10PL021

ELKS CROSSING

RAPID CITY, SOUTH DAKOTA

TRAFFIC IMPACT ANALYSIS

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I. INTRODUCTION

The Elks Crossing development is proposed to be located east of Elk Vale Road along the future extension of Minnesota Street in the City of Rapid City, South Dakota. The proposed development would cover approximately 115 acres within the Southeast Connector Neighborhood in Rapid City, South Dakota. Land uses proposed for the site include 200 multi-family residential units, 135 single family units, 33,000 Square Feet of office development, and approximately 367,000 Square Feet of retail development. Future retail development would be clustered along Elk Vale Road, while residential development would cover the east portion of the site. The roadway network in the vicinity of the site can be seen on **Figure 1**.

Currently eastern access to Elk Vale Road is provided by a right-in-right-out intersection at Willowbend Road. In the future, the Willowbend Road access would be eliminated and access to the site would primarily be provided via the connection of Minnesota Street east of Elk Vale Road. Marlin Drive would provide for traffic circulation within the site, running parallel to and east of Elk Vale Road, which can be seen on **Figure 2**.

The purposes of this study are to assess the traffic impacts on the adjacent roadways related to the proposed development and to determine the necessary intersection geometry and signalization requirements for the intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive. To accomplish these objectives, two future scenarios are considered:

- **Short-Term Future**. This scenario examines the traffic impacts at Year 2011 associated with partial buildout of the site completed. A portion of the site north of Minnesota Street would be constructed during this scenario. Minnesota Street would be extended east from Elk Vale Road to serve the Elks Crossing development and the surrounding developments of Elks Country Estates and Elk Meadows, but would not connect to Jolly Lane.
- **Long-Term Future**. This scenario examines the traffic impacts at Year 2030 associated with full buildout of the site. Minnesota Street would be extended west from Elk Vale Road as a Minor Arterial, and east past Jolly Lane. The Long-Term Future assumes complete buildout of the proposed development and the surrounding developments of Elks Country Estates and Elk Meadows, and other surrounding developments shown in the draft Southeast Connector Neighborhood Future Land Use Plan (www.rcgov.org).

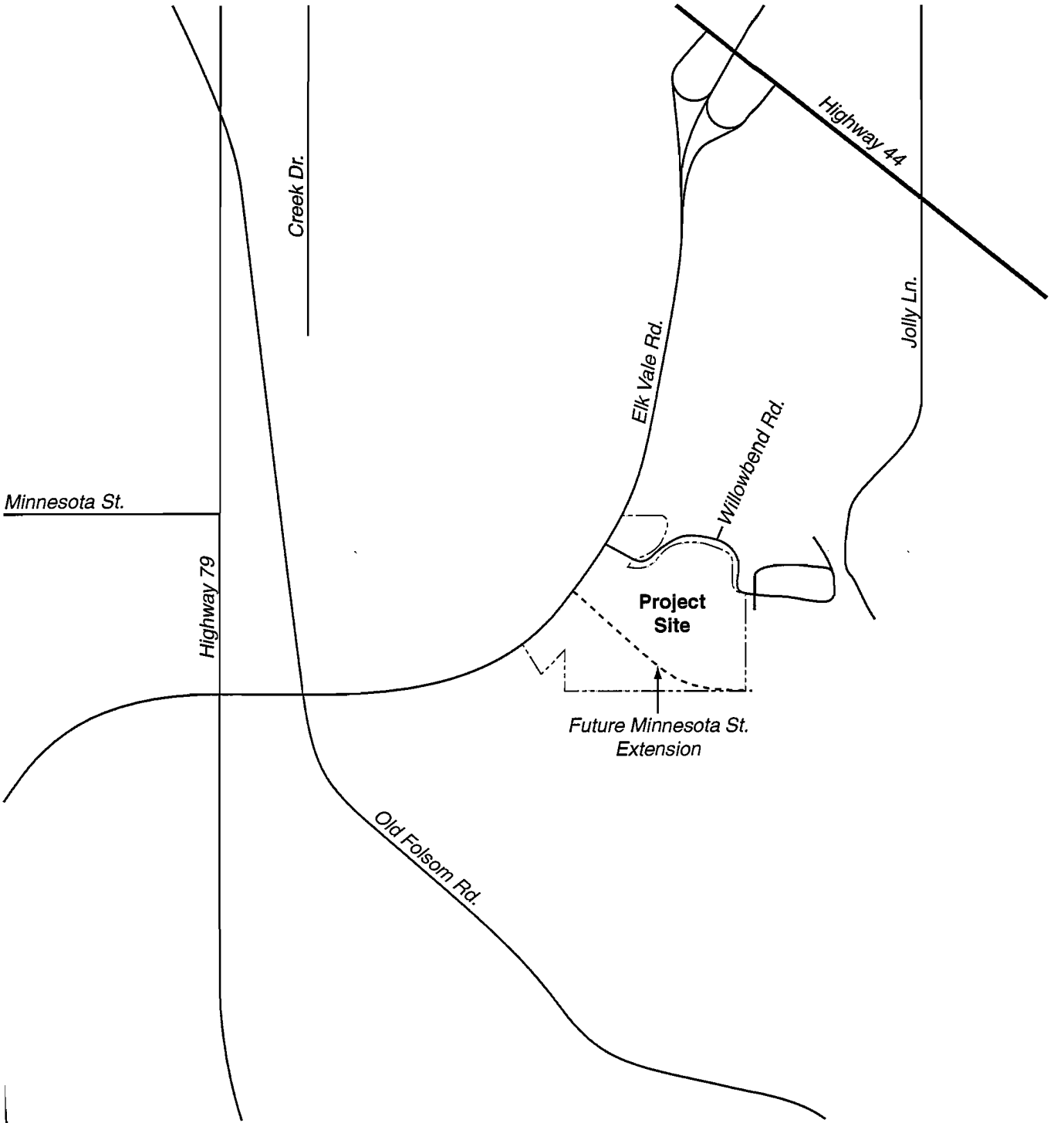

Figure 1
Project Vicinity

NOTE: Drawing Not to Scale

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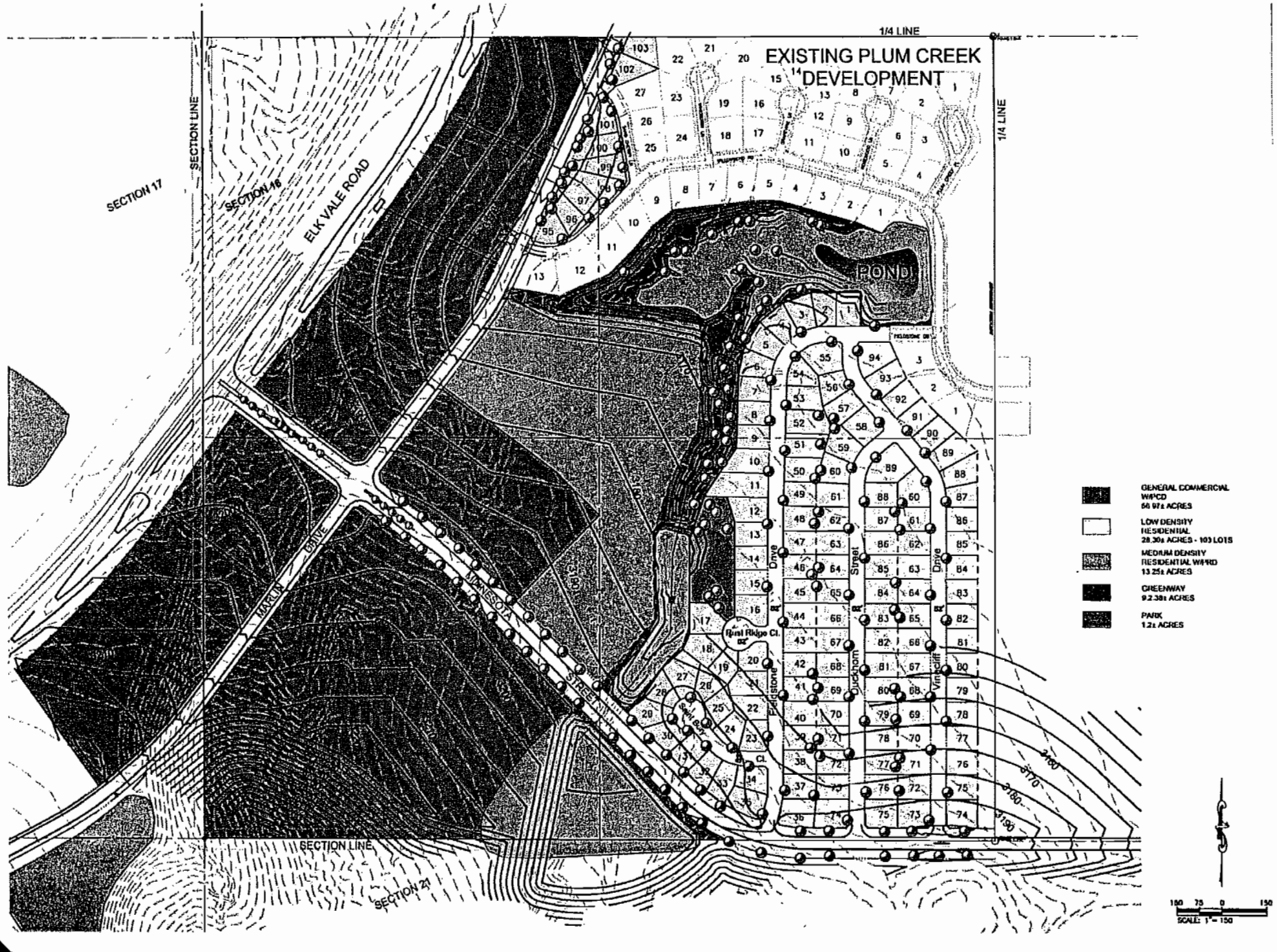

Figure 2
Site Plan

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II. EXISTING CONDITIONS

A. Existing Roadway Network

- ***Elk Vale Road***. A Principal Arterial, Elk Vale Road has a north-south orientation in the vicinity of the site and a posted speed limit of 60 MPH. Elk Vale Road is four lanes wide and provides a regional connection to and through Rapid City north of the site.
- ***South Dakota (SD) Highway 44***. This highway has a southeast-northwest orientation and runs across Rapid City as Omaha Street. In the vicinity of the site, Highway 44 is a four lane arterial providing access to downtown Rapid City north of the site.
- ***South Dakota Highway 79***. This highway has a north-south orientation and runs across Rapid City as Cambell Street. In the vicinity of the site, Highway 79 is a four lane arterial providing access to downtown Rapid City west of the site.
- ***Jolly Lane***. A Collector roadway, Jolly Lane extends north from the Elks Country Estates development to SD 44.

B. Surrounding Land Use

Located in the City of Rapid City, the proposed development site is located east of Elk Vale Road and west of the existing Elks Country Estates. Surrounding land use in the vicinity of the intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive includes residential development east of the site, including the developments of Elks Country Estates and Elk Meadows. South of the site, office and commercial development is planned. To the west of Elk Vale Road, office, commercial, and residential is planned along the future extension of Minnesota Street. **Figure 4** depicts existing and future development in the vicinity of the site.

C. Existing Traffic Volumes

Existing traffic volumes at the Elk Vale Road / Willowbend Road intersection are presented on **Figure 3**. Traffic counts were conducted during November of 2008 during the weekday PM peak hour. Morning peak hour volumes were estimated based upon the PM peak. The counts were performed at the intersection of Willowbend Road, north of the future site, to account for existing traffic at Elks Country Estates, which is allowed right-in-right-out access to Elk Vale Road.

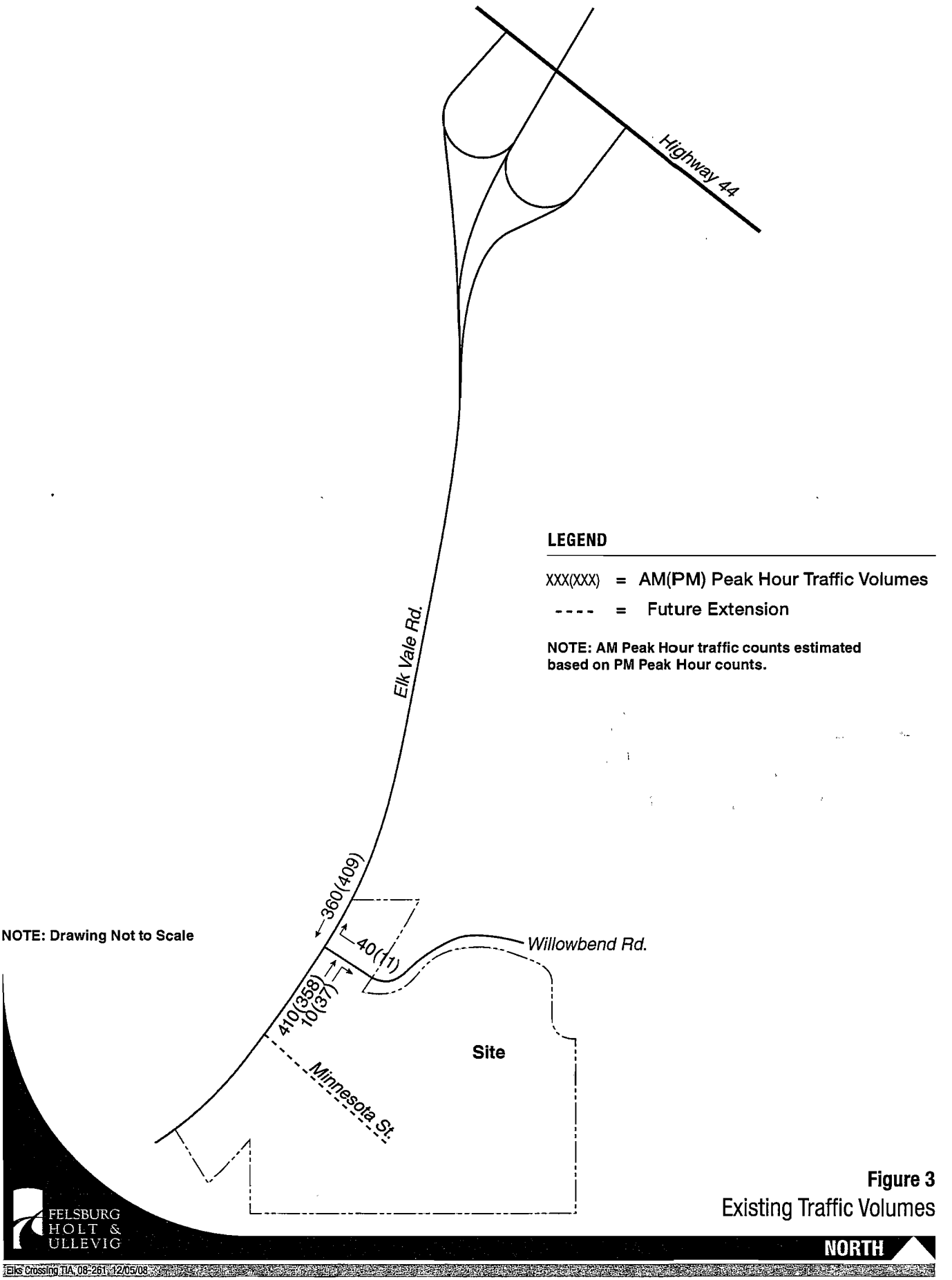


Figure 3
Existing Traffic Volumes

III. FUTURE CONDITIONS WITHOUT DEVELOPMENT

A. *Future Roadway Network Improvements*

As shown on **Figure 4**, the following roadway improvements are anticipated to occur in the future without the proposed development.

- ***Minnesota Street***. Minnesota Street would be constructed to create a minor arterial providing access between Highway 79 and locations east of the proposed site.
- ***Jolly Lane***. Jolly Lane would be extended as a Collector from the existing location at Elks Country Estates south through Elk Meadows, connecting with the Minnesota Street extension.
- Several southern roads would be constructed to connect Minnesota Street south through the zoned office, commercial, and residential.
- ***Fairmont Boulevard***. Fairmont Boulevard would be extended west to Elk Vale Road as a Minor Arterial in the Long-Term Future.

B. *Short-Term Future (Year 2011) Background Traffic Conditions*

Traffic Volumes
The following steps were taken to project Short-Term Future background traffic volumes:

1. PM peak hour traffic counts were conducted at the intersection of Elk Vale Road with Willowbend Road. AM peak hour counts were estimated based on the PM peak hour results.

2. The Willowbend connection to Elk Vale Road is planned to be closed when Minnesota Street is constructed. To account for this change, counted traffic volumes were shifted to the Elk Vale / Minnesota Street intersection.

3. Based on the Rapid City Regional Travel Demand model, an annual growth rate of 3.2 percent was applied to existing traffic volumes along Elk Vale Road.

4. Traffic volumes generated by future development surrounding the site were added to account for new residential development within the Elks County Estates and Elks Meadows subdivisions. It was assumed that proposed new development of Elks Meadows would reach 50 percent of total buildout by the Year 2011.

Figure 4 identifies the Short-Term Future background development parcels east of the project site. Year 2011 projected traffic volumes can be seen on **Figure 5**.

Traffic Operations
To address Short-Term Future traffic operations along Elk Vale Road without the development, intersection analyses were conducted using the techniques from the HCM-2000.

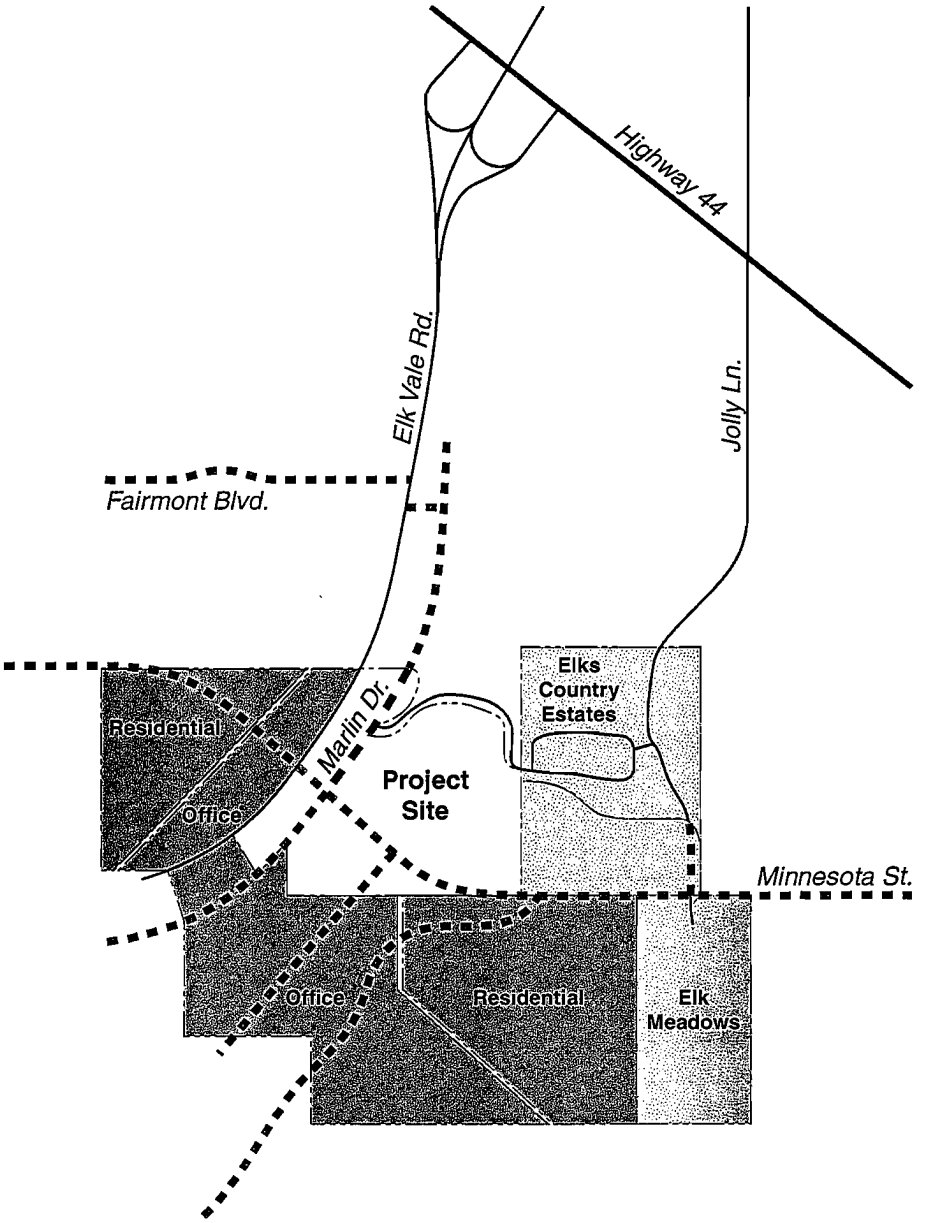
Traffic operations within the study area were evaluated according to techniques documented in the Highway Capacity Manual, (Transportation Research Board, 2000) using the existing traffic volumes and intersection geometry. Level of Service (LOS) is a qualitative measure of traffic operational conditions, based on roadway capacity and vehicle delay. Level of Service is described by a letter designation ranging from A to F, with LOS A representing almost free-flow travel, while LOS F represents congested conditions. For signalized intersections, LOS is calculated for the entire intersection while LOS for unsignalized intersections is calculated for movements which must yield right-of-way to other traffic movements.

Figure 5 shows the results for projected Year 2011 background traffic conditions, including traffic control devices and intersection lane geometry. The stop controlled approach at Minnesota Street / Marlin Drive and the signalized intersection at Elk Vale Road / Minnesota Street would operate at LOS C or better during both peak hours.

Operational results are described below by intersection:

- **Elk Vale Road / Minnesota Road:** This proposed intersection Short-Term Future background traffic conditions were evaluated based on information included in the *Manual on Uniform Traffic Control Devices* (MUTCD) which indicate that the intersection would meet Warrant 3, Peak Hour criteria for signalization. The proposed signalized intersection is anticipated to operate at LOS C during both peak hours by the Year 2011.
- **Minnesota Road / Marlin Drive:** This proposed intersection Short-Term Future background traffic conditions were evaluated based on information included in the *Manual on Uniform Traffic Control Devices* (MUTCD) which indicate that the intersection would not warrant signalization. Therefore, with construction of the Minnesota Street / Marlin Drive intersection, it is anticipated that southbound Marlin Drive would be STOP sign controlled. This planned traffic control device would result in satisfactory peak hour operations at all critical movements. All movements are anticipated to operate at LOS B or better during both peak hours.

Level of service worksheets for Year 2011 background traffic may be found in **Appendix A**.



LEGEND

- = Short-Term & Long-Term Future Development
- = Long-Term Future Development in Southeast Connector LU Plan
- = Long-Term Future Roadway Network
- = Short-Term Future Roadway Network

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NOTE: Drawing Not to Scale

Figure 4
Background Development Parcels

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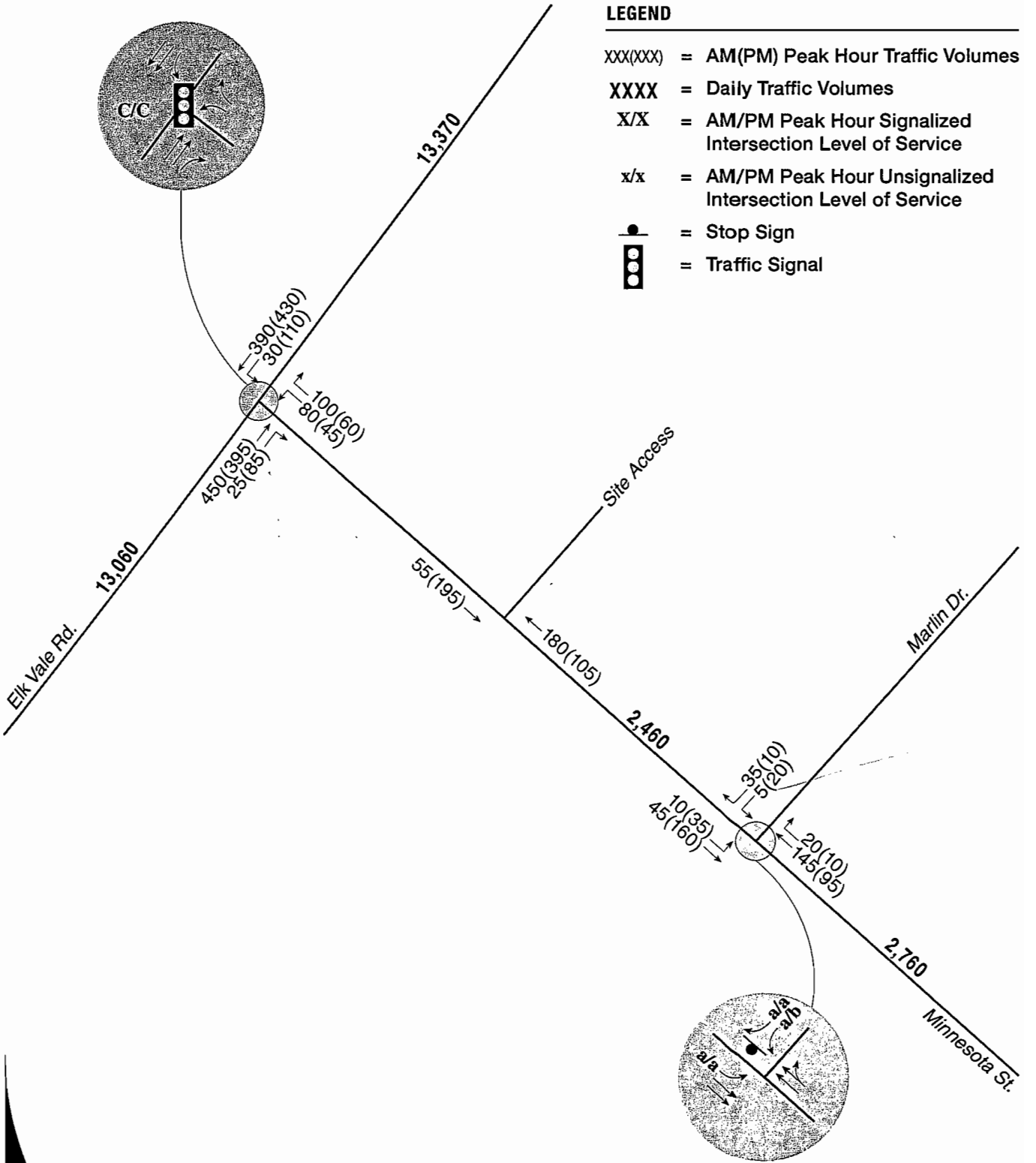

Figure 5
Short-Term Background Traffic Volumes, Lane Geometry and Level of Service

NOTE: Drawing Not to Scale

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C. *Long-Term Future (Year 2030) Background Traffic Conditions*

Traffic Volumes
The following steps were taken to project Long-Term Future background traffic volumes:

1. Based on the Rapid City Regional Travel Demand model, an annual growth rate of 3.2 percent was applied to existing traffic volumes along Elk Vale Road.

2. Elks Country Estates, located due east of the site, is proposed to be fully built out with 110 single family dwelling units and 96 multi-family dwelling units. Estimated vehicle-trips associated with this development were added to the growth projections. Estimates were developed based on information included in *Trip Generation* (Institute of Transportation Engineers, 8th Edition, 2008).

3. Elk Meadows, located southeast of the site, is proposed to be fully built out with 288 single family dwelling units. Estimated vehicle-trips associated with this development were added to the growth projections.

4. Approximately 144 acres of land immediately south of the site is proposed to be developed into office and commercial space totaling 442 KSF (1,000 Square Feet). Estimated vehicle-trips associated with this development were added to the growth projections.

5. Approximately 115 acres of land southeast of the site is proposed to be developed into single family units totaling 414 dwelling units. Estimated vehicle trips associated with this development were added to the growth projections.

6. Approximately 38 acres of land west of Elk Vale Road along Minnesota Street is proposed to be developed into office space totaling 70 KSF and single family homes totaling 146 units. Estimated vehicle trips associated with this development were added to the growth projections.

7. In addition, the land use plans for the area east of the project site was examined to determine future through traffic along Minnesota Street that could be expected by the classification change of the road into a Minor Arterial.

Figure 4 identifies the Long-Term Future background development parcels east of the project site. Year 2030 projected traffic volumes can be seen on **Figure 6**.

Traffic Operations
To address Long-Term Future traffic operations along Elk Vale Road without the development, a LOS analysis was conducted using the techniques from the HCM-2000.

Figure 6 shows the results of the projected Year 2011 background traffic conditions, including traffic control devices and intersection lane geometry. The signalized intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive would operate at LOS C or better during both peak hours.

Operational results are described below by intersection:

- **Elk Vale Road / Minnesota Street:** By Year 2030, this signalized intersection would be redesigned to include the west leg of Minnesota Street and allow all turning movements at the intersection. The resulting intersection would operate at LOS C or better during each peak period.
- **Minnesota Street / Marlin Drive:** By Year 2030, the intersection would be redesigned to include the south leg of Marlin Drive and allow all turning movements at the intersection. Also by Year 2030, traffic conditions at this intersection are anticipated to meet signal warrants outlined in the MUTCD. Under signalized control, the resulting intersection would operate at LOS B or better during each peak period.

Level of service worksheets for Year 2030 background traffic may be found in **Appendix B**.

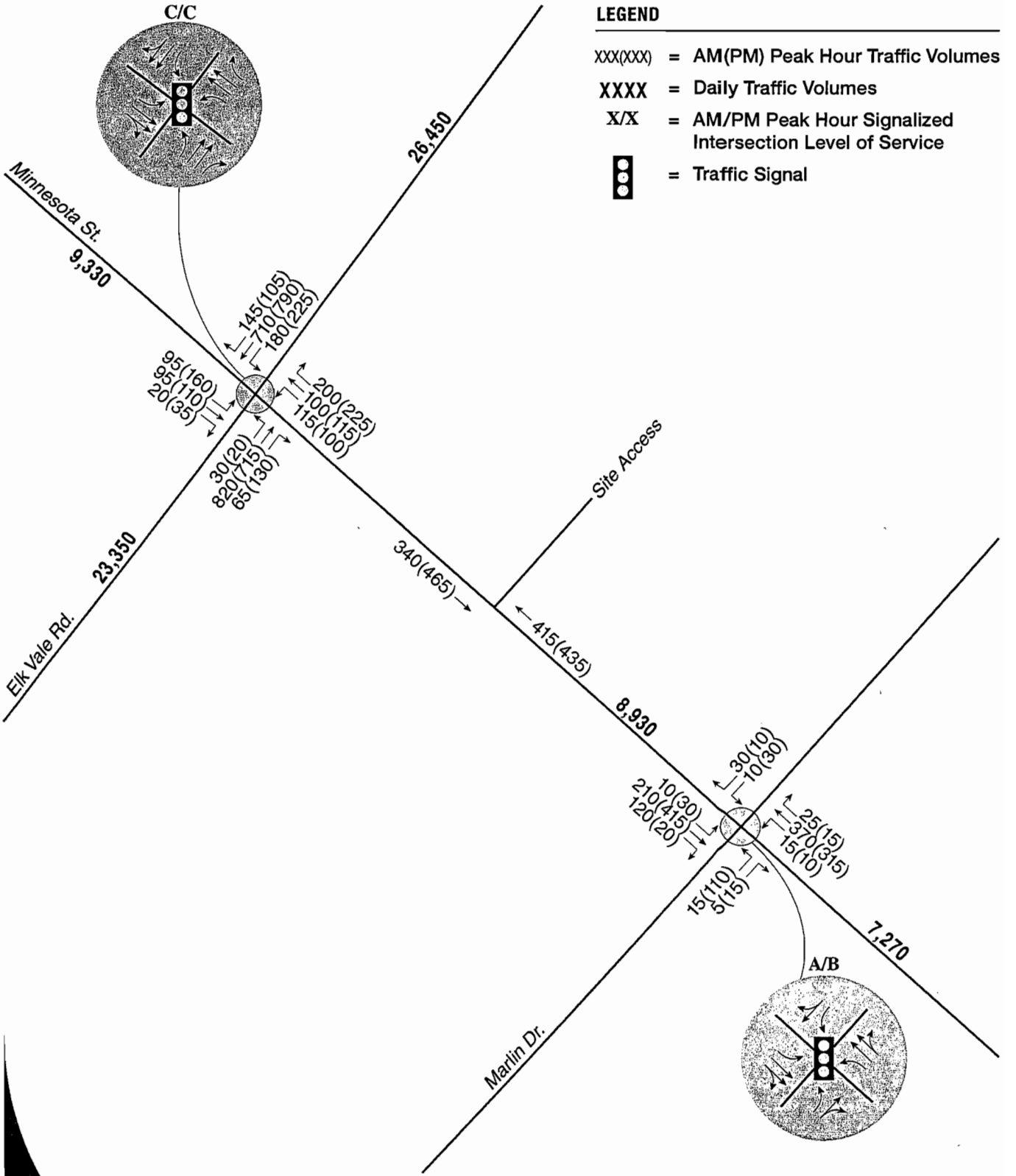

Figure 6
Long-Term Background Traffic Volumes, Lane Geometry and Level of Service

NOTE: Drawing Not to Scale

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IV. SITE TRIP GENERATION AND DISTRIBUTION

A. Trip Generation

The number of vehicle-trips to be generated by the proposed development was estimated based on trip rates and procedures documented in Trip Generation (Institute of Transportation Engineers (ITE), 8th Edition, 2008) and the Trip Generation Handbook (ITE, 2nd Edition, 2004). Land use codes (LUC) 210 (Single Family Detached), LUC 220 (Apartments), LUC 710 (General Office Building), and LUC 820 (Shopping Center) were used to estimate trips for the development. Given the location of the site along Elk Vale Road and the mixed-use nature of the site, trip generation estimates included calculations of retail pass-by trips and vehicle-trips that would remain internal to the site.

Short-Term Future
As discussed in Section I of this report, it is anticipated that the Short-Term site development would include the portion north of Minnesota Street. The completed construction would include 30 KSF of retail uses, 33 KSF of office, 100 apartment dwelling units, and 64 single family dwelling units. Pass-by trips, or vehicle-trips attracted to the site from traffic already passing on the adjacent streets, were estimated to comprise 45 percent of the land use trips generated. Site trip generation estimates were also adjusted to account for the internal trips that would occur between the residences and retail space within the proposed development. A calculation sheet for internal capture in the Short-Term Future can be seen in **Appendix C**.

As shown in **Table 1**, the site is anticipated to generate approximately 4,745 total vehicle-trips per day by the Year 2011, with approximately 1,989 pass-by and internal vehicle-trips. It is estimated that approximately 276 new vehicle trips would occur during the PM peak hour.

Table 1. Year 2011 - Trip Generation Summary

Land Use	LUC	Size	Units	Rate or Eq	Daily	AM Peak Hour			PM Peak Hour		
						In	Out	Total	In	Out	Total
Retail	820	30	KSF	Eq	3,105	46	30	76	139	145	284
Office/Commercial	710	33	KSF	Rate	363	45	6	51	8	41	49
Medium Density Residential	220	100	DU	Rate	665	10	41	51	40	22	62
Low Density Residential	210	64	DU	Rate	612	12	36	48	41	24	65
Total Trips					**4,745**	**113**	**113**	**226**	**228**	**232**	**460**
Total Internal Trips					762	10	10	20	36	36	72
Passby Trips (45% of External Retail Trips)					1,227	31	12	43	56	56	112
Total New External Trips					**2,756**	**72**	**91**	**163**	**136**	**140**	**276**

Long-Term Future
It is anticipated that the development would reach full buildout by the Year 2030. The completed construction would include 367 KSF of general commercial, 33 KSF of office and commercial, 200 apartment dwelling units, and 135 single family dwelling units. Pass-by vehicle trips would represent approximately 27 percent of site retail traffic. An example calculation sheet for internal capture in the Long-Term Future can be seen in **Appendix C**.

Table 2 summarizes Year 2030 trip generation estimates. As shown, the site would generate approximately 18,796 total vehicle-trips per day, with approximately 6,003 pass-by and internal vehicle-trips. It is estimated that approximately 1,221 new vehicle trips would occur during the PM peak hour due to the proposed development.

Table 2. Year 2030 Trip Generation Summary

Land Use	LUC	Size	Units	Rate or Eq	Daily	AM Peak Hour			PM Peak Hour		
						In	Out	Total	In	Out	Total
Retail	820	367	KSF	Eq	15,811	202	130	332	745	775	1,520
Office/Commercial	710	33	KSF	Rate	363	45	6	51	8	41	49
Medium Density Residential	220	200	DU	Rate	1,330	20	82	102	81	43	124
Low Density Residential	210	135	DU	Rate	1,292	25	76	101	86	50	136
				Total	**18,796**	**292**	**294**	**586**	**920**	**909**	**1,829**
				Total Internal Trips	2,003	38	38	76	114	114	228
				Passby Trips (27% of External Retail Trips)	4,000	49	30	79	185	195	380
				Total New External Trips	**12,793**	**205**	**226**	**431**	**621**	**600**	**1,221**

B. Trip Distribution and Traffic Assignment

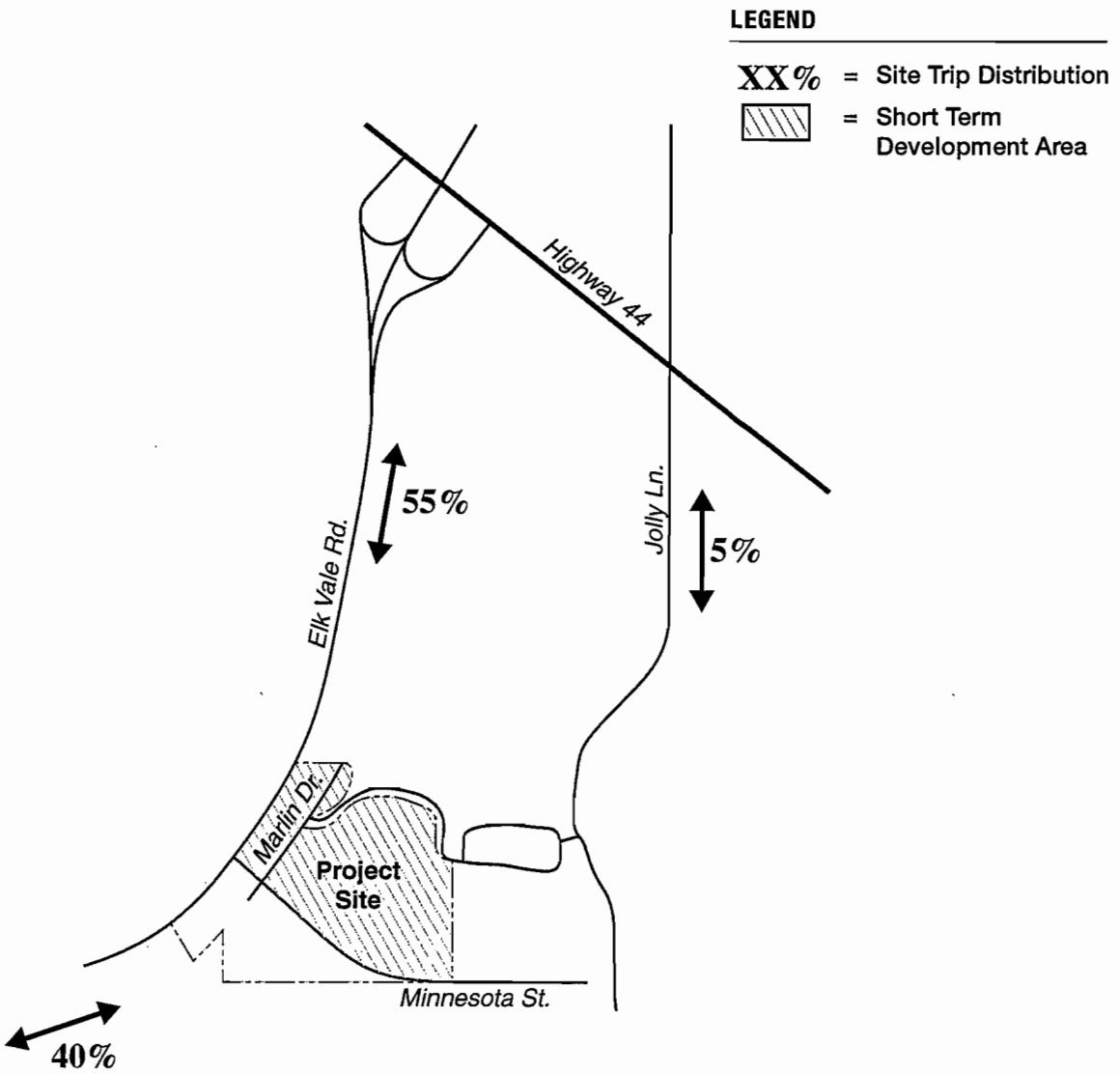
The site trip distribution assumptions for the future analysis time periods are shown on **Figure 7** and **Figure 9**. The distribution for both of these scenarios was developed based on the existing traffic patterns and the location of the site relative to existing and future land uses in the surrounding area. The Long-Term Future scenario has its own distribution, separate from the Short-Term Future scenario, since a new roadway connection to Highway 79 is anticipated via the newly extended Minnesota Street as well as due to the development of the surrounding roadway network which would occur over time.

The Short-Term Future trip distribution would allocate 5 percent of site traffic to/from the north via Jolly Lane, 40 percent to/from the south via Elk Vale Road, and 55 percent to/from the north via Elk Vale Road.

For the Long-Term Future scenario, the trip distribution would allocate 15 percent of site traffic to/from the north via Marlin Drive, 35 percent to/from the north via Elk Vale Road, 15 percent to/from the west via Minnesota Street, 20 percent to/from the south via Elk Vale Road, and the remaining 15 percent of trips are split evenly between north Jolly Lane, east Minnesota Street, and south Marlin Drive. The allocation of 15 percent of site traffic to Marlin Drive north was based on the assumption that Marlin Drive would provide a connection to Elk Vale Road and Fairmont Boulevard west. This percentage would decrease if such connections were not completed.

For both future scenarios, passby trips were assigned to Elk Vale Road based on the existing north-south directional split during peak hours.

Trips to and from the site were assigned to the roadway network based on the Short-Term Future and Long-Term Future trip distribution percentages. Daily and Peak hour site generated traffic volumes can be seen on **Figure 8** for the Year 2011 and on **Figure 10** for the Year 2030.



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NOTE: Drawing Not to Scale

Figure 7
Short Term (2011) Trip Distribution

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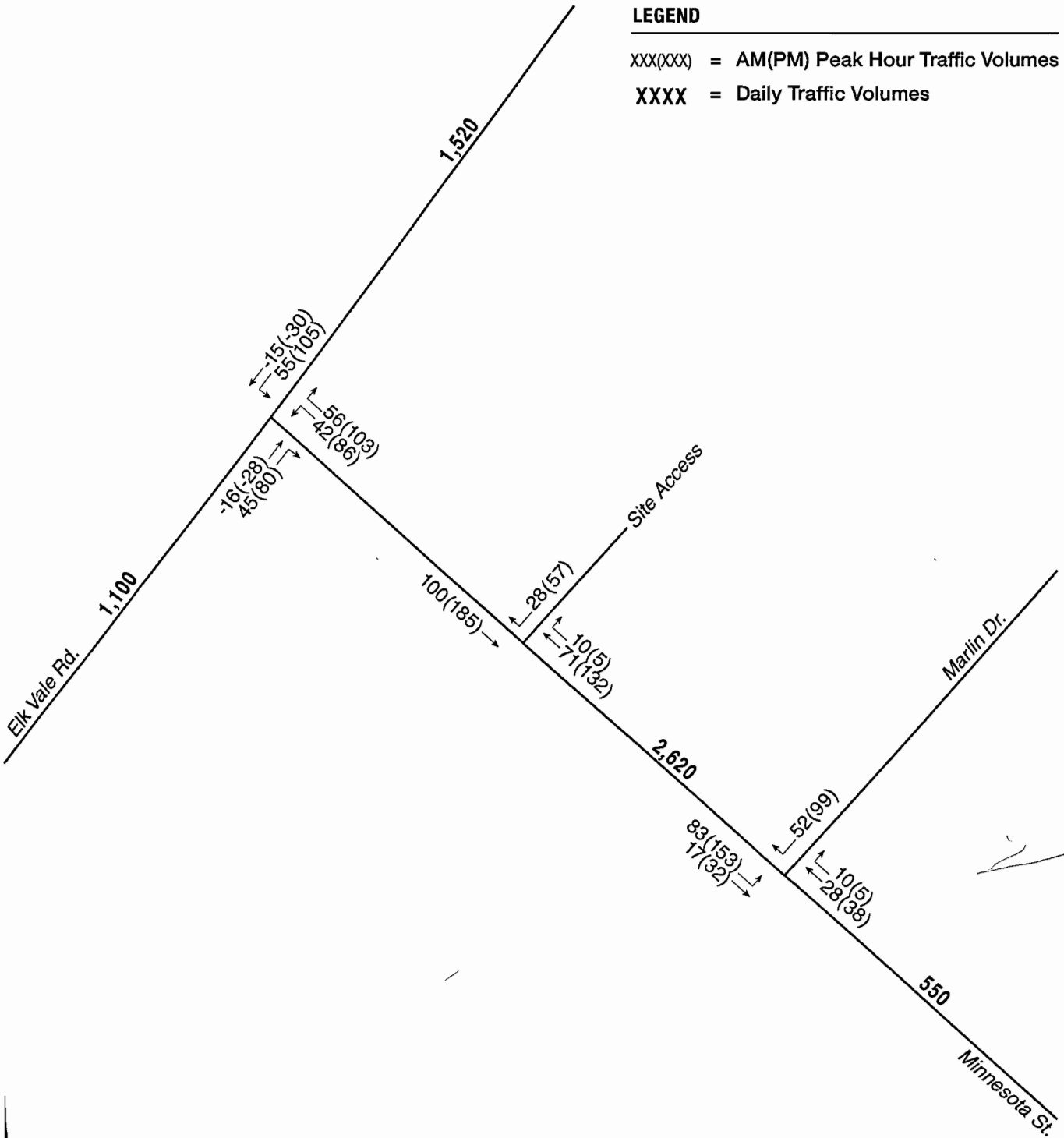

Figure 8
Short-Term Site Generated Traffic Volumes

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LEGEND

XX% = Site Trip Distribution

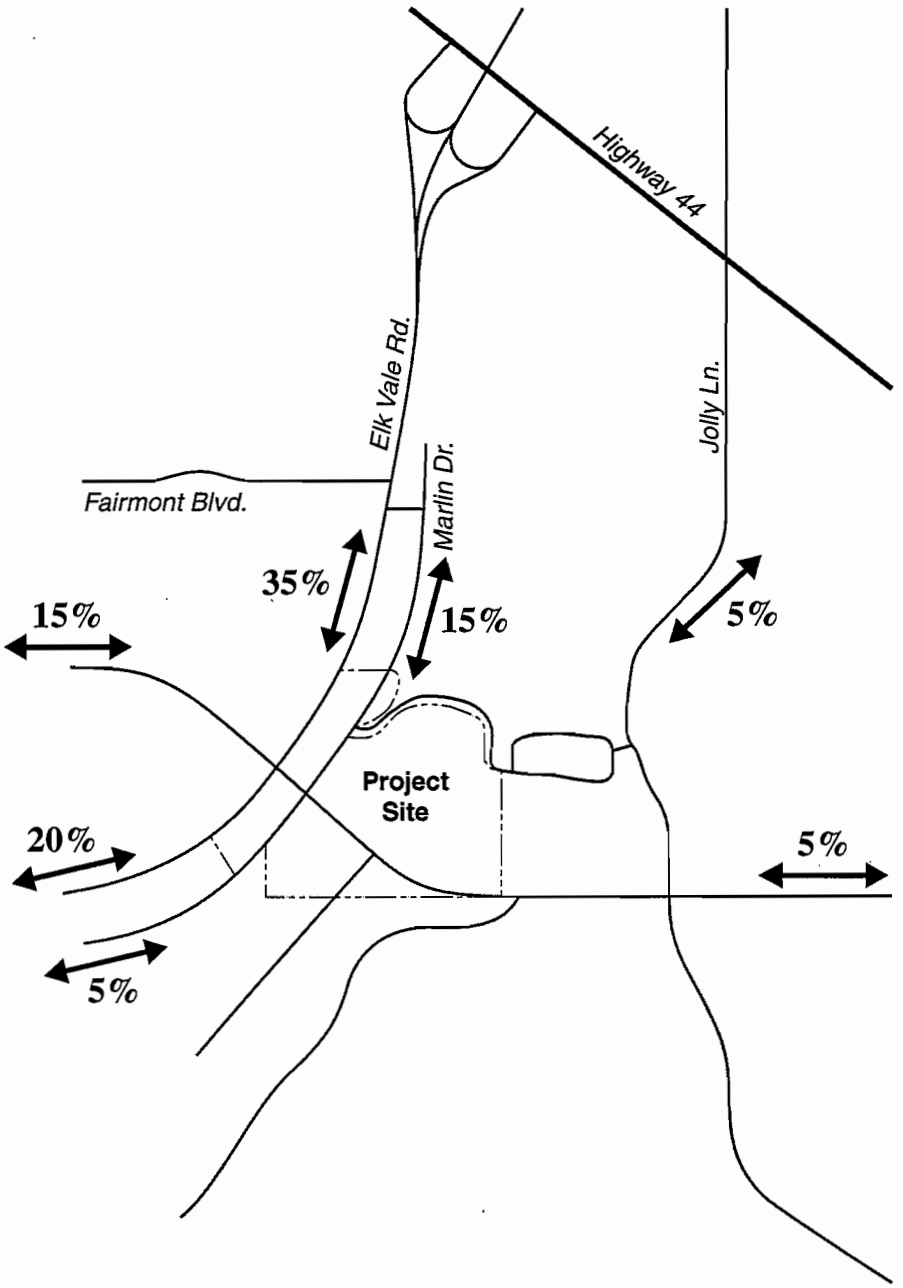

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Figure 9
Long Term (2030) Trip Distribution

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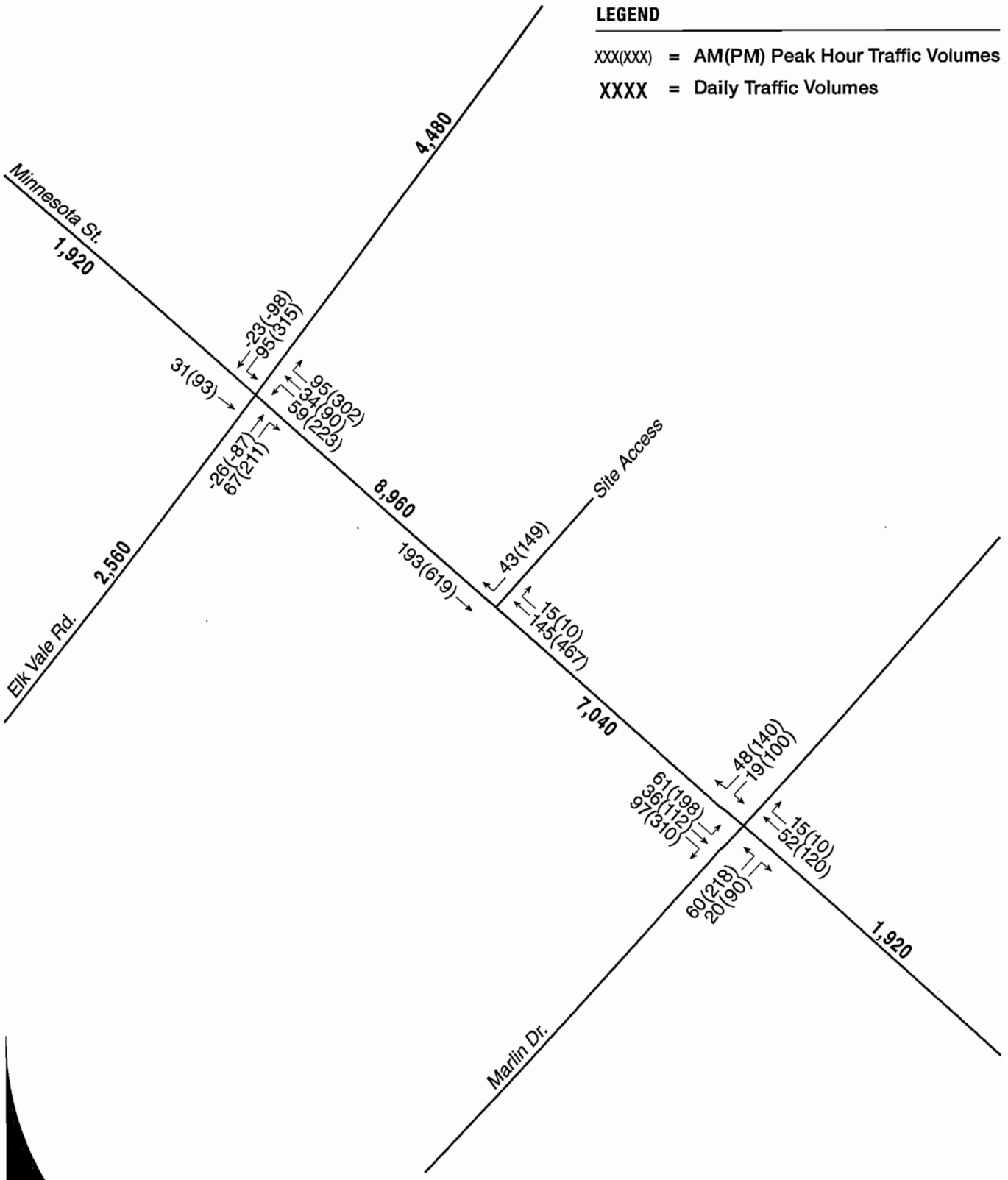

Figure 10
Long-Term Site Generated Traffic Volumes

NOTE: Drawing Not to Scale

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V. FUTURE CONDITIONS WITH DEVELOPMENT

A. Site Accesses

Primary access to the proposed development is planned to be provided via multiple accesses along Minnesota Street and Marlin Drive, with network access via the intersection of Elk Vale Road / Minnesota.

B. Short-Term Future (Year 2011) Total Traffic Conditions

Traffic Volumes
The site generated traffic volumes from **Figure 8** were added to the 2011 background traffic volumes shown on **Figure 5** in order to determine total traffic volumes for the Short-Term Future scenario. The projected Year 2011 traffic volumes are shown on **Figure 11**. The proposed development would add approximately 10 percent to daily traffic volumes along Elk Vale Road and would double traffic along Minnesota Street east of Elk Vale Road.

Traffic Operations
To address Short-Term Future (Year 2011) traffic operations along Elk Vale Road, a LOS analysis was conducted using the techniques from the HCM-2000. Projected Year 2011 total traffic conditions can be seen on **Figure 11**.

Operational results are described below by intersection:

- **Elk Vale Road / Minnesota Road:** This proposed intersection Short-Term Future total traffic conditions were evaluated based on information included in the *Manual on Uniform Traffic Control Devices* (MUTCD) which indicate that the intersection would meet Warrant 3, Peak Hour criteria for signalization. The proposed signalized intersection is anticipated to operate at LOS C during both peak hours during the Year 2030.
- **Minnesota Road / Marlin Drive:** This proposed intersection Short-Term Future total traffic conditions were evaluated based on information included in the *Manual on Uniform Traffic Control Devices* (MUTCD) which indicate that the intersection would not warrant signalization. Therefore, with construction of the Minnesota Street / Marlin Drive intersection, it is anticipated that southbound Marlin Drive would be STOP sign controlled. This planned traffic control device would result in satisfactory peak hour operations at all critical movements with LOS C or better for all movements.

Level of service worksheets for Year 2011 total traffic may be found in **Appendix D**.

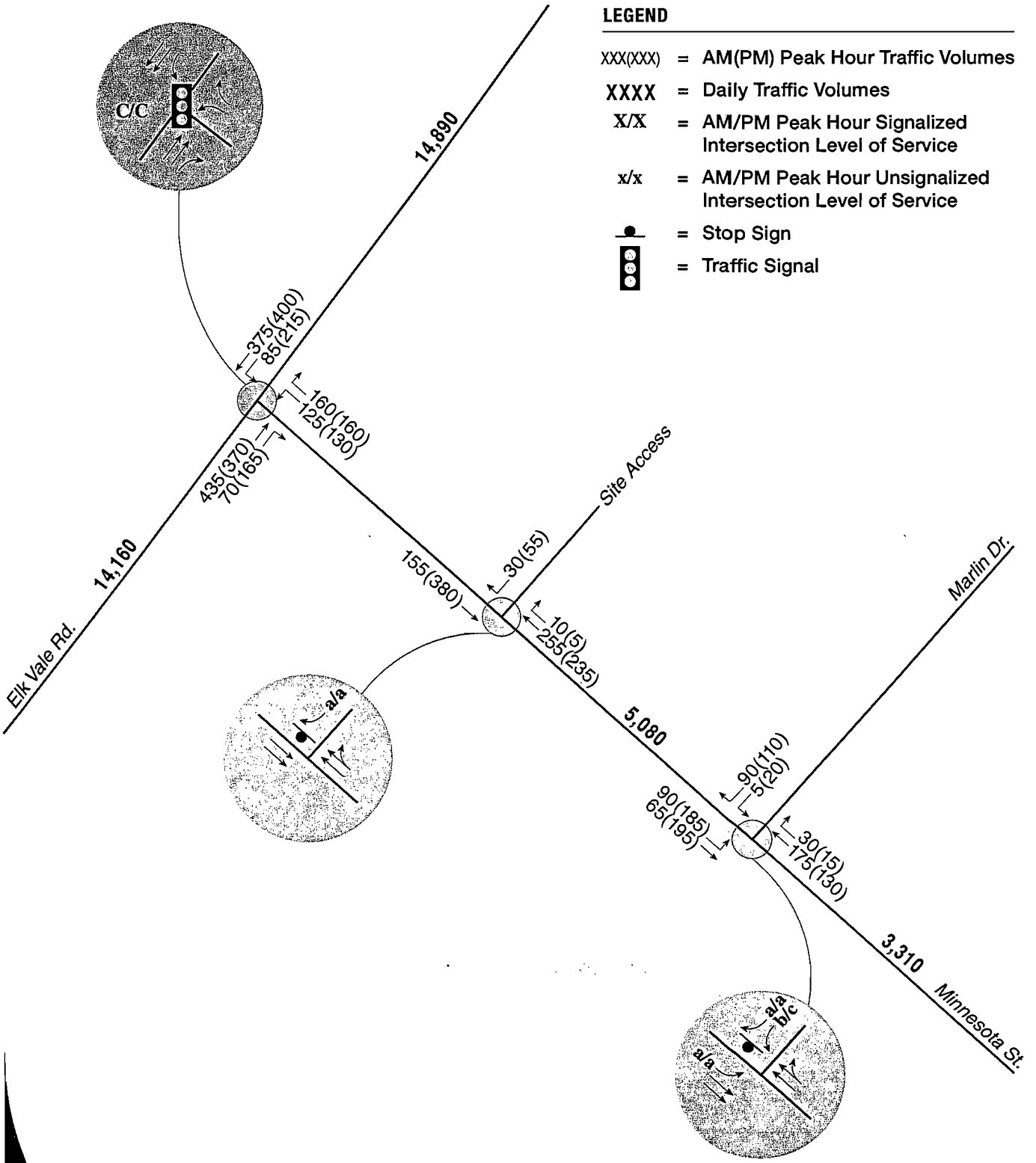

Figure 11
Short Term (2011) Total Traffic Volumes, Lane Geometry and Level of Service

NOTE: Drawing Not to Scale

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Auxiliary Lanes
In order to accommodate the volume increases due to the site traffic, the auxiliary lanes would need to be lengthened to adequately handle the addition of site traffic to the study intersections. **Table 3** provides the Total Traffic turn lane lengths.

Table 3. Short-Term Future – Total Traffic Turn Lane Lengths

Intersection	Approach	Lane Type	Storage Length (feet)
Elk Vale Road / Minnesota Street	Westbound	Left turn lane	100
		Right turn lane	50
	Northbound	Right turn lane	75
	Southbound	Left turn lane	132[1]
Minnesota Street / Marlin Drive	Eastbound	Left turn lane	50
	Southbound	Left turn lane	50

[1] Actual 95th percentile queue length result from intersection LOS analysis. Actual result is reported here to demonstrate that short term storage requirements may be roughly accommodated within the current available southbound left turn lane storage length of 125 feet.

Since Elk Vale Road is a state highway, the total auxiliary lane lengths required are prescribed by the Road Design Manual. The northbound right turn lane at Elk Vale Road / Minnesota Street would require a total length of 507 feet, including the taper. The southbound left turn lane at Elk Vale Road / Minnesota Street would require a total length of 587 feet, including the taper. This length is roughly equivalent to the length of the current southbound left turn lane along Elk Vale Road.

C. Long-Term Future (Year 2030) Total Traffic Conditions

Traffic Volumes
The site generated traffic volumes on **Figure 10** were added to the projected Year 2030 background traffic volumes on **Figure 6** in order to obtain the Year 2030 total traffic volumes shown on **Figure 12**. The proposed development would add approximately 20 percent to daily traffic volumes along Elk Vale Road and approximately double volumes along Minnesota Street east of Elk Vale Road.

Traffic Operations
To address Long-Term Future (Year 2030) traffic operations along Elk Vale Road with all of the development constructed, a LOS analysis was conducted using the techniques from the HCM-2000. The projected Year 2030 total traffic conditions can be seen on **Figure 12**. Operational results are described below by intersection:

- **Elk Vale Road / Minnesota Street:** By the Year 2030, the signalized intersection would be redesigned to include the west leg of Minnesota Street and allow all turning movements at the intersection. The resulting intersection would operate at LOS C during the AM peak period and LOS D during the PM peak period.
- **Minnesota Street / Marlin Drive:** By the Year 2030, the intersection would be redesigned to include the south leg of Marlin Drive and allow all turning movements at the intersection. Also by Year 2030, traffic conditions at this intersection are anticipated

to meet signal Warrant 3, Peak Hour criteria for signalization, outlined in the MUTCD. Under signalized control, the intersection would operate at LOS B during the AM peak period and LOS C during the PM peak period.

Level of service worksheets for Year 2030 total traffic may be found in **Appendix E.**

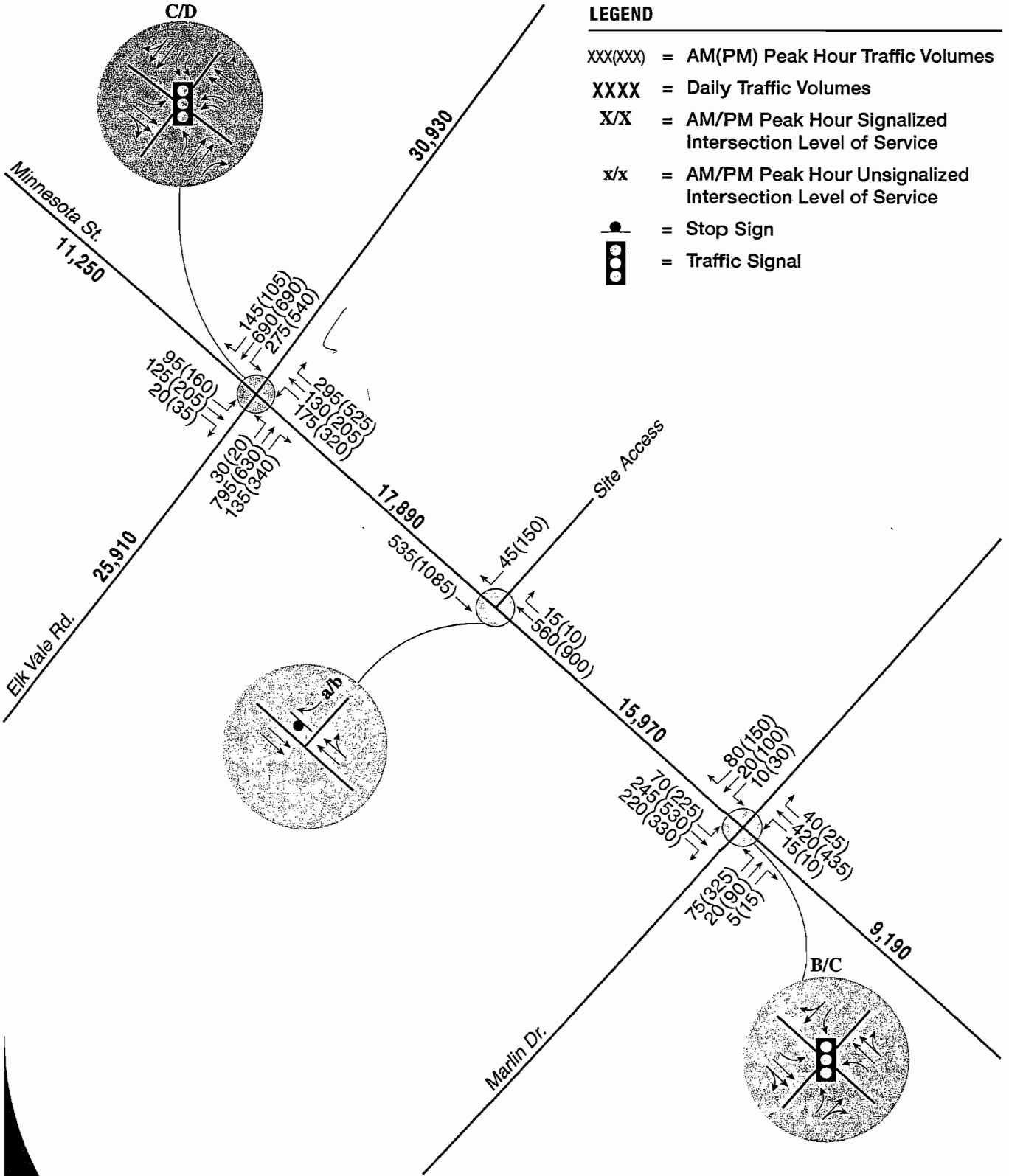

Figure 12
Long Term (2030) Total Traffic Volumes, Lane Geometry and Level of Service

NOTE: Drawing Not to Scale

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Auxiliary Lanes
In order to accommodate the volume increases due to the buildout of the site and surrounding area, the auxiliary lanes as depicted in **Table 3** would need to be lengthened, and in some cases additional lanes would need to be added to adequately handle the addition of traffic to the study intersections. **Table 4** provides the total traffic turn lane lengths as required to attain acceptable LOS values throughout the system as well as to account for the close spacing of the Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive intersections

Two locations require the addition of a second separate left turn lane to account for the increased turn volumes in the Long-Term Future. These movements are the southbound and westbound left turns at the Elk Vale Road / Minnesota Street intersection. In addition, many of the turn lanes require additional storage length to accommodate the increased volumes for the total traffic scenario. **Table 4** shows a summary of the recommended turn lanes and the corresponding storage lengths.

Table 4. Long-Term Future – Total Traffic Turn Lane Lengths

Intersection	Approach	Lane Type	Storage Length (feet)
Elk Vale Road / Minnesota Street	Westbound	Dual left turn lane	150
		Right turn lane	200
	Northbound	Right turn lane	75
	Southbound	Dual left turn lane	275
Minnesota Street / Marlin Drive	Eastbound	Left turn lane	150
	Southbound	Left turn lane	50

Since Elk Vale Road is a state highway, the total auxiliary lane lengths required are prescribed by the Road Design Manual. The northbound right turn lane at Elk Vale Road / Minnesota Street would require a total length of 530 feet, including the taper. The southbound dual left turn lanes at Elk Vale Road / Minnesota Street would require a total length of 730 feet, including the taper.

D. Level of Service Summary

Table 5 was prepared as a summary of the preceding level of service analyses.

Table 5. Intersection Level of Service Summary – AM / PM Peak Hour

Intersection	Traffic Control	Critical Movements	AM / PM Intersection Level of Service & Delay							
			Short-Term Background		Short-Term Total		Long-Term Background		Long-Term Total	
			LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Elk Vale Road / Minnesota Street	Signal	ALL	C/C	32/30	C/C	30/27	C/C	31/35	C/D	31/36
Minnesota Street / Marlin Drive	Stop	SB LT	a/b	9/11	b/c	13/17	*	*	*	*
	Signal	ALL	*	*	*	*	A/B	9/14	B/C	19/28

VII. SUMMARY AND RECOMMENDATIONS

The Elks Crossing development is proposed to be located east of Elk Vale Road along the future extension of Minnesota Street in the City of Rapid City, South Dakota. The proposed development would cover approximately 115 acres within the Southeast Connector Neighborhood in Rapid City, South Dakota. Land uses proposed for the site include 200 multi-family residential units, 135 single family units, 33,000 Square Feet of office development, and approximately 367,000 Square Feet of retail development. Future retail development would be clustered along Elk Vale Road, while residential development would cover the east portion of the site.

The intersection of Elk Vale Road / Minnesota Street is anticipated to be the main access for the development. Marlin Drive would provide for traffic circulation within the site, running parallel to and east of Elk Vale Road.

At buildout, the Elks Crossing development is estimated to generate approximately 12,800 total vehicle-trips per day, with 431 of these trips occurring during the AM peak hour and 1,221 trips during the PM peak hour.

Findings and recommendations related to the analysis for this site are summarized below by future scenario.

A. Short-Term Future

The following roadway improvements are planned to be completed by Year 2011.

- Construct Minnesota Street east of Elk Vale Road to provide access to the east. Signalize the intersection at Elk Vale Road and Minnesota Street.
- Construct Marlin Drive north of Minnesota Street as a parallel road to Elk Vale Road to provide movement throughout the project site and surrounding area. Add STOP sign control to the southbound leg at the intersection of Minnesota Street and Marlin Drive.
- The site would require the construction of turn lanes at the intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive as shown in **Table 6**.

In the Short-Term Future condition, the signalized intersection of Elk Vale Road / Minnesota Street would operate at LOS C during both the AM and PM peak hours. The intersection of Minnesota Street / Marlin Drive would be stop sign controlled with a stop sign for southbound Marlin Drive drivers and would operate at LOS C or better for all movements.

Table 6. Short-Term Future Total – Intersection Auxiliary Lanes

Intersection	Approach	Lane Type	Storage Length (feet)
Elk Vale Road / Minnesota Street	Westbound	Left turn lane	100
		Right turn lane	50
	Northbound	Right turn lane	75
	Southbound	Left turn lane	132[1]
Minnesota Street / Marlin Drive	Eastbound	Left turn lane	50
	Southbound	Left turn lane	50

[1] Actual 95th percentile queue length result from intersection LOS analysis. Actual result is reported here to demonstrate that short term storage requirements may be roughly accommodated within the current available southbound left turn lane storage length of 125 feet.

The northbound right turn lane at Elk Vale Road / Minnesota Street would require a total length of 507 feet, including the taper. The southbound left turn lane at Elk Vale Road / Minnesota Street would require a total length of 587 feet, including the taper. This length is roughly equivalent to the length of the current southbound left turn lane along Elk Vale Road.

B. Long-Term Future

The following roadway improvements are planned to be completed by Year 2030.

- Minnesota Street would be constructed to create a Minor Arterial providing access between Highway 79 and locations east of the proposed site.
- Jolly Lane would be extended from the existing location at Elks Country Estates south through Elk Meadows.
- Several southern roads would be constructed to connect Minnesota Street south through the zoned office and residential areas.
- Signalize the intersection at Minnesota Street and Marlin Drive.
- The site would require construction of additional turn lanes and/or added turn lane lengths at the intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive as shown in **Table 7**.

In the Long-Term Future condition, the signalized intersections of Elk Vale Road / Minnesota Street and Minnesota Street / Marlin Drive would operate at LOS D or better during both the AM and PM peak hours.

Table 7. Long-Term Future Total – Intersection Auxiliary Lanes

Intersection	Approach	Lane Type	Storage Length (feet)
Elk Vale Road / Minnesota Street	Westbound	Dual left turn lane	150
		Right turn lane	200
	Northbound	Right turn lane	75
	Southbound	Dual left turn lane	275
Minnesota Street / Marlin Drive	Eastbound	Left turn lane	150
	Southbound	Left turn lane	50

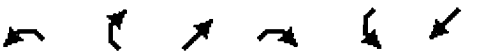
The northbound right turn lane at Elk Vale Road / Minnesota Street would require a total length of 530 feet, including the taper. The southbound dual left turn lanes at Elk Vale Road / Minnesota Street would require a total length of 730 feet, including the taper.

Given the above lane geometry along Minnesota Street and storage lengths, the site can be completed given the proposed intersection spacing of 500 feet between Elk Vale Road and Marlin Drive. In addition, it is anticipated that the intersection of Minnesota Street / Marlin Drive would need to be signalized when warranted, anticipated to occur by the year 2030 at the latest.

APPENDIX A 2011 BACKGROUND LEVEL OF SERVICE WORKSHEETS

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

11/26/2008



Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	80	100	450	25	30	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1652	1583	3195	1583	1770	3195
Flt Permitted	0.95	1.00	1.00	1.00	0.23	1.00
Satd. Flow (perm)	1652	1583	3195	1583	423	3195
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	109	489	27	33	424
RTOR Reduction (vph)	0	40	0	21	0	0
Lane Group Flow (vph)	87	69	489	6	33	424
Heavy Vehicles (%)	2%	2%	13%	2%	2%	13%
Turn Type		Perm		Perm	pm+pt	
Protected Phases	2		4		3	8
Permitted Phases		2		4	8	
Actuated Green, G (s)	68.1	68.1	23.2	23.2	31.9	31.9
Effective Green, g (s)	68.1	68.1	23.2	23.2	31.9	31.9
Actuated g/C Ratio	0.63	0.63	0.21	0.21	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1042	998	686	340	184	944
v/s Ratio Prot	c0.05		c0.15		0.01	c0.13
v/s Ratio Perm		0.04		0.00	0.05	
v/c Ratio	0.08	0.07	0.71	0.02	0.18	0.45
Uniform Delay, d1	7.8	7.7	39.3	33.4	28.3	30.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	3.5	0.0	0.5	0.3
Delay (s)	7.9	7.8	42.8	33.4	28.8	31.3
Level of Service	A	A	D	C	C	C
Approach Delay (s)	7.9		42.3			31.1
Approach LOS	A		D			C

Intersection Summary			
HCM Average Control Delay	32.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	108.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (veh/h)	10	45	145	20	5	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)	11	49	158	22	5	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)		614				
pX, platoon unblocked						
vC, conflicting volume	179				215	90
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	179				215	90
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	96
cM capacity (veh/h)	1394				748	950

Direction, Lane #	SE 1	SE 2	SE 3	NW 1	NW 2	SW 1	SW 2
Volume Total	11	24	24	105	74	5	38
Volume Left	11	0	0	0	0	5	0
Volume Right	0	0	0	0	22	0	38
cSH	1394	1700	1700	1700	1700	748	950
Volume to Capacity	0.01	0.01	0.01	0.06	0.04	0.01	0.04
Queue Length 95th (ft)	1	0	0	0	0	1	3
Control Delay (s)	7.6	0.0	0.0	0.0	0.0	9.8	8.9
Lane LOS	A					A	A
Approach Delay (s)	1.4			0.0		9.1	
Approach LOS						A	

Intersection Summary				
Average Delay	1.7			
Intersection Capacity Utilization	18.3%	ICU Level of Service		A
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
7: Minnesota St & Site Access

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	55	180	0	0	0
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)	0	60	196	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		310				
pX, platoon unblocked						
vC, conflicting volume	196				226	98
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	196				226	98
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	100
cM capacity (veh/h)	1375				742	939

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	30	30	130	65	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.08	0.04	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	8.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

11/26/2008

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	45	60	395	85	110	430
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1652	1583	3195	1583	1770	3195
Flt Permitted	0.95	1.00	1.00	1.00	0.26	1.00
Satd. Flow (perm)	1652	1583	3195	1583	481	3195
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	49	65	429	92	120	467
RTOR Reduction (vph)	0	27	0	74	0	0
Lane Group Flow (vph)	49	38	429	18	120	467
Heavy Vehicles (%)	2%	2%	13%	2%	2%	13%
Turn Type		Perm		Perm	pm+pt	
Protected Phases	2		4		3	8
Permitted Phases		2		4	8	
Actuated Green, G (s)	57.7	57.7	19.7	19.7	34.3	34.3
Effective Green, g (s)	57.7	57.7	19.7	19.7	34.3	34.3
Actuated g/C Ratio	0.58	0.58	0.20	0.20	0.34	0.34
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	953	913	629	312	302	1096
v/s Ratio Prot	c0.03		c0.13		0.04	c0.15
v/s Ratio Perm		0.02		0.01	0.09	
v/c Ratio	0.05	0.04	0.68	0.06	0.40	0.43
Uniform Delay, d1	9.2	9.2	37.2	32.6	23.9	25.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.1	3.1	0.1	0.9	0.3
Delay (s)	9.3	9.2	40.3	32.7	24.8	25.5
Level of Service	A	A	D	C	C	C
Approach Delay (s)	9.3		39.0			25.4
Approach LOS	A		D			C

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	30.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (veh/h)	35	160	95	10	20	10
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)	38	174	103	11	22	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		614				
pX, platoon unblocked						
vC, conflicting volume	114				272	57
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				272	57
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				97	99
cM capacity (veh/h)	1473				677	997

Direction, Lane #	SE 1	SE 2	SE 3	NW 1	NW 2	SW 1	SW 2
Volume Total	38	87	87	69	45	22	11
Volume Left	38	0	0	0	0	22	0
Volume Right	0	0	0	0	11	0	11
cSH	1473	1700	1700	1700	1700	677	997
Volume to Capacity	0.03	0.05	0.05	0.04	0.03	0.03	0.01
Queue Length 95th (ft)	2	0	0	0	0	2	1
Control Delay (s)	7.5	0.0	0.0	0.0	0.0	10.5	8.7
Lane LOS	A					B	A
Approach Delay (s)	1.3			0.0		9.9	
Approach LOS						A	

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	18.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
7: Minnesota St & Site Access

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑			↱
Volume (veh/h)	0	195	105	0	0	0
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)	0	212	114	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		310				
pX, platoon unblocked						
vC, conflicting volume	114				220	57
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				220	57
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	100
cM capacity (veh/h)	1473				748	997

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	106	106	76	38	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.06	0.06	0.04	0.02	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	8.7%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX B 2030 BACKGROUND LEVEL OF SERVICE WORKSHEETS

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

11/26/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	95	95	20	115	100	200	30	820	65	180	710	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1652	3446		1652	3539	1583	1770	3195	1583	1770	3166	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1652	3446		1652	3539	1583	1770	3195	1583	1770	3166	
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)	103	103	22	125	109	217	33	891	71	196	772	158
RTOR Reduction (vph)	0	17	0	0	0	167	0	0	46	0	18	0
Lane Group Flow (vph)	103	108	0	125	109	50	33	891	25	196	912	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	13%	2%	2%	13%	2%
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases						2			4			
Actuated Green, G (s)	9.5	20.6		11.8	22.9	22.9	4.6	35.9	35.9	15.7	47.0	
Effective Green, g (s)	9.5	20.6		11.8	22.9	22.9	4.6	35.9	35.9	15.7	47.0	
Actuated g/C Ratio	0.10	0.21		0.12	0.23	0.23	0.05	0.36	0.36	0.16	0.47	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	157	710		195	810	363	81	1147	568	278	1488	
v/s Ratio Prot	0.06	c0.03		c0.08	0.03		0.02	c0.28		c0.11	0.29	
v/s Ratio Perm						0.03			0.02			
v/c Ratio	0.66	0.15		0.64	0.13	0.14	0.41	0.78	0.04	0.71	0.61	
Uniform Delay, d1	43.7	32.5		42.1	30.7	30.7	46.4	28.5	20.9	40.0	19.7	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	9.5	0.1		7.0	0.3	0.8	3.3	3.4	0.0	7.9	0.8	
Delay (s)	53.2	32.6		49.1	31.0	31.5	49.7	31.9	20.9	47.8	20.5	
Level of Service	D	C		D	C	C	D	C	C	D	C	
Approach Delay (s)		41.9			36.2			31.7			25.2	
Approach LOS		D			D			C			C	

Intersection Summary				
HCM Average Control Delay	30.7	HCM Level of Service	C	
HCM Volume to Capacity ratio	0.59			
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.0	
Intersection Capacity Utilization	55.7%	ICU Level of Service	B	
Analysis Period (min)	15			
c Critical Lane Group				

HCM Signalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

11/26/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	10	210	120	15	370	30	15	0	5	10	0	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	10	12	12	10	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.95		1.00	0.99		1.00	0.85		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)	1652	3346		1652	3499		1652	1583		1652	1583	
Flt Permitted	0.95	1.00		0.95	1.00		0.70	1.00		0.98	1.00	
Satd. Flow (perm)	1652	3346		1652	3499		1220	1583		1696	1583	
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)	11	228	130	16	402	33	16	0	5	11	0	33
RTOR Reduction (vph)	0	28	0	0	2	0	0	5	0	0	32	0
Lane Group Flow (vph)	11	330	0	16	433	0	16	0	0	11	1	0
Turn Type	Prot			Prot			pm+pt			pm+pt		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases							4			8		
Actuated Green, G (s)	1.6	89.6		3.2	91.2		8.8	5.7		5.6	4.1	
Effective Green, g (s)	1.6	89.6		3.2	91.2		8.8	5.7		5.6	4.1	
Actuated g/C Ratio	0.01	0.77		0.03	0.79		0.08	0.05		0.05	0.04	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	23	2584		46	2751		104	78		81	56	
v/s Ratio Prot	0.01	0.10		c0.01	c0.12		c0.00	0.00		0.00	0.00	
v/s Ratio Perm							c0.01			0.00		
v/c Ratio	0.48	0.13		0.35	0.16		0.15	0.00		0.14	0.02	
Uniform Delay, d1	56.8	3.3		55.4	3.0		50.0	52.4		52.9	54.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	14.8	0.1		4.5	0.1		0.7	0.0		0.8	0.2	
Delay (s)	71.6	3.4		59.9	3.1		50.7	52.5		53.7	54.2	
Level of Service	E	A		E	A		D	D		D	D	
Approach Delay (s)		5.5			5.2			51.1			54.0	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.16		
Actuated Cycle Length (s)	116.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	26.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
9: Minnesota St & Site Access

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (veh/h)	0	340	415	0	0	0
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)	0	370	451	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		287	327			
pX, platoon unblocked	0.99				0.99	0.99
vC, conflicting volume	451				636	226
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	426				613	198
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	100
cM capacity (veh/h)	1119				420	802

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	185	185	301	150	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.11	0.11	0.18	0.09	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary				
Average Delay	0.0			
Intersection Capacity Utilization	14.8%	ICU Level of Service		A
Analysis Period (min)	15			

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

11/26/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	160	110	35	100	115	225	20	715	130	225	790	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1652	3412		1652	3539	1583	1770	3195	1583	1770	3175	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1652	3412		1652	3539	1583	1770	3195	1583	1770	3175	
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)	174	120	38	109	125	245	22	777	141	245	859	114
RTOR Reduction (vph)	0	30	0	0	0	199	0	0	95	0	10	0
Lane Group Flow (vph)	174	128	0	109	125	46	22	777	46	245	963	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	13%	2%	2%	13%	2%
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases						2			4			
Actuated Green, G (s)	14.4	21.8		11.2	18.6	18.6	3.1	32.5	32.5	18.5	47.9	
Effective Green, g (s)	14.4	21.8		11.2	18.6	18.6	3.1	32.5	32.5	18.5	47.9	
Actuated g/C Ratio	0.14	0.22		0.11	0.19	0.19	0.03	0.32	0.32	0.18	0.48	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	238	744		185	658	294	55	1038	514	327	1521	
v/s Ratio Prot	c0.11	c0.04		0.07	0.04		0.01	c0.24		c0.14	0.30	
v/s Ratio Perm						0.03			0.03			
v/c Ratio	0.73	0.17		0.59	0.19	0.15	0.40	0.75	0.09	0.75	0.63	
Uniform Delay, d1	40.9	31.8		42.2	34.3	34.1	47.5	30.1	23.5	38.6	19.5	
Progression Factor	1.00	1.00		0.96	0.82	2.17	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	11.0	0.1		4.7	0.6	1.1	4.7	3.0	0.1	9.1	0.9	
Delay (s)	51.9	31.9		45.4	28.9	75.2	52.3	33.1	23.5	47.6	20.4	
Level of Service	D	C		D	C	E	D	C	C	D	C	
Approach Delay (s)		42.4			56.3			32.1			25.8	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	34.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

11/26/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	30	415	20	10	315	20	110	0	15	29	0	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	10	12	12	10	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.85		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)	1652	3515		1652	3507		1652	1583		1652	1583	
Flt Permitted	0.95	1.00		0.95	1.00		0.44	1.00		0.75	1.00	
Satd. Flow (perm)	1652	3515		1652	3507		761	1583		1299	1583	
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)	33	451	22	11	342	22	120	0	16	32	0	11
RTOR Reduction (vph)	0	2	0	0	3	0	0	12	0	0	10	0
Lane Group Flow (vph)	33	471	0	11	361	0	120	4	0	32	1	0
Turn Type	Prot			Prot			pm+pt			Perm		
Protected Phases	1	6		5	2		7	4			8	
Permitted Phases							4			8		
Actuated Green, G (s)	5.2	64.0		1.5	60.3		22.5	22.5		5.6	5.6	
Effective Green, g (s)	5.2	64.0		1.5	60.3		22.5	22.5		5.6	5.6	
Actuated g/C Ratio	0.05	0.64		0.02	0.60		0.22	0.22		0.06	0.06	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	86	2250		25	2115		286	356		73	89	
v/s Ratio Prot	c0.02	c0.13		0.01	0.10		c0.05	0.00			0.00	
v/s Ratio Perm							c0.04			0.02		
v/c Ratio	0.38	0.21		0.44	0.17		0.42	0.01		0.44	0.01	
Uniform Delay, d1	45.9	7.5		48.8	8.8		32.5	30.1		45.7	44.6	
Progression Factor	1.20	0.70		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.6	0.2		11.9	0.2		1.0	0.0		4.2	0.0	
Delay (s)	57.5	5.4		60.7	9.0		33.5	30.1		49.8	44.6	
Level of Service	E	A		E	A		C	C		D	D	
Approach Delay (s)		8.8			10.5			33.1			48.5	
Approach LOS		A			B			C			D	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
9: Minnesota St & Site Access

11/26/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	465	435	0	0	0
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)	0	505	473	0	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		287	327			
pX, platoon unblocked	0.97				0.97	0.97
vC, conflicting volume	473				726	236
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	401				661	158
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	100
cM capacity (veh/h)	1122				385	836

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	253	253	315	158	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.15	0.15	0.19	0.09	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	16.2%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX C INTERNAL CAPTURE EXAMPLE CALCULATION

10PL021

MULTI-USE DEVELOPMENT
TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Land Use A Residental

ITE LU CODE Size 335 DU	Total	Internal	External
Enter	1,311	436	875
Exit	1,311	498	813
Total	2,622	934	1,688
%	100%	36%	64%

38% 498 Demand
498 Balanced
9% 711 Demand

33% 433 Demand
433 Balanced
11% 870 Demand

0% 0 Demand
0 Balanced
0% 0 Demand

3% 39 Demand
4 Balanced
2% 4 Demand

Land Use B
Retail

ITE LU CODE Size 367 KSF	Total	Internal	External
Enter	7,905	538	7,367
Exit	7,906	460	7,446
Total	15,811	998	14,813
%	100%	6%	94%

Land Use C
Office

ITE LU CODE Size 33 KSF	Total	Internal	External
Enter	181	27	154
Exit	182	44	138
Total	363	71	292
%	100%	20%	80%

Demand 4% 316 — Balance 40 — Demand 22% 40
3% 237 Demand — 27 Balance — 15% 27 Demand

Net External Trips for Multi-Use Development	Land Use A	Land Use B	Land Use C	Total	
Enter	875	7,367	154	8,395	
Exit	813	7,446	138	8,397	
Total	1,688	14,813	292	16,793	Overall Internal Capture
Single-Use Trip Gen. Est	2,622	15,811	363	18,796	11%
Trip Capture %	36%	6%	20%		

Source: ITE Trip Generation Manual

APPENDIX D 2011 TOTAL TRAFFIC LEVEL OF SERVICE WORKSHEETS

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

12/18/2008

Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	125	160	435	70	85	375
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1652	1583	3195	1583	1770	3195
Flt Permitted	0.95	1.00	1.00	1.00	0.23	1.00
Satd. Flow (perm)	1652	1583	3195	1583	423	3195
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	174	473	76	92	408
RTOR Reduction (vph)	0	68	0	60	0	0
Lane Group Flow (vph)	136	106	473	16	92	408
Heavy Vehicles (%)	2%	2%	13%	2%	2%	13%
Turn Type		Perm		Perm	pm+pt	
Protected Phases	2		4		3	8
Permitted Phases		2		4	8	
Actuated Green, G (s)	65.6	65.6	22.1	22.1	34.4	34.4
Effective Green, g (s)	65.6	65.6	22.1	22.1	34.4	34.4
Actuated g/C Ratio	0.61	0.61	0.20	0.20	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1003	962	654	324	238	1018
v/s Ratio Prot	c0.08		c0.15		0.03	c0.13
v/s Ratio Perm		0.07		0.01	0.09	
v/c Ratio	0.14	0.11	0.72	0.05	0.39	0.40
Uniform Delay, d1	9.1	8.9	40.1	34.5	27.4	28.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	0.2	4.0	0.1	1.0	0.3
Delay (s)	9.4	9.1	44.1	34.6	28.5	29.0
Level of Service	A	A	D	C	C	C
Approach Delay (s)	9.2		42.7		28.9	
Approach LOS	A		D		C	

Intersection Summary			
HCM Average Control Delay	30.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	108.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	33.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

12/18/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (veh/h)	90	65	175	30	5	90
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)	98	71	190	33	5	98
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		614				
pX, platoon unblocked						
vC, conflicting volume	223				438	111
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	223				438	111
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				99	89
cM capacity (veh/h)	1343				508	920

Direction, Lane #	SE 1	SE 2	SE 3	NW 1	NW 2	SW 1	SW 2
Volume Total	98	35	35	127	96	5	98
Volume Left	98	0	0	0	0	5	0
Volume Right	0	0	0	0	33	0	98
cSH	1343	1700	1700	1700	1700	508	920
Volume to Capacity	0.07	0.02	0.02	0.07	0.06	0.01	0.11
Queue Length 95th (ft)	6	0	0	0	0	1	9
Control Delay (s)	7.9	0.0	0.0	0.0	0.0	12.2	9.4
Lane LOS	A					B	A
Approach Delay (s)	4.6			0.0		9.5	
Approach LOS						A	

Intersection Summary				
Average Delay	3.5			
Intersection Capacity Utilization	24.1%	ICU Level of Service		A
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
7: Minnesota St & Site Access

12/18/2008

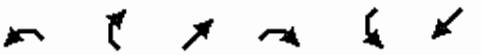
Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	155	255	10	0	30
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	168	277	11	0	33
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		310				
pX, platoon unblocked						
vC, conflicting volume	288				367	144
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	288				367	144
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	96
cM capacity (veh/h)	1271				606	877

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	84	84	185	103	33
Volume Left	0	0	0	0	0
Volume Right	0	0	0	11	33
cSH	1700	1700	1700	1700	877
Volume to Capacity	0.05	0.05	0.11	0.06	0.04
Queue Length 95th (ft)	0	0	0	0	3
Control Delay (s)	0.0	0.0	0.0	0.0	9.3
Lane LOS					A
Approach Delay (s)	0.0		0.0		9.3
Approach LOS					A

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	17.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

12/18/2008



Movement	NWL	NWR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	130	160	370	165	215	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1652	1583	3195	1583	1770	3195
Flt Permitted	0.95	1.00	1.00	1.00	0.27	1.00
Satd. Flow (perm)	1652	1583	3195	1583	507	3195
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	141	174	402	179	234	435
RTOR Reduction (vph)	0	82	0	145	0	0
Lane Group Flow (vph)	141	92	402	34	234	435
Heavy Vehicles (%)	2%	2%	13%	2%	2%	13%
Turn Type		Perm		Perm	pm+pt	
Protected Phases	2		4		3	8
Permitted Phases		2		4	8	
Actuated Green, G (s)	53.0	53.0	18.9	18.9	39.0	39.0
Effective Green, g (s)	53.0	53.0	18.9	18.9	39.0	39.0
Actuated g/C Ratio	0.53	0.53	0.19	0.19	0.39	0.39
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	876	839	604	299	401	1246
v/s Ratio Prot	c0.09		c0.13		c0.09	0.14
v/s Ratio Perm		0.06		0.02	0.13	
v/c Ratio	0.16	0.11	0.67	0.11	0.58	0.35
Uniform Delay, d1	12.1	11.7	37.6	33.6	22.2	21.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.3	2.8	0.2	2.2	0.2
Delay (s)	12.5	12.0	40.4	33.8	24.4	21.7
Level of Service	B	B	D	C	C	C
Approach Delay (s)	12.2		38.4			22.6
Approach LOS	B		D			C

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

12/18/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (veh/h)	185	195	130	15	20	110
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)	201	212	141	16	22	120
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		614				
pX, platoon unblocked						
vC, conflicting volume	158				658	79
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	158				658	79
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	86				94	88
cM capacity (veh/h)	1420				341	966

Direction, Lane #	SE 1	SE 2	SE 3	NW 1	NW 2	SW 1	SW 2
Volume Total	201	106	106	94	63	22	120
Volume Left	201	0	0	0	0	22	0
Volume Right	0	0	0	0	16	0	120
cSH	1420	1700	1700	1700	1700	341	966
Volume to Capacity	0.14	0.06	0.06	0.06	0.04	0.06	0.12
Queue Length 95th (ft)	12	0	0	0	0	5	11
Control Delay (s)	8.0	0.0	0.0	0.0	0.0	16.3	9.3
Lane LOS	A					C	A
Approach Delay (s)	3.9			0.0		10.3	
Approach LOS						B	

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
7: Minnesota St & Site Access

12/18/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	380	235	5	0	55
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)	0	413	255	5	0	60
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		310				
pX, platoon unblocked						
vC, conflicting volume	261				465	130
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	261				465	130
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	93
cM capacity (veh/h)	1301				526	895

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	207	207	170	91	60
Volume Left	0	0	0	0	0
Volume Right	0	0	0	5	60
cSH	1700	1700	1700	1700	895
Volume to Capacity	0.12	0.12	0.10	0.05	0.07
Queue Length 95th (ft)	0	0	0	0	5
Control Delay (s)	0.0	0.0	0.0	0.0	9.3
Lane LOS					A
Approach Delay (s)	0.0		0.0		9.3
Approach LOS					A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	16.7%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX E 2030 TOTAL TRAFFIC LEVEL OF SERVICE WORKSHEETS

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

12/3/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	95	125	20	175	130	300	30	795	135	275	690	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1652	3465		3204	3539	1583	1770	3195	1583	3433	3165	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1652	3465		3204	3539	1583	1770	3195	1583	3433	3165	
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)	103	136	22	190	141	326	33	864	147	299	750	158
RTOR Reduction (vph)	0	13	0	0	0	217	0	0	95	0	18	0
Lane Group Flow (vph)	103	145	0	190	141	109	33	864	52	299	890	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	13%	2%	2%	13%	2%
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases						2			4			
Actuated Green, G (s)	9.5	25.1		10.3	25.9	25.9	4.5	35.2	35.2	13.4	44.1	
Effective Green, g (s)	9.5	25.1		10.3	25.9	25.9	4.5	35.2	35.2	13.4	44.1	
Actuated g/C Ratio	0.10	0.25		0.10	0.26	0.26	0.04	0.35	0.35	0.13	0.44	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	157	870		330	917	410	80	1125	557	460	1396	
v/s Ratio Prot	c0.06	0.04		0.06	0.04		0.02	c0.27		c0.09	0.28	
v/s Ratio Perm						c0.07			0.03			
v/c Ratio	0.66	0.17		0.58	0.15	0.27	0.41	0.77	0.09	0.65	0.64	
Uniform Delay, d1	43.7	29.3		42.8	28.6	29.5	46.5	28.8	21.7	41.1	21.7	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	9.5	0.1		2.4	0.4	1.6	3.4	3.2	0.1	3.3	1.0	
Delay (s)	53.2	29.4		45.2	28.9	31.1	49.9	32.0	21.8	44.4	22.7	
Level of Service	D	C		D	C	C	D	C	C	D	C	
Approach Delay (s)		38.8			34.7			31.1			28.1	
Approach LOS		D			C			C			C	

Intersection Summary			
HCM Average Control Delay	31.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	55.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

12/3/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	70	245	220	15	420	40	75	20	5	10	20	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	10	12	12	10	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.93		1.00	0.99		1.00	0.97		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1652	3288		1652	3494		1652	1811		1652	1640	
Flt Permitted	0.95	1.00		0.95	1.00		0.36	1.00		0.74	1.00	
Satd. Flow (perm)	1652	3288		1652	3494		630	1811		1286	1640	
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)	76	266	239	16	457	43	82	22	5	11	22	87
RTOR Reduction (vph)	0	81	0	0	4	0	0	4	0	0	79	0
Lane Group Flow (vph)	76	424	0	16	496	0	82	23	0	11	30	0
Turn Type	Prot			Prot			pm+pt			pm+pt		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases							4			8		
Actuated Green, G (s)	9.4	76.7		3.2	70.5		24.1	18.6		11.9	10.4	
Effective Green, g (s)	9.4	76.7		3.2	70.5		24.1	18.6		11.9	10.4	
Actuated g/C Ratio	0.08	0.66		0.03	0.61		0.21	0.16		0.10	0.09	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	134	2174		46	2124		216	290		137	147	
v/s Ratio Prot	c0.05	0.13		0.01	c0.14		c0.03	0.01		0.00	0.02	
v/s Ratio Perm							c0.05			0.01		
v/c Ratio	0.57	0.20		0.35	0.23		0.38	0.08		0.08	0.20	
Uniform Delay, d1	51.3	7.6		55.4	10.4		38.5	41.4		47.0	49.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.4	0.2		4.5	0.3		1.1	0.1		0.3	0.7	
Delay (s)	56.8	7.8		59.9	10.7		39.6	41.5		47.3	49.6	
Level of Service	E	A		E	B		D	D		D	D	
Approach Delay (s)		14.2			12.2			40.1			49.4	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	18.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	116.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	38.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
9: Minnesota St & Site Access

12/3/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	535	560	15	0	45
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)	0	582	609	16	0	49
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		287	327			
pX, platoon unblocked	0.95				0.95	0.95
vC, conflicting volume	625				908	312
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	493				758	163
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)	1011				327	808

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	291	291	406	219	49
Volume Left	0	0	0	0	0
Volume Right	0	0	0	16	49
cSH	1700	1700	1700	1700	808
Volume to Capacity	0.17	0.17	0.24	0.13	0.06
Queue Length 95th (ft)	0	0	0	0	5
Control Delay (s)	0.0	0.0	0.0	0.0	9.7
Lane LOS					A
Approach Delay (s)	0.0		0.0		9.7
Approach LOS					A

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	26.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Minnesota St & Elk Vale Rd

12/3/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	160	205	35	320	205	525	20	630	340	540	690	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1652	3462		3204	3539	1583	1770	3195	1583	3433	3172	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1652	3462		3204	3539	1583	1770	3195	1583	3433	3172	
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)	174	223	38	348	223	571	22	685	370	587	750	114
RTOR Reduction (vph)	0	14	0	0	0	293	0	0	269	0	11	0
Lane Group Flow (vph)	174	247	0	348	223	278	22	685	101	587	853	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	13%	2%	2%	13%	2%
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases						2			4			
Actuated Green, G (s)	13.3	21.7		15.2	23.6	23.6	2.0	27.4	27.4	19.7	45.1	
Effective Green, g (s)	13.3	21.7		15.2	23.6	23.6	2.0	27.4	27.4	19.7	45.1	
Actuated g/C Ratio	0.13	0.22		0.15	0.24	0.24	0.02	0.27	0.27	0.20	0.45	
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	220	751		487	835	374	35	875	434	676	1431	
v/s Ratio Prot	0.11	0.07		c0.11	0.06		0.01	c0.21		c0.17	0.27	
v/s Ratio Perm						c0.18			0.06			
v/c Ratio	0.79	0.33		0.71	0.27	0.74	0.63	0.78	0.23	0.87	0.60	
Uniform Delay, d1	42.0	33.0		40.3	31.1	35.4	48.6	33.6	28.2	38.9	20.6	
Progression Factor	1.00	1.00		0.90	0.80	0.81	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	17.4	0.3		4.2	0.7	10.6	30.3	4.6	0.3	11.4	0.7	
Delay (s)	59.4	33.3		40.5	25.6	39.3	79.0	38.2	28.4	50.3	21.3	
Level of Service	E	C		D	C	D	E	D	C	D	C	
Approach Delay (s)		43.7			37.0			35.7			33.0	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM Average Control Delay	35.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
2: Minnesota St & Marlin Dr

12/3/2008

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	225	530	330	10	435	25	325	90	15	30	100	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	12	12	10	12	12	10	12	12	10	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.94		1.00	0.99		1.00	0.98		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1652	3335		1652	3511		1652	1824		1652	1695	
Flt Permitted	0.95	1.00		0.95	1.00		0.20	1.00		0.68	1.00	
Satd. Flow (perm)	1652	3335		1652	3511		346	1824		1188	1695	
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)	245	576	359	11	473	27	353	98	16	33	109	163
RTOR Reduction (vph)	0	89	0	0	4	0	0	6	0	0	55	0
Lane Group Flow (vph)	245	846	0	11	496	0	353	108	0	33	217	0
Turn Type	Prot			Prot			pm+pt			Perm		
Protected Phases	1	6		5	2		7	4			8	
Permitted Phases							4			8		
Actuated Green, G (s)	18.5	44.0		0.8	26.3		43.2	43.2		16.1	16.1	
Effective Green, g (s)	18.5	44.0		0.8	26.3		43.2	43.2		16.1	16.1	
Actuated g/C Ratio	0.18	0.44		0.01	0.26		0.43	0.43		0.16	0.16	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	306	1467		13	923		451	788		191	273	
v/s Ratio Prot	c0.15	c0.25		0.01	0.14		c0.18	0.06			0.13	
v/s Ratio Perm							c0.16			0.03		
v/c Ratio	0.80	0.58		0.85	0.54		0.78	0.14		0.17	0.79	
Uniform Delay, d1	39.0	21.0		49.5	31.6		22.3	17.1		36.2	40.4	
Progression Factor	0.62	0.56		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	10.8	1.3		166.4	2.2		8.6	0.1		0.4	14.6	
Delay (s)	34.9	13.1		216.0	33.9		30.9	17.2		36.6	54.9	
Level of Service	C	B		F	C		C	B		D	D	
Approach Delay (s)		17.6			37.8			27.6			53.0	
Approach LOS		B			D			C			D	

Intersection Summary				
HCM Average Control Delay	28.1	HCM Level of Service	C	
HCM Volume to Capacity ratio	0.70			
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	74.4%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
9: Minnesota St & Site Access

12/3/2008

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↑↑	↑↑↱			↱
Volume (veh/h)	0	1085	900	10	0	150
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)	0	1179	978	11	0	163
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		287	327			
pX, platoon unblocked	0.89				0.91	0.89
vC, conflicting volume	989				1573	495
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	733				1217	175
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	78
cM capacity (veh/h)	770				157	743

Direction, Lane #	SE 1	SE 2	NW 1	NW 2	SW 1
Volume Total	590	590	652	337	163
Volume Left	0	0	0	0	0
Volume Right	0	0	0	11	163
cSH	1700	1700	1700	1700	743
Volume to Capacity	0.35	0.35	0.38	0.20	0.22
Queue Length 95th (ft)	0	0	0	0	21
Control Delay (s)	0.0	0.0	0.0	0.0	11.2
Lane LOS					B
Approach Delay (s)	0.0		0.0		11.2
Approach LOS					B

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		