

**1.12 Map Reference:** Billings East, Montana 7.5' Quad Map

**1.13 City, Town:** Billings, Montana

**1.14 Narrative of Access:** From the northeast end of the Metra parking lot drop into coulee north of Metra and proceed west along north edge. County shops are located on the south of the creek. The site is located along sandstone cliffs north of the creek, below a hotel. The fence line from the original site map is no longer extant, but a fence post at the site remains.

# MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM

Form No. 2

## Environmental Setting

---

- 2.1 Geographic Setting:** Sandstone rimrock **Site No.:** 24YL407
- 2.2 Elevation:** 3188 ft above sea level
- 2.3 View Aspect:** southwest
- 2.4 Major River Drainage:** Yellowstone River
- 2.5 Minor Drainage:** Alkali Creek
- 2.6 Available Water Sources:** Yellowstone River
- 2.7 Vegetation-Regional:** Needle-and-thread grass, blue grama grass, western wheatgrass, broom snakeweed, sagebrush, yucca, juniper, cottonwood.
- 2.8 Vegetation-Local:** grasses, sedges, willows, and weeds.
- 2.9 Sediments Deposition:** Loam and sandy loam at the base of the rimrock, which is composed of Cretaceous Eagle Sandstone
- 2.10 Surface Visibility/Season of Survey:** 10% / Spring
- 2.11 Other Factors Pertaining to Site:**

**MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM**

**Form No. 3 Assessment, Recording Management Documentation**

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**3.1 Condition/Integrity** **Site No.:** 24YL608

Pictographs are in poor condition

**3.2 Evaluation: Does this property meet National Register criteria for eligibility?**

Yes [ ]                      No [ ]

**3.3 Evaluation Procedure/Justification:**

Unknown. The site has reportedly received archaeological testing, but there is no documentation regarding the results. It appears unlikely that the site is eligible.

**3.4 Recommendations:**

**3.5 Site Located By:** **Date:**

**3.6 Site Recorded By:** **Date:**

**3.7 Site Form Update and Revision By:** Patrick Walker-Kuntz **Date:** 3/21/2003

**3.8 Federal or State Permit No.:**

**3.9 Publication(s)/Report Where Site is Described:**

Walker-Kuntz, Patrick  
2003 *Sixth Ave North to Bench Boulevard Cultural Resource Inventory Report*. Field Research Services for Morrison-Maierle, Inc. Billings, Montana.

**3.10 Artifact Repository:**

**3.11 Field Notes/Maps/Photo Repository:**

**3.12 Photo and Accession Numbers:**

**\*\*\*\*\*FOR SHPO USE ONLY\*\*\*\*\***

**Management Data:** **Formal Determination of Eligibility:**  
\_\_\_\_ Undetermined **Date:** \_\_\_\_\_  
\_\_\_\_ Formally determined ineligible for NRHP **Date:** \_\_\_\_\_  
\_\_\_\_ Formal consensus determination, eligible for NRHP **Date:** \_\_\_\_\_  
\_\_\_\_ Listed on NRHP **Date:** \_\_\_\_\_

**Updated Management Information:** \_\_\_\_\_ **Date:** \_\_\_\_\_

# MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM

Form No. 4

Prehistoric Site Description

Site No.: 24YL608

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## 4.1 Site Dimensions:

\_\_\_\_\_ Estimated \_\_\_\_\_ Measured

---

## 4.2 Feature Descriptions:

See 1.11

Amateur archaeologists from Billings initially discovered site 24YL608 in 1970. This small rock shelter and pictograph site was revisited in 1972 by Dr. Larry Loendorf, then at the University of North Dakota (Loendorf 1972). The site was subsequently tested by the UND crew, but no report was produced (Sharrock 1974). The site boundaries of the site were apparently extended by Heidenreich in 1977, resulting in a designation of 24YL608a (the original site) and 24YL608b (Heidenreich 1978). Heidenreich test excavated 24YL608b, but the results and recommendations were somewhat contentious (Heidenreich 1990). This portion of the site no longer exists due to commercial development.

---

## 4.3 Artifact Descriptions/Collections:

Unknown

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4.4 **Subsurface Testing:** Loendorf 1972. Heidenriech 1978

---

## 4.5 Cultural/Temporal Classification:

Assessment based on:

---

## 4.6 Site Function/Interpretation:

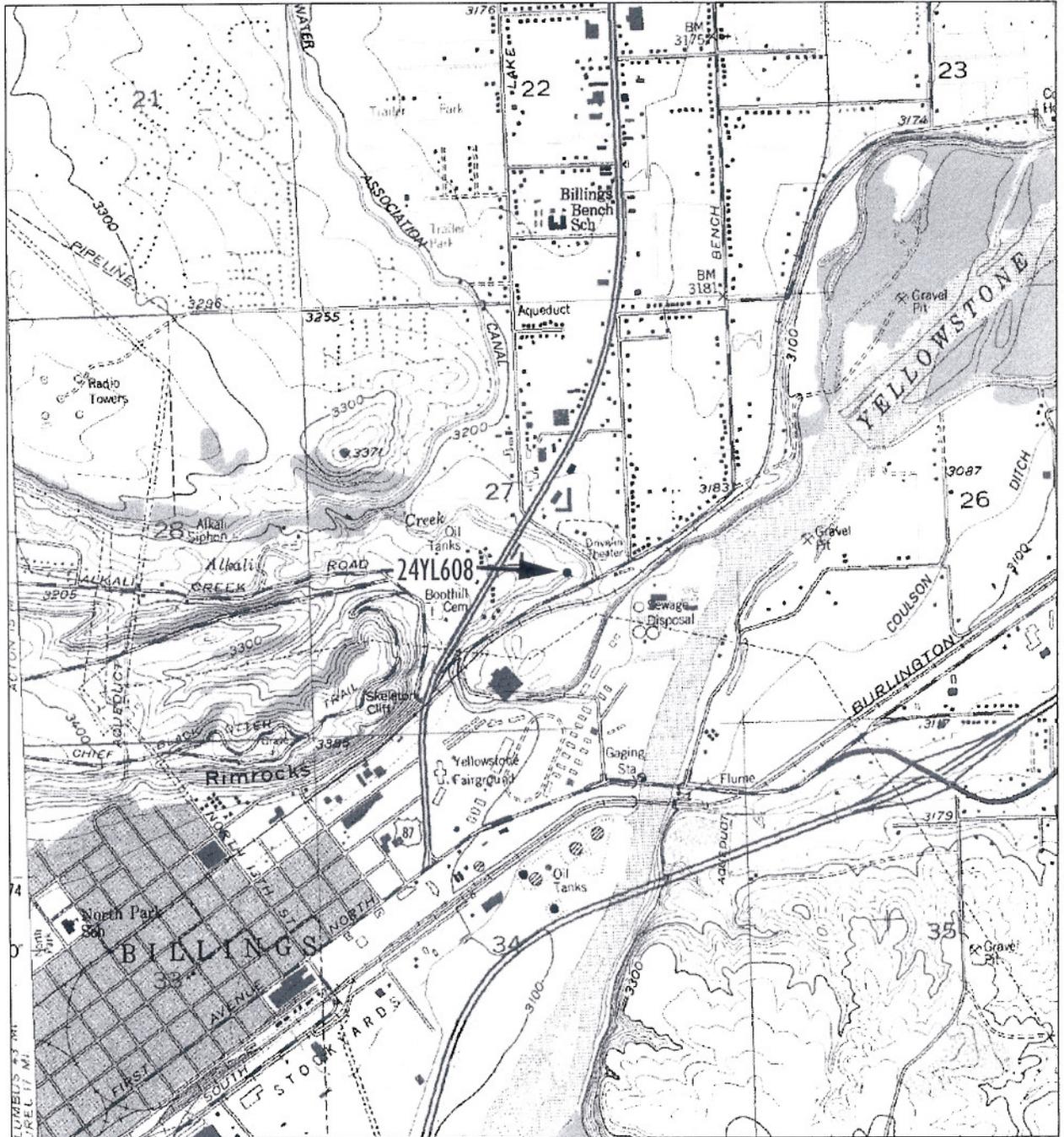
Form No. 6

Topographic Map

Site No.: 24YL608

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# MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM

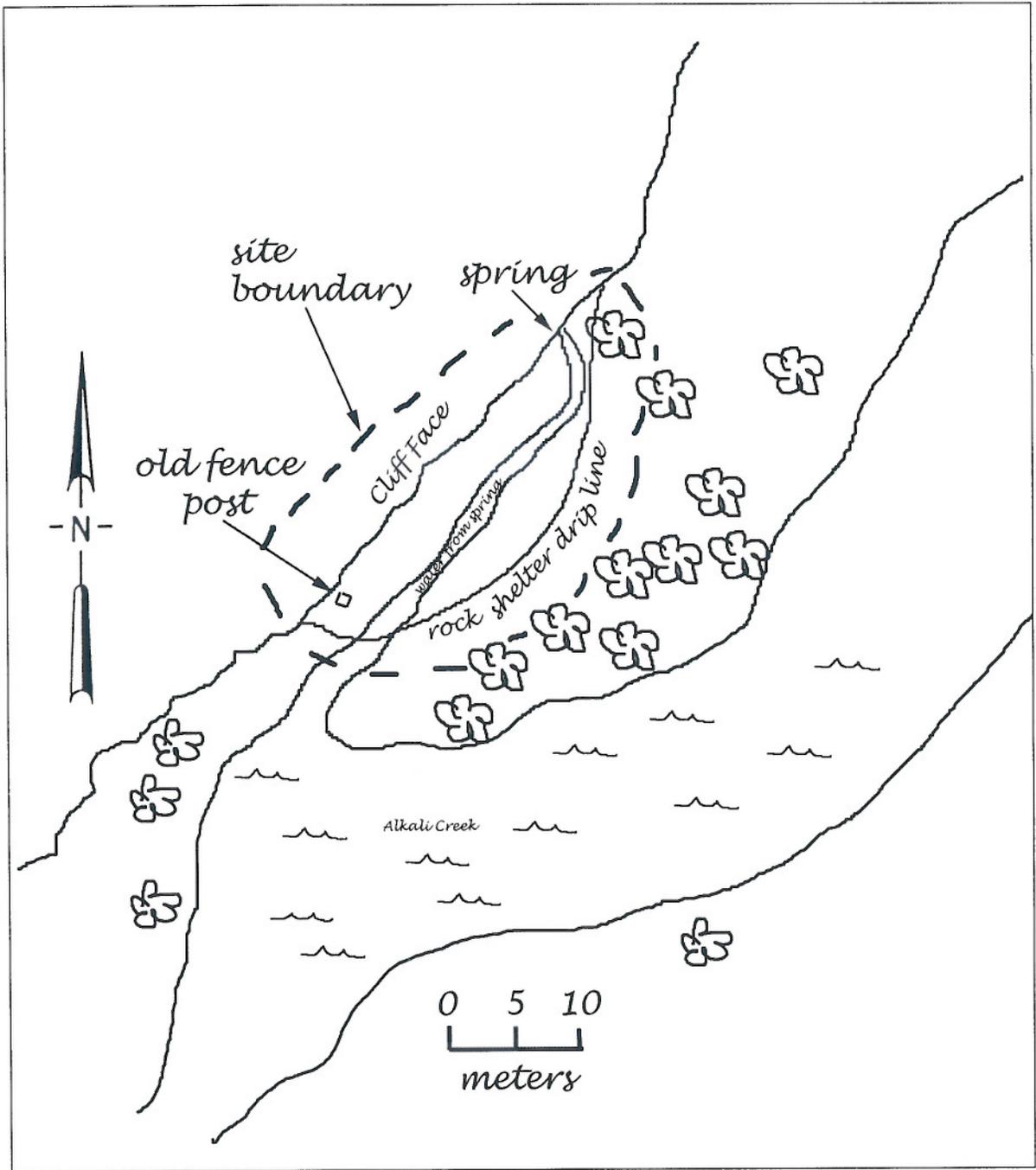


MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM

Form No. 7

Site Sketch Map

Site No.: 24YL608



Legend

Map Drawn By PWK

Scale

Date 3/21/2003

**MONTANA CULTURAL RESOURCES INFORMATION SYSTEM FORM**

**SITE OVERVIEW**



**View to the west**



**View to the east**

MAIN STREET



24YL608

HOTEL

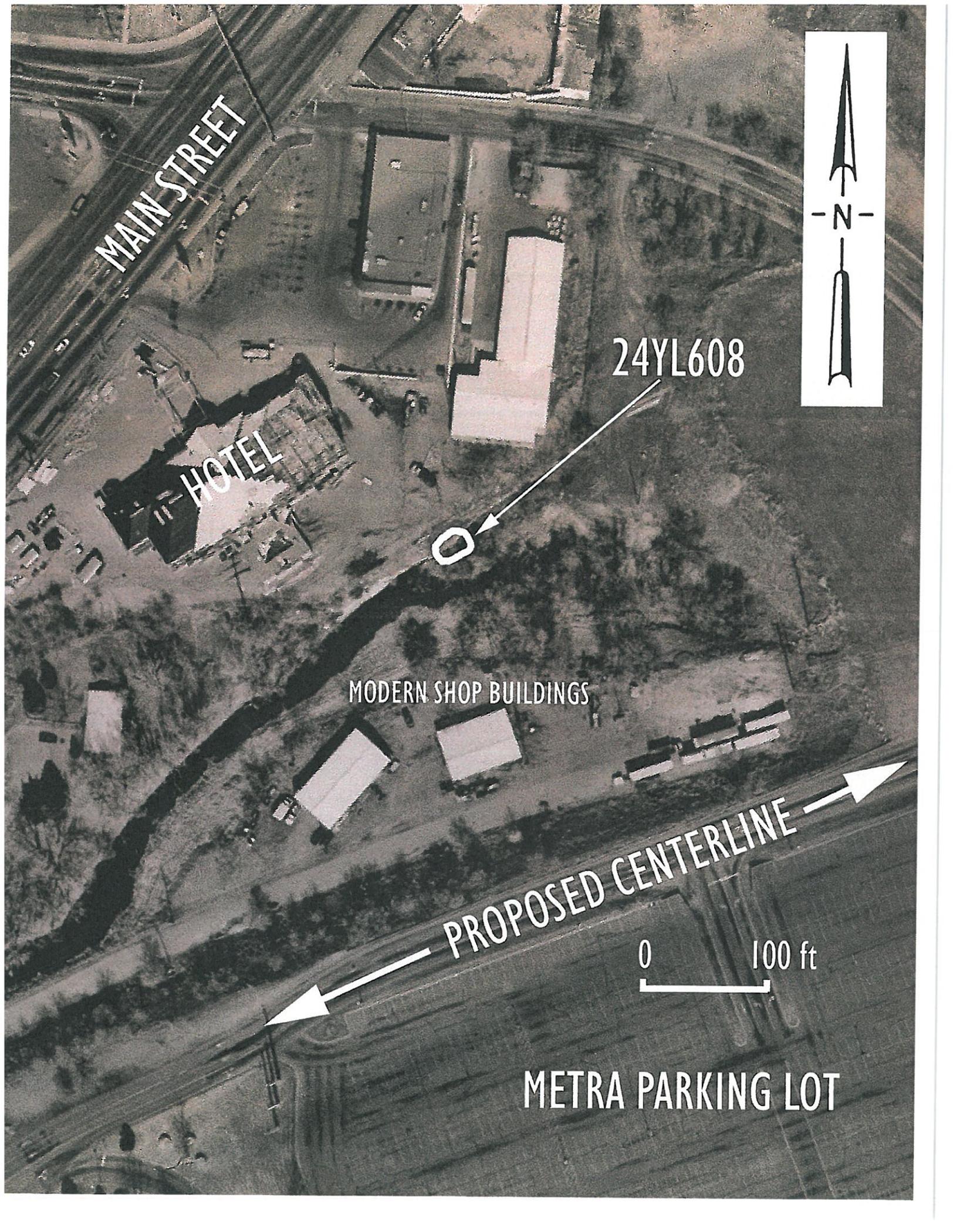


MODERN SHOP BUILDINGS

PROPOSED CENTERLINE

0 100 ft

METRA PARKING LOT



Attachment B U.S. Census Bureau Data 2010

## Montana

Want more? [Browse data sets for Montana](#)

People QuickFacts	Montana	USA
<i>i</i> Population, 2014 estimate	1,023,579	318,857,056
<i>i</i> Population, 2013 estimate	1,014,864	316,497,531
<i>i</i> Population, 2010 (April 1) estimates base	989,417	308,758,105
<i>i</i> Population, percent change - April 1, 2010 to July 1, 2014	3.5%	3.3%
<i>i</i> Population, percent change - April 1, 2010 to July 1, 2013	2.6%	2.5%
<i>i</i> Population, 2010	989,415	308,745,538
<i>i</i> Persons under 5 years, percent, 2013	6.0%	6.3%
<i>i</i> Persons under 18 years, percent, 2013	22.1%	23.3%
<i>i</i> Persons 65 years and over, percent, 2013	16.2%	14.1%
<i>i</i> Female persons, percent, 2013	49.8%	50.8%
<hr/>		
<i>i</i> White alone, percent, 2013 (a)	89.5%	77.7%
<i>i</i> Black or African American alone, percent, 2013 (a)	0.6%	13.2%
<i>i</i> American Indian and Alaska Native alone, percent, 2013 (a)	6.5%	1.2%
<i>i</i> Asian alone, percent, 2013 (a)	0.8%	5.3%
<i>i</i> Native Hawaiian and Other Pacific Islander alone, percent, 2013 (a)	0.1%	0.2%
<i>i</i> Two or More Races, percent, 2013	2.5%	2.4%
<i>i</i> Hispanic or Latino, percent, 2013 (b)	3.3%	17.1%
<i>i</i> White alone, not Hispanic or Latino, percent, 2013	87.0%	62.6%
<hr/>		
<i>i</i> Living in same house 1 year & over, percent, 2009-2013	83.6%	84.9%
<i>i</i> Foreign born persons, percent, 2009-2013	2.0%	12.9%
<i>i</i> Language other than English spoken at home, pct age 5+, 2009-2013	4.4%	20.7%
<i>i</i> High school graduate or higher, percent of persons age 25+, 2009-2013	92.1%	86.0%
<i>i</i> Bachelor's degree or higher, percent of persons age 25+, 2009-2013	28.7%	28.8%
<i>i</i> Veterans, 2009-2013	94,404	21,263,779
<i>i</i> Mean travel time to work (minutes), workers age 16+, 2009-2013	18.0	25.5
<i>i</i> Housing units, 2013	485,771	132,802,859
<i>i</i> Homeownership rate, 2009-2013	68.3%	64.9%

<i>i</i> Housing units in multi-unit structures, percent, 2009-2013	16.8%	26.0%
<i>i</i> Median value of owner-occupied housing units, 2009-2013	\$184,200	\$176,700
<i>i</i> Households, 2009-2013	405,525	115,610,216
<i>i</i> Persons per household, 2009-2013	2.39	2.63
<i>i</i> Per capita money income in past 12 months (2013 dollars), 2009-2013	\$25,373	\$28,155
<i>i</i> Median household income, 2009-2013	\$46,230	\$53,046
<i>i</i> Persons below poverty level, percent, 2009-2013	15.2%	15.4%
<b>Business QuickFacts</b>	<b>Montana</b>	<b>USA</b>
<i>i</i> Private nonfarm establishments, 2013	36,529 <sup>1</sup>	7,488,353
<i>i</i> Private nonfarm employment, 2013	350,196 <sup>1</sup>	118,266,253
<i>i</i> Private nonfarm employment, percent change, 2012-2013	1.8% <sup>1</sup>	2.0%
<i>i</i> Nonemployer establishments, 2012	84,767	22,735,915
<i>i</i> Total number of firms, 2007	114,398	27,092,908
<i>i</i> Black-owned firms, percent, 2007	0.2%	7.1%
<i>i</i> American Indian- and Alaska Native-owned firms, percent, 2007	2.0%	0.9%
<i>i</i> Asian-owned firms, percent, 2007	0.6%	5.7%
<i>i</i> Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	S	0.1%
<i>i</i> Hispanic-owned firms, percent, 2007	1.0%	8.3%
<i>i</i> Women-owned firms, percent, 2007	24.6%	28.8%
<i>i</i> Manufacturers shipments, 2007 (\$1000)	10,638,145	5,319,456,312
<i>i</i> Merchant wholesaler sales, 2007 (\$1000)	8,202,782	4,174,286,516
<i>i</i> Retail sales, 2007 (\$1000)	14,686,854	3,917,663,456
<i>i</i> Retail sales per capita, 2007	\$15,343	\$12,990
<i>i</i> Accommodation and food services sales, 2007 (\$1000)	2,079,426	613,795,732
<i>i</i> Building permits, 2013	4,854	990,822
<b>Geography QuickFacts</b>	<b>Montana</b>	<b>USA</b>
<i>i</i> Land area in square miles, 2010	145,545.80	3,531,905.43
<i>i</i> Persons per square mile, 2010	6.8	87.4
<i>i</i> FIPS Code	30	

## Yellowstone County, Montana

Want more? [Browse data sets for Yellowstone County](#)

People QuickFacts	Yellowstone County	Montana
<i>i</i> Population, 2014 estimate	155,634	1,023,579
<i>i</i> Population, 2013 estimate	154,060	1,014,864
<i>i</i> Population, 2010 (April 1) estimates base	147,975	989,417
<i>i</i> Population, percent change - April 1, 2010 to July 1, 2014	5.2%	3.5%
<i>i</i> Population, percent change - April 1, 2010 to July 1, 2013	4.1%	2.6%
<i>i</i> Population, 2010	147,972	989,415
<i>i</i> Persons under 5 years, percent, 2013	6.5%	6.0%
<i>i</i> Persons under 18 years, percent, 2013	23.6%	22.1%
<i>i</i> Persons 65 years and over, percent, 2013	15.0%	16.2%
<i>i</i> Female persons, percent, 2013	51.0%	49.8%
<hr/>		
<i>i</i> White alone, percent, 2013 (a)	91.5%	89.5%
<i>i</i> Black or African American alone, percent, 2013 (a)	0.8%	0.6%
<i>i</i> American Indian and Alaska Native alone, percent, 2013 (a)	4.3%	6.5%
<i>i</i> Asian alone, percent, 2013 (a)	0.7%	0.8%
<i>i</i> Native Hawaiian and Other Pacific Islander alone, percent, 2013 (a)	0.1%	0.1%
<i>i</i> Two or More Races, percent, 2013	2.7%	2.5%
<i>i</i> Hispanic or Latino, percent, 2013 (b)	5.1%	3.3%
<i>i</i> White alone, not Hispanic or Latino, percent, 2013	87.4%	87.0%
<hr/>		
<i>i</i> Living in same house 1 year & over, percent, 2009-2013	82.7%	83.6%
<i>i</i> Foreign born persons, percent, 2009-2013	1.7%	2.0%
<i>i</i> Language other than English spoken at home, pct age 5+, 2009-2013	4.0%	4.4%
<i>i</i> High school graduate or higher, percent of persons age 25+, 2009-2013	92.3%	92.1%
<i>i</i> Bachelor's degree or higher, percent of persons age 25+, 2009-2013	28.7%	28.7%
<i>i</i> Veterans, 2009-2013	13,513	94,404
<i>i</i> Mean travel time to work (minutes), workers age 16+, 2009-2013	19.0	18.0
<i>i</i> Housing units, 2013	64,883	485,771

i Homeownership rate, 2009-2013	68.8%	68.3%
i Housing units in multi-unit structures, percent, 2009-2013	19.9%	16.8%
i Median value of owner-occupied housing units, 2009-2013	\$181,500	\$184,200
i Households, 2009-2013	61,023	405,525
i Persons per household, 2009-2013	2.40	2.39
i Per capita money income in past 12 months (2013 dollars), 2009-2013	\$27,761	\$25,373
i Median household income, 2009-2013	\$51,342	\$46,230
i Persons below poverty level, percent, 2009-2013	12.3%	15.2%

<b>Business QuickFacts</b>	<b>Yellowstone County</b>	<b>Montana</b>
i Private nonfarm establishments, 2013	5,521	36,529 <sup>1</sup>
i Private nonfarm employment, 2013	68,676	350,196 <sup>1</sup>
i Private nonfarm employment, percent change, 2012-2013	3.1%	1.8% <sup>1</sup>
i Nonemployer establishments, 2012	11,195	84,767

i Total number of firms, 2007	15,726	114,398
i Black-owned firms, percent, 2007	0.4%	0.2%
i American Indian- and Alaska Native-owned firms, percent, 2007	2.0%	2.0%
i Asian-owned firms, percent, 2007	0.8%	0.6%
i Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	F	S
i Hispanic-owned firms, percent, 2007	S	1.0%
i Women-owned firms, percent, 2007	25.0%	24.6%

i Manufacturers shipments, 2007 (\$1000)	5,739,955	10,638,145
i Merchant wholesaler sales, 2007 (\$1000)	2,772,504	8,202,782
i Retail sales, 2007 (\$1000)	2,840,723	14,686,854
i Retail sales per capita, 2007	\$20,284	\$15,343
i Accommodation and food services sales, 2007 (\$1000)	361,729	2,079,426
i Building permits, 2013	2,097	4,854

<b>Geography QuickFacts</b>	<b>Yellowstone County</b>	<b>Montana</b>
i Land area in square miles, 2010	2,633.29	145,545.80
i Persons per square mile, 2010	56.2	6.8
i FIPS Code	111	30
i Metropolitan or Micropolitan Statistical Area	Billings, MT Metro Area	

## Billings (city), Montana

Want more? [Browse data sets for Billings \(city\)](#)

People QuickFacts	Billings	Montana
<i>i</i> Population, 2013 estimate	109,059	1,014,864
<i>i</i> Population, 2010 (April 1) estimates base	104,190	989,417
<i>i</i> Population, percent change - April 1, 2010 to July 1, 2013	4.7%	2.6%
<i>i</i> Population, 2010	104,170	989,415
<i>i</i> Persons under 5 years, percent, 2010	7.0%	6.3%
<i>i</i> Persons under 18 years, percent, 2010	22.6%	22.6%
<i>i</i> Persons 65 years and over, percent, 2010	15.0%	14.8%
<i>i</i> Female persons, percent, 2010	51.7%	49.8%
<hr/>		
<i>i</i> White alone, percent, 2010 (a)	89.6%	89.4%
<i>i</i> Black or African American alone, percent, 2010 (a)	0.8%	0.4%
<i>i</i> American Indian and Alaska Native alone, percent, 2010 (a)	4.4%	6.3%
<i>i</i> Asian alone, percent, 2010 (a)	0.7%	0.6%
<i>i</i> Native Hawaiian and Other Pacific Islander alone, percent, 2010 (a)	0.1%	0.1%
<i>i</i> Two or More Races, percent, 2010	2.9%	2.5%
<i>i</i> Hispanic or Latino, percent, 2010 (b)	5.2%	2.9%
<i>i</i> White alone, not Hispanic or Latino, percent, 2010	86.9%	87.8%
<hr/>		
<i>i</i> Living in same house 1 year & over, percent, 2009-2013	80.0%	83.6%
<i>i</i> Foreign born persons, percent, 2009-2013	1.8%	2.0%
<i>i</i> Language other than English spoken at home, pct age 5+, 2009-2013	4.4%	4.4%
<i>i</i> High school graduate or higher, percent of persons age 25+, 2009-2013	92.7%	92.1%
<i>i</i> Bachelor's degree or higher, percent of persons age 25+, 2009-2013	30.5%	28.7%
<i>i</i> Veterans, 2009-2013	9,530	94,404
<i>i</i> Mean travel time to work (minutes), workers age 16+, 2009-2013	17.3	18.0
<i>i</i> Housing units, 2010	46,317	482,825
<i>i</i> Homeownership rate, 2009-2013	63.3%	68.3%
<i>i</i> Housing units in multi-unit structures, percent, 2009-2013	25.8%	16.8%
<i>i</i> Median value of owner-occupied housing units,	\$180,900	\$184,200

2009-2013

<b>i</b> Households, 2009-2013	44,134	405,525
<b>i</b> Persons per household, 2009-2013	2.33	2.39
<b>i</b> Per capita money income in past 12 months (2013 dollars), 2009-2013	\$27,544	\$25,373
<b>i</b> Median household income, 2009-2013	\$48,908	\$46,230
<b>i</b> Persons below poverty level, percent, 2009-2013	14.1%	15.2%

<b>Business QuickFacts</b>	<b>Billings</b>	<b>Montana</b>
<b>i</b> Total number of firms, 2007	11,697	114,398
<b>i</b> Black-owned firms, percent, 2007	0.5%	0.2%
<b>i</b> American Indian- and Alaska Native-owned firms, percent, 2007	1.7%	2.0%
<b>i</b> Asian-owned firms, percent, 2007	1.0%	0.6%
<b>i</b> Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	F	S
<b>i</b> Hispanic-owned firms, percent, 2007	S	1.0%
<b>i</b> Women-owned firms, percent, 2007	26.7%	24.6%

<b>i</b> Manufacturers shipments, 2007 (\$1000)	D 10,638,145	
<b>i</b> Merchant wholesaler sales, 2007 (\$1000)	2,225,969	8,202,782
<b>i</b> Retail sales, 2007 (\$1000)	2,406,272	14,686,854
<b>i</b> Retail sales per capita, 2007	\$23,638	\$15,343
<b>i</b> Accommodation and food services sales, 2007 (\$1000)	335,832	2,079,426

<b>Geography QuickFacts</b>	<b>Billings</b>	<b>Montana</b>
<b>i</b> Land area in square miles, 2010	43.41	145,545.80
<b>i</b> Persons per square mile, 2010	2,399.5	6.8
<b>i</b> FIPS Code	06550	30
Counties	<a href="#">Yellowstone County</a>	

## Attachment C Potentially Hazardous Sites

# Hazardous Waste Handlers Report

**EPA ID Number:** MT0000000356

**Facility Name:** PACIFIC RECYCLING BILLINGS

**Report Last Updated:** 05/31/2015

## I. Owner and/or Operator Information

<b>Owner(s):</b>	PACIFIC RECYCLING BILLINGS
	MONTANA RAIL LINK INC
<b>Operator(s):</b>	PACIFIC RECYCLING BILLINGS
	MONTANA RAIL LINK INC

## II. Facility Location

<b>Address:</b>	777 4TH AVE N, BILLINGS 59101	<b>Latitude:</b>	45.7968
<b>County:</b>	YELLOWSTONE	<b>Longitude:</b>	-108.4837

## III. Other Business Information

NAICS Code	Description
42393	Recyclable Material Merchant Wholesalers

### Other Business Names Used at this Location as noted in DEQ CEDARS database

PACIFIC RECYCLING BILLINGS

## IV. Hazardous Waste Generation

<b>Current Status</b>	Active
<b>Generator Classification</b>	Large Quantity Generator
<b>Last Reporting Year</b>	1996
<b>Hazardous Waste Amount Generated in Last Reporting Year (Tons)</b>	984
<b>Hazardous Waste Code</b>	<b>Waste Description</b>

## V. Hazardous Waste Permit Or Equivalent

**Has a Hazardous Waste Permit or equivalent Enforcement Order been issued to this facility**

NO

## VI. Report Explanation

Data for each report is taken from the hazardous waste handler section of DEQ's CEDARS database. This dataset contains information provided by the handlers during registration and annual waste generation reporting. This data is maintained and updated by the Hazardous Waste Section of the Waste and Underground Tank Management Bureau of DEQ's Permitting and Compliance Division and should only be used for planning purposes. More detailed, hardcopy information and reports are available from the Hazardous Waste Section and may be viewed or obtained during regular business hours. Data found in these reports is updated the first of every month.

### Facility Information

- *EPA ID Number* - A unique code assigned to each generator, transporter, and treatment, storage, or disposal facility to facilitate identification and tracking of chemicals or hazardous waste.
- *Facility Name* - The current name of the business.

### Owner and/or Operator Information

- *Owner* - Current facility owner or owners.
- *Operator* - Current facility operator or operators.

### Facility Location

- Address, county, and geographic location of the facility.

### Other Business Information

- *North American Industry Classification System (NAICS)* - The industry type as defined in the NAICS classification system for manufacturing establishments.
- *Other Business Names Used at this Location* - former businesses located at this facility address which reported hazardous waste generation activities to DEQ.

### Hazardous Waste Generation Activities

- *Status*
  - Active - handler is generating hazardous waste at the facility
  - Inactive - handler is not currently generating hazardous waste at the facility
  - Closed - handler is out of business and no longer generating hazardous waste
- *Generator Classification*
  - Small Quantity - generates between 220 pounds and 2,200 pounds (100 kg and 1,000 kg) of non-acute hazardous waste or no more than 2.2 pounds (1 kg) of acute hazardous waste in a given month

- Large Quantity - generates more than 2,200 pounds (1,000 kg) of non-acute hazardous waste or more than 2.2 pounds (1 kg) of acute hazardous waste in a given month
- Conditionally Exempt Small Quantity - generates less than 220 pounds (100 kg) of non-acute hazardous waste or no more than 2.2 pounds of acute hazardous waste in a given month.
- Non-Generators - facilities that did not handle or generate hazardous waste during the latest reporting year, are closing, or going to an inactive status
- *Last Reporting Year* - the latest year in which the handler submitted an annual hazardous waste generation report.
- *Hazardous Waste Amount Generated in Last Reporting Year (Tons)* - the amount, in tons, of hazardous waste the handler generated at this facility during the last reporting year.
- *Hazardous Waste Types Generated in Last Reporting Year* - hazardous waste types are derived from hazardous waste codes and descriptions in 40 CFR 261 Subpart B Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste.

#### Hazardous Waste Permit or Equivalent

- Yes - the site is required to have a hazardous waste permit or other enforcement mechanism to operate or maintain post-closure care of a hazardous waste management unit and conduct facility-wide corrective action.
- No - the site does not require a hazardous waste permit or other enforcement mechanism.

\*\*For more information, please contact the Montana DEQ Hazardous Waste Section at 406-444-5300

# Hazardous Waste Handlers Report

EPA ID Number: MTD081128589

Facility Name: CONOCOPHILLIPS CO GLACIER DIST OFFICE

Report Last Updated: 05/31/2015

[New Search](#) [View Data in Map](#)

## I. Owner and/or Operator Information

**Owner(s):** PHILLIPS 66 PIPELINE LLC  
PHILLIPS 66 COMPANY

**Operator(s):** PHILLIPS 66 PIPELINE LLC  
PHILLIPS 66 COMPANY

## II. Facility Location

**Address:** 338 HWY 87 E, BILLINGS 59101 **Latitude:** 45.7971

**County:** YELLOWSTONE **Longitude:** -108.481

## III. Other Business Information

NAICS Code	Description
42271	Petroleum Bulk Stations and Terminals

### Other Business Names Used at this Location as noted in DEQ CEDARS database

CONOCO PIPELINE CO BILLINGS  
CONOCO PIPELINE GLACIER OFFICE BILLINGS  
CONOCOPHILLIPS CO GLACIER DIST OFFICE  
PHILLIPS 66 PIPELINE LLC BILLINGS STATION  
PHILLIPS 66 PIPELINE LLC YELLOWSTONE SEMINOE PUMP STATION

## IV. Hazardous Waste Generation

**Current Status** Active

**Generator Classification** Large Quantity Generator

**Last Reporting Year** 2012

**Hazardous Waste Amount Generated in Last Reporting Year (Tons)** 14.74

<b>Hazardous Waste Code</b>	<b>Waste Description</b>
D008	LEAD

## V. Hazardous Waste Permit Or Equivalent

**Has a Hazardous Waste Permit or equivalent Enforcement Order been issued to this facility**

NO

## VI. Report Explanation

Data for each report is taken from the hazardous waste handler section of DEQ's CEDARS database. This dataset contains information provided by the handlers during registration and annual waste generation reporting. This data is maintained and updated by the Hazardous Waste Section of the Waste and Underground Tank Management Bureau of DEQ's Permitting and Compliance Division and should only be used for planning purposes. More detailed, hardcopy information and reports are available from the Hazardous Waste Section and may be viewed or obtained during regular business hours. Data found in these reports is updated the first of every month.

### Facility Information

- *EPA ID Number* - A unique code assigned to each generator, transporter, and treatment, storage, or disposal facility to facilitate identification and tracking of chemicals or hazardous waste.
- *Facility Name* - The current name of the business.

### Owner and/or Operator Information

- *Owner* - Current facility owner or owners.
- *Operator* - Current facility operator or operators.

### Facility Location

- Address, county, and geographic location of the facility.

### Other Business Information

- *North American Industry Classification System (NAICS)* - The industry type as defined in the NAICS classification system for manufacturing establishments.
- *Other Business Names Used at this Location* - former businesses located at this facility address which reported hazardous waste generation activities to DEQ.

### Hazardous Waste Generation Activities

- *Status*
  - Active - handler is generating hazardous waste at the facility
  - Inactive - handler is not currently generating hazardous waste at the facility
  - Closed - handler is out of business and no longer generating hazardous waste

- *Generator Classification*
  - Small Quantity - generates between 220 pounds and 2,200 pounds (100 kg and 1,000 kg) of non-acute hazardous waste or no more than 2.2 pounds (1 kg) of acute hazardous waste in a given month
  - Large Quantity - generates more than 2,200 pounds (1,000 kg) of non-acute hazardous waste or more than 2.2 pounds (1 kg) of acute hazardous waste in a given month
  - Conditionally Exempt Small Quantity - generates less than 220 pounds (100 kg) of non-acute hazardous waste or no more than 2.2 pounds of acute hazardous waste in a given month.
  - Non-Generators - facilities that did not handle or generate hazardous waste during the latest reporting year, are closing, or going to an inactive status
- *Last Reporting Year* - the latest year in which the handler submitted an annual hazardous waste generation report.
- *Hazardous Waste Amount Generated in Last Reporting Year (Tons)* - the amount, in tons, of hazardous waste the handler generated at this facility during the last reporting year.
- *Hazardous Waste Types Generated in Last Reporting Year* - hazardous waste types are derived from hazardous waste codes and descriptions in 40 CFR 261 Subpart B Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste.

#### Hazardous Waste Permit or Equivalent

- Yes - the site is required to have a hazardous waste permit or other enforcement mechanism to operate or maintain post-closure care of a hazardous waste management unit and conduct facility-wide corrective action.
- No - the site does not require a hazardous waste permit or other enforcement mechanism.

\*\*For more information, please contact the Montana DEQ Hazardous Waste Section at 406-444-5300

## CMG CONSTRUCTION - ALKALI CREEK ROAD MAINTENANCE AND SLOPE RECONST CERCLIS SITE

**EPA Identifier:**

110041936091

**CERCLIS ID:** 110041936091**Location:**

45.806751251221, -  
108.50701141357

**Address:**

E ALKALI CREEK RD  
BILLINGS, MT

**Create Date:** 31-AUG-10**Update Date:** 07-FEB-13**SIC Codes:** 1611, 1794**SIC Descriptions:**

EXCAVATION WORK, HIGHWAY AND STREET CONSTRUCTION, EXCEPT ELEVATED HIGHWAYS

**Programs:** {NPDES}**Program Interests:**

ICIS-NPDES NON-MAJOR

## SWORDS PARK PATH PROJECT CERCLIS SITE

**EPA Identifier:**

110024877640

**CERCLIS ID:** 110024877640

**Location:**

45.801944, -108.531944

**Address:**

T1N R26E S30 SE

BILLINGS, MT

**Create Date:** 23-JUN-06

**Update Date:** 07-FEB-13

**SIC Codes:** 1611

**SIC Descriptions:**

HIGHWAY AND STREET CONSTRUCTION, EXCEPT ELEVATED HIGHWAYS

**Programs:** {NPDES,PCS}

**Program Interests:**

ICIS-NPDES NON-MAJOR, NPDES NON-

## Attachment D Study Area Soil Types

Soil Types within the Study Area

Map Unit Symbol	Map Unit Name
285F	Blacksheep, dry Cabbart, dry-Rock outcrop complex, 8 to 60 percent slopes
Mo	McRae loam, 4 to 7 percent slopes
Mn	McRae loam, 0 to 1 percent slopes
UL	Urban land
Ld	Lambert soils, 7 to 35 percent slopes
Hm	Haverson and Lohmiller soils, channeled, 0 to 35 percent slopes
Hs	Hilly, gravelly land
GP	Gravel pit
Hd	Haverson silty clay loam, 0 to 1 percent slopes

Source: United States Department of Agriculture



Attachment E Executive Order 11988:  
Floodplain Management

**Plan, Prepare & Mitigate**

Before, During & After a Disaster

**Disaster Survivor Assistance**

Apply for Assistance, Disaster Declarations

**Response & Recovery**

Tools, Teams, Individual & Public Assistance

**Topics & Audiences**

Grants, How to Help, Private Sector, Tribal

**Blog, Newsroom, Videos & Photos**

News Releases, Social Media, FEMA App

**About FEMA**

Offices, Careers, Employee Info, Policies, FAQs

## Executive Order 11988: Floodplain Management

This page is about Executive Order 11988: Floodplain Management.

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

### Description and Intent

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities" for the following actions:

- acquiring, managing, and disposing of federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements;
- conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

### Summary of Requirements

The guidelines address an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps, which are summarized below, reflect the decision-making process required in Section 2(a) of the Order.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).
2. Conduct early public review, including public notice.
3. Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside of the floodplain.
4. Identify impacts of the proposed action.

5. If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.
6. Reevaluate alternatives.
7. Present the findings and a public explanation.
8. Implement the action.

Among a number of things, the Interagency Task Force on Floodplain Management clarified the EO with respect to development in flood plains, emphasizing the requirement for agencies to select alternative sites for projects outside the flood plains, if practicable, and to develop measures to mitigate unavoidable impacts.

Attachment F Montana Access Guideline  
Figure

Category	Cross Section	Area	Signal Spacing Bandwidth	Median Opening Spacing <sup>1</sup>	Minimum <sup>2</sup> Unsignalized Access Spacing	Denial of Direct Access When Other Available
Metric						
NHS	Undivided	Rural - Very Low Volume	N/A	N/A	N/A <sup>3</sup>	no <sup>3</sup>
		Rural	800 m - 45%	N/A	200 m	yes <sup>4</sup>
		Intermediate	800 m - 45%	N/A	200 m	yes <sup>4</sup>
	Divided	Developed	400 m - 40%	N/A	75m/90 m <sup>5</sup> - 100 m/115 m <sup>5</sup>	yes <sup>4</sup>
		Intermediate	800 m - 45%	800 m F - 400 m D	165 m	yes <sup>4</sup>
		Developed	400 m - 40%	400 m F - 200 m D	75 m	yes <sup>4</sup>
Primary	Undivided	Rural - Very Low Volume	N/A	N/A	N/A <sup>2</sup>	no
		Rural	800 m - 45%	N/A	200 m	yes <sup>4</sup>
		Intermediate	800 m - 45%	N/A	130 m, 165 m, 200 m <sup>6</sup>	yes <sup>4</sup>
	Divided	Developed	800 m - 45%	N/A	75m/90 m <sup>5</sup> - 100 m/115 m <sup>5</sup>	no
		Intermediate	800 m - 45%	800 m F - 400 m D	105 m, 130 m, 165 <sup>7</sup>	yes <sup>4</sup>
		Developed	400 m - 35%	400 m F - 200 m D	45 m	no
<b>US Customary</b>						
NHS	Undivided	Rural - Very Low Volume	N/A	N/A	N/A <sup>3</sup>	no <sup>3</sup>
		Rural	½ mile - 45%	N/A	660 ft	yes <sup>4</sup>
		Intermediate	½ mile - 45%	N/A	660 ft	yes <sup>4</sup>
	Divided	Developed	¼ mile - 40%	N/A	250 ft/300 ft <sup>5</sup> - 325 ft/375 ft <sup>5</sup>	yes <sup>4</sup>
		Intermediate	½ mile - 45%	½ mile F - ¼ mile D	550 ft	yes <sup>4</sup>
		Developed	¼ mile - 40%	¼ mile F - ¼ mile D	250 ft	yes <sup>4</sup>
Primary	Undivided	Rural - Very Low Volume	N/A	N/A	N/A <sup>2</sup>	no
		Rural	½ mile - 45%	N/A	660 ft	yes <sup>4</sup>
		Intermediate	½ mile - 45%	N/A	440 ft, 550 ft, 660 ft <sup>6</sup>	yes <sup>4</sup>
	Divided	Developed	½ mile - 45%	N/A	250 ft/300 ft <sup>5</sup> - 325 ft/375 ft <sup>5</sup>	no
		Intermediate	½ mile - 45%	½ mile F - ¼ mile D	350 ft, 440 ft, 550 ft <sup>7</sup>	yes <sup>4</sup>
		Developed	¼ mile - 35%	¼ mile F - ¼ mile D	150 ft	no

- 1) N/A = Not Applicable, F = Full Movement, D = Directional Only
- 2) Stricter criteria could apply if supported by other jurisdictions and Tribal governments.
- 3) Considerations other than unsignalized access spacing should govern (e.g., sight distance).
- 4) If alternative access is unavailable, one direct approach may be allowed. For major traffic generators, more than one driveway may be allowed if it is proven to MDT's satisfaction that there will be a significant benefit to the highway network. This will require submission of a traffic impact study by the applicant.
- 5) Two-lane/multi-lane undivided with or without TWLTL, 75 m/ 90 m (250 ft/300 ft) applies to posted speeds of 35 mph or lower, 100 m/115 m (325 ft/375 ft) applies to posted speeds greater than 35 mph but less than 45 mph.
- 6) The 130 m (440 ft) value applies to a 45 mph posted speed, 165 m (550 ft) applies to a 50 mph posted speed, and 200 m (660 ft) applies to a 55 mph or above posted speed.
- 7) The 105 m (350 ft) value applies to a 45 mph posted speed, 130 m (440 ft) applies to a 50 mph posted speed, and 165 m (550 ft) applies to a 55 mph or above posted speed.

**Recommended Montana Access Guidelines  
Figure 8-2A**

Attachment G Travel Demand Model Output  
and Analysis Worksheets

### AM PEAK HOUR POST PROCESSED VOLUMES

ID	Intersection	Year	Intersection Leg							
			North		South		West		East	
			In	Out	In	Out	In	Out	In	Out
1	Lake Elmo Drive/Main Street	2010 Model	1818	929	1057	2102	165	299	14	5
		2015 Count	1796	857	1023	2306	514	179	68	59
		2035 Model	2334	1208	1358	2689	207	360	8	5
		2040 Volume	2312	1136	1324	2893	556	240	62	59
2	Lake Elmo Drive/Bench Boulevard	2010 Model	9	7	0	0	160	342	351	167
		2015 Count	34	39	0	0	200	795	801	201
		2035 Model	10	4	0	0	306	647	654	311
		2040 Volume	34	36	0	0	346	1100	1104	345
3	Alkali Creek Road/Airport Road	2010 Model	189	76	0	0	283	573	587	284
		2015 Count	342	41	0	0	478	810	509	478
		2035 Model	391	178	0	0	451	706	949	410
		2040 Volume	544	142	0	0	645	943	871	604
4	6th Avenue Bypass/Airport Road	2010 Model	0	0	68	185	283	573	587	284
		2015 Count	0	0	26	154	478	509	509	350
		2035 Model	0	0	2	364	451	706	949	410
		2040 Volume	0	0	68	333	645	642	871	476
5	Swords Lane/Airport Road	2010 Model	0	0	0	0	284	587	597	289
		2015 Count	7	28	41	7	348	507	495	349
		2035 Model	0	0	15	1	410	949	953	427
		2040 Volume	7	28	56	8	474	869	851	487
6	Airport Road/Main Street	2010 Model	2119	1049	980	1930	289	597	0	0
		2015 Count	2350	997	759	1995	336	503	75	22
		2035 Model	2689	1358	1400	2645	427	953	68	48
		2040 Volume	2920	1306	1179	2710	474	859	143	70
7	Alkali Creek Road/Bench Blvd	2010 Model	0	0	0	0	171	320	351	167
		2015 Count	30	60	2	0	181	741	788	200
		2035 Model	107	30	0	0	258	579	647	306
		2040 Volume	137	90	2	0	268	1000	1084	339
8	6th Avenue Bypass/Aronson Ave	2010 Model	289	161	0	359	0	174	0	0
		2015 Count	154	26	0	760	943	254	107	164
		2035 Model	364	2	0	545	158	154	177	77
		2040 Volume	229	161	0	945	1101	234	283	240
9	Swords Lane/Aronson Avenue	2010 Model	0	0	0	0	0	0	0	0
		2015 Count	7	42	2	8	161	109	146	157
		2035 Model	1	15	1	50	77	177	168	82
		2040 Volume	8	57	3	58	237	285	314	239
10	Aronson Avenue/Main Street	2010 Model	1930	980	963	1964	0	0	0	0
		2015 Count	1966	812	936	2118	158	131	3	2
		2035 Model	2645	1400	1483	2809	82	168	0	0
		2040 Volume	2681	1232	1456	2963	240	299	3	2
11	6th Avenue/Main Street	2010 Model	1964	963	1297	1203	0	1384	342	160
		2015 Count	2106	887	1270	1672	0	1394	759	182
		2035 Model	2809	1483	1817	2150	0	1391	579	258
		2040 Volume	2951	1407	1790	2619	0	1400	996	280
12	4th Avenue/Main Street	2010 Model	1203	1297	663	1221	643	0	0	0
		2015 Count	1688	1345	923	1794	537	0	0	9
		2035 Model	2150	1817	1107	2185	727	0	0	0
		2040 Volume	2635	1865	1367	2758	622	0	0	9

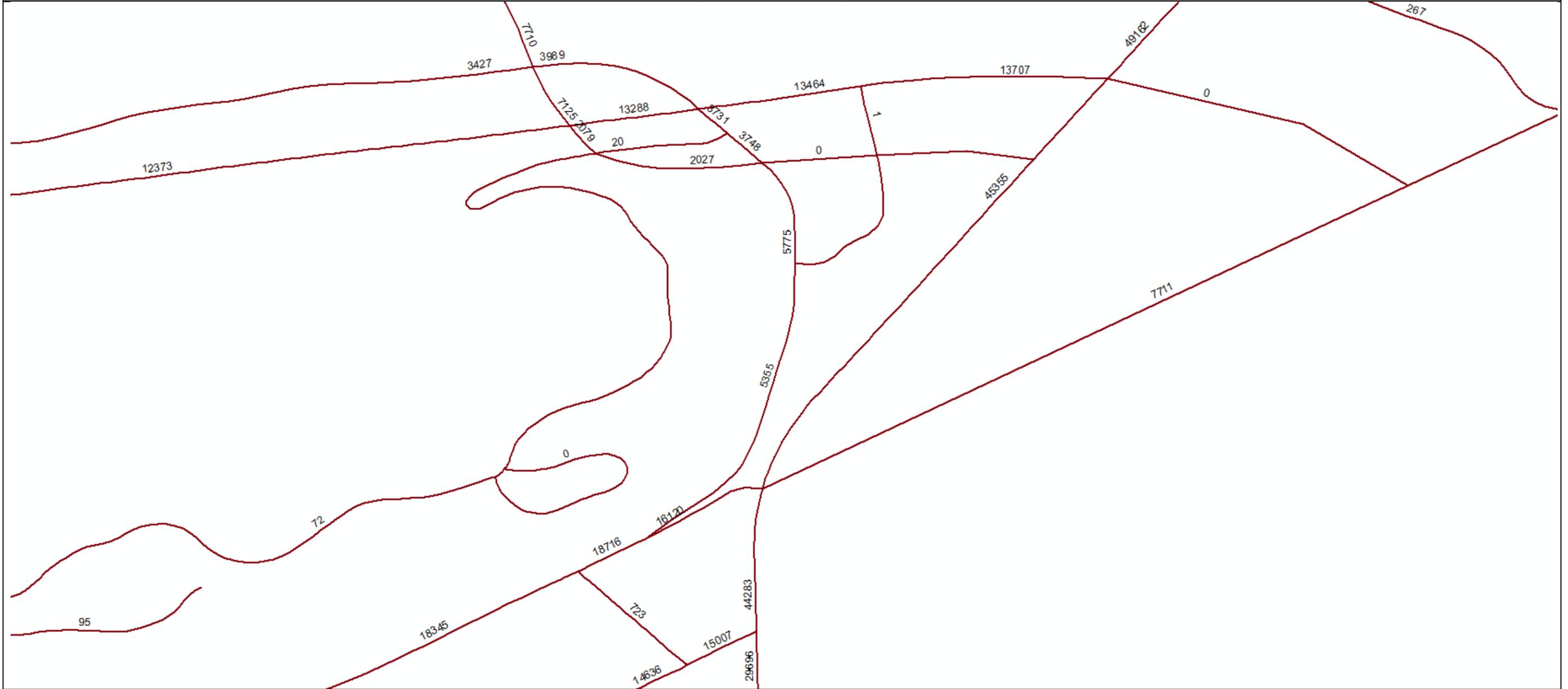
AM Peak	Total 6.5%	N/E 4.3%	S/W 8.6%
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**PM PEAK HOUR POST PROCESSED VOLUMES**

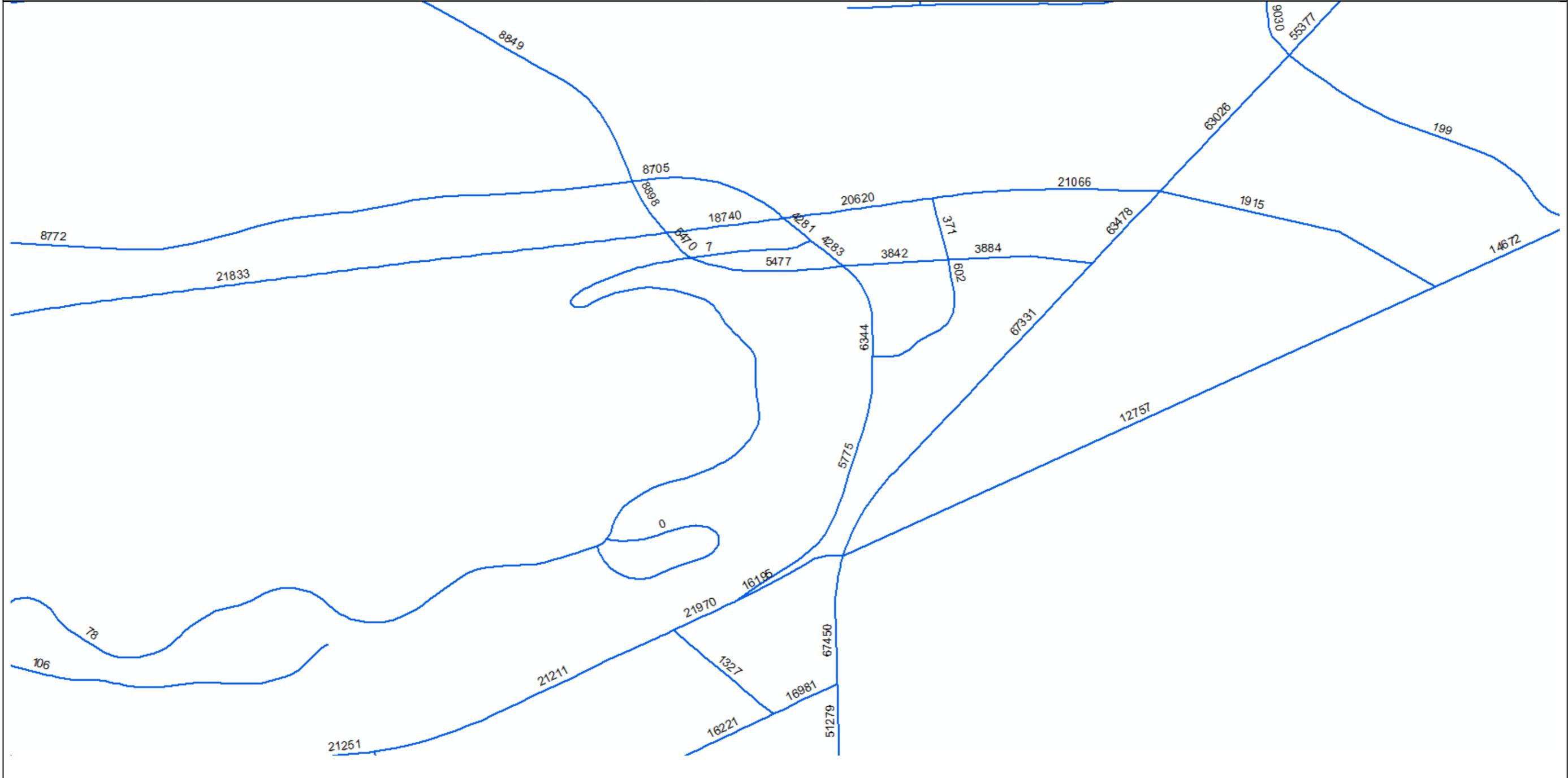
ID	Intersection	Year	Intersection Leg							
			North		South		West		East	
			In	Out	In	Out	In	Out	In	Out
1	Lake Elmo Drive/Main Street	2010 Model	1378	2209	2514	1594	392	227	10	11
		2015 Count	1115	2452	2863	1498	393	478	155	98
		2035 Model	1769	2873	3231	2039	493	273	6	11
		2040 Volume	1506	3116	3579	1943	494	524	150	98
2	Lake Elmo Drive/Bench Boulevard	2010 Model	7	16	0	0	380	259	266	396
		2015 Count	57	69	0	0	821	397	410	822
		2035 Model	7	9	0	0	727	490	496	739
		2040 Volume	57	62	0	0	1168	628	640	1164
3	Alkali Creek Road/Airport Road	2010 Model	144	182	0	0	674	434	445	675
		2015 Count	146	77	0	0	1149	495	426	1149
		2035 Model	296	423	0	0	1072	535	719	975
		2040 Volume	299	318	0	0	1547	596	700	1449
4	6th Avenue Bypass/Airport Road	2010 Model	0	0	161	140	674	434	445	675
		2015 Count	0	0	34	415	1151	426	426	770
		2035 Model	0	0	5	276	1072	535	719	975
		2040 Volume	0	0	161	551	1549	527	700	1070
5	Swords Lane/Airport Road	2010 Model	0	0	0	0	675	445	453	688
		2015 Count	19	23	49	18	768	422	427	800
		2035 Model	0	0	36	1	975	719	723	1015
		2040 Volume	19	23	85	19	1068	696	697	1127
6	Airport Road/Main Street	2010 Model	1606	2495	2331	1463	688	453	0	0
		2015 Count	1540	2784	2199	1272	749	418	78	92
		2035 Model	2039	3231	3329	2005	1015	723	51	115
		2040 Volume	1972	3520	3197	1814	1076	688	129	207
7	Alkali Creek Road/Bench Blvd	2010 Model	0	0	0	0	406	243	266	396
		2015 Count	100	61	4	3	740	368	404	816
		2035 Model	81	72	0	0	613	439	490	727
		2040 Volume	181	133	4	3	947	564	628	1147
8	6th Avenue Bypass/Aronson Ave	2010 Model	219	383	0	272	0	132	0	0
		2015 Count	415	34	0	201	330	882	471	99
		2035 Model	276	4	0	413	375	117	134	182
		2040 Volume	472	383	0	341	705	867	605	281
9	Swords Lane/Aronson Avenue	2010 Model	0	0	0	0	0	0	0	0
		2015 Count	16	47	19	44	102	474	102	530
		2035 Model	1	36	2	38	182	134	128	196
		2040 Volume	17	83	21	82	284	608	230	726
10	Aronson Avenue/Main Street	2010 Model	1463	2331	2290	1489	0	0	0	0
		2015 Count	1258	2234	2733	1332	101	520	0	6
		2035 Model	2005	3329	3527	2129	196	128	0	0
		2040 Volume	1800	3232	3970	1972	297	648	0	6
11	6th Avenue/Main Street	2010 Model	1489	2290	3084	912	0	1049	259	380
		2015 Count	1329	2189	2988	1090	0	716	392	714
		2035 Model	2129	3527	4321	1630	0	1054	439	613
		2040 Volume	1969	3426	4225	1808	0	721	572	947
12	4th Avenue/Main Street	2010 Model	912	3084	1577	925	1529	0	0	0
		2015 Count	1096	3523	2034	1268	1676	0	0	15
		2035 Model	1630	4321	2632	1656	1730	0	0	0
		2040 Volume	1814	4760	3089	1999	1877	0	0	15

PM Peak	Total	N/E	S/W
	8.3%	10.2%	6.5%

2010 Model – Daily, Two-Volumes  
Airport Rd/Main St Study Area



2035 Model – Daily, Two-Volumes  
Airport Rd/Main St Study Area

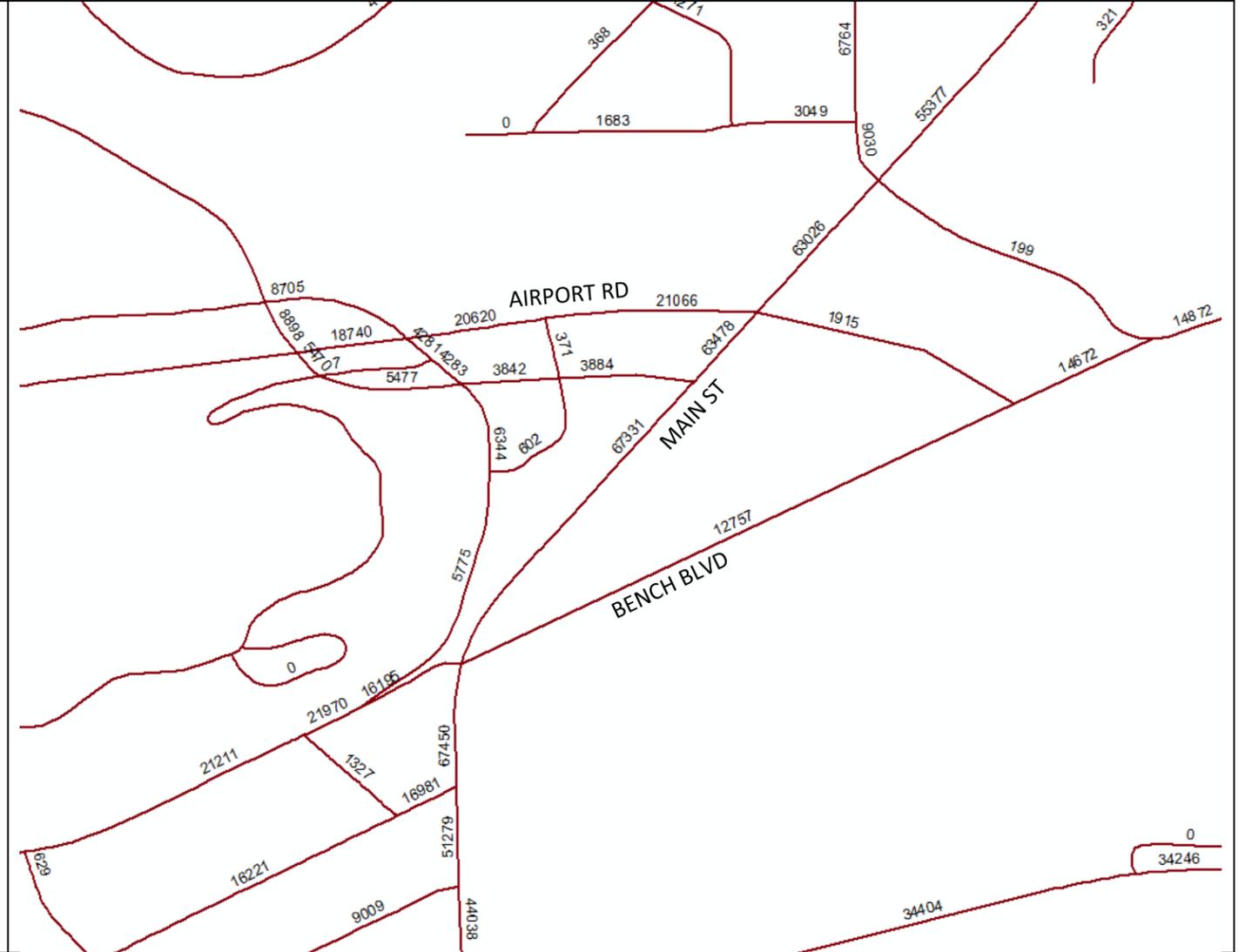


Main Street from 1<sup>st</sup> Avenue to Hilltop Road (Study Area)

2014 Billings LRTP – 2035 Model



Airport Rd/Main St – 2035 Model

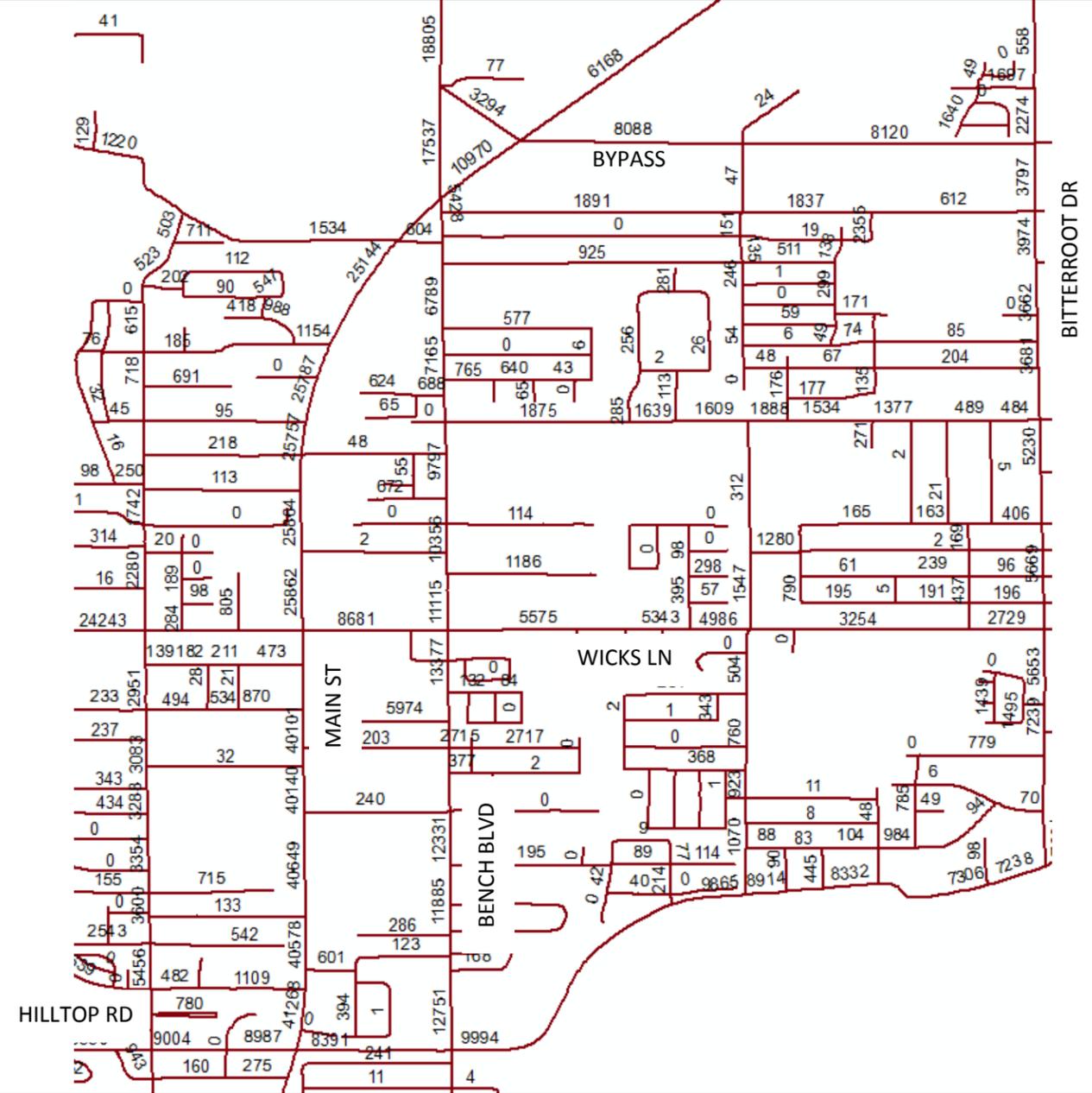


Main Street from Hiltop Road to Billings Bypass

2014 Billings LRTP – 2035 Model



Airport Rd/Main St – 2035 Model





Attachment H Year 2040 Future Conditions  
Synchro LOS Worksheets

# HCM Signalized Intersection Capacity Analysis

## 1: Main St (Hwy 87) & Lake Elmo Dr

Future Year 2040 AM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	3	29	854	66	16	29	114	1024	59	24	2465	2	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.91		1.00	0.91		
Frbp, ped/bikes		1.00	1.00	1.00	1.00	0.99	1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Frft		1.00	0.85	1.00	1.00	0.85	1.00	0.99		1.00	1.00		
Flt Protected		1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1591	1389	1615	1604	1428	1509	4129		1524	4462		
Flt Permitted		0.98	1.00	0.74	1.00	1.00	0.05	1.00		0.25	1.00		
Satd. Flow (perm)		1566	1389	1252	1604	1428	83	4129		404	4462		
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Adj. Flow (vph)	3	29	854	66	16	29	114	1024	59	24	2465	2	
RTOR Reduction (vph)	0	0	10	0	0	25	0	3	0	0	0	0	
Lane Group Flow (vph)	0	32	844	66	16	4	114	1080	0	24	2467	0	
Confl. Peds. (#/hr)	2					2	1					1	
Confl. Bikes (#/hr)									1			1	
Heavy Vehicles (%)	0%	7%	4%	0%	6%	0%	7%	12%	0%	6%	4%	0%	
Turn Type	Perm	NA	pm+ov	Perm	NA	pm+ov	pm+pt	NA		pm+pt	NA		
Protected Phases		8	5		4	1	5	2		1	6		
Permitted Phases	8		8	4		4	2			6			
Actuated Green, G (s)		12.3	43.9	12.3	12.3	17.2	108.4	99.0		77.2	72.3		
Effective Green, g (s)		12.3	43.9	12.3	12.3	17.2	108.4	99.0		77.2	72.3		
Actuated g/C Ratio		0.09	0.34	0.09	0.09	0.13	0.83	0.76		0.59	0.56		
Clearance Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		
Lane Grp Cap (vph)		148	517	118	151	238	415	3144		282	2481		
v/s Ratio Prot			c0.40		0.01	0.00	0.07	0.26		0.00	c0.55		
v/s Ratio Perm		0.02	0.21	0.05		0.00	0.16			0.05			
v/c Ratio		0.22	1.63	0.56	0.11	0.02	0.27	0.34		0.09	0.99		
Uniform Delay, d1		54.4	43.0	56.3	53.8	49.0	24.5	5.0		11.4	28.6		
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.57	0.17		1.00	1.00		
Incremental Delay, d2		0.7	293.4	5.6	0.3	0.0	0.3	0.3		0.1	16.8		
Delay (s)		55.1	336.4	61.9	54.1	49.1	38.7	1.1		11.5	45.4		
Level of Service		E	F	E	D	D	D	A		B	D		
Approach Delay (s)		326.3			57.4			4.7			45.1		
Approach LOS		F			E			A			D		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			88.3		HCM 2000 Level of Service						F		
HCM 2000 Volume to Capacity ratio			1.30										
Actuated Cycle Length (s)			130.0		Sum of lost time (s)					13.8			
Intersection Capacity Utilization			128.0%		ICU Level of Service					H			
Analysis Period (min)			15										

c Critical Lane Group

# HCM Unsignalized Intersection Capacity Analysis

## 2: Bench Blvd & Lake Elmo Dr

Future Year 2040 AM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↶	↷	↷		↶	↷
Volume (veh/h)	19	340	1298	49	17	42
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	19	340	1298	49	17	42
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	TWLTL			
Median storage (veh)			2			
Upstream signal (ft)		504				
pX, platoon unblocked					0.95	
vC, conflicting volume	1347				1700	1322
vC1, stage 1 conf vol					1322	
vC2, stage 2 conf vol					378	
vCu, unblocked vol	1347				1710	1322
tC, single (s)	4.1				6.6	6.2
tC, 2 stage (s)					5.6	
tF (s)	2.2				3.7	3.3
p0 queue free %	96				92	78
cM capacity (veh/h)	518				210	193
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	19	340	1347	17	42	
Volume Left	19	0	0	17	0	
Volume Right	0	0	49	0	42	
cSH	518	1700	1700	210	193	
Volume to Capacity	0.04	0.20	0.79	0.08	0.22	
Queue Length 95th (ft)	3	0	0	7	20	
Control Delay (s)	12.2	0.0	0.0	23.6	28.8	
Lane LOS	B			C	D	
Approach Delay (s)	0.6		0.0	27.3		
Approach LOS				D		
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			89.7%	ICU Level of Service		E
Analysis Period (min)			15			

# HCM Unsignalized Intersection Capacity Analysis

## 4: 6th Ave Bypass & E Airport Rd

Future Year 2040 AM Peak Hour

	→	↘	↙	←	↖	↗	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	↑↑	↗		↑↑↑		↗	
Volume (veh/h)	591	316	0	770	0	22	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	
Hourly flow rate (vph)	591	316	0	770	0	22	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None			None			
Median storage (veh)							
Upstream signal (ft)	1202						
pX, platoon unblocked							
vC, conflicting volume			907			848	296
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			907			848	296
tC, single (s)			4.1			6.8	6.9
tC, 2 stage (s)							
tF (s)			2.2			3.5	3.3
p0 queue free %			100			100	97
cM capacity (veh/h)			759			305	707
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	296	296	316	257	257	257	22
Volume Left	0	0	0	0	0	0	0
Volume Right	0	0	316	0	0	0	22
cSH	1700	1700	1700	1700	1700	1700	707
Volume to Capacity	0.17	0.17	0.19	0.15	0.15	0.15	0.03
Queue Length 95th (ft)	0	0	0	0	0	0	2
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Lane LOS	B						
Approach Delay (s)	0.0			0.0		10.3	
Approach LOS	B						
Intersection Summary							
Average Delay			0.1				
Intersection Capacity Utilization			28.3%	ICU Level of Service		A	
Analysis Period (min)	15						

# HCM Unsignalized Intersection Capacity Analysis

## 5: Swords Ln & E Airport Rd

Future Year 2040 AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 			 			 	
Volume (veh/h)	16	586	12	2	706	26	56	14	27	4	2	8
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	16	586	12	2	706	26	56	14	27	4	2	8
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)					728							
pX, platoon unblocked												
vC, conflicting volume	732			598			990	1360	299	1082	1353	366
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	732			598			990	1360	299	1082	1353	366
tC, single (s)	4.1			4.1			7.5	6.5	7.1	8.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.4	4.0	4.0	3.3
p0 queue free %	98			100			71	90	96	96	99	99
cM capacity (veh/h)	882			989			196	147	680	105	148	637
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1						
Volume Total	309	305	355	379	97	14						
Volume Left	16	0	2	0	56	4						
Volume Right	0	12	0	26	27	8						
cSH	882	1700	989	1700	230	219						
Volume to Capacity	0.02	0.18	0.00	0.22	0.42	0.06						
Queue Length 95th (ft)	1	0	0	0	49	5						
Control Delay (s)	0.7	0.0	0.1	0.0	31.5	22.6						
Lane LOS	A		A		D	C						
Approach Delay (s)	0.3		0.0		31.5	22.6						
Approach LOS					D	C						
<b>Intersection Summary</b>												
Average Delay			2.5									
Intersection Capacity Utilization			49.7%		ICU Level of Service				A			
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 6: Main St (Hwy 87) & E Airport Rd/Alkali Creek Rd

Future Year 2040 AM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations								  			  		
Volume (vph)	426	58	105	45	166	7	70	845	0	38	2812	529	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8		
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91		1.00	0.91		
Frbp, ped/bikes	1.00	1.00	0.99		1.00	1.00	1.00	1.00		1.00	1.00		
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00		
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	0.98		
Flt Protected	0.95	0.96	1.00		0.99	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)	1461	1468	1198		1595	1445	1154	4219		1614	4386		
Flt Permitted	0.95	0.96	1.00		0.99	1.00	0.05	1.00		0.30	1.00		
Satd. Flow (perm)	1461	1468	1198		1595	1445	63	4219		511	4386		
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Adj. Flow (vph)	426	58	105	45	166	7	70	845	0	38	2812	529	
RTOR Reduction (vph)	0	0	74	0	0	7	0	0	0	0	21	0	
Lane Group Flow (vph)	239	245	31	0	211	0	70	845	0	38	3320	0	
Confl. Peds. (#/hr)			1	1			4		2	2		4	
Heavy Vehicles (%)	5%	9%	19%	7%	5%	0%	40%	10%	0%	0%	3%	3%	
Turn Type	Split	NA	Perm	Split	NA	Perm	pm+pt	NA		pm+pt	NA		
Protected Phases	4	4		3	3		5	2		1	6		
Permitted Phases			4			3	2			6			
Actuated Green, G (s)	23.6	23.6	23.6		6.4	6.4	82.8	77.3		80.6	76.2		
Effective Green, g (s)	23.6	23.6	23.6		6.4	6.4	82.8	77.3		80.6	76.2		
Actuated g/C Ratio	0.18	0.18	0.18		0.05	0.05	0.64	0.59		0.62	0.59		
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8		
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0	3.0	0.2		3.0	0.2		
Lane Grp Cap (vph)	265	266	217		78	71	86	2508		354	2570		
v/s Ratio Prot	0.16	c0.17			c0.13		c0.03	0.20		0.00	c0.76		
v/s Ratio Perm			0.03			0.00	0.48			0.06			
v/c Ratio	0.90	0.92	0.14		2.71	0.00	0.81	0.34		0.11	1.29		
Uniform Delay, d1	52.1	52.3	44.7		61.8	58.8	34.1	13.4		9.7	26.9		
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.94	1.81		0.65	0.67		
Incremental Delay, d2	30.9	34.8	0.3		802.3	0.0	38.1	0.3		0.0	131.6		
Delay (s)	82.9	87.1	45.0		864.1	58.8	70.2	24.5		6.4	149.5		
Level of Service	F	F	D		F	E	E	C		A	F		
Approach Delay (s)		77.9			838.3			28.0			147.9		
Approach LOS		E			F			C			F		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			147.8									HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio			1.27										
Actuated Cycle Length (s)			130.0									Sum of lost time (s)	18.3
Intersection Capacity Utilization			113.1%									ICU Level of Service	H
Analysis Period (min)			15										
c Critical Lane Group													

# HCM Signalized Intersection Capacity Analysis

## 7: Alkali Creek Rd & Bench Blvd

Future Year 2040 AM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	0	251	0	0	1190	150	2	0	0	108	0	57	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)		6.0			6.0		4.0			4.0	5.0		
Lane Util. Factor		1.00			1.00		1.00			1.00	1.00		
Frbp, ped/bikes		1.00			1.00		1.00			1.00	0.98		
Flpb, ped/bikes		1.00			1.00		1.00			1.00	1.00		
Frt		1.00			0.98		1.00			1.00	0.85		
Flt Protected		1.00			1.00		0.95			0.95	1.00		
Satd. Flow (prot)		1635			1635		808			1538	1409		
Flt Permitted		1.00			1.00		0.00			0.95	1.00		
Satd. Flow (perm)		1635			1635		0			1538	1409		
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Adj. Flow (vph)	0	251	0	0	1190	150	2	0	0	108	0	57	
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	52	0	
Lane Group Flow (vph)	0	251	0	0	1337	0	2	0	0	108	5	0	
Confl. Peds. (#/hr)			4	4			3					3	
Confl. Bikes (#/hr)						2							
Heavy Vehicles (%)	0%	4%	0%	0%	2%	3%	100%	0%	0%	5%	0%	0%	
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt			pm+pt	NA		
Protected Phases	5	2		1	6		3	8		7	4		
Permitted Phases	2			6			8			4			
Actuated Green, G (s)		59.4			59.4		0.6			13.2	7.6		
Effective Green, g (s)		59.4			59.4		0.6			13.2	7.6		
Actuated g/C Ratio		0.72			0.72		0.01			0.16	0.09		
Clearance Time (s)		6.0			6.0		4.0			4.0	5.0		
Vehicle Extension (s)		3.0			3.0		3.0			3.0	3.0		
Lane Grp Cap (vph)		1175			1175		5			245	129		
v/s Ratio Prot		0.15			0.82		0.00			0.07	0.00		
v/s Ratio Perm													
v/c Ratio		0.21			1.14		0.40			0.44	0.04		
Uniform Delay, d1		3.8			11.6		40.8			31.4	34.2		
Progression Factor		1.00			1.00		1.00			1.00	1.00		
Incremental Delay, d2		0.1			73.0		45.2			1.3	0.1		
Delay (s)		3.9			84.6		86.0			32.6	34.3		
Level of Service		A			F		F			C	C		
Approach Delay (s)		3.9			84.6			86.0			33.2		
Approach LOS		A			F			F			C		

### Intersection Summary

HCM 2000 Control Delay	68.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	82.6	Sum of lost time (s)	19.0
Intersection Capacity Utilization	103.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 TWSC  
 8: 6th Ave Bypass & Aronson Ave

Future Year 2040 AM Peak Hour

Intersection												
Int Delay, s/veh	8.2											

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	26	246	1130	52	233	0	0	0	0	0	0	316
Conflicting Peds, #/hr	0	0	2	2	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	Free
Storage Length	-	-	400	-	-	-	-	-	-	-	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	86	86	86	86	86	86	86	86	86	86	86	86
Heavy Vehicles, %	0	4	1	0	7	0	0	0	0	0	0	2
Mvmt Flow	30	286	1314	60	271	0	0	0	0	0	0	367

Major/Minor	Major1			Minor1			Major2		
Conflicting Flow All	0	0	-	349	349	288	-	-	-
Stage 1	-	-	-	349	349	-	-	-	-
Stage 2	-	-	-	0	0	-	-	-	-
Critical Hdwy	-	-	-	6.4	6.57	6.2	-	-	-
Critical Hdwy Stg 1	-	-	-	5.4	5.57	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	3.5	4.063	3.3	-	-	-
Pot Cap-1 Maneuver	-	-	0	652	567	756	0	0	0
Stage 1	-	-	0	719	625	-	0	0	0
Stage 2	-	-	0	-	-	-	0	0	0
Platoon blocked, %	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	-	651	0	755	-	-	-
Mov Cap-2 Maneuver	-	-	-	651	0	-	-	-	-
Stage 1	-	-	-	718	0	-	-	-	-
Stage 2	-	-	-	-	0	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s		16.1	0
HCM LOS		C	

Minor Lane/Major Mvmt	EBL	EBTWBLn1
Capacity (veh/h)	-	651
HCM Lane V/C Ratio	-	0.509
HCM Control Delay (s)	-	16.1
HCM Lane LOS	-	C
HCM 95th %tile Q(veh)	-	2.9

# HCM Unsignalized Intersection Capacity Analysis

## 9: Swords Ln & Aronson Ave

Future Year 2040 AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	21	225	0	56	280	75	0	3	2	2	9	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	21	225	0	56	280	75	0	3	2	2	9	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	355			225			706	734	225	700	696	318
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	355			225			706	734	225	700	696	318
iC, single (s)	4.2			4.3			7.1	6.5	6.2	7.1	6.5	6.2
iC, 2 stage (s)												
iF (s)	2.3			2.4			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			96			100	99	100	99	97	99
cM capacity (veh/h)	1140			1260			328	328	819	336	345	728
Direction, Lane #												
	EB 1	WB 1	NB 1	SB 1								
Volume Total	246	411	5	16								
Volume Left	21	56	0	2								
Volume Right	0	75	2	5								
cSH	1140	1260	432	411								
Volume to Capacity	0.02	0.04	0.01	0.04								
Queue Length 95th (ft)	1	3	1	3								
Control Delay (s)	0.9	1.5	13.4	14.1								
Lane LOS	A	A	B	B								
Approach Delay (s)	0.9	1.5	13.4	14.1								
Approach LOS			B	B								
Intersection Summary												
Average Delay			1.6									
Intersection Capacity Utilization			48.3%	ICU Level of Service						A		
Analysis Period (min)			15									

HCM 2010 TWSC  
 10: Main St (Hwy 87) & Aronson Ave

Future Year 2040 AM Peak Hour

**Intersection**

Int Delay, s/veh 760.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	0	230	0	0	0	387	987	3	0	2903	18
Conflicting Peds, #/hr	0	0	0	0	0	0	3	0	0	0	0	3
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	Stop	-	-	None	-	-	None	-	-	Free
Storage Length	-	-	0	-	-	-	290	-	-	60	-	100
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	88	88	88	88	88	88	88	88	88	88	88	88
Heavy Vehicles, %	0	0	4	0	0	0	6	14	0	0	5	17
Mvmt Flow	0	0	261	0	0	0	440	1122	3	0	3299	20

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	4627	5304	1652	3323	5302	563	3299	0	0	1125	0	0
Stage 1	3299	3299	-	2003	2003	-	-	-	-	-	-	-
Stage 2	1328	2005	-	1320	3299	-	-	-	-	-	-	-
Critical Hdwy	6.4	6.5	7.18	6.4	6.5	7.1	5.42	-	-	5.3	-	-
Critical Hdwy Stg 1	7.3	5.5	-	7.3	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.7	5.5	-	6.7	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.8	4	3.94	3.8	4	3.9	3.16	-	-	3.1	-	-
Pot Cap-1 Maneuver	1	0	~ 73	9	0	406	~ 24	-	-	346	-	0
Stage 1	4	22	-	39	105	-	-	-	-	-	-	0
Stage 2	149	105	-	151	22	-	-	-	-	-	-	0
Platoon blocked, %												
Mov Cap-1 Maneuver	1	0	~ 73	-	0	406	~ 24	-	-	346	-	-
Mov Cap-2 Maneuver	1	0	-	-	0	-	-	-	-	-	-	-
Stage 1	4	22	-	39	105	-	-	-	-	-	-	-
Stage 2	149	105	-	-	22	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	\$ 1280.3	0	\$ 2278.2	0
HCM LOS	F	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT
Capacity (veh/h)	~ 24	-	-	73	-	346
HCM Lane V/C Ratio	18.324	-	-	3.58	-	-
HCM Control Delay (s)	\$ 8106.3	-	-	\$ 1280.3	0	0
HCM Lane LOS	F	-	-	F	A	A
HCM 95th %tile Q(veh)	55	-	-	27.2	-	0

**Notes**

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

# HCM Signalized Intersection Capacity Analysis

## 11: Main St (Hwy 87) & 6th Ave

Future Year 2040 AM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	0	0	0	795	447	4	130	1374	256	0	2305	1002	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)				4.5	4.5		4.5	4.8	4.0		4.8	4.0	
Lane Util. Factor				0.91	0.91		1.00	0.91	1.00		0.95	0.88	
Frb, ped/bikes				1.00	1.00		1.00	1.00	1.00		1.00	0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00	1.00		1.00	1.00	
Frt				1.00	1.00		1.00	1.00	0.85		1.00	0.85	
Flt Protected				0.95	0.98		0.95	1.00	1.00		1.00	1.00	
Satd. Flow (prot)				1441	2978		1553	4181	1403		3076	2463	
Flt Permitted				0.95	0.98		0.05	1.00	1.00		1.00	1.00	
Satd. Flow (perm)				1441	2978		90	4181	1403		3076	2463	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Adj. Flow (vph)	0	0	0	795	447	4	130	1374	256	0	2305	1002	
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0	
Lane Group Flow (vph)	0	0	0	405	841	0	130	1374	256	0	2305	1002	
Confl. Peds. (#/hr)							1					1	
Heavy Vehicles (%)	0%	0%	0%	2%	1%	0%	4%	11%	3%	0%	5%	2%	
Turn Type				Split	NA		pm+pt	NA	Free		NA	Free	
Protected Phases				4	4		1	2			2		
Permitted Phases							2		Free			Free	
Actuated Green, G (s)				32.5	32.5		83.7	73.0	130.0		73.0	130.0	
Effective Green, g (s)				32.5	32.5		83.7	73.0	130.0		73.0	130.0	
Actuated g/C Ratio				0.25	0.25		0.64	0.56	1.00		0.56	1.00	
Clearance Time (s)				4.5	4.5		4.5	4.8			4.8		
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0		
Lane Grp Cap (vph)				360	744		178	2347	1403		1727	2463	
v/s Ratio Prot				0.28	c0.28		c0.06	0.33			c0.75		
v/s Ratio Perm							0.41		0.18			0.41	
v/c Ratio				1.12	1.13		0.73	0.59	0.18		1.33	0.41	
Uniform Delay, d1				48.8	48.8		37.7	18.6	0.0		28.5	0.0	
Progression Factor				1.00	1.00		1.06	0.81	1.00		0.48	1.00	
Incremental Delay, d2				85.8	75.1		13.2	1.0	0.3		151.0	0.0	
Delay (s)				134.5	123.8		53.1	16.1	0.3		164.8	0.0	
Level of Service				F	F		D	B	A		F	A	
Approach Delay (s)		0.0			127.3			16.5			114.9		
Approach LOS		A			F			B			F		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			89.9	HCM 2000 Level of Service					F				
HCM 2000 Volume to Capacity ratio			1.22										
Actuated Cycle Length (s)			130.0	Sum of lost time (s)					13.8				
Intersection Capacity Utilization			117.3%	ICU Level of Service					H				
Analysis Period (min)			15										
c Critical Lane Group													

# HCM Signalized Intersection Capacity Analysis

12: Main St (Hwy 87) & 4th Ave N

Future Year 2040 AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 	 						  		 	  	
Volume (vph)	304	11	180	0	0	0	0	1456	4	5	3094	0
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	5.0	5.0						5.6		5.6	5.6	
Lane Util. Factor	0.86	0.86						0.91		1.00	0.91	
Frbp, ped/bikes	1.00	0.99						1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00						1.00		1.00	1.00	
Frt	1.00	0.89						1.00		1.00	1.00	
Flt Protected	0.95	0.99						1.00		0.95	1.00	
Satd. Flow (prot)	2572	2222						4107		1615	4378	
Flt Permitted	0.95	0.99						1.00		0.16	1.00	
Satd. Flow (perm)	2572	2222						4107		264	4378	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	304	11	180	0	0	0	0	1456	4	5	3094	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	258	237	0	0	0	0	0	1460	0	5	3094	0
Confl. Peds. (#/hr)			1	1						1	1	
Confl. Bikes (#/hr)							1					
Heavy Vehicles (%)	8%	14%	16%	0%	0%	0%	0%	13%	0%	0%	6%	0%
Turn Type	Perm	NA						NA		Perm	NA	
Protected Phases		4						2			2	
Permitted Phases	4									2		
Actuated Green, G (s)	21.5	21.5						97.9		97.9	97.9	
Effective Green, g (s)	21.5	21.5						97.9		97.9	97.9	
Actuated g/C Ratio	0.17	0.17						0.75		0.75	0.75	
Clearance Time (s)	5.0	5.0						5.6		5.6	5.6	
Vehicle Extension (s)	3.0	3.0						0.2		0.2	0.2	
Lane Grp Cap (vph)	425	367						3092		198	3296	
v/s Ratio Prot								0.36			c0.71	
v/s Ratio Perm	0.10	0.11								0.02		
v/c Ratio	0.61	0.97dr						0.47		0.03	0.94	
Uniform Delay, d1	50.3	50.7						6.2		4.0	13.5	
Progression Factor	1.00	1.00						1.00		0.41	0.54	
Incremental Delay, d2	2.5	3.9						0.5		0.0	0.7	
Delay (s)	52.8	54.6						6.7		1.7	8.1	
Level of Service	D	D						A		A	A	
Approach Delay (s)		53.6			0.0			6.7			8.0	
Approach LOS		D			A			A			A	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			12.1					HCM 2000 Level of Service		B		
HCM 2000 Volume to Capacity ratio			0.89									
Actuated Cycle Length (s)			130.0					Sum of lost time (s)		10.6		
Intersection Capacity Utilization			84.7%					ICU Level of Service		E		
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

Summary of All Intervals

Run Number	1	10	2	3	4	5	6
Start Time	7:00	7:00	7:00	7:00	7:00	7:00	7:00
End Time	8:15	8:15	8:15	8:15	8:15	8:15	8:15
Total Time (min)	75	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1	1
Vehs Entered	9487	9206	9343	9300	9584	9442	9388
Vehs Exited	9182	8960	9115	9064	9218	9175	9077
Starting Vehs	648	683	714	704	665	650	675
Ending Vehs	953	929	942	940	1031	917	986
Travel Distance (mi)	9075	8804	9003	8970	9165	9064	8952
Travel Time (hr)	1664.4	1817.5	1760.4	1646.3	1685.1	1535.4	1791.9
Total Delay (hr)	1384.9	1546.1	1483.1	1369.2	1402.8	1256.6	1515.9
Total Stops	15444	14079	15037	15008	19026	16037	15562
Fuel Used (gal)	614.5	643.6	634.6	608.1	622.4	584.9	641.6

Summary of All Intervals

Run Number	7	8	9	Avg
Start Time	7:00	7:00	7:00	7:00
End Time	8:15	8:15	8:15	8:15
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intervals	1	1	1	1
Vehs Entered	9298	9554	9325	9389
Vehs Exited	9096	9353	9026	9123
Starting Vehs	734	749	699	685
Ending Vehs	936	950	998	951
Travel Distance (mi)	8932	9251	8943	9016
Travel Time (hr)	1874.8	1683.7	1764.7	1722.4
Total Delay (hr)	1599.7	1398.7	1489.4	1444.6
Total Stops	15016	17730	18576	16151
Fuel Used (gal)	657.3	623.8	636.2	626.7

Interval #0 Information Seeding

Start Time	7:00
End Time	7:15
Total Time (min)	15
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	7:15
End Time	8:15
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	1	10	2	3	4	5	6
Vehs Entered	9487	9206	9343	9300	9584	9442	9388
Vehs Exited	9182	8960	9115	9064	9218	9175	9077
Starting Vehs	648	683	714	704	665	650	675
Ending Vehs	953	929	942	940	1031	917	986
Travel Distance (mi)	9075	8804	9003	8970	9165	9064	8952
Travel Time (hr)	1664.4	1817.5	1760.4	1646.3	1685.1	1535.4	1791.9
Total Delay (hr)	1384.9	1546.1	1483.1	1369.2	1402.8	1256.6	1515.9
Total Stops	15444	14079	15037	15008	19026	16037	15562
Fuel Used (gal)	614.5	643.6	634.6	608.1	622.4	584.9	641.6

Interval #1 Information Recording

Start Time	7:15
End Time	8:15
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	7	8	9	Avg
Vehs Entered	9298	9554	9325	9389
Vehs Exited	9096	9353	9026	9123
Starting Vehs	734	749	699	685
Ending Vehs	936	950	998	951
Travel Distance (mi)	8932	9251	8943	9016
Travel Time (hr)	1874.8	1683.7	1764.7	1722.4
Total Delay (hr)	1599.7	1398.7	1489.4	1444.6
Total Stops	15016	17730	18576	16151
Fuel Used (gal)	657.3	623.8	636.2	626.7

8: 6th Ave Bypass & Aronson Ave Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	SBR	All
Denied Delay (hr)	3.6	59.7	231.3	0.0	0.0	0.0	294.6
Denied Del/Veh (s)	504.4	506.8	504.6	0.0	0.0	0.0	393.4
Total Delay (hr)	0.0	0.4	7.6	0.2	0.7	0.1	9.0
Total Del/Veh (s)	4.4	4.5	21.5	10.6	10.4	1.7	14.6

10: Main St (Hwy 87) & Aronson Ave Performance by movement

Movement	EBT	EBR	NBL	NBT	NBR	SBT	SBR	All
Denied Delay (hr)	0.0	0.3	0.1	1.0	0.0	0.0	0.0	1.4
Denied Del/Veh (s)	0.0	3.2	1.0	3.5	0.0	0.0	0.3	1.2
Total Delay (hr)	0.0	3.7	16.8	2.5	0.0	4.3	0.0	27.3
Total Del/Veh (s)	7.2	40.7	150.5	9.2	1.6	6.7	5.0	24.4

Total Zone Performance

Denied Delay (hr)	296.0
Denied Del/Veh (s)	491.9
Total Delay (hr)	36.3
Total Del/Veh (s)	906.7

RAMPS AND RAMP JUNCTIONS WORKSHEET									
General Information					Site Information				
Analyst	Brett Korporaal		Freeway/Dir of Travel	Airport Rd					
Agency or Company	Kittelson & Associates, Inc.		Junction	Alkali Creek Rd					
Date Performed	7/29/2015		Jurisdiction	MDT					
Analysis Time Period	AM Peak Hour		Analysis Year	Future Year - 2040					
Project Description Airport Rd/Main St - Billings									
Inputs									
Upstream Adj Ramp		Freeway Number of Lanes, N			2			Downstream Adj Ramp	
<input type="checkbox"/> Yes <input type="checkbox"/> On		Ramp Number of Lanes, N			1			<input type="checkbox"/> Yes <input type="checkbox"/> On	
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off		Acceleration Lane Length, L <sub>A</sub>			750			<input checked="" type="checkbox"/> No <input type="checkbox"/> Off	
L <sub>up</sub> = ft		Deceleration Lane Length L <sub>D</sub>						L <sub>down</sub> = ft	
V <sub>u</sub> = veh/h		Freeway Volume, V <sub>F</sub>			660			V <sub>D</sub> = veh/h	
		Ramp Volume, V <sub>R</sub>			703				
		Freeway Free-Flow Speed, S <sub>FF</sub>			55.0				
		Ramp Free-Flow Speed, S <sub>FR</sub>			25.0				
Conversion to pc/h Under Base Conditions									
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f <sub>HV</sub>	f <sub>p</sub>	v = V/PHF x f <sub>HV</sub> x f <sub>p</sub>	
Freeway	660	1.00	Rolling	5	0	0.930	1.00	709	
Ramp	703	1.00	Rolling	5	0	0.930	1.00	756	
UpStream									
DownStream									
Merge Areas					Diverge Areas				
Estimation of v <sub>12</sub>					Estimation of v <sub>12</sub>				
$V_{12} = V_F (P_{FM})$ (Equation 13-6 or 13-7) P <sub>FM</sub> = 1.000 using Equation (Exhibit 13-6) V <sub>12</sub> = 709 pc/h V <sub>3</sub> or V <sub>av34</sub> = 0 pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					$V_{12} = V_R + (V_F - V_R)P_{FD}$ (Equation 13-12 or 13-13) P <sub>FD</sub> = using Equation (Exhibit 13-7) V <sub>12</sub> = pc/h V <sub>3</sub> or V <sub>av34</sub> = pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)				
Capacity Checks					Capacity Checks				
	Actual	Capacity		LOS F?		Actual	Capacity		LOS F?
V <sub>FO</sub>	1465	Exhibit 13-8		No	V <sub>F</sub>		Exhibit 13-8		
					V <sub>FO</sub> = V <sub>F</sub> - V <sub>R</sub>		Exhibit 13-8		
					V <sub>R</sub>		Exhibit 13-10		
Flow Entering Merge Influence Area					Flow Entering Diverge Influence Area				
	Actual	Max Desirable		Violation?		Actual	Max Desirable		Violation?
V <sub>R12</sub>	1465	Exhibit 13-8	4600:All	No	V <sub>12</sub>		Exhibit 13-8		
Level of Service Determination (if not F)					Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$ D <sub>R</sub> = 11.9 (pc/mi/ln) LOS = B (Exhibit 13-2)					$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D <sub>R</sub> = (pc/mi/ln) LOS = (Exhibit 13-2)				
Speed Determination					Speed Determination				
M <sub>S</sub> = 0.300 (Exhibit 13-11) S <sub>R</sub> = 51.1 mph (Exhibit 13-11) S <sub>0</sub> = N/A mph (Exhibit 13-11) S = 51.1 mph (Exhibit 13-13)					D <sub>S</sub> = (Exhibit 13-12) S <sub>R</sub> = mph (Exhibit 13-12) S <sub>0</sub> = mph (Exhibit 13-12) S = mph (Exhibit 13-13)				

# HCM Signalized Intersection Capacity Analysis

## 1: Main St (Hwy 87) & Lake Elmo Dr

Future Year 2040 PM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	24	56	445	127	88	97	641	3138	101	29	1364	11	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.91		1.00	0.91		
Frbp, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		
Fr t		1.00	0.85	1.00	1.00	0.85	1.00	1.00		1.00	1.00		
Fl t Protected		0.99	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1675	1363	1568	1700	1417	1583	4483		1615	4458		
Fl t Permitted		0.89	1.00	0.64	1.00	1.00	0.08	1.00		0.06	1.00		
Satd. Flow (perm)		1516	1363	1060	1700	1417	140	4483		101	4458		
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	
Adj. Flow (vph)	26	60	478	137	95	104	689	3374	109	31	1467	12	
RTOR Reduction (vph)	0	0	7	0	0	38	0	2	0	0	1	0	
Lane Group Flow (vph)	0	86	471	137	95	66	689	3481	0	31	1478	0	
Confl. Peds. (#/hr)							1		1	1		1	
Confl. Bikes (#/hr)									1				
Heavy Vehicles (%)	0%	0%	6%	3%	0%	2%	2%	3%	2%	0%	4%	0%	
Turn Type	Perm	NA	pm+ov	Perm	NA	pm+ov	pm+pt	NA		pm+pt	NA		
Protected Phases		8	5		4	1	5	2		1	6		
Permitted Phases	8		8	4		4	2			6			
Actuated Green, G (s)		22.5	69.0	22.5	22.5	27.5	118.2	108.7		72.2	67.2		
Effective Green, g (s)		22.5	69.0	22.5	22.5	27.5	118.2	108.7		72.2	67.2		
Actuated g/C Ratio		0.15	0.46	0.15	0.15	0.18	0.79	0.72		0.48	0.45		
Clearance Time (s)		4.5	4.5	4.5	4.5	4.5	4.5	4.8		4.5	4.8		
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		
Lane Grp Cap (vph)		227	667	159	255	302	557	3248		99	1997		
v/s Ratio Prot			0.22		0.06	0.01	c0.38	0.78		0.01	0.33		
v/s Ratio Perm		0.06	0.13	c0.13		0.04	c0.59			0.14			
v/c Ratio		0.38	0.71	0.86	0.37	0.22	1.24	1.07		0.31	0.74		
Uniform Delay, d1		57.5	32.4	62.2	57.4	52.1	42.9	20.6		61.8	34.2		
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.28	0.49		1.00	1.00		
Incremental Delay, d2		1.1	3.4	35.0	0.9	0.4	108.1	33.0		1.8	2.5		
Delay (s)		58.5	35.8	97.2	58.3	52.5	163.2	43.1		63.6	36.7		
Level of Service		E	D	F	E	D	F	D		E	D		
Approach Delay (s)		39.3			72.4			63.0			37.3		
Approach LOS		D			E			E			D		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			55.5		HCM 2000 Level of Service					E			
HCM 2000 Volume to Capacity ratio			1.20										
Actuated Cycle Length (s)			150.0		Sum of lost time (s)					13.8			
Intersection Capacity Utilization			99.6%		ICU Level of Service					F			
Analysis Period (min)			15										

c Critical Lane Group

# HCM Unsignalized Intersection Capacity Analysis

## 2: Bench Blvd & Lake Elmo Dr

Future Year 2040 PM Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↶	↷	↷		↷	↷
Volume (veh/h)	62	1353	720	53	59	45
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	66	1439	766	56	63	48
Pedestrians			1		2	
Lane Width (ft)			12.0		12.0	
Walking Speed (ft/s)			4.0		4.0	
Percent Blockage			0		0	
Right turn flare (veh)						
Median type		None	TWLTL			
Median storage (veh)			2			
Upstream signal (ft)		504				
pX, platoon unblocked					0.26	
vC, conflicting volume	824				2368	796
vC1, stage 1 conf vol					796	
vC2, stage 2 conf vol					1572	
vCu, unblocked vol	824				4834	796
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	92				0	88
cM capacity (veh/h)	813				35	383
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	66	1439	822	63	48	
Volume Left	66	0	0	63	0	
Volume Right	0	0	56	0	48	
cSH	813	1700	1700	35	383	
Volume to Capacity	0.08	0.85	0.48	1.80	0.12	
Queue Length 95th (ft)	7	0	0	172	11	
Control Delay (s)	9.8	0.0	0.0	628.8	15.7	
Lane LOS	A			F	C	
Approach Delay (s)	0.4		0.0	363.5		
Approach LOS				F		
Intersection Summary						
Average Delay			16.8			
Intersection Capacity Utilization			89.9%	ICU Level of Service		E
Analysis Period (min)			15			

# HCM Unsignalized Intersection Capacity Analysis

## 4: 6th Ave Bypass & E Airport Rd

Future Year 2040 PM Peak Hour

	→	↘	↙	←	↖	↗	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	↑↑	↗		↑↑↑		↗	
Volume (veh/h)	1059	625	0	659	0	35	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	
Hourly flow rate (vph)	1151	679	0	716	0	38	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None			None			
Median storage (veh)							
Upstream signal (ft)				1202			
pX, platoon unblocked							
vC, conflicting volume			1830		1390	576	
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			1830		1390	576	
tC, single (s)			4.1		6.8	6.9	
tC, 2 stage (s)							
tF (s)			2.2		3.5	3.3	
p0 queue free %			100		100	92	
cM capacity (veh/h)			338		136	466	
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	576	576	679	239	239	239	38
Volume Left	0	0	0	0	0	0	0
Volume Right	0	0	679	0	0	0	38
cSH	1700	1700	1700	1700	1700	1700	466
Volume to Capacity	0.34	0.34	0.40	0.14	0.14	0.14	0.08
Queue Length 95th (ft)	0	0	0	0	0	0	7
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	13.4
Lane LOS							B
Approach Delay (s)	0.0			0.0			13.4
Approach LOS							B
Intersection Summary							
Average Delay			0.2				
Intersection Capacity Utilization			46.6%	ICU Level of Service		A	
Analysis Period (min)			15				

# HCM Unsignalized Intersection Capacity Analysis

## 5: Swords Ln & E Airport Rd

Future Year 2040 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑			↕			↕	
Volume (veh/h)	5	1053	36	18	613	33	33	6	47	21	2	13
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	1120	38	19	652	35	35	6	50	22	2	14
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None					None						
Median storage (veh)												
Upstream signal (ft)	728											
pX, platoon unblocked												
vC, conflicting volume	687			1159			1529	1876	579	1332	1877	344
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	687			1159			1529	1876	579	1332	1877	344
tC, single (s)	4.1			4.1			7.6	6.5	7.0	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			97			50	91	89	76	97	98
cM capacity (veh/h)	916			610			71	70	456	92	70	658
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1						
Volume Total	565	598	345	361	91	38						
Volume Left	5	0	19	0	35	22						
Volume Right	0	38	0	35	50	14						
cSH	916	1700	610	1700	131	130						
Volume to Capacity	0.01	0.35	0.03	0.21	0.70	0.29						
Queue Length 95th (ft)	0	0	2	0	97	28						
Control Delay (s)	0.2	0.0	1.0	0.0	79.2	43.8						
Lane LOS	A		A		F	E						
Approach Delay (s)	0.1		0.5		79.2	43.8						
Approach LOS					F	E						
Intersection Summary												
Average Delay			4.7									
Intersection Capacity Utilization			50.5%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Signalized Intersection Capacity Analysis  
 6: Main St (Hwy 87) & E Airport Rd/Alkali Creek Rd

Future Year 2040 PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	870	221	80	40	129	42	140	2956	24	53	1480	415
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91		1.00	0.91	
Frbp, ped/bikes	1.00	1.00	0.98		1.00	1.00	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00		1.00	0.97	
Flt Protected	0.95	0.97	1.00		0.99	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1490	1528	1218		1652	1445	1442	4501		1615	4284	
Flt Permitted	0.95	0.97	1.00		0.99	1.00	0.05	1.00		0.05	1.00	
Satd. Flow (perm)	1490	1528	1218		1652	1445	75	4501		89	4284	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	926	235	85	43	137	45	149	3145	26	56	1574	441
RTOR Reduction (vph)	0	0	66	0	0	43	0	0	0	0	30	0
Lane Group Flow (vph)	574	587	19	0	180	2	149	3171	0	56	1985	0
Confl. Peds. (#/hr)			5	5			4					4
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	3%	2%	16%	7%	0%	0%	12%	3%	0%	0%	5%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3	2			6		
Actuated Green, G (s)	33.5	33.5	33.5		5.5	5.5	97.2	86.2		83.2	76.7	
Effective Green, g (s)	33.5	33.5	33.5		5.5	5.5	97.2	86.2		83.2	76.7	
Actuated g/C Ratio	0.22	0.22	0.22		0.04	0.04	0.65	0.57		0.55	0.51	
Clearance Time (s)	4.5	4.5	4.5		4.5	4.5	4.5	4.8		4.5	4.8	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	332	341	272		60	52	194	2586		115	2190	
v/s Ratio Prot	c0.39	0.38			c0.11		c0.08	c0.70		0.02	0.46	
v/s Ratio Perm			0.02			0.00	0.42			0.25		
v/c Ratio	1.73	1.72	0.07		3.00	0.03	0.77	1.23		0.49	0.91	
Uniform Delay, d1	58.2	58.2	46.0		72.2	69.7	44.7	31.9		33.6	33.4	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.71	1.47		1.21	0.69	
Incremental Delay, d2	340.4	336.8	0.1		943.0	0.2	1.7	102.1		2.1	4.7	
Delay (s)	398.7	395.0	46.1		1015.2	69.9	33.5	148.8		42.8	27.8	
Level of Service	F	F	D		F	E	C	F		D	C	
Approach Delay (s)		372.9			826.1			143.7			28.2	
Approach LOS		F			F			F			C	

Intersection Summary

HCM 2000 Control Delay	172.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.41		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	18.3
Intersection Capacity Utilization	126.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

# HCM Signalized Intersection Capacity Analysis

## 7: Alkali Creek Rd & Bench Blvd

Future Year 2040 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations								 				
Volume (vph)	21	1128	0	5	589	171	4	2	2	285	0	29
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	5.0		4.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99		1.00	0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.97		1.00	0.93		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1615	1667		1615	1601		1214	2955		1614	1411	
Flt Permitted	0.24	1.00		0.07	1.00		1.00	1.00		0.52	1.00	
Satd. Flow (perm)	414	1667		116	1601		1278	2955		882	1411	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	22	1187	0	5	620	180	4	2	2	300	0	31
RTOR Reduction (vph)	0	0	0	0	7	0	0	4	0	0	28	0
Lane Group Flow (vph)	22	1187	0	5	793	0	4	0	0	300	3	0
Confl. Peds. (#/hr)	1		1	1		1			1	1		
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	0%	2%	0%	0%	3%	0%	33%	0%	0%	0%	0%	0%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	60.9	59.4		59.1	58.5		4.3	3.7		14.4	9.8	
Effective Green, g (s)	60.9	59.4		59.1	58.5		4.3	3.7		14.4	9.8	
Actuated g/C Ratio	0.68	0.66		0.66	0.65		0.05	0.04		0.16	0.11	
Clearance Time (s)	4.0	6.0		4.0	6.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	302	1107		86	1047		61	122		196	154	
v/s Ratio Prot	c0.00	c0.71		0.00	0.50		0.00	0.00		c0.11	0.00	
v/s Ratio Perm	0.05			0.04			0.00			c0.13		
v/c Ratio	0.07	1.07		0.06	0.76		0.07	0.00		1.53	0.02	
Uniform Delay, d1	6.8	15.0		19.9	10.6		40.6	41.1		37.1	35.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	48.6		0.3	3.2		0.5	0.0		262.8	0.1	
Delay (s)	6.9	63.6		20.2	13.8		41.1	41.1		299.9	35.6	
Level of Service	A	E		C	B		D	D		F	D	
Approach Delay (s)		62.6			13.8			41.1			275.2	
Approach LOS		E			B			D			F	

### Intersection Summary

HCM 2000 Control Delay	75.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.20		
Actuated Cycle Length (s)	89.4	Sum of lost time (s)	19.0
Intersection Capacity Utilization	99.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 TWSC  
 8: Aronson Ave & 6th Ave Bypass

Future Year 2040 PM Peak Hour

**Intersection**

Int Delay, s/veh 0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Vol, veh/h	34	150	261	0	635	0	0	625	0	0
Conflicting Peds, #/hr	0	0	4	4	0	0	0	0	0	0
Sign Control	Free	Free	Free	Stop	Stop	Stop	Free	Free	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	Free	-	-
Storage Length	-	-	400	-	-	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	0	-	0	-
Grade, %	-	0	-	-	0	-	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	92	92
Heavy Vehicles, %	0	6	2	0	0	0	0	0	2	2
Mvmt Flow	36	160	278	0	676	0	0	665	0	0

Major/Minor	Major1			Minor1			Major2		
Conflicting Flow All	0	0	-	236	236	164	-	-	-
Stage 1	-	-	-	236	236	-	-	-	-
Stage 2	-	-	-	0	0	-	-	-	-
Critical Hdwy	-	-	-	6.4	6.5	6.2	-	-	-
Critical Hdwy Stg 1	-	-	-	5.4	5.5	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	3.5	4	3.3	-	-	-
Pot Cap-1 Maneuver	-	-	0	757	~ 668	886	0	0	-
Stage 1	-	-	0	808	713	-	0	0	-
Stage 2	-	-	0	-	-	-	0	0	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	-	754	0	883	-	-	-
Mov Cap-2 Maneuver	-	-	-	754	0	-	-	-	-
Stage 1	-	-	-	805	0	-	-	-	-
Stage 2	-	-	-	-	0	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s			0
HCM LOS		-	

Minor Lane/Major Mvmt	EBL	EBTWBLn1
Capacity (veh/h)	-	-
HCM Lane V/C Ratio	-	-
HCM Control Delay (s)	-	-
HCM Lane LOS	-	-
HCM 95th %tile Q(veh)	-	-

**Notes**

-: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

# HCM Unsignalized Intersection Capacity Analysis

## 9: Swords Ln & Aronson Ave

Future Year 2040 PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	16	132	7	59	622	49	8	18	48	22	9	5
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	143	8	64	676	53	9	20	52	24	10	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	729			151			1023	1040	147	1075	1017	703
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	729			151			1023	1040	147	1075	1017	703
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			96			96	91	94	86	96	99
cM capacity (veh/h)	884			1442			196	218	905	166	224	441
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>WB 1</b>	<b>NB 1</b>	<b>SB 1</b>								
Volume Total	168	793	80	39								
Volume Left	17	64	9	24								
Volume Right	8	53	52	5								
cSH	884	1442	419	196								
Volume to Capacity	0.02	0.04	0.19	0.20								
Queue Length 95th (ft)	2	3	18	18								
Control Delay (s)	1.1	1.2	15.6	27.9								
Lane LOS	A	A	C	D								
Approach Delay (s)	1.1	1.2	15.6	27.9								
Approach LOS			C	D								
<b>Intersection Summary</b>												
Average Delay			3.2									
Intersection Capacity Utilization			69.2%		ICU Level of Service				C			
Analysis Period (min)			15									

HCM 2010 TWSC  
 10: Main St (Hwy 87) & Aronson Ave

Future Year 2040 PM Peak Hour

**Intersection**

Int Delay, s/veh 192.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	0	200	0	0	0	723	3136	6	0	1555	45
Conflicting Peds, #/hr	0	0	0	0	0	0	6	0	0	0	0	6
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	Stop	-	-	None	-	-	None	-	-	Free
Storage Length	-	-	0	-	-	-	290	-	-	60	-	100
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	8	0	0	0	0	3	0	0	5	0
Mvmt Flow	0	0	215	0	0	0	777	3372	6	0	1672	48

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	4576	6605	842	5599	6602	1689	1672	0	0	3378	0	0
Stage 1	1672	1672	-	4930	4930	-	-	-	-	-	-	-
Stage 2	2904	4933	-	669	1672	-	-	-	-	-	-	-
Critical Hdwy	6.4	6.5	7.26	6.4	6.5	7.1	5.3	-	-	5.3	-	-
Critical Hdwy Stg 1	7.3	5.5	-	7.3	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.7	5.5	-	6.7	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.8	4	3.98	3.8	4	3.9	3.1	-	-	3.1	-	-
Pot Cap-1 Maneuver	1	0	254	0	0	72	~ 187	-	-	25	-	0
Stage 1	68	154	-	0	3	-	-	-	-	-	-	0
Stage 2	14	3	-	380	154	-	-	-	-	-	-	0
Platoon blocked, %												
Mov Cap-1 Maneuver	1	0	253	0	0	72	~ 186	-	-	25	-	-
Mov Cap-2 Maneuver	1	0	-	0	0	-	-	-	-	-	-	-
Stage 1	68	154	-	0	3	-	-	-	-	-	-	-
Stage 2	14	3	-	57	154	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	66.6	0	276.9	0
HCM LOS	F	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT
Capacity (veh/h)	~ 186	-	-	253	-	25
HCM Lane V/C Ratio	4.18	-	-	0.85	-	-
HCM Control Delay (s)	\$ 1480.2	-	-	66.6	0	0
HCM Lane LOS	F	-	-	F	A	A
HCM 95th %tile Q(veh)	77.7	-	-	6.9	-	0

**Notes**

-: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

# HCM Signalized Intersection Capacity Analysis

11: Main St (Hwy 87) & 6th Ave N

Future Year 2040 PM Peak Hour

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	0	0	0	462	130	19	106	3846	1131	0	1204	780	
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Total Lost time (s)				4.5	4.5		4.5	4.8	4.0		4.8	4.0	
Lane Util. Factor				0.91	0.91		1.00	0.91	1.00		0.95	0.88	
Flt				1.00	0.99		1.00	1.00	0.85		1.00	0.85	
Flt Protected				0.95	0.97		0.95	1.00	1.00		1.00	1.00	
Satd. Flow (prot)				1427	2917		1599	4506	1417		3106	2469	
Flt Permitted				0.95	0.97		0.14	1.00	1.00		1.00	1.00	
Satd. Flow (perm)				1427	2917		227	4506	1417		3106	2469	
Peak-hour factor, PHF	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	
Adj. Flow (vph)	0	0	0	557	157	23	128	4634	1363	0	1451	940	
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	0	
Lane Group Flow (vph)	0	0	0	278	457	0	128	4634	1363	0	1451	940	
Heavy Vehicles (%)	0%	0%	0%	3%	1%	0%	1%	3%	2%	0%	4%	3%	
Turn Type				Split	NA		pm+pt	NA	Free		NA	Free	
Protected Phases				4	4		1	2			2		
Permitted Phases							2		Free			Free	
Actuated Green, G (s)				25.5	25.5		110.7	106.2	150.0		106.2	150.0	
Effective Green, g (s)				25.5	25.5		110.7	106.2	150.0		106.2	150.0	
Actuated g/C Ratio				0.17	0.17		0.74	0.71	1.00		0.71	1.00	
Clearance Time (s)				4.5	4.5		4.5	4.8			4.8		
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0		
Lane Grp Cap (vph)				242	495		208	3190	1417		2199	2469	
v/s Ratio Prot				c0.19	0.16		0.02	c1.03			0.47		
v/s Ratio Perm							0.43		c0.96			0.38	
v/c Ratio				1.15	1.09dl		0.62	1.45	0.96		0.66	0.38	
Uniform Delay, d1				62.2	61.3		9.9	21.9	0.0		12.0	0.0	
Progression Factor				1.00	1.00		0.78	0.78	1.00		0.25	1.00	
Incremental Delay, d2				103.9	22.8		0.5	203.9	2.5		1.2	0.3	
Delay (s)				166.2	84.1		8.2	221.0	2.5		4.3	0.3	
Level of Service				F	F		A	F	A		A	A	
Approach Delay (s)		0.0			115.0			167.9			2.7		
Approach LOS		A			F			F			A		
<b>Intersection Summary</b>													
HCM 2000 Control Delay			121.0		HCM 2000 Level of Service					F			
HCM 2000 Volume to Capacity ratio			1.41										
Actuated Cycle Length (s)			150.0		Sum of lost time (s)				13.8				
Intersection Capacity Utilization			105.1%		ICU Level of Service				G				
Analysis Period (min)			15										
dl Defacto Left Lane. Recode with 1 though lane as a left lane.													
c Critical Lane Group													

# HCM Signalized Intersection Capacity Analysis

12: Main St (Hwy 87) & 4th Ave N

Future Year 2040 PM Peak Hour

														
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
Lane Configurations														
Volume (vph)	2148	9	362	0	0	0	0	2935	15	4	1919	0		
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700		
Total Lost time (s)	5.0	5.0						5.6		5.6	5.6			
Lane Util. Factor	0.86	0.86						0.91		1.00	0.91			
Frbp, ped/bikes	1.00	0.99						1.00		1.00	1.00			
Flpb, ped/bikes	1.00	1.00						1.00		1.00	1.00			
Frt	1.00	0.95						1.00		1.00	1.00			
Flt Protected	0.95	0.97						1.00		0.95	1.00			
Satd. Flow (prot)	2750	2619						4460		1615	4420			
Flt Permitted	0.95	0.97						1.00		0.05	1.00			
Satd. Flow (perm)	2750	2619						4460		91	4420			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92		
Adj. Flow (vph)	2335	10	393	0	0	0	0	3190	16	4	2086	0		
RTOR Reduction (vph)	0	2	0	0	0	0	0	1	0	0	0	0		
Lane Group Flow (vph)	1564	1172	0	0	0	0	0	3205	0	4	2086	0		
Confl. Peds. (#/hr)			3	3				1				1		
Heavy Vehicles (%)	1%	17%	4%	0%	0%	0%	0%	4%	0%	0%	5%	0%		
Turn Type	Perm	NA						NA		Perm	NA			
Protected Phases		4						2			2			
Permitted Phases	4									2				
Actuated Green, G (s)	65.0	65.0						74.4		74.4	74.4			
Effective Green, g (s)	65.0	65.0						74.4		74.4	74.4			
Actuated g/C Ratio	0.43	0.43						0.50		0.50	0.50			
Clearance Time (s)	5.0	5.0						5.6		5.6	5.6			
Vehicle Extension (s)	3.0	3.0						0.2		0.2	0.2			
Lane Grp Cap (vph)	1191	1134						2212		45	2192			
v/s Ratio Prot								c0.72			0.47			
v/s Ratio Perm	c0.57	0.45								0.04				
v/c Ratio	1.31	1.23dl						1.45		0.09	0.95			
Uniform Delay, d1	42.5	42.5						37.8		19.9	36.1			
Progression Factor	1.00	1.00						1.00		0.97	0.91			
Incremental Delay, d2	147.0	35.8						204.7		2.6	7.9			
Delay (s)	189.5	78.3						242.5		21.8	40.6			
Level of Service	F	E						F		C	D			
Approach Delay (s)		141.8			0.0			242.5			40.6			
Approach LOS		F			A			F			D			
<b>Intersection Summary</b>														
HCM 2000 Control Delay			155.7									HCM 2000 Level of Service	F	
HCM 2000 Volume to Capacity ratio			1.39											
Actuated Cycle Length (s)			150.0								10.6		Sum of lost time (s)	
Intersection Capacity Utilization			118.2%										ICU Level of Service	H
Analysis Period (min)			15											
dl Defacto Left Lane. Recode with 1 though lane as a left lane.														
c Critical Lane Group														

RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Information					Site Information					
Analyst	Brett Korporaal		Freeway/Dir of Travel	Airport Rd		Agency or Company	Kittelson & Associates, Inc.		Junction	Alkali Creek Rd
Date Performed	7/29/2015		Jurisdiction	MDT		Analysis Time Period	PM Peak Hour		Analysis Year	Future Year - 2040
Project Description Airport Rd/Main St - Billings										
Inputs										
Upstream Adj Ramp	Freeway Number of Lanes, N		2		Downstream Adj Ramp					
<input type="checkbox"/> Yes <input type="checkbox"/> On	Ramp Number of Lanes, N		1		<input type="checkbox"/> Yes <input type="checkbox"/> On					
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off	Acceleration Lane Length, L <sub>A</sub>		750		<input checked="" type="checkbox"/> No <input type="checkbox"/> Off					
L <sub>up</sub> = ft	Deceleration Lane Length L <sub>D</sub>				L <sub>down</sub> = ft					
V <sub>u</sub> = veh/h	Freeway Volume, V <sub>F</sub>		464		V <sub>D</sub> = veh/h					
	Ramp Volume, V <sub>R</sub>		261							
	Freeway Free-Flow Speed, S <sub>FF</sub>		55.0							
	Ramp Free-Flow Speed, S <sub>FR</sub>		25.0							
Conversion to pc/h Under Base Conditions										
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f <sub>HV</sub>	f <sub>p</sub>	v = V/PHF x f <sub>HV</sub> x f <sub>p</sub>		
Freeway	464	1.00	Rolling	5	0	0.930	1.00	499		
Ramp	261	1.00	Rolling	5	0	0.930	1.00	281		
UpStream										
DownStream										
Merge Areas					Diverge Areas					
Estimation of v <sub>12</sub>					Estimation of v <sub>12</sub>					
$V_{12} = V_F (P_{FM})$ (Equation 13-6 or 13-7) P <sub>FM</sub> = 1.000 using Equation (Exhibit 13-6) V <sub>12</sub> = 499 pc/h V <sub>3</sub> or V <sub>av34</sub> = 0 pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					$V_{12} = V_R + (V_F - V_R)P_{FD}$ (Equation 13-12 or 13-13) P <sub>FD</sub> = using Equation (Exhibit 13-7) V <sub>12</sub> = pc/h V <sub>3</sub> or V <sub>av34</sub> = pc/h (Equation 13-14 or 13-17) Is V <sub>3</sub> or V <sub>av34</sub> > 2,700 pc/h? <input type="checkbox"/> Yes <input type="checkbox"/> No Is V <sub>3</sub> or V <sub>av34</sub> > 1.5 * V <sub>12</sub> /2 <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, V <sub>12a</sub> = pc/h (Equation 13-16, 13-18, or 13-19)					
Capacity Checks					Capacity Checks					
	Actual	Capacity		LOS F?		Actual	Capacity		LOS F?	
V <sub>FO</sub>	780	Exhibit 13-8		No	V <sub>F</sub>		Exhibit 13-8			
					V <sub>FO</sub> = V <sub>F</sub> - V <sub>R</sub>		Exhibit 13-8			
					V <sub>R</sub>		Exhibit 13-10			
Flow Entering Merge Influence Area					Flow Entering Diverge Influence Area					
	Actual	Max Desirable		Violation?		Actual	Max Desirable		Violation?	
V <sub>R12</sub>	780	Exhibit 13-8		No	V <sub>12</sub>		Exhibit 13-8			
Level of Service Determination (if not F)					Level of Service Determination (if not F)					
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$ D <sub>R</sub> = 6.7 (pc/mi/ln) LOS = A (Exhibit 13-2)					$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D <sub>R</sub> = (pc/mi/ln) LOS = (Exhibit 13-2)					
Speed Determination					Speed Determination					
M <sub>S</sub> =	0.292 (Exhibit 13-11)				D <sub>S</sub> =	(Exhibit 13-12)				
S <sub>R</sub> =	51.2 mph (Exhibit 13-11)				S <sub>R</sub> =	mph (Exhibit 13-12)				
S <sub>0</sub> =	N/A mph (Exhibit 13-11)				S <sub>0</sub> =	mph (Exhibit 13-12)				
S =	51.2 mph (Exhibit 13-13)				S =	mph (Exhibit 13-13)				