

TRAFFIC ACCESSIBILITY STUDY

for

Chalice Acres Subdivision Lot 4

Billings, MT

Prepared for

KINCAID LAND, LLC

Prepared by



MARVIN & ASSOCIATES

**1300 North Transtech Way
Billings, MT 59102**

April 2014

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P.T.O.E. # 259

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Marvin & Associates

**Chalice Acres Subdivision Lot 4
TRAFFIC ACCESSIBILITY STUDY**

Chalice Acres Subdivision Lot 4 Traffic Accessibility Study

INTRODUCTION

This report summarizes a traffic accessibility study completed for the Chalice Acres Subdivision Lot 4 development in Billings, Montana. The proposed Chalice Acres Lot 4 property is located on the west side of Bench Boulevard approximately 850 feet south of the Wicks Lane and Bench Boulevard intersection (see Figure 1). This property is currently undeveloped and all of the surrounding property is occupied by businesses and residences.

Octagon Engineering prepared a site plan for the developer, Kincaid Land, LLC. The developer retained Marvin & Associates to provide a Traffic Accessibility Study (TAS) after having had discussions with City of Billings Public Works staff. City of Billings staff indicated that the study should focus on the accesses and the key intersection of Wicks Lane and Bench Boulevard. Therefore, this study focuses on the two site accesses and the intersection of Wicks Lane and Bench Boulevard.

The study methodology and analysis procedures within this study employ the latest technology and nationally accepted standards in the area of site development and transportation impact assessment. Recommendations made within this report are based on accepted standards and the professional judgment of the author.

SITE LOCATION & DESCRIPTION

Figure 1 shows the proposed Chalice Acres Lot 4 site plan overlaid on a Google aerial photo. There are two accesses proposed for the Chalice Acres Lot 4 property. The northern access would be aligned to enter Bench Boulevard opposite Kingston Avenue, a local street serving an existing townhouse development. The southern access would be located approximately 180 feet south of Kingston Avenue. There would be a single circulation road within the site that would access the four apartment buildings. Each of the buildings would have 10 apartment units.

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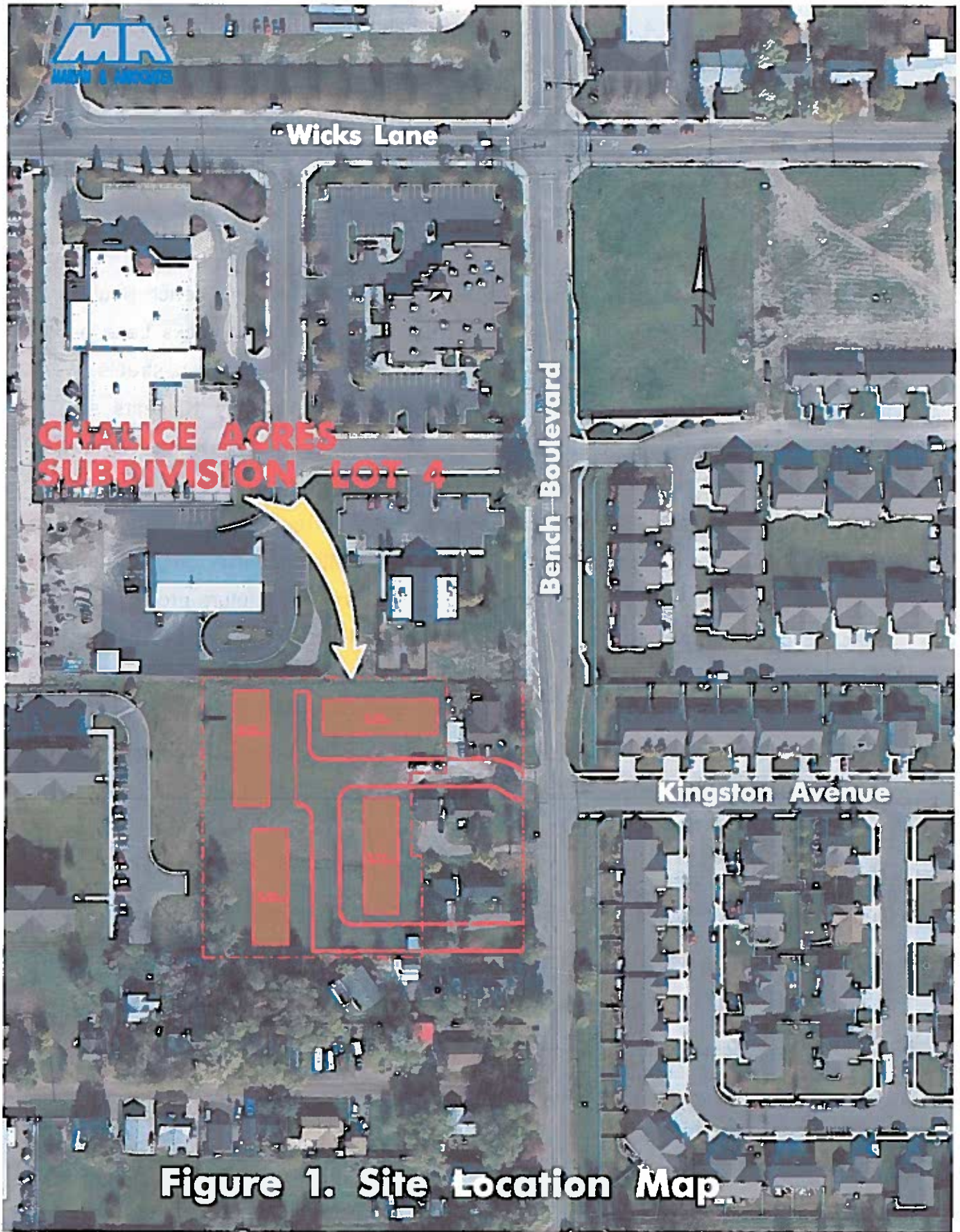


Figure 1. Site Location Map.

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The Chalice Acres Lot 4 apartments will have parking in front of each building and it has been assumed that the City of Billings Building Department has or will check that the number of spaces agree with City Building Codes.

EXISTING CONDITIONS

Streets & Intersections

The adjacent and potentially impacted streets are Wicks Lane and Bench Boulevard, along with the intersection of those two streets (see Figure 1). Wicks Lane and a portion of Bench Boulevard, along with the intersection of those two streets, were reconstructed as part of the Walmart development approximately 12 years ago. A project that connected Bench Boulevard to Main Street at 6th Avenue North was constructed in 2012 and reconstruction of Bench Boulevard from Metra to Hilltop Road was completed in 2013. The new connection resulted in redistribution of traffic at the Bench Boulevard and Wicks Lane intersection. Traffic patterns are substantially different than those used to design the original intersection. A future project has also been designed that will reconstruct Bench Boulevard from Hilltop Road to HWY 87 at Main Street, north of Wicks Lane. That project will result in modifications to the Wicks Lane and Bench Boulevard intersection and the typical section all along Bench Boulevard. The future typical section on Bench Boulevard will accommodate two thru lanes with a center two-way left-turn lane with bike lanes on each side of the roadway.

Traffic Volumes

Turning movement counts were taken between 4:30 and 5:45 pm on April 1 and April 2, 2014 at the Wicks Lane and Kingston Avenue intersections with Bench Boulevard. Figure 2, on the following page, illustrates turning movement counts and average weekday traffic (AWT) on the surrounding streets and intersections. AWT volumes in Figure 2 were not counted but were estimated using turning movement counts and daily traffic variation factors from the MDT permanent count station data on Main Street.

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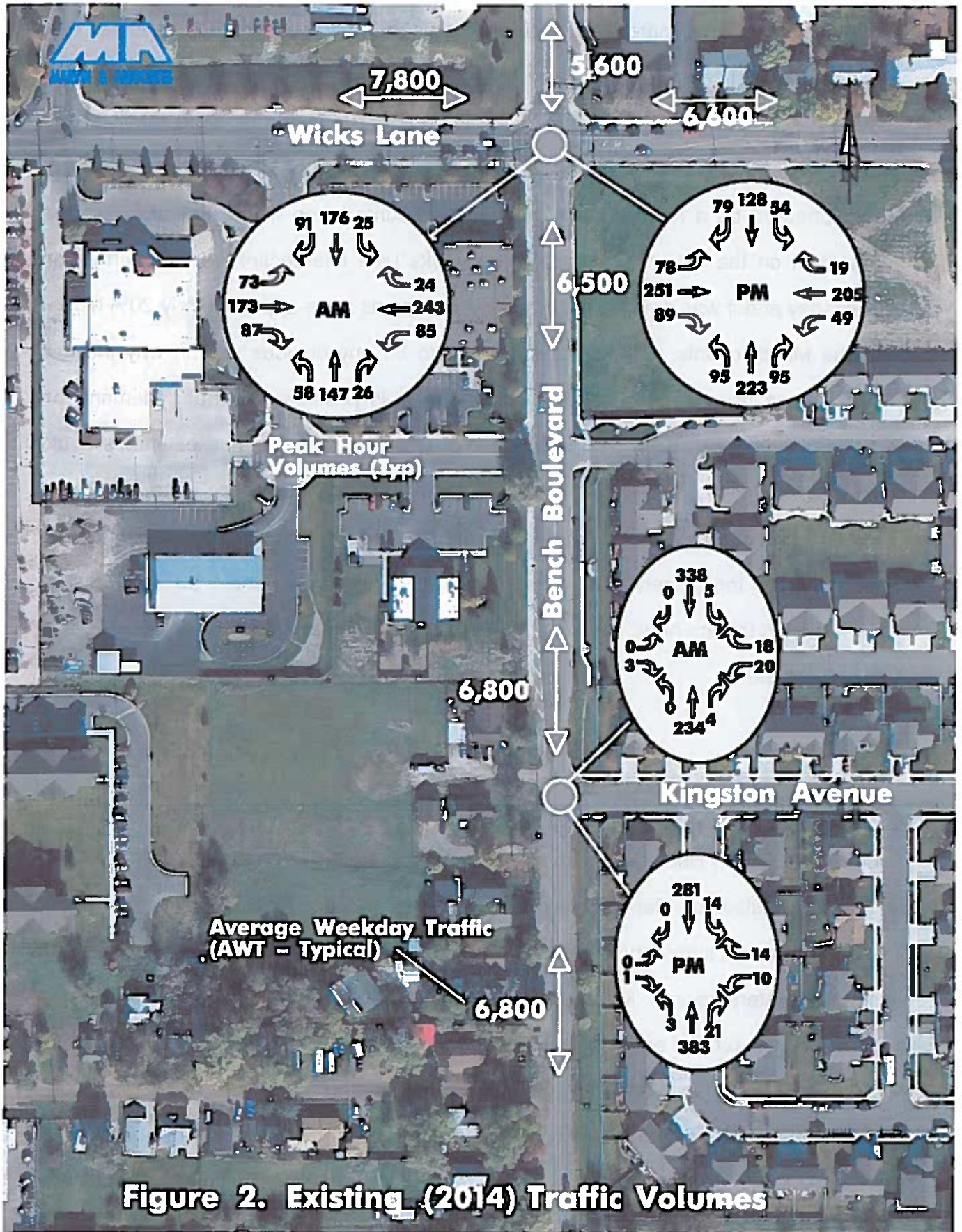


Figure 2. Existing (2014) Traffic Volumes

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The traffic counts are approximately the same as the average peak hour volumes that would be experienced at these intersections over the course of a year, according to the daily and seasonal factors. It should be noted that traffic counts were taken at the intersection of Wicks lane and Bench Boulevard on Thursday March 27, 2014. Since there appeared to be a large imbalance between counts taken at the Kingston Avenue intersection on the following Tuesday, the Wicks lane intersection was recounted on Wednesday and it was determined that the April counts were approximately 20% higher than the March counts. There doesn't appear to be any obvious reason why the two counts should have been substantially different. It is possible that traffic demand on Bench Boulevard can be highly variable. Thus, design hour volume estimates could have a low level of confidence. Peak am hour traffic volumes were calculated using directional splits, historic hourly counts, and a traffic balancing routine. Since the peak pm hour trip generation potential of the development would be substantially greater than in the am hour, it was felt that the cost of performing actual am hour counts was not justified.

Capacity

Capacity calculations were completed for the stop controlled intersection of Kingston Avenue and Bench Boulevard and for the signal controlled intersection of Wicks Lane and Bench Boulevard. Capacity calculations can be found in Appendix A of this report. Table 1 provides a summary of measures of effectiveness (MOEs) for each approach at each of the intersections. MOEs include the control delay in seconds per vehicle, the level of service (LOS), and the volume to capacity (V/C) for each of the intersection approach legs. It can be seen that all of the movements at both of the intersections have a LOS of "B" or better, which indicates that all movements are operating at acceptable levels of service.

Chalice Acres Subdivision Lot 4 Traffic Accessibility Study

Table 1. Capacity Analysis Summary 2014 Existing Conditions

Intersection	MOE	NB		SB		EB		WB	
<i>Movement Group</i>		L	TR	L	TR	L	TR	L	TR
<i>Bench Boulevard & Wicks Lane Peak AM Hour</i>	Control Delay (s/veh)	10.4	10.9	9.9	11.4	11.2	12.0	11.3	12.1
	LOS	B	B	A	B	B	B	B	B
	V/C Ratio	0.16	0.26	0.06	0.34	0.20	0.35	0.21	0.36
	Queue Length (95%)	2	3	1	4	2	4	2	5
<i>Movement Group</i>		L	TR	L	TR	L	TR	L	TR
<i>Bench Boulevard & Wicks Lane Peak AM Hour</i>	Control Delay (s/veh)	10.8	12.1	10.4	10.9	11.2	12.8	11.0	11.8
	LOS	B	B	B	B	B	B	B	B
	V/C Ratio	0.23	0.45	0.16	0.26	0.20	0.46	0.15	0.30
	Queue Length (95%)	6	6	2	4	3	5	2	4
<i>Movement Group</i>		LTR		LTR		LR		LR	
<i>Kingston Avenue & Bench Boulevard Peak AM Hour</i>	Control Delay (s/veh)	8.0		7.8		10.4		13.3	
	LOS	A		A		B		B	
	V/C Ratio	0.00		0.00		0.01		0.10	
	Queue Length (95%)	0.0		0.0		0.0		0.4	
<i>Movement Group</i>		LTR		LTR		LR		LR	
<i>Kingston Avenue & Bench Boulevard Peak PM Hour</i>	Control Delay (s/veh)	7.9		8.4		9.9		14.6	
	LOS	A		A		B		B	
	V/C Ratio	0.00		0.01		0.00		0.08	
	Queue Length (95%)	0.0		0.0		0.0		0.3	

TRIP GENERATION

Trip generation rates found in the ITE Trip Generation report, Ninth Edition, were evaluated and it was found that these rates could be applied specifically to the type of development being proposed on this site. The ITE Trip Generation Code 220 for Apartments was used with the independent variable for this land-use being the number of apartments (40 units). The following rates and calculations were used:

AWT: $T=6.65(X) = 6.65(40) = 266$ AWT

Peak AM: $T=0.49(X)+3.73 = 0.49(40)+3.73 = 23$ (20% entering)

Peak PM: $T=0.55(X)+17.65 = 0.55(40)+17.65 = 40$ (65% entering)

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The following peak am and pm hour trip generation numbers would apply to the two accesses:

AM Hour:	5 Enter	18 Exit
PM Hour:	26 Enter	14 Exit

In addition to total trip generation numbers, it is sometimes important to know the type of trips to properly evaluate traffic impacts. Some percentage of total trips could be assigned to the pedestrian mode, since there are significant complimentary trip attractors within walking distance of the proposed development. However the total trip generation numbers are so low that any fraction thereof would be irrelevant.

Internal capture trips are of significant importance for certain developments. In this case, it doesn't appear that there would be any significant internal capture trips.

There are also three classifications of trip types related to use of the street system: 1) Primary purpose trips are trips for which the development is a primary destination from any particular origin. 2) Diverted linked trips are trips made to the development as a secondary destination and are diverted from a path between an origin and a primary destination. 3) Passerby trips are also trips made to a development as a secondary destination, but the primary trip path is on the adjacent street system, i.e. stop on the way home from work. For this development, it was assumed that no passerby trips could be considered.

The combination of all trip types results in the net number of new or system added trips. In this case, the net number of trips would equal the total trips as stated above.

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TRIP DISTRIBUTION

There are various methods of determining the directional distribution of trips to and from site developments and subdivisions. For large and complex developments within the middle of a large urbanized area, the task is best accomplished by creating a computerized transportation model of the urban street system and including the proposed development changes. Trip distribution for moderate sized developments may be completed by manipulation of data provided by a current transportation plan. Smaller developments or developments on the fringe of a small urban area can be easily handled by using existing traffic volumes on adjacent streets or by an area of influence method, or both. In this case, the use of existing traffic patterns at the existing intersections would provide an acceptable means of distributing trips.

The analogy method of trip distribution resulted in an estimated distribution of 45% to and from the north and 55% to and from the south on the Bench Boulevard. Of the 45% trips distributed north of the site, 30% would be directed to and from the west on Wicks Lane with 10% to and from the north on Bench Boulevard and the remaining 5% would be to and from the east on Wicks Lane.

TRAFFIC ASSIGNMENT

Assignment of site traffic to the street system and site access points is normally dependent upon several factors, directional distribution, passerby distribution and operational conditions at the site and on the street system. Directional distribution was discussed in the previous section. Assignment of traffic to the access points is influenced by internal site circulation, number of approaches, internal travel time and capacity of the access movements. In this case, it was determined that travel times and delays would result in approximately 45% of the site traffic assigned to the north access and 55% to the south access, which is directly proportional to the trip distribution.

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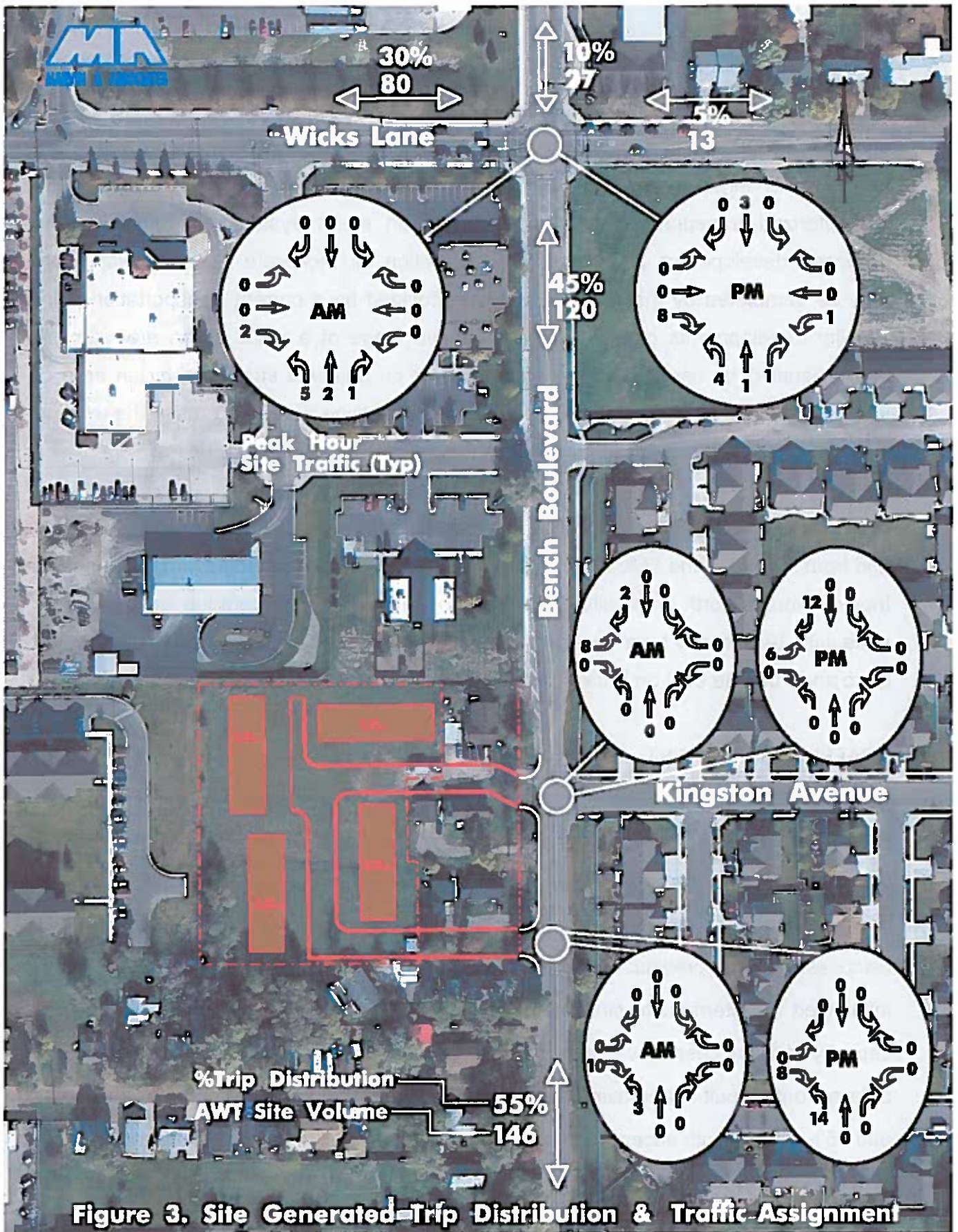


Figure 3. Site Generated Trip Distribution & Traffic Assignment

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Figure 3 shows the percentage trip distribution, average weekday traffic (AWT) assignment, and the peak am and pm hour traffic assignments. It can be seen that in the am and pm hours all of the traffic to and from the north would use the northern approach and all of the site traffic to and from the south would use the southern approach due to the relative travel times and delays associated with each access. In actual operations, there may be vehicles accessing the site using all of the turning movement options for a variety of reasons, but the theoretical demand for those movements shown as zero would not exist based on the site development circulation and access patterns.

TRAFFIC IMPACTS

Traffic Volumes

Figure 4 presents a summary of peak am and pm hour volumes at the access points and on the surrounding street system. The turning movement volumes are calculated by adding the site traffic assignment to existing traffic volumes. Also shown in Figure 4, are the relative percentage increase that site traffic would add to existing AWT volumes. The largest percentages increases would occur on Bench Boulevard adjacent to the proposed development due to access movements into and out of the site. The percentage increase in traffic on Bench Boulevard would only be approximately 2%. Normally traffic counting samples can only estimate average traffic conditions within 10% accuracy and from the two separate counts taken at Wicks and Bench, it appears that traffic volumes can vary by more than 20% in a one week period. Therefore, it can be assumed that the 2% increase could be considered insignificant.

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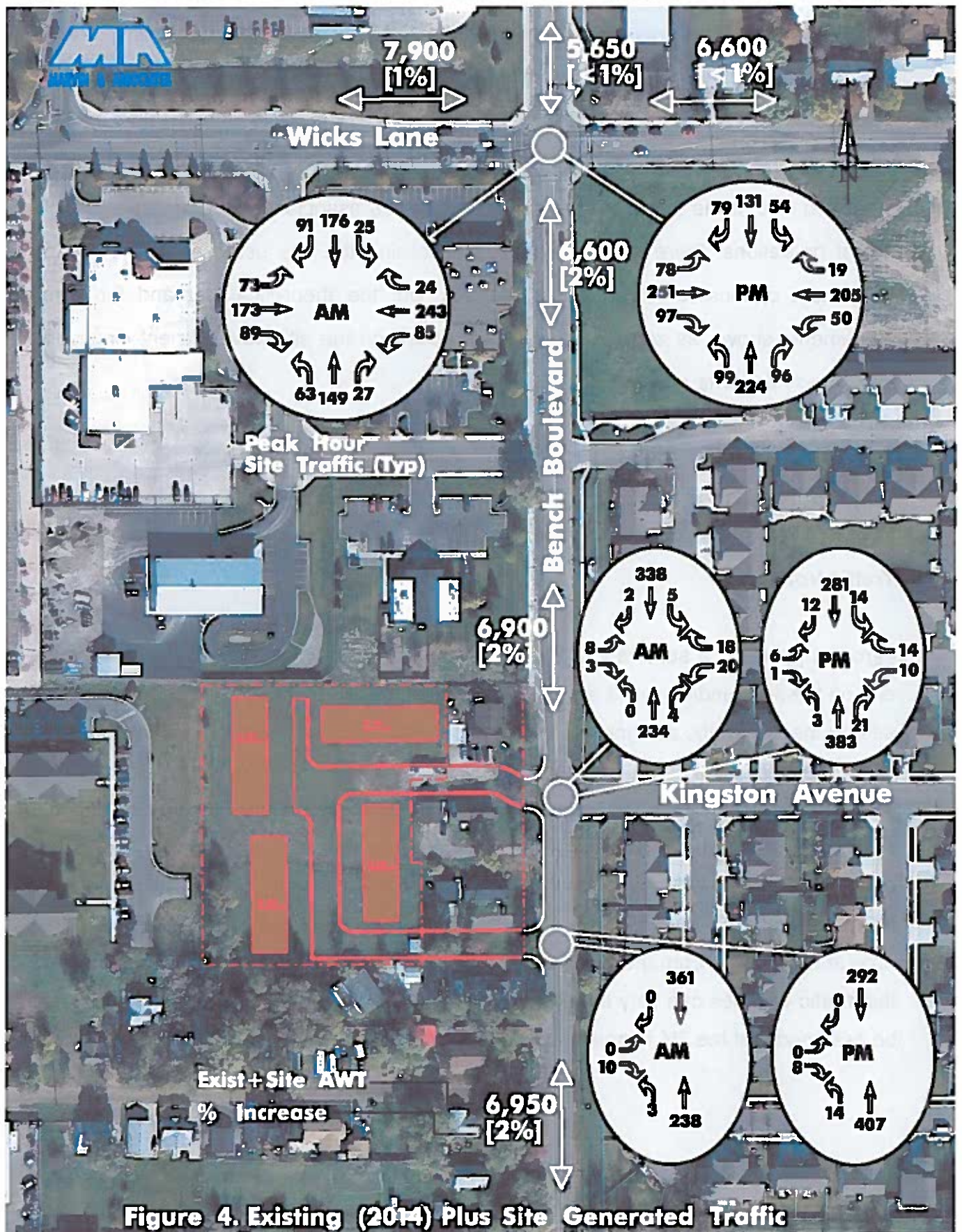


Figure 4. Existing (2014) Plus Site Generated Traffic

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Capacity Impacts

Appendix "B" contains capacity calculations for existing plus site traffic (peak hour) conditions. Table 2 is a summary of capacity impacts at the site accesses and at the intersection of Wicks Lane and Bench Boulevard in the same format as contained in Table 1.

Table 2. Capacity Analysis Summary 2014 Existing Plus Site Traffic

Intersection	MOE	NB		SB		EB		WB	
		L	TR	L	TR	L	TR	L	TR
<i>Movement Group</i>		L	TR	L	TR	L	TR	L	TR
<i>Bench Boulevard & Wicks Lane Peak AM Hour</i>	<i>Control Delay (s/veh)</i>	10.5	10.9	9.9	11.4	11.2	12.1	11.3	12.1
	<i>LOS</i>	B	B	A	B	B	B	B	B
	<i>V/C Ratio</i>	0.17	0.26	0.06	0.34	0.20	0.35	0.21	0.36
	<i>Queue Length (95%)</i>	3	4	1	4	2	4	2	5
<i>Movement Group</i>		L	TR	L	TR	L	TR	L	TR
<i>Bench Boulevard & Wicks Lane Peak AM Hour</i>	<i>Control Delay (s/veh)</i>	10.8	12.1	10.4	10.9	11.2	12.9	11.0	11.8
	<i>LOS</i>	B	B	B	B	B	B	B	B
	<i>V/C Ratio</i>	0.24	0.45	0.16	0.26	0.20	0.47	0.16	0.30
	<i>Queue Length (95%)</i>	5	5	2	4	4	6	2	3
<i>Movement Group</i>		LTR		LTR		LR		LR	
<i>Kingston Avenue & Bench Boulevard Peak AM Hour</i>	<i>Control Delay (s/veh)</i>	8.0		7.8		14.5		13.4	
	<i>LOS</i>	A		A		B		B	
	<i>V/C Ratio</i>	0.00		0.00		0.05		0.10	
	<i>Queue Length (95%)</i>	0.0		0.0		0.2		0.4	
<i>Movement Group</i>		LTR		LTR		LR		LR	
<i>Kingston Avenue & Bench Boulevard Peak PM Hour</i>	<i>Control Delay (s/veh)</i>	7.9		8.4		17.8		14.7	
	<i>LOS</i>	A		A		C		B	
	<i>V/C Ratio</i>	0.00		0.01		0.05		0.08	
	<i>Queue Length (95%)</i>	0.0		0.0		0.2		0.3	
<i>Movement Group</i>		LT				LR			
<i>Southern Site Access & Bench Boulevard Peak AM Hour</i>	<i>Control Delay (s/veh)</i>	8.0				10.7			
	<i>LOS</i>	A				B			
	<i>V/C Ratio</i>	0.00				0.03			
	<i>Queue Length (95%)</i>	0.0				0.1			
<i>Movement Group</i>		LTR				LR			
<i>Southern Site Access & Bench Boulevard Peak PM Hour</i>	<i>Control Delay (s/veh)</i>	7.9				10.1			
	<i>LOS</i>	A				B			
	<i>V/C Ratio</i>	0.01				0.02			
	<i>Queue Length (95%)</i>	0.0				0.1			

In comparing Table 1 to Table 2 it can be seen that all movements at the accesses and intersection would still operate at or above LOS "B". It can also be seen that the addition of site generated traffic to the proposed access at the Kingston Avenue intersection would operate at LOS "C" while the south access would operate at LOS "B". Since none of the MOEs would be impacted to any significant degree, it could be

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concluded that additional traffic generated by the site development would not impact the efficiency of existing traffic operations.

Safety Impacts

In addition to capacity impacts, safety of the proposed site layout and access would be a prime factor in consideration of impacts to the street system. Increased traffic volumes at the access points wouldn't necessarily result in an increased number of accidents due to increased exposure rates. At certain points along the system, usually at intersections, safety concerns are the greatest. From observations of existing conditions, the biggest factor that could be involved with potential safety would be sight distance at the approaches. Since there are no immovable objects that currently obstruct sight distance, the only obstructions would be queued vehicles. Since there are only single lanes in each direction and the capacity calculations indicate that queues will be no more than a single vehicle, conflicts should not exist. Turn lane warrants were examined and it was discovered that the projected traffic volumes would be well under the warranting values.

Pedestrians

Pedestrian access to the site from the public street system is not expected to be significant and the movement of pedestrians between adjacent developments doesn't have the potential to be substantial. Existing pedestrian traffic in the area was minimal with the only pedestrian activity occurring at the intersection of Wicks and Bench.

FUTURE ACCESS OPERATIONS

Consideration of access operations in the future need to be assessed to determine if future traffic increases on the roadway system would change the efficiency of the proposed accesses. Since a future MDT project will widen Bench Boulevard and will provide a continuous center turn-lane, bike lanes and sidewalks, evaluation of future operations assumed that the improvements would be in-place within the next 5 years. Capacity calculations using an annual growth rate of 2% along with the planned typical road section were completed (Appendix C). It was determined that the northern access

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at the intersection of Kingston Avenue would operate at LOS "C" while the southern access would operate at LOS "B". Thus, the planned access should provide acceptable levels of service in future years.

CONCLUSIONS & RECOMMENDATIONS

The proposed subdivision development would generate new vehicular trips on the existing street system. On a daily basis, new traffic on Bench Boulevard would represent an increase of approximately 2% of existing traffic volumes on Bench Boulevard. The proposed accesses to the site property would operate at acceptable levels of service initially and well into the future. Capacity calculations at the existing intersection of Wicks Lane and Bench Boulevard indicate that the proposed site development traffic would not degrade existing levels of service to any substantial degree and additional vehicle queues at that intersection would not impede operations on Bench Boulevard.

The only identifiable development conditions that need to be addressed would be associated with potential safety concerns. The study analysis indicates that no additional measures such as additional traffic lanes are warranted as a mitigation measure. Since the development accesses will be constructed as street approaches, it would be necessary to install stop signs at their intersections with Bench Boulevard. Internally, traffic speeds should be relatively low (20 mph or less). However, the internal curves are 90 degree turns and the line of sight on the inside of those curves could present a safety problem if any permanent structure or landscaping is placed in the corner areas. Therefore, the sight lines on those corners should be maintained (see Figure 5).

Figure 5 shows new driveway locations for two of the three existing residential houses fronting on Bench Boulevard. The existing driveways would be too close to the access streets and the driveway approaches should be moved to the new subdivision streets, as shown.

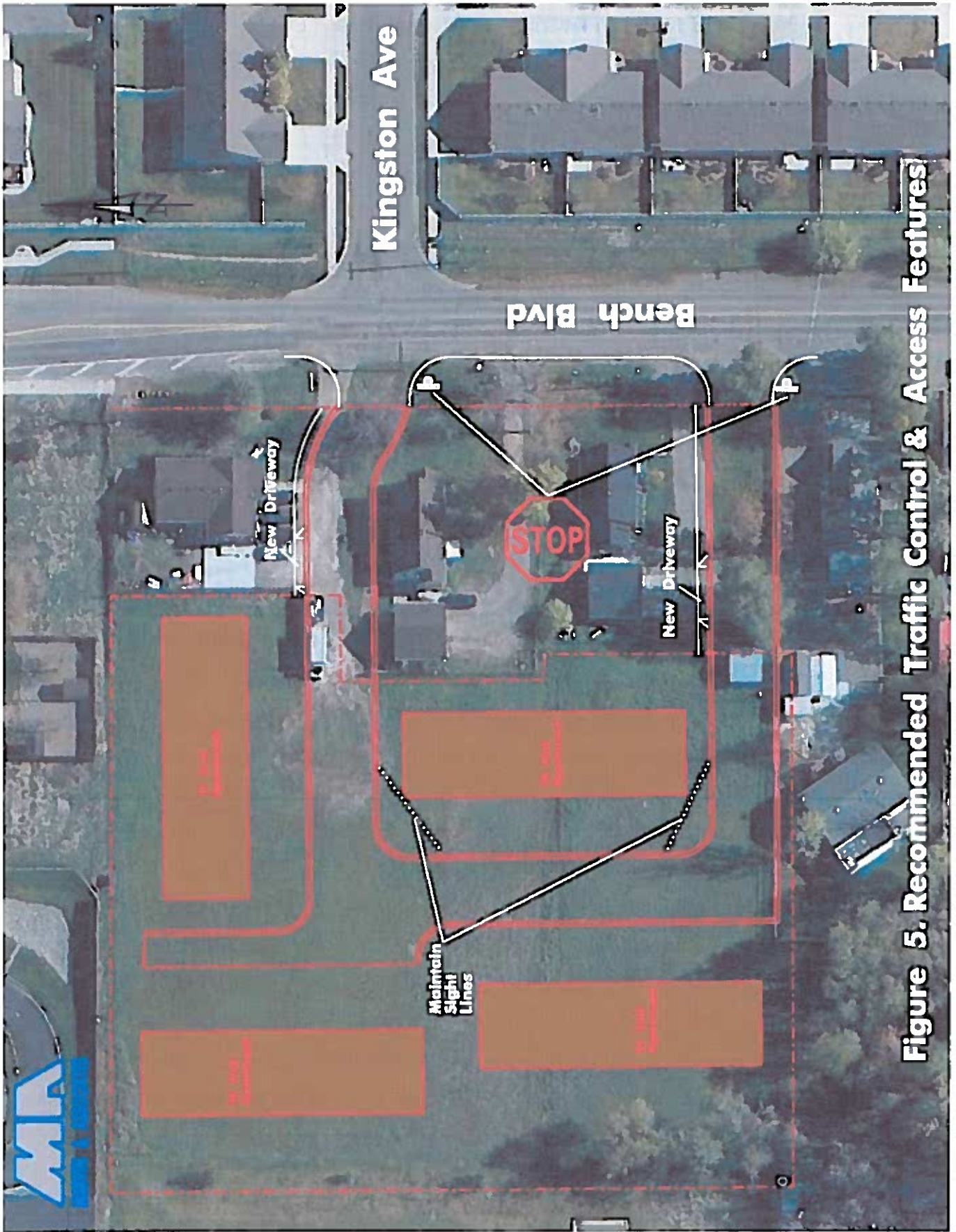


Figure 5. Recommended Traffic Control & Access Features

APPENDIX "A"

Existing Capacity Calculations

HCM Analysis Summary

2014 Existing
R Marvin
AM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist AM

Area Type: Non CBD
Analysis Duration: 15 mins.

Lanes			Geometry: Movements Serviced by Lane and Lane Widths (feet)											
Approach	Outbound		Lane 1		Lane 2		Lane 3		Lane 4		Lane 5		Lane 6	
EB	2	1	L	12.0	TR	12.0								
WB	2	1	L	12.0	TR	12.0								
NB	2	1	L	12.0	TR	12.0								
SB	2	1	L	12.0	TR	12.0								
Data			East			West			North			South		
			L	T	R	L	T	R	L	T	R	L	T	R
Movement Volume (vph)			73	173	87	85	243	24	58	147	26	25	176	91
PHF			0.86	0.86	0.86	0.91	0.91	0.91	0.80	0.80	0.80	0.87	0.87	0.87
% Heavy Vehicles			0	0	0	0	0	0	0	0	0	0	0	0
Lane Groups			L	TR		L	TR		L	TR		L	TR	
Arrival Type			3	3		3	3		3	3		3	3	
RTOR Vol (vph)			32			8			8			35		
Peds/Hour			5			5			5			5		
% Grade			0			0			0			0		
Buses/Hour			0			0			0			0		
Parkers/Hour (Left Right)			--		--	--		--	--		--	--		--
Signal Settings: Actuated			Operational Analysis				Cycle Length: 60.0 Sec				Lost Time Per Cycle: 9.0 Sec			
Phase:			1	2	3	4	5	6	7	8	Ped Only			
EB			LTP											
WB			LTP											
NB				LTP										
SB				LTP										
Green			25.0	26.0										0
Yellow	All Red		3.5	1.0	3.5	1.0								

Capacity Analysis Results									Approach:	
App	Lane Group	Cap (vph)	v/s Ratio	g/C Ratio	Lane Group	v/c Ratio	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
EB	L	423	0.084	0.417	L	0.201	11.2	B	11.8	B
	TR	762	0.145	0.417	TR	0.348	12.0	B		
WB	L	441	0.088	0.417	L	0.211	11.3	B	11.9	B
	* TR	784	0.152	0.417	TR	0.364	12.1	B		
NB	L	462	0.068	0.433	L	0.156	10.4	B	10.8	B
	TR	809	0.110	0.433	TR	0.255	10.9	B		
SB	L	515	0.024	0.433	L	0.056	9.9	A	11.2	B
	* TR	793	0.145	0.433	TR	0.335	11.4	B		

NETSIM Summary Results

2014 Existing
R Marvin
AM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist AM

App	Lane Group	Queues Per Lane Avg/Max (veh)	Average Speed (mph)	Spillback in Worst Lane (% of Peak Period)	
EB	L	1 / 2	10.7	0.0	
	TR	2 / 4	18.4	0.0	
	All		16.9	0.0	
WB	L	1 / 2	15.1	0.0	
	TR	3 / 5	16.7	0.0	
	All		16.5	0.0	
NB	L	1 / 2	9.9	0.0	
	TR	2 / 3	17.9	0.0	
	All		16.0	0.0	
SB	L	0 / 1	12.2	0.0	
	TR	3 / 4	17.1	0.0	
	All		16.7	0.0	
Intersect.			16.5		

HCM Analysis Summary

2014 Existing
R Marvin
PM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist PM

Area Type: Non CBD
Analysis Duration: 15 mins.

Lanes			Geometry: Movements Serviced by Lane and Lane Widths (feet)											
	Approach	Outbound	Lane 1		Lane 2		Lane 3		Lane 4		Lane 5		Lane 6	
EB	2	I	L	12.0	TR	12.0								
WB	2	I	L	12.0	TR	12.0								
NB	2	I	L	12.0	TR	12.0								
SB	2	I	L	12.0	TR	12.0								
Data	East			West			North			South				
	L	T	R	L	T	R	L	T	R	L	T	R		
Movement Volume (vph)	78	251	89	49	205	19	95	223	95	54	128	79		
PHF	0.86	0.86	0.86	0.91	0.91	0.91	0.80	0.80	0.80	0.87	0.87	0.87		
% Heavy Vehicles	0	0	0	0	0	0	0	0	0	0	0	0		
Lane Groups	L	TR		L	TR		L	TR		L	TR			
Arrival Type	3	3		3	3		3	3		3	3			
RTOR Vol (vph)	36			6			32			31				
Peds/Hour	5			5			5			5				
% Grade	0			0			0			0				
Buses/Hour	0			0			0			0				
Parkers/Hour (Left Right)	---		---	---		---	---		---	---		---		
Signal Settings: Actuated		Operational Analysis				Cycle Length: 60.0 Sec				Lost Time Per Cycle: 9.0 Sec				
Phase:	1	2	3	4	5	6	7	8	Ped Only					
EB	LTP													
WB	LTP													
NB		LTP												
SB		LTP												
Green	25.0	26.0										0		
Yellow	All Red	3.5	1.0	3.5	1.0									

Capacity Analysis Results									Approach:	
App	Lane Group	Cap (vph)	v/s Ratio	g/C Ratio	Lane Group	v/c Ratio	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
EB	L	465	0.082	0.417	L	0.196	11.2	B	12.5	B
	* TR	770	0.192	0.417	TR	0.460	12.8	B		
WB	L	363	0.062	0.417	L	0.149	11.0	B	11.6	B
	TR	785	0.127	0.417	TR	0.304	11.8	B		
NB	L	517	0.100	0.433	L	0.230	10.8	B	11.8	B
	* TR	795	0.195	0.433	TR	0.450	12.1	B		
SB	L	381	0.071	0.433	L	0.163	10.4	B	10.8	B
	TR	789	0.111	0.433	TR	0.256	10.9	B		

NETSIM Summary Results

2014 Existing
R Marvin
PM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist PM

App	Lane Group	Queues Per Lane Avg/Max (veh)	Average Speed (mph)	Spillback in Worst Lane (% of Peak Period)	
EB	L	1 / 3	11.1	0.0	
	TR	4 / 5	17.6	0.0	
	All		16.5	0.0	
WB	L	1 / 2	8.9	0.0	
	TR	2 / 4	18.2	0.0	
	All		17.0	0.0	
NB	L	2 / 6	7.8	0.0	
	TR	3 / 6	16.2	0.0	
	All		14.2	0.0	
SB	L	1 / 2	9.6	0.0	
	TR	2 / 4	18.7	0.0	
	All		16.9	0.0	
Intersect.			15.8		

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information				
Analyst	R Marvin		Intersection	Bench & Kingston			
Agency/Co.	Marvin Associates		Jurisdiction	City of Billings			
Date Performed	4/2/2014		Analysis Year	2014 Existing			
Analysis Time Period	Peak AM						
Project Description Chalice Acres Sub Lot 4							
East/West Street: Kingston Avenue			North/South Street: Bench Boulevard				
Intersection Orientation: North-South			Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	0	234	4	5	338	0	
Peak-Hour Factor, PHF	0.81	0.81	0.81	0.89	0.89	1.00	
Hourly Flow Rate, HFR (veh/h)	0	288	4	5	379	0	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	LTR			LTR			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	0		3	20		18	
Peak-Hour Factor, PHF	0.50	1.00	0.50	0.75	1.00	0.75	
Hourly Flow Rate, HFR (veh/h)	0	0	6	26	0	24	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration	LR			LR			
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	LTR	LTR	LR			LR	
v (veh/h)	0	5	50			6	
C (m) (veh/h)	1191	1281	482			672	
v/c	0.00	0.00	0.10			0.01	
95% queue length	0.00	0.01	0.35			0.03	
Control Delay (s/veh)	8.0	7.8	13.3			10.4	
LOS	A	A	B			B	
Approach Delay (s/veh)	--	--	13.3			10.4	
Approach LOS	--	--	B			B	

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information			
Analyst	R Marvin			Intersection	Bench & Kingston		
Agency/Co.	Marvin Associates			Jurisdiction	City of Billings		
Date Performed	4/2/2014			Analysis Year	2014 Existing		
Analysis Time Period	Peak PM						
Project Description Chalice Acres Sub Lot 4							
East/West Street: Kingston Avenue				North/South Street: Bench Boulevard			
Intersection Orientation: North-South				Study Period (hrs): 0.25			
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	3	383	21	14	281	0	
Peak-Hour Factor, PHF	0.81	0.81	0.81	0.89	0.89	0.89	
Hourly Flow Rate, HFR (veh/h)	3	472	25	15	315	0	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	LTR			LTR			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	0		1	10		14	
Peak-Hour Factor, PHF	0.50	1.00	0.50	0.75	1.00	0.75	
Hourly Flow Rate, HFR (veh/h)	0	0	2	13	0	18	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration		LR			LR		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	LTR	LTR	LR			LR	
v (veh/h)	3	15	31			2	
C (m) (veh/h)	1257	1077	406			730	
v/c	0.00	0.01	0.08			0.00	
95% queue length	0.01	0.04	0.25			0.01	
Control Delay (s/veh)	7.9	8.4	14.6			9.9	
LOS	A	A	B			A	
Approach Delay (s/veh)	--	--	14.6			9.9	
Approach LOS	--	--	B			A	

APPENDIX "B"

Existing Plus Site Traffic Capacity Calculations

HCM Analysis Summary

2014 Existing Plus Site
R Marvin
AM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist Plus AM

Area Type: Non CBD
Analysis Duration: 15 mins.

Lanes			Geometry: Movements Served by Lane and Lane Widths (feet)											
	Approach	Outbound	Lane 1		Lane 2		Lane 3		Lane 4		Lane 5		Lane 6	
EB	2	1	L	12.0	TR	12.0								
WB	2	1	L	12.0	TR	12.0								
NB	2	1	L	12.0	TR	12.0								
SB	2	1	L	12.0	TR	12.0								
Data	Fast			West			North			South				
	L	T	R	L	T	R	L	T	R	L	T	R		
Movement Volume (vph)	73	173	89	85	243	24	63	149	27	25	176	91		
PHF	0.86	0.86	0.86	0.91	0.91	0.91	0.80	0.80	0.80	0.87	0.87	0.87		
% Heavy Vehicles	0	0	0	0	0	0	0	0	0	0	0	0		
Lane Groups	L	TR		L	TR		L	TR		L	TR			
Arrival Type	3	3		3	3		3	3		3	3			
RTOR Vol (vph)	32			8			8			35				
Peds/Hour	5			5			5			5				
% Grade	0			0			0			0				
Buses/Hour	0			0			0			0				
Parkers/Hour (Left Right)	---		---		---		---		---		---			
Signal Settings: Actuated		Operational Analysis				Cycle Length: 60.0 Sec				Lost Time Per Cycle: 9.0 Sec				
Phase:	1	2	3	4	5	6	7	8	Ped Only					
EB	LTP													
WB	LTP													
NB		LTP												
SB		LTP												
Green	25.0	26.0										0		
Yellow	All Red	3.5	1.0	3.5	1.0									

Capacity Analysis Results									Approach:	
App	Lane Group	Cap (vph)	v/s Ratio	g/C Ratio	Lane Group	v/c Ratio	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
EB	L	423	0.084	0.417	L	0.201	11.2	B	11.9	B
	TR	761	0.146	0.417	TR	0.351	12.1	B		
WB	L	439	0.088	0.417	L	0.212	11.3	B	11.9	B
	* TR	784	0.152	0.417	TR	0.364	12.1	B		
NB	L	462	0.074	0.433	L	0.171	10.5	B	10.8	B
	TR	809	0.113	0.433	TR	0.260	10.9	B		
SB	L	514	0.024	0.433	L	0.056	9.9	A	11.2	B
	* TR	793	0.145	0.433	TR	0.335	11.4	B		

NETSIM Summary Results

2014 Existing Plus Site
R Marvin
AM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist Plus AM

App	Lane Group	Queues Per Lane Avg/Max (veh)	Average Speed (mph)	Spillback in Worst Lane (% of Peak Period)	
EB	L	1 / 2	10.4	0.0	
	TR	3 / 4	18.1	0.0	
	All		16.6	0.0	
WB	L	1 / 2	14.6	0.0	
	TR	3 / 5	16.6	0.0	
	All		16.4	0.0	
NB	L	1 / 3	7.5	0.0	
	TR	2 / 4	18.8	0.0	
	All		15.5	0.0	
SB	L	0 / 1	12.3	0.0	
	TR	3 / 4	17.2	0.0	
	All		16.8	0.0	
Intersect.			16.3		

HCM Analysis Summary

2014 Existing Plus Site
R Marvin
PM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist Plus PM

Area Type: Non CBD
Analysis Duration: 15 mins.

Geometry: Movements Serviced by Lane and Lane Widths (feet)

Lanes			Geometry: Movements Serviced by Lane and Lane Widths (feet)											
Approach	Outbound		Lane 1		Lane 2		Lane 3		Lane 4		Lane 5		Lane 6	
EB	2	1	L	12.0	TR	12.0								
WB	2	1	L	12.0	TR	12.0								
NB	2	1	L	12.0	TR	12.0								
SB	2	1	L	12.0	TR	12.0								
Data			East			West			North			South		
			L	T	R	L	T	R	L	T	R	L	T	R
Movement Volume (vph)			78	251	97	50	205	19	99	224	96	54	131	79
PHF			0.86	0.86	0.86	0.91	0.91	0.91	0.80	0.80	0.80	0.87	0.87	0.87
% Heavy Vehicles			0	0	0	0	0	0	0	0	0	0	0	0
Lane Groups			L	TR		L	TR		L	TR		L	TR	
Arrival Type			3	3		3	3		3	3		3	3	
RTOR Vol (vph)			36			6			32			31		
Peds/Hour			5			5			5			5		
% Grade			0			0			0			0		
Buses/Hour			0			0			0			0		
Parkers/Hour (Left Right)			---		---	---		---	---		---	---		---
Signal Settings: Actuated			Operational Analysis					Cycle Length: 60.0 Sec			Lost Time Per Cycle: 9.0 Sec			
Phase:			1	2	3	4	5	6	7	8				Ped Only
EB			LTP											
WB			LTP											
NB				LTP										
SB				LTP										
Green			25.0	26.0										0
Yellow	All Red		3.5	1.0	3.5	1.0								

Capacity Analysis Results

App	Lane Group	Cap (vph)	v/s Ratio	g/C Ratio	Lane Group	v/c Ratio	Delay (sec/veh)	LOS	Approach:	
									Delay (sec/veh)	LOS
EB	L	465	0.082	0.417	L	0.196	11.2	B	12.5	B
	* TR	767	0.197	0.417	TR	0.473	12.9	B		
WB	L	355	0.065	0.417	L	0.155	11.0	B	11.6	B
	TR	785	0.127	0.417	TR	0.304	11.8	B		
NB	L	515	0.104	0.433	L	0.241	10.8	B	11.8	B
	* TR	795	0.196	0.433	TR	0.453	12.1	B		
SB	L	379	0.071	0.433	L	0.164	10.4	B	10.8	B
	TR	789	0.113	0.433	TR	0.261	10.9	B		

NETSIM Summary Results

2014 Existing Plus Site
R Marvin
PM Hour

Wicks/Bench
4/3/14
Case: Bench Wicks Capacity Exist Plus PM

App	Lane Group	Queues Per Lane Avg/Max (veh)	Average Speed (mph)	Spillback in Worst Lane (% of Peak Period)	
EB	L	1 / 4	9.5	0.0	
	TR	4 / 6	17.2	0.0	
	All		15.9	0.0	
WB	L	1 / 2	7.6	0.0	
	TR	2 / 3	18.0	0.0	
	All		16.5	0.0	
NB	L	1 / 5	9.7	0.0	
	TR	3 / 5	17.4	0.0	
	All		15.8	0.0	
SB	L	1 / 2	10.1	0.0	
	TR	2 / 4	18.4	0.0	
	All		16.8	0.0	
Intersect.			16.1		

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information				
Analyst	R Marvin		Intersection	Bench & Kingston			
Agency/Co.	Marvin Associates		Jurisdiction	City of Billings			
Date Performed	4/2/2014		Analysis Year	2014 Existing Plus Site			
Analysis Time Period	Peak AM						
Project Description Chalice Acres Sub Lot 4							
East/West Street: Kingston Avenue			North/South Street: Bench Boulevard				
Intersection Orientation: North-South			Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	0	234	4	5	338	2	
Peak-Hour Factor, PHF	0.81	0.81	0.81	0.89	0.89	0.89	
Hourly Flow Rate, HFR (veh/h)	0	288	4	5	379	2	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	LTR			LTR			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	8		3	20		18	
Peak-Hour Factor, PHF	0.50	1.00	0.50	0.75	1.00	0.75	
Hourly Flow Rate, HFR (veh/h)	16	0	6	26	0	24	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration		LR			LR		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	LTR	LTR		LR			LR
v (veh/h)	0	5		50			22
C (m) (veh/h)	1189	1281		481			401
v/c	0.00	0.00		0.10			0.05
95% queue length	0.00	0.01		0.35			0.17
Control Delay (s/veh)	8.0	7.8		13.4			14.5
LOS	A	A		B			B
Approach Delay (s/veh)	--	--		13.4			14.5
Approach LOS	--	--		B			B

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information				
Analyst	R Marvin		Intersection	Bench & Kingston			
Agency/Co.	Marvin Associates		Jurisdiction	City of Billings			
Date Performed	4/2/2014		Analysis Year	2014 Existing Plus			
Analysis Time Period	Peak PM						
Project Description <i>Chalice Acres Sub Lot 4</i>							
East/West Street: <i>Kingston Avenue</i>			North/South Street: <i>Bench Boulevard</i>				
Intersection Orientation: <i>North-South</i>			Study Period (hrs): <i>0.25</i>				
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	3	383	21	14	281	12	
Peak-Hour Factor, PHF	0.81	0.81	0.81	0.89	0.89	0.89	
Hourly Flow Rate, HFR (veh/h)	3	472	25	15	315	13	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	<i>Undivided</i>						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	<i>LTR</i>			<i>LTR</i>			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	6		1	10		14	
Peak-Hour Factor, PHF	0.50	1.00	0.50	0.75	1.00	0.75	
Hourly Flow Rate, HFR (veh/h)	12	0	2	13	0	18	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		<i>N</i>			<i>N</i>		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration		<i>LR</i>			<i>LR</i>		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	<i>LTR</i>	<i>LTR</i>		<i>LR</i>			<i>LR</i>
v (veh/h)	3	15		31			14
C (m) (veh/h)	1243	1077		403			296
v/c	0.00	0.01		0.08			0.05
95% queue length	0.01	0.04		0.25			0.15
Control Delay (s/veh)	7.9	8.4		14.7			17.8
LOS	<i>A</i>	<i>A</i>		<i>B</i>			<i>C</i>
Approach Delay (s/veh)	--	--		14.7			17.8
Approach LOS	--	--		<i>B</i>			<i>C</i>

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information			
Analyst	R Marvin			Intersection	South Access & Bench		
Agency/Co.	Marvin Associates			Jurisdiction	City of Billings		
Date Performed	4/3/2014			Analysis Year	2014 Existing Plus Site		
Analysis Time Period	Peak AM						
Project Description <i>Chalice Acres Sub Lot 4</i>							
East/West Street: <i>Southern Access</i>				North/South Street: <i>Bench Blvd</i>			
Intersection Orientation: <i>North-South</i>				Study Period (hrs): <i>0.25</i>			
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	3	238			361	0	
Peak-Hour Factor, PHF	0.90	0.90	1.00	1.00	0.90	0.90	
Hourly Flow Rate, HFR (veh/h)	3	264	0	0	401	0	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	<i>Undivided</i>						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	<i>LT</i>						<i>TR</i>
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	0		10				
Peak-Hour Factor, PHF	0.50	1.00	0.50	1.00	1.00	1.00	
Hourly Flow Rate, HFR (veh/h)	0	0	20	0	0	0	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		<i>N</i>			<i>N</i>		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration		<i>LR</i>					
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	<i>LT</i>						<i>LR</i>
v (veh/h)	3						20
C (m) (veh/h)	1169						653
v/c	0.00						0.03
95% queue length	0.01						0.09
Control Delay (s/veh)	8.1						10.7
LOS	<i>A</i>						<i>B</i>
Approach Delay (s/veh)	--	--					10.7
Approach LOS	--	--					<i>B</i>

TWO-WAY STOP CONTROL SUMMARY								
General Information				Site Information				
Analyst	R Marvin			Intersection	South Access & Bench			
Agency/Co.	Marvin Associates			Jurisdiction	City of Billings			
Date Performed	4/3/2014			Analysis Year	2014 Existing Plus Site			
Analysis Time Period	Peak PM							
Project Description Chalice Acres Sub Lot 4								
East/West Street: Southern Access				North/South Street: Bench Blvd				
Intersection Orientation: North-South				Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments								
Major Street	Northbound			Southbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)	14	407			292	0		
Peak-Hour Factor, PHF	0.92	0.92	1.00	1.00	0.90	0.90		
Hourly Flow Rate, HFR (veh/h)	15	442	0	0	324	0		
Percent Heavy Vehicles	0	--	--	0	--	--		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration	LT					TR		
Upstream Signal		0			0			
Minor Street	Eastbound			Westbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	0		8					
Peak-Hour Factor, PHF	0.50	1.00	0.50	1.00	1.00	1.00		
Hourly Flow Rate, HFR (veh/h)	0	0	16	0	0	0		
Percent Heavy Vehicles	0	0	0	0	0	0		
Percent Grade (%)	0			0				
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	0	0	0	0	0		
Configuration		LR						
Delay, Queue Length, and Level of Service								
Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	15						16	
C (m) (veh/h)	1247						722	
v/c	0.01						0.02	
95% queue length	0.04						0.07	
Control Delay (s/veh)	7.9						10.1	
LOS	A						B	
Approach Delay (s/veh)	--	--				10.1		
Approach LOS	--	--				B		

APPENDIX "C"

Future Conditions Capacity at Accesses

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information			
Analyst	R Marvin			Intersection	Bench & Kingston		
Agency/Co.	Marvin Associates			Jurisdiction	City of Billings		
Date Performed	4/2/2014			Analysis Year	Year 2020 Conditions		
Analysis Time Period	Peak PM						
Project Description Chalice Acres Sub Lot 4							
East/West Street: Kingston Avenue				North/South Street: Bench Boulevard			
Intersection Orientation: North-South				Study Period (hrs): 0.25			
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	3	435	21	16	320	12	
Peak-Hour Factor, PHF	0.83	0.83	0.83	0.91	0.91	0.91	
Hourly Flow Rate, HFR (veh/h)	3	524	25	17	351	13	
Percent Heavy Vehicles	0	--	--	0	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	1	1	0	1	1	0	
Configuration	L		TR	L		TR	
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	6		1	12		16	
Peak-Hour Factor, PHF	0.50	1.00	0.50	0.75	1.00	0.75	
Hourly Flow Rate, HFR (veh/h)	12	0	2	16	0	21	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	0	0	0	0	0	
Configuration		LR			LR		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	L	L		LR			LR
v (veh/h)	3	17		37			14
C (m) (veh/h)	1206	1031		356			255
v/c	0.00	0.02		0.10			0.05
95% queue length	0.01	0.05		0.34			0.17
Control Delay (s/veh)	8.0	8.6		16.3			19.9
LOS	A	A		C			C
Approach Delay (s/veh)	--	--		16.3			19.9
Approach LOS	--	--		C			C

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information					
Analyst	R Marvin		Intersection	South Access & Bench				
Agency/Co.	Marvin Associates		Jurisdiction	City of Billings				
Date Performed	4/3/2014		Analysis Year	2020 Conditions				
Analysis Time Period	Peak PM							
Project Description Chalice Acres Sub Lot 4								
East/West Street: Southern Access			North/South Street: Bench Blvd					
Intersection Orientation: North-South			Study Period (hrs): 0.25					
Vehicle Volumes and Adjustments								
Major Street	Northbound			Southbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)	14	462			333	0		
Peak-Hour Factor, PHF	0.92	0.92	1.00	1.00	0.90	0.90		
Hourly Flow Rate, HFR (veh/h)	15	502	0	0	370	0		
Percent Heavy Vehicles	0	–	–	0	–	–		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	1	1	0	0	1	0		
Configuration	L	T				TR		
Upstream Signal		0			0			
Minor Street	Eastbound			Westbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	0		8					
Peak-Hour Factor, PHF	0.50	1.00	0.50	1.00	1.00	1.00		
Hourly Flow Rate, HFR (veh/h)	0	0	16	0	0	0		
Percent Heavy Vehicles	0	0	0	0	0	0		
Percent Grade (%)	0			0				
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	0	0	0	0	0		
Configuration		LR						
Delay, Queue Length, and Level of Service								
Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L						LR	
v (veh/h)	15						16	
C (m) (veh/h)	1200						680	
v/c	0.01						0.02	
95% queue length	0.04						0.07	
Control Delay (s/veh)	8.0						10.4	
LOS	A						B	
Approach Delay (s/veh)	–	--					10.4	
Approach LOS	–	--					B	

