

Intersection Traffic Control Feasibility Study



Dakota County CP 6-06 CSAH 73 & CR 6 in West St. Paul

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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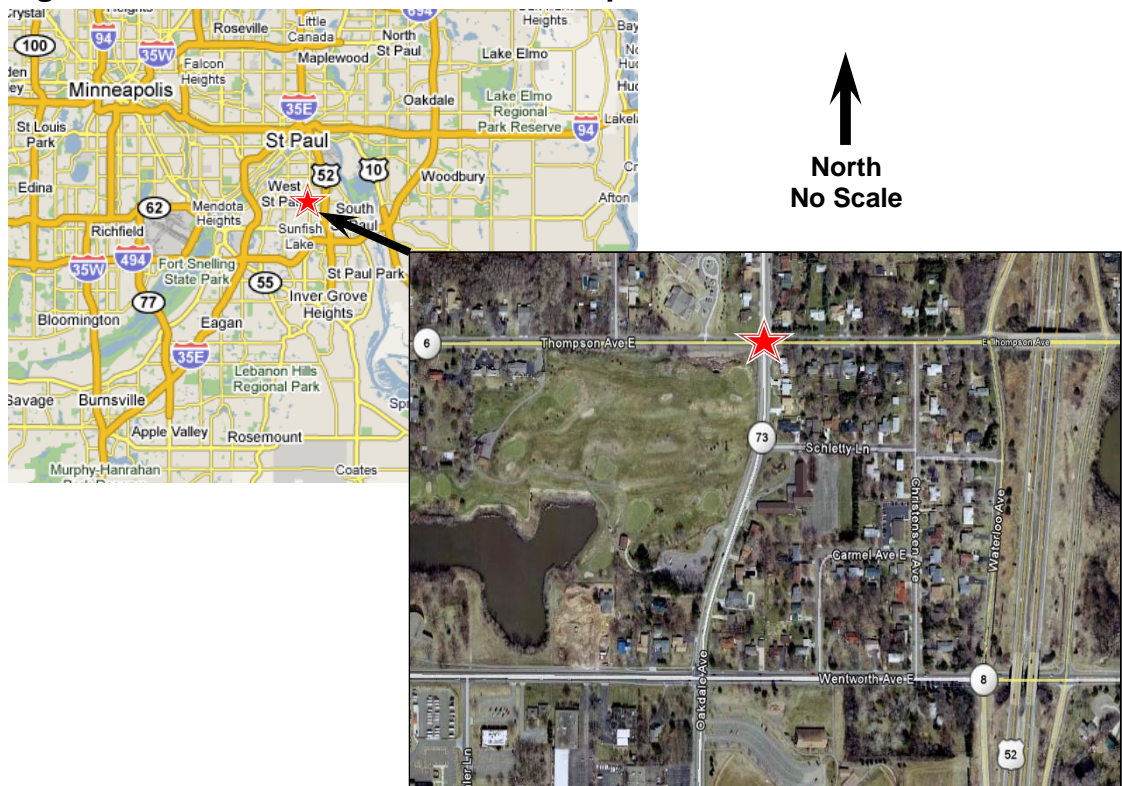
1. Purpose and Need

The intersection of Dakota County State Aid Highway 73 (Oakdale Avenue) and Dakota County Road 6 (Thompson Avenue), called CSAH 73/CR 6 hereafter, in West St. Paul, MN is one of the busiest intersections under Dakota County's jurisdiction controlled with all-way stop signs. The purpose of this *Feasibility Study* is twofold: (1) to determine the most appropriate long term level of traffic control for the intersection and (2) if a change in traffic control is needed, to determine in what year that change should occur. The traffic control alternatives are analyzed in the existing, near term (Year 2010), and long term horizons (Year 2030).

2. Description of Location

The City of West St. Paul is located south of St. Paul and is situated in the northern portion of Dakota County. Figure 2.1 shows the location of the study intersection as well as its proximity to major intersections. According to the US Census Bureau, the 2000 population of West St. Paul was estimated to be 19,405.

Figure 2.1 – CSAH 73/CR 6 Location Map



3. Existing Conditions

a. Intersection Geometry

CSAH 73

CSAH 73 is a two lane, undivided roadway with a 30 mph posted speed limit at the intersection with CR 6. It is designated as a collector roadway by Dakota County. The 2007 Average Annual Daily Traffic volume on CSAH 73 is 5,400 vehicles per day north of CR 6 and 7,600 vehicles per day south of CR 6. The stop sign controlled northbound and southbound approaches currently each have one shared left/through/right lane and one parking lane. During congested periods motorists use the parking lanes as right turn lanes.

CR 6

CR 6 is a two lane, undivided roadway with a 30 mph posted speed limit at the intersection with CSAH 73. It operates as a local collector, but is undesignated by Dakota County. The 2007 Average Annual Daily Traffic volume on CR 6 is 8,900 vehicles per day west of CSAH 73 and 10,100 vehicles per day east of CSAH 73. The stop sign controlled westbound and eastbound approaches currently each have one shared left/through/right lane and one parking lane. During congested periods motorists use the parking lanes as right turn lanes. There are Metro Transit bus stops on County Road 6 both east and west of CSAH 73 downstream from the intersection.

The Trunk Highway 52/CR 6 interchange, approximately 1,000 feet east of the CSAH 73/CR 6 intersection, will be improved in 2009 through a Mn/DOT project. The intersections at the interchange will have traffic signal control. The interchange is far enough away from the CSAH 73/CR 6 intersection that platoons of vehicles going along the CR 6 corridor will not adversely impact the operation of the intersections at CSAH 73 or the Highway 52 interchange.

b. Traffic Data

Hourly traffic volumes for the existing northbound, southbound, eastbound, and westbound approaches of the existing CSAH 73/CR 6 intersection are contained in Appendix A in Table A-1. The existing turning movement volumes for the intersection are shown in Table 3.1.

Table 3.1 – 2008 Turning Movement Peak Hour Volumes

	SB CSAH 73			WB CR 6			NB CSAH 73			EB CR 6		
	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt
AM	34	95	11	79	220	38	49	95	40	12	137	40
PM	55	214	18	108	228	59	64	214	127	10	285	119

Source: Dakota County

c. Crash Data

There were ten State reported crashes at the intersection from January 1, 2005 to December 31, 2007 (four right angle crashes, three rear end crashes, two left turn crashes, and one sideswipe crash). A crash diagram is included in Appendix B and a summary is shown in Figure 3.1. There are no significant crash patterns at the intersection.

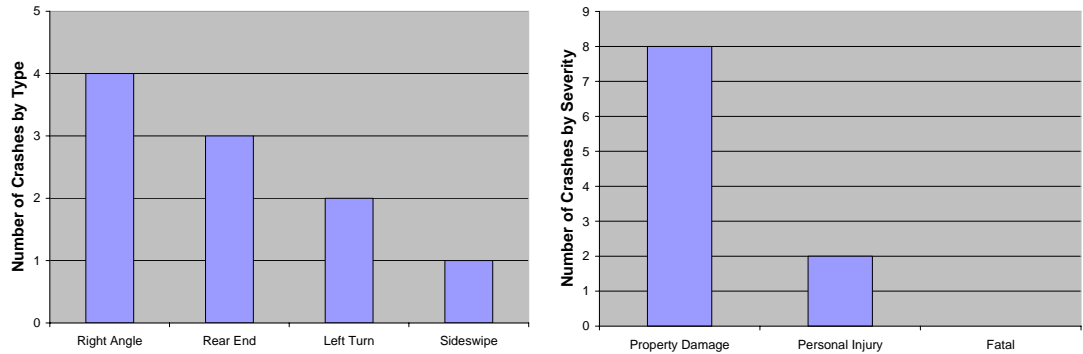


Figure 3.1 – 2005 through 2007 Crash Summary

Based on the 2008 average daily entering volumes, the intersection had 0.56 crashes per million entering vehicles on average from 2005 through 2007. Based on Mn/DOT's *2008 Traffic Safety Fundamentals Handbook*, it is expected all way stop sign controlled intersections have 0.60 crashes per million entering vehicles on average and signal controlled intersections have 0.70 crashes per million entering vehicles on average. Because signalized intersections have higher average crash rates than intersections with all way stop sign control, traffic signal installation is not considered a safety improvement. The CSAH 73/CR 6 intersection had a lower crash rate than the average all way stop sign controlled intersection from 2005 through 2007.

d. Intersection Observations

The existing CSAH 73/CR 6 intersection is controlled with all-way stop signs. The intersection was observed for an hour during the morning, midday, and evening peak periods. The westbound queue built up to 18 vehicles (to Christensen Avenue but not through the CR 6/Christensen intersection) at about 4:15 p.m., but completely dissipated by 4:30 p.m. Other than that fifteen minute period, the queues quickly dissipated at the intersection. Semi-trucks had no difficulty making turns at the intersection and there was little pedestrian activity at the intersection. A detailed report of the observations is included in Appendix C.

St. Croix Lutheran High is located north of the study intersection on CSAH 73. School hours are from 8:05 am to 2:58 pm. Any

pedestrian or vehicular traffic generated by the school at the study intersection is not expected to have a significant impact on the study intersection's operation because the school's peak traffic periods occur largely outside of the peak traffic periods of the study intersection.

e. Warrant Analyses

A traffic signal warrant analysis was conducted for the existing intersection per the *Minnesota Manual on Uniform Traffic Control Devices*. Mn/DOT has developed a procedure for reducing the right turn volumes used in a warrant analysis based on the amount of traffic that conflicts with the right turn movement. If there is little conflicting volume for a right turn movement, the right turn movement does not benefit from installation of traffic signal control. Dakota County uses the right turn reduction procedure developed by Mn/DOT. Following the procedure resulted in 100% of the right turn volumes being removed from the minor street approach volumes in the warrant analysis. The full warrant analyses are contained in Appendix D. None of the warrants are currently met for installation of traffic signal control.

f. Capacity Analyses

The *Highway Capacity Manual* documents procedures for determining the performance of different traffic control measures at intersections. Intersections are assigned a "Level of Service" letter grade for the peak hour of traffic based on the number of lanes at the intersection, traffic volumes, and traffic control. Level of Service A (LOS A) represents light traffic flow (free flow conditions) while Level of Service F (LOS F) represents heavy traffic flow (over capacity conditions). LOS D is considered acceptable in urban conditions.

In conjunction with City and County staff, it was determined to use micro-simulation to evaluate the stop sign controlled intersection because it will give the most accurate assessment of operations. The existing conditions and traffic volumes were entered into the model SimTraffic™. The simulation software was seeded with a random number seed of 0, a seeding duration of 1 minute, and a recording duration of 60 minutes. Then the simulation software was run and recorded five times with random number seeds of 1, 2, 3, 4, and 5; using a seeding duration of 1 minute and a recording duration of 60 minutes. The model predicts there is 15.4 seconds of delay per vehicle (LOS C) in the a.m. peak hour and 25.3 seconds of delay per vehicle (LOS D) in the p.m. peak hour. The detailed SimTraffic™ reports are included in Appendix E.

4. Future Conditions

a. Traffic Forecasts

Dakota County provided Average Annual Daily traffic volumes for the years 2007 and 2030 (forecasts) as shown in Table 4.1. Based on these daily traffic volumes, the annual compounded growth rates shown in Table 4.1 were developed for each leg of the intersection.

Table 4.1 – Compounded Growth Rates

Intersection Leg	Existing AADT	2030 AADT	Compound Growth Rate
CR 6 -West	8,900	10,500	0.721%
CR 6 -East	10,100	13,700	1.334%
CSAH 73 - South	7,600	10,200	1.288%
CSAH 73 - North	5,400	7,800	1.612%

The turning movement peak hour volumes from Table 3.1 were factored by approach leg with the compounded growth rates in Table 4.1 to develop the turning movement volume forecasts shown in Table 4.2. Likewise, the daily approach volumes in Table A-1 were factored to develop the 2010 and 2030 approach volumes in Appendix A Tables A-2 and A-3.

Table 4.2 – Future Turning Movement Peak Hour Volumes

	SB CSAH 73			WB CR 6			NB CSAH 73			EB CR 6		
	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt
2010 AM	40	100	10	80	230	40	50	100	40	10	140	40
2030 AM	50	130	10	100	300	50	60	130	40	10	160	50
2010 PM	60	230	20	110	240	60	70	230	130	10	300	120
2030 PM	70	300	30	150	300	80	90	270	170	10	340	140

b. Future Intersection Configuration Alternatives

Based on discussions with City and County staff, the following lane configurations are to be studied in conjunction with each traffic control strategy.

All-Way Stop Sign Control

To allow for the following configuration, both CSAH 73 and CR 6 will need to be widened.

- Northbound CSAH 73: one left/through and one through/right lane
- Southbound CSAH 73: one left/through and one through/right lane
- Westbound CR 6: one left/through and one through/right lane
- Eastbound CR 6: one left/through and one through/right lane

- or -

Roundabout Control

- Northbound CSAH 73: single entry
- Southbound CSAH 73: single entry
- Westbound CR 6: single entry
- Eastbound CR 6: single entry
- The roundabout will be a single lane roundabout

- or -

Traffic Signal Control

- Northbound CSAH 73: one left turn lane and one shared through/right turn lane
- Southbound CSAH 73: one left turn lane and one shared through/right turn lane
- Westbound CR 6: one left turn lane and one shared through/right turn lane
- Eastbound CR 6: one left turn lane and one shared through/right turn lane
- Protected/Permitted (left turns allowed on the green arrow or green circle indications) phasing will be assumed for all left turn movements. The County will determine left turn phasing with implementation of an improvement project.

5. Analysis of Alternatives

a. All Way Stop

The future conditions, as described in Section 4b along with the turning movement volume forecasts from Table 4.2 were entered into the SimTraffic™ model. The model was seeded with a random number seed of 0, a seeding duration of 1 minute, and a recording duration of 60 minutes. Then the simulation software was run and recorded five times with random number seeds of 1, 2, 3, 4, and 5; using a seeding duration of 1 minute and a recording duration of 60 minutes. The overall intersection delay is shown in Table 5.1 and detailed SimTraffic™ reports are included in Appendix E.

The existing conditions, as described in Section 3a along with the turning movement volume forecasts from Table 4.2 were entered into the SimTraffic™ model. There will be 14.0 seconds of delay per vehicle (LOS B) in the 2010 a.m. peak hour and 26.5 seconds of delay per vehicle (LOS D) in the 2010 p.m. peak hour. There will be 17.0 seconds of delay per vehicle (LOS C) in the 2030 a.m. peak hour and 91.1 seconds of delay per vehicle (LOS F) in the 2030 p.m. peak hour. Table 5.1 also shows the forecasted delay the existing

intersection configuration will experience with the future volumes compared with the delay results from other traffic control alternatives. The detailed SimTraffic™ reports are included in Appendix E.

The option of retaining the all way stop sign control and widening each approach to the intersection from one lane to two lanes, along with the turning movement volume forecasts from Table 4.2 were also entered into the SimTraffic™ model. There will be 11.0 seconds of delay per vehicle (LOS B) in the 2010 a.m. peak hour and 12.8 seconds of delay per vehicle (LOS B) in the 2010 p.m. peak hour. There will be 12.6 seconds of delay per vehicle (LOS B) in the 2030 a.m. peak hour and 16.9 seconds of delay per vehicle (LOS C) in the 2030 p.m. peak hour. Table 5.1 also shows the forecasted delay this configuration will experience with the future volumes compared with the delay results from other traffic control alternatives. The detailed SimTraffic™ reports are included in Appendix E.

The intersection will need to be improved as traffic volumes continue to grow at the intersection. Based on an iterative SimTraffic™ analysis, it is forecast the existing intersection will operate unacceptably at the Level of Service D/E boundary (35 seconds per vehicle of overall intersection delay) in 2014.

b. Traffic Control Signal

Warrant Analysis

A traffic signal warrant analysis was conducted for the intersection per the *Minnesota Manual on Uniform Traffic Control Devices*. The warrant analysis is based on the following assumptions:

- The approach volumes shown in Tables A-2 and A-3 were factored to remove the right turning volumes on the minor street approaches.
- All legs will have 2+ legs per County policy.
- The Mn/DOT procedure for right turn reduction was used as the County uses this practice. Following the procedure resulted in 100% of the right turn volumes being removed from the minor street approach volumes in the warrant analysis.

The full warrant analyses are contained in the Appendix. No warrants will be met in 2010, but Warrant 1 a & c (Eight Hour Vehicular Volumes) and Warrant 2 (Four Hour Volumes) are met in the 2030 scenario.

Capacity Analyses

An intersection capacity analysis was conducted for the intersection as a traffic signal controlled intersection per the *Highway Capacity Manual*. The analysis was performed using Synchro™ software. The lane configuration noted for the traffic signal control scenario in

Section 4b was used along with the peak hour volumes from Table 4.2 to determine the overall delay. There will be 13.1 seconds of delay per vehicle (LOS B) in the 2010 a.m. peak hour and 21.9 seconds of delay per vehicle (LOS C) in the 2010 p.m. peak hour. There will be 15.3 seconds of delay per vehicle (LOS B) in the 2030 a.m. peak hour and 31.7 seconds of delay per vehicle (LOS C) in the 2030 p.m. peak hour. Table 5.1 also shows the forecasted delay this configuration will experience with the future volumes compared with the delay results from other traffic control alternatives. The full results are contained in Appendix F.

c. Roundabout

An intersection capacity analysis was conducted for the intersection as a roundabout controlled intersection using Rodel™ software. The lane configuration noted for the roundabout control scenario in Section 4b was used along with the peak hour volumes from Table 4.2 to determine the overall delay. There will be 7.7 seconds of delay per vehicle (LOS A) in the 2010 a.m. peak hour and 16.0 seconds of delay per vehicle (LOS C) in the 2010 p.m. peak hour. There will be 10.3 seconds of delay per vehicle (LOS B) in the 2030 a.m. peak hour and 25.9 seconds of delay per vehicle (LOS D) in the 2030 p.m. peak hour. Table 5.1 also shows the forecasted delay this configuration will experience with the future volumes compared with the delay results from other traffic control alternatives. The full results are contained in Appendix G.

The Insurance Institute for Highway Safety found in their March 2000 report titled “Crash Reductions Following Installation of Roundabouts in the United States” that less crashes occur at intersections controlled with roundabouts versus traffic signals. This is likely due to the lower speed of the vehicles going through the intersection, the requirement for approaching vehicles to yield to vehicles within the intersection, and the lower likelihood of right angle or head on collisions. However, there is not an existing crash problem to be corrected at the intersection.

d. Non-Traditional Intersection

The additional right-of-way required for the different non-traditional intersections is not justified at the CSAH 73/CR 6 intersection. The traditional all-way stop, roundabout, or traffic signal will provide adequate capacity.

e. Access Management Treatments

Access management treatments are not feasible at the study intersection.

f. **Grade Separation**

The forecasted traffic volumes at the study intersection do not warrant the expense of an interchange.

Table 5.1 – 2010 & 2030 Capacity Analyses

Scenario	All Way Stop (existing)	All Way Stop (2 lanes per approach)	Single Lane Roundabout	Signal
2010 AM	14.0	11.0	7.7	13.1
2030 AM	17.0	12.6	10.3	15.3
2010 PM	26.5	12.8	16.0	21.9
2030 PM	91.1	16.9	25.9	31.7

Notes: All way stop delay from SimTraffic, Roundabout delay from Rodel, Signal delay from Synchro HCM. Delay is measured in seconds per vehicle.

6. Preliminary Design

Widening CSAH 73 and CR 6 to provide a shared left/through and shared through/right lane at the intersection will be significantly cheaper than installing a roundabout or traffic signal and no right-of-way will need to be purchased. Further, operational analysis shows an all way stop with roadway widening will operate acceptably now and into the future. A preliminary design has been prepared for this alternative and is included in Appendix H. During final design, it may be possible to lessen the predicted right-of-way needed for the widening project or shift more of the right-of-way needed to the City owned golf course parcel.

The preliminary layout removes the parking lanes currently on CSAH 73 and CR 6 near the intersection. These parking lanes would also be removed if a traffic signal or roundabout were installed at the intersection. The appropriate parking restrictions at the intersection will be determined during the final design process.

Included in Appendix I is a detailed, preliminary cost break down for the road widening. This cost estimate is at a preliminary level and doesn't contain costs for final design items such as right-of-way acquisition, storm sewer, utility relocation, signing, temporary easements, or contingencies. It is anticipated the widening project will cost approximately \$200,000.

7. Recommended Alternative

It is recommended the CSAH 73/CR 6 intersection be controlled with all-way stop sign control and widened to provide two lanes of approach on each leg of the intersection for the following reasons:

- Widening each approach and retaining the all-way stop sign control will be less expensive than adding traffic signal or roundabout control.
- The intersection will operate with less delay with the widening/all-way stop sign control option versus the traffic signal or roundabout options.

The SimTraffic model predicts there will be 12.6 seconds of delay per vehicle (LOS B) in the 2030 a.m. peak hour and 16.9 seconds of delay per vehicle (LOS C) in the 2030 p.m. peak hour with the widening/all-way stop sign control option.

- There were ten State reported crashes from January 1, 2005 to December 31, 2007. While a relative number, the suggested widening is expected to improve the safety at the intersection because queuing and delay will be reduced.

It is recommended the widening project be implemented in approximately 2014 when the existing intersection is predicted to operate unacceptably at Level of Service E.

8. Appendix

A. Approach Volumes

B. 2005 to 2007 Crash Diagram

C. Intersection Observations

D. Traffic Signal Warrant Analyses

E. Level of Service for All-Way Stop (SimTraffic)

F. Level of Service for Traffic Control Signal (Synchro)

G. Level of Service for Roundabout (Rodel)

H. Preliminary Layout

I. Preliminary Cost

Appendix A - Approach Volumes

Table A-1: 2008 Approach Volumes

Interval Begin	DAILY AVERAGES			
	CSAH 73 south of CR 6	CSAH 73 north of CR 6	CR 6 west of CSAH 73	CR 6 east of CSAH 73
	NB	SB	EB	WB
12:00 AM	21	9	41	39
1:00 AM	12	11	16	18
2:00 AM	10	6	14	13
3:00 AM	5	4	7	15
4:00 AM	6	8	20	26
5:00 AM	44	31	50	86
6:00 AM	108	90	106	191
7:00 AM	172	119	153	281
8:00 AM	181	149	208	336
9:00 AM	188	134	195	319
10:00 AM	193	162	244	316
11:00 AM	226	152	248	387
12:00 PM	248	181	304	436
1:00 PM	250	183	268	380
2:00 PM	222	196	268	398
3:00 PM	320	221	304	458
4:00 PM	388	234	350	396
5:00 PM	348	271	334	392
6:00 PM	263	201	303	366
7:00 PM	200	139	220	263
8:00 PM	164	125	192	210
9:00 PM	141	85	169	182
10:00 PM	75	46	83	103
11:00 PM	41	27	44	69
Totals	3,826	2,784	4,141	5,680

Appendix A - Approach Volumes

Table A-2: 2010 Approach Volumes

Interval Begin	DAILY AVERAGES			
	CSAH 73 south of CR 6	CSAH 73 north of CR 6	CR 6 west of CSAH 73	CR 6 east of CSAH 73
	NB	SB	EB	WB
12:00 AM	20	10	40	40
1:00 AM	10	10	20	20
2:00 AM	10	10	10	10
3:00 AM	10	0	10	20
4:00 AM	10	10	20	30
5:00 AM	50	30	50	90
6:00 AM	110	90	110	200
7:00 AM	180	120	160	290
8:00 AM	190	150	210	350
9:00 AM	190	140	200	330
10:00 AM	200	170	250	320
11:00 AM	230	160	250	400
12:00 PM	250	190	310	450
1:00 PM	260	190	270	390
2:00 PM	230	200	270	410
3:00 PM	330	230	310	470
4:00 PM	400	240	360	410
5:00 PM	360	280	340	400
6:00 PM	270	210	310	380
7:00 PM	210	140	220	270
8:00 PM	170	130	190	220
9:00 PM	140	90	170	190
10:00 PM	80	50	80	110
11:00 PM	40	30	40	70
Totals	3,950	2,880	4,200	5,870

Appendix A - Approach Volumes

Table A-3: 2030 Approach Volumes

Interval Begin	DAILY AVERAGES			
	CSAH 73 south of CR 6	CSAH 73 north of CR 6	CR 6 west of CSAH 73	CR 6 east of CSAH 73
	NB	SB	EB	WB
12:00 AM	30	10	50	50
1:00 AM	20	20	20	20
2:00 AM	10	10	20	20
3:00 AM	10	10	10	20
4:00 AM	10	10	20	30
5:00 AM	60	40	60	120
6:00 AM	140	130	120	260
7:00 AM	230	170	180	380
8:00 AM	240	210	240	450
9:00 AM	250	190	230	430
10:00 AM	260	230	290	420
11:00 AM	300	220	290	520
12:00 PM	330	260	360	580
1:00 PM	330	260	310	510
2:00 PM	290	280	310	530
3:00 PM	420	310	360	610
4:00 PM	510	330	410	530
5:00 PM	460	390	390	520
6:00 PM	350	290	350	490
7:00 PM	270	200	260	350
8:00 PM	220	180	220	280
9:00 PM	190	120	200	240
10:00 PM	100	70	100	140
11:00 PM	50	40	50	90
Totals	5,080	3,980	4,850	7,590

Appendix B - 2005 to 2007 Crash Diagram

Dakota County Highway Department



NORTH

CSAH 73
Oakdale Ave.
R.P.: 12.537

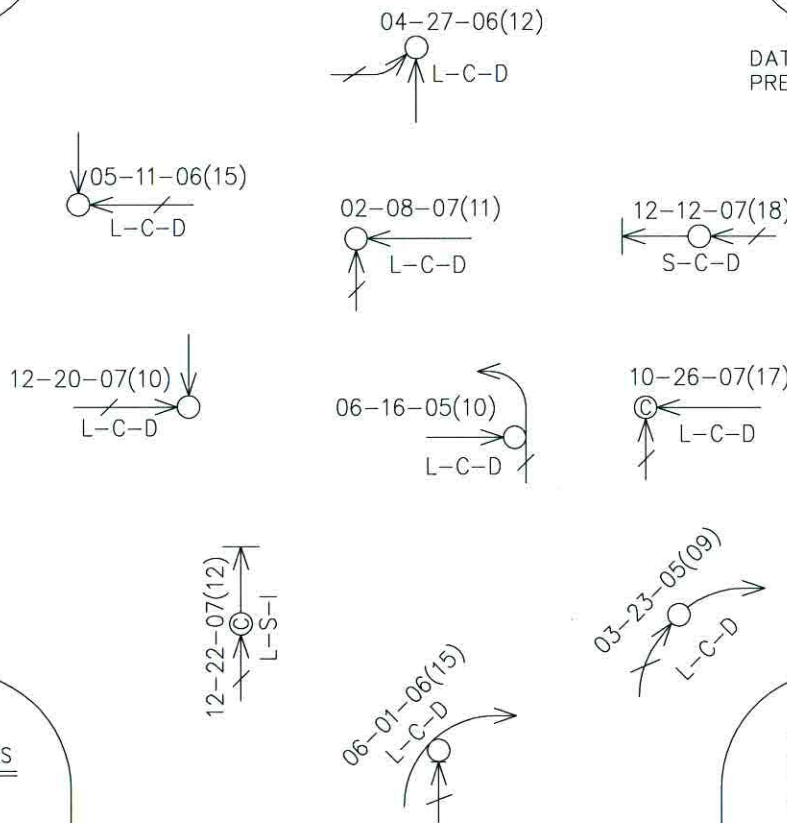
CR 6
Thompson Ave.
R.P.: 0.500

Collision Diagram

ACCIDENT TOTALS

2005..... 2
2006..... 3
2007..... 5

DATE PREPARED: 08-25-08
PREPARED BY: PV



ACCIDENTS SUMMARY

10 ACCIDENTS . . . 3 YEARS

2 . . . PERSONAL INJURY
8 . . . PROPERTY DAMAGE

8 . . NB	5 . . EB	9 . . DAY
2 . . SB	5 . . WB	1 . . NIGHT

9 . . CLEAR	9 . . DRY
1 . . SNOW	1 . . ICE

ACCIDENTS SUMMARY

4 . . . RIGHT ANGLE
3 . . . REAR END
2 . . . LEFT TURN
1 . . . SIDESWIPE

Standard Symbols

	M V BACKING UP		SCHOOL BUS		PEDESTRIAN		BICYCLE		MOTORCYCLE
	MOTOR VEHICLE STOPPED		FATAL ACCIDENT		PARKING		FIXED OBJECT		ANIMAL
	PARTY AT FAULT		PERSONAL INJURY	<u>LIGHT:</u>			<u>WEATHER:</u>		<u>SURFACE:</u>
	OUT OF CONTROL		PROPERTY DAMAGE	L = DAYLIGHT	C = CLEAR	D = DRY			
	OVERTURN			D = DARK	R = RAINING	W = WET			
	REAR END			S = DARK W/ STREET LIGHTS	S = SNOWING	S = SNOW			
	RIGHT ANGLE				F = FOG	I = ICE			

INTERSECTION CR 6 & CSAH 73
FROM 01-01-05 TO 12-31-07

IN WEST ST PAUL
SOURCE MNDOT PRINTOUT

Appendix C - Intersection Observations



**INTERSECTION OBSERVATION BY MIKE SPACK, PE
CSAH 73 (Oakdale Ave) & County Road 6 (Thompson Ave)
West St. Paul, Dakota County, MN
Tuesday, July 29, 2008, from 7:00 a.m. to 8:00 a.m.
Weather – Clear with daily high between 85 and 90 degrees**

General Observations

1. Intersection operated at approximately LOS A
2. Queues dissipate quickly
3. Vehicles use parking lanes as right turn lanes if there is any congestion
4. Little pedestrian or bike traffic

Maximum Queues (vehicles per lane):

NB = 3 vehicles, WB = 3 vehicles, SB = 3 vehicles, and EB = 4 vehicles

Time Log of Observations:

7:02 WB bicycle
7:11 NB right used parking lane
7:12 NB Darts mini-bus stopped
7:14 NB to EB bus
7:15 NB pedestrian on west side
7:19 Car backing out of driveway onto CSAH 73 from SE quad driveway
7:21 NB to WB pedestrian
7:22 WB to NB bicycle
7:23 NB right used parking lane
7:24 WB bus
7:26 EB to SB right used parking lane
7:26 NB pedestrian on east side
7:32 SB to EB bicycle
7:39 WB roll through
7:41 NB bicycle
7:41 NB to EB bus
7:42 WB to NB right used parking lane
7:44 EB to SB right used parking lane
7:46 EB bus
7:47 SB bicycle
7:48 WB bus
7:56 WB to NB right used parking lane

Appendix C - Intersection Observations



**INTERSECTION OBSERVATION BY MIKE SPACK, PE
CSAH 73 (Oakdale Ave) & County Road 6 (Thompson Ave)
West St. Paul, Dakota County, MN
Tuesday, July 29, 2008, from 11:00 a.m. to 12:00 p.m.
Weather – Clear with daily high between 85 and 90 degrees**

General Observations

1. Intersection operated at approximately LOS A or B
2. Queues dissipated quickly
3. Semi's are few but have no problems
4. Parking lanes operated as right turn lanes
5. Little bike or pedestrian traffic

Maximum Queues (vehicles per lane):

NB = 4 vehicles, WB = 6 vehicles, SB = 4 vehicles, and EB = 5 vehicles

Time Log of Observations:

11:07 SB bicycle
11:10 NB to EB right used parking lane
11:12 WB to NB right used parking lane
11:16 WB to NB right used parking lane
11:16 Car backing out of SE corner driveway onto CSAH 73
11:18 SB bicycle
11:18 WB to NB right used parking lane
11:20 NB mail drop-off at stop sign
11:22 NB to EB right using parking lane
11:26 WB bus
11:29 NB to EB right using parking lane
11:33 SB to WB right using parking lane
11:34 WB to NB right using parking lane
11:35 NB to EB right using parking lane
11:44 NB to EB right using parking lane
11:45 WB 10 mph roll-through
11:46 EB bus
11:47 EB to SB right using parking lane
11:48 WB using parking lane to bypass left turner
11:49 Queue of 2 WB to NB right using parking lane
11:50 EB to SB right using parking lane
11:56 NB 4 bicycles on trails
11:58 EB to SB right using parking lane

Appendix C - Intersection Observations



INTERSECTION OBSERVATION BY MIKE SPACK, PE
CSAH 73 (Oakdale Ave) & County Road 6 (Thompson Ave)
West St. Paul, Dakota County, MN
Tuesday, July 29, 2008, from 4:00 p.m. to 5:00 p.m.
Weather – Clear with daily high between 85 and 90 degrees

General Observations

1. Intersection operated at approximately LOS C
2. A few longer queues dissipated quickly
3. Approximately 10 minutes of long WB queues, they backed up to Christensen Street, but not passed it.

Maximum Queues (vehicles per lane):

NB = 8 vehicles, WB = 18 vehicles, SB = 8 vehicles, and EB = 5 vehicles

Time Log of Observations:

4:00 WB to NB right used parking lane
4:05 EB to SB right used parking lane
4:07 NB to EB right used parking lane
4:08 NB to EB right used parking lane
4:08 WB to NB right used parking lane
4:09 NB to EB right used parking lane (2 cars)
4:10 NB to EB right used parking lane
4:10 EB to SB pedestrian
4:11 WB bicycle
4:13 WB car used parking lane as bypass
4:14 NB to EB right used parking lane (2 cars)
4:14 SB to EB pedestrian
4:14 EB bus
4:15 WB to NB right used parking lane
4:16 WB pedestrian
4:16 SB bicycle on east side
4:16 EB to SB right used parking lane
4:17 WB to NB right used parking lane (4 cars)
4:18 NB bicycle
4:19 NB to EB right used parking lane
4:20 EB to SB right used parking lane (2 cars)
4:20 NB to EB right used parking lane
(Vehicles making right turns continued using parking lanes almost exclusively – stopped noting at this point)
4:28 Queues all dissipated (peak since 4:15)
4:34 SB and WB queues built to 8, dissipated by 4:37
4:46 NB bicycle
4:48 WB to SB bus
4:52 SB pedestrians (2)
4:53 NB bicycles (3)
4:53 EB bus

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2008 Signal Warrant Analysis
Right Turns Removed from Minor Leg
City of West St. Paul, Dakota County, MN

Signal Warrants - Summary

Major Street Approaches

Eastbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 4,141

Westbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 5,680

Minor Street Approaches

Northbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 2,756

Southbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 2,590

Warrant Summary (Urban values apply.)

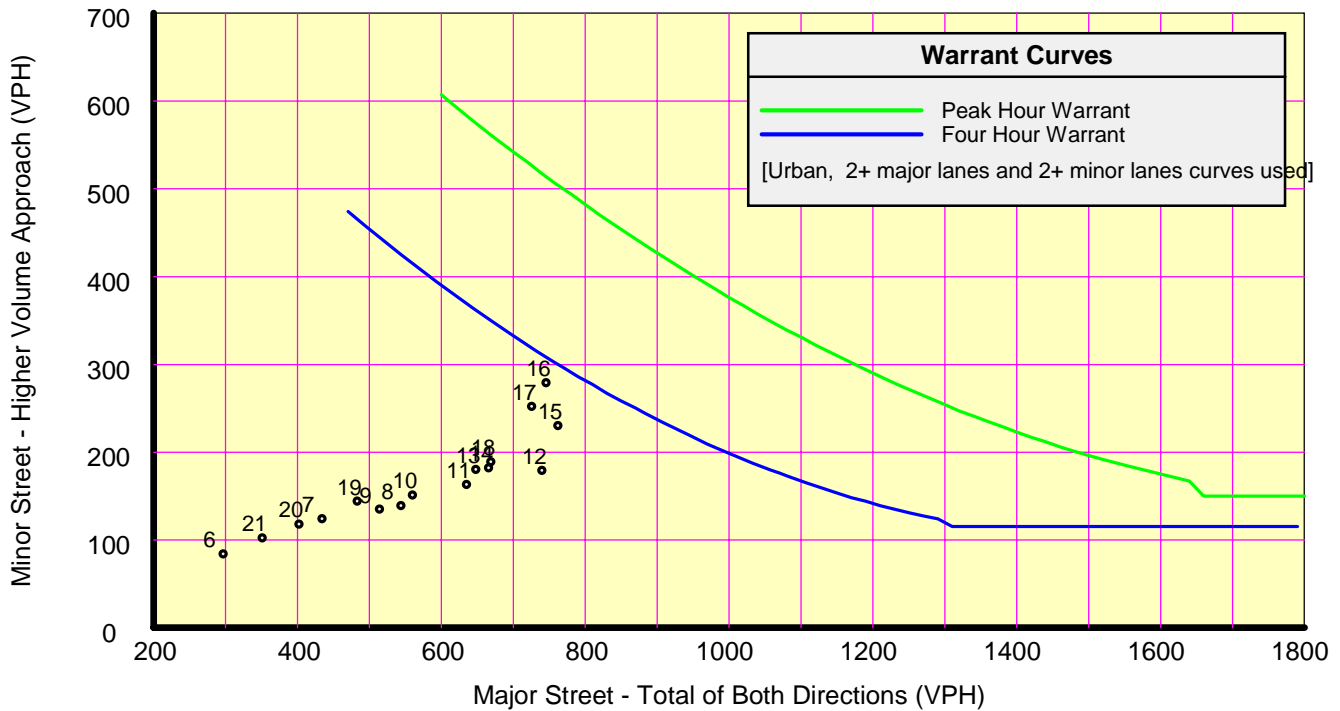
Warrant 1 - Eight Hour Vehicular Volumes	Not Satisfied
Warrant 1A - Minimum Vehicular Volume	Not Satisfied
Required volumes reached for 3 hours, 8 are needed	
Warrant 1B - Interruption of Continuous Traffic	Not Satisfied
Required volumes reached for 0 hours, 8 are needed	
Warrant 1 A&B - Combination of Warrants	Not Satisfied
Required volumes reached for 4 hours, 8 are needed	
Warrant 2 - Four Hour Volumes	Not Satisfied
Number of hours (0) volumes exceed minimum < minimum required (4).	
Warrant 3 - Peak Hour	Not Satisfied
Warrant 3A - Peak Hour Delay	Not Satisfied
Total approach volumes and delays on minor street do not exceed minimums for any hour.	
Warrant 3B - Peak Hour Volumes	Not Satisfied
Volumes do not exceed minimums for any hour.	
Warrant 4 - Pedestrian Volumes	Not Satisfied
Required 4 Hr pedestrian volume reached for 0 hour(s) and the single hour volume for 0 hour(s)	
Warrant 5 - School Crossing	Not Satisfied
Number of gaps > .0 seconds (0) exceeds the number of minutes in the crossing period (0).	
Warrant 6 - Coordinated Signal System	Not Satisfied
No adjacent coordinated signals are present	
Warrant 7 - Crash Experience	Not Satisfied
Number of accidents (-1) is less than minimum (5). Volume minimums are met.	
Warrant 8 - Roadway Network	Not Satisfied
Major Route conditions not met. One or more volume requirement met.	

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2008 Signal Warrant Analysis
 Right Turns Removed from Minor Leg
 City of West St. Paul, Dakota County, MN

Signal Warrants - Summary



Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor Vol	Dir	War-1A			War-1B			War-1A&B		
				Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	80	15	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
01:00	34	10	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
02:00	27	7	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
03:00	22	4	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
04:00	46	7	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
05:00	136	32	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
06:00	297	84	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
07:00	434	124	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
08:00	544	139	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
09:00	514	135	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
10:00	560	151	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
11:00	635	163	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
12:00	740	179	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
13:00	648	180	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
14:00	666	182	SB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
15:00	762	230	NB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
16:00	746	279	NB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
17:00	726	252	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
18:00	669	189	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
19:00	483	144	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
20:00	402	118	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
21:00	351	102	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
22:00	186	54	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
23:00	113	30	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2010 Signal Warrant Analysis
Right Turns Removed from Minor Leg
City of West St. Paul, Dakota County, MN

Signal Warrants - Summary

Major Street Approaches

Eastbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 4,200

Westbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 5,870

Minor Street Approaches

Northbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 2,844

Southbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 2,679

Warrant Summary (Urban values apply.)

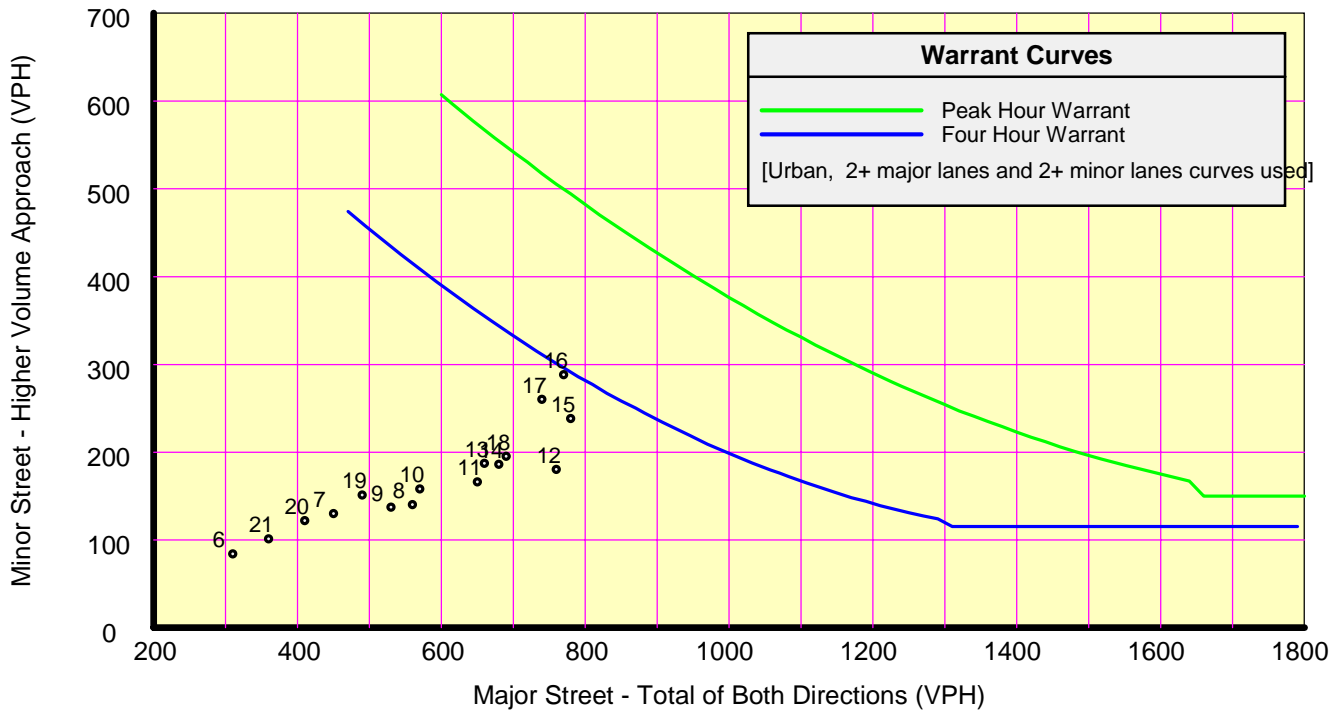
Warrant 1 - Eight Hour Vehicular Volumes	Not Satisfied
Warrant 1A - Minimum Vehicular Volume	Not Satisfied
Required volumes reached for 3 hours, 8 are needed	
Warrant 1B - Interruption of Continuous Traffic	Not Satisfied
Required volumes reached for 0 hours, 8 are needed	
Warrant 1 A&B - Combination of Warrants	Not Satisfied
Required volumes reached for 4 hours, 8 are needed	
Warrant 2 - Four Hour Volumes	Not Satisfied
Number of hours (0) volumes exceed minimum < minimum required (4).	
Warrant 3 - Peak Hour	Not Satisfied
Warrant 3A - Peak Hour Delay	Not Satisfied
Total approach volumes and delays on minor street do not exceed minimums for any hour.	
Warrant 3B - Peak Hour Volumes	Not Satisfied
Volumes do not exceed minimums for any hour.	
Warrant 4 - Pedestrian Volumes	Not Satisfied
Required 4 Hr pedestrian volume reached for 0 hour(s) and the single hour volume for 0 hour(s)	
Warrant 5 - School Crossing	Not Satisfied
Number of gaps > .0 seconds (0) exceeds the number of minutes in the crossing period (0).	
Warrant 6 - Coordinated Signal System	Not Satisfied
No adjacent coordinated signals are present	
Warrant 7 - Crash Experience	Not Satisfied
Number of accidents (-1) is less than minimum (5). Volume minimums are met.	
Warrant 8 - Roadway Network	Not Satisfied
Major Route conditions not met. One or more volume requirement met.	

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2010 Signal Warrant Analysis
 Right Turns Removed from Minor Leg
 City of West St. Paul, Dakota County, MN

Signal Warrants - Summary



Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor Vol	Dir	War-1A			War-1B			War-1A&B		
				Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	80	14	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
01:00	40	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
02:00	20	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
03:00	30	7	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
04:00	50	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
05:00	140	36	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
06:00	310	84	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
07:00	450	130	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
08:00	560	140	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
09:00	530	137	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
10:00	570	158	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
11:00	650	166	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
12:00	760	180	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
13:00	660	187	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
14:00	680	186	SB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
15:00	780	238	NB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
16:00	770	288	NB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
17:00	740	260	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
18:00	690	195	SB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
19:00	490	151	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
20:00	410	122	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
21:00	360	101	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
22:00	190	58	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
23:00	110	29	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2030 Signal Warrant Analysis
Right Turns Removed from Minor Leg
City of West St. Paul, Dakota County, MN

Signal Warrants - Summary

Major Street Approaches

Eastbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 4,850

Westbound: CR 6

Number of Lanes: 2
Approach Speed: 0
Total Approach Volume: 7,590

Minor Street Approaches

Northbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 3,657

Southbound: CSAH 73

Number of Lanes: 2

Total Approach Volume: 3,701

Warrant Summary (Urban values apply.)

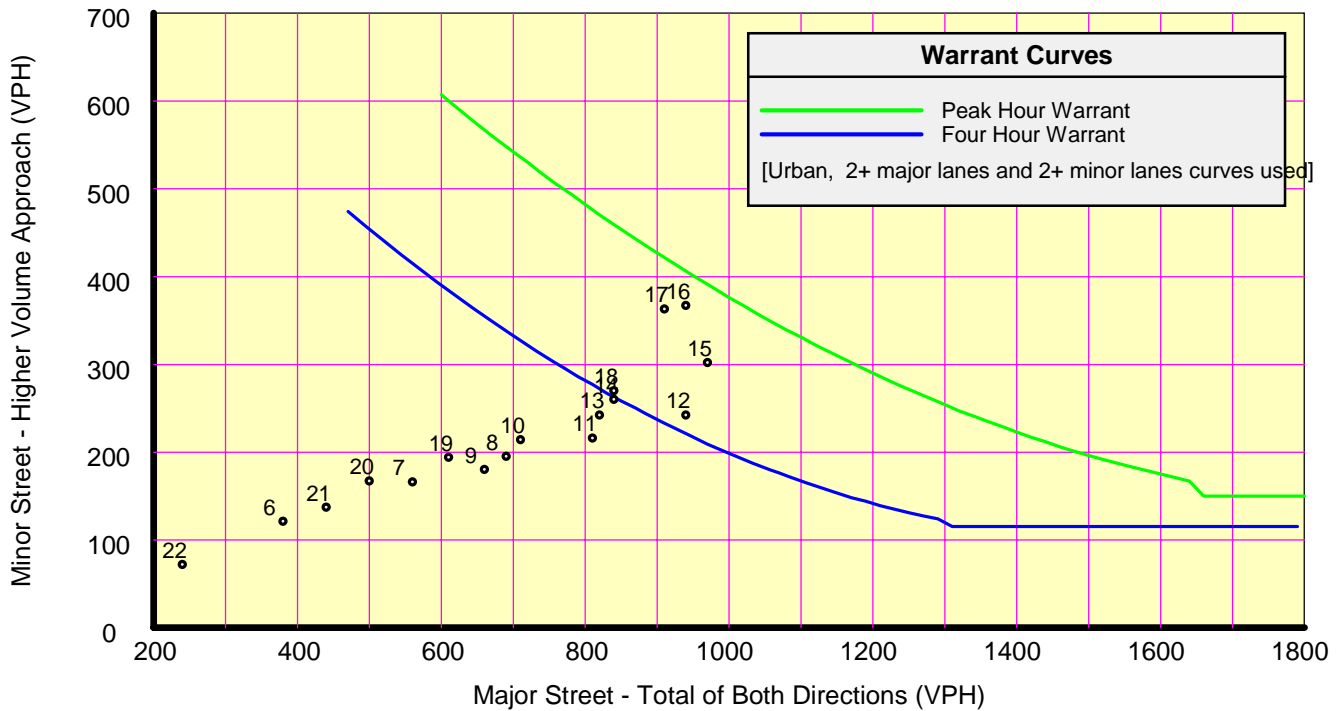
Warrant 1 - Eight Hour Vehicular Volumes	Satisfied
Warrant 1A - Minimum Vehicular Volume	Satisfied
Required volumes reached for 9 hours, 8 are needed	
Warrant 1B - Interruption of Continuous Traffic	Not Satisfied
Required volumes reached for 4 hours, 8 are needed	
Warrant 1 A&B - Combination of Warrants	Satisfied
Required volumes reached for 8 hours, 8 are needed	
Warrant 2 - Four Hour Volumes	Satisfied
Number of hours (5) volumes exceed minimum >= minimum required (4).	
Warrant 3 - Peak Hour	Not Satisfied
Warrant 3A - Peak Hour Delay	Not Satisfied
Total approach volumes and delays on minor street do not exceed minimums for any hour.	
Warrant 3B - Peak Hour Volumes	Not Satisfied
Volumes do not exceed minimums for any hour.	
Warrant 4 - Pedestrian Volumes	Not Satisfied
Required 4 Hr pedestrian volume reached for 0 hour(s) and the single hour volume for 0 hour(s)	
Warrant 5 - School Crossing	Not Satisfied
Number of gaps > .0 seconds (0) exceeds the number of minutes in the crossing period (0).	
Warrant 6 - Coordinated Signal System	Not Satisfied
No adjacent coordinated signals are present	
Warrant 7 - Crash Experience	Not Satisfied
Number of accidents (-1) is less than minimum (5). Volume minimums are met.	
Warrant 8 - Roadway Network	Not Satisfied
Major Route conditions not met. One or more volume requirement met.	

Appendix D - Signal Warrant Analyses

CSAH 73 & CR 6

2030 Signal Warrant Analysis
 Right Turns Removed from Minor Leg
 City of West St. Paul, Dakota County, MN

Signal Warrants - Summary



Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor Vol	Dir	War-1A			War-1B			War-1A&B		
				Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	100	22	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
01:00	40	19	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
02:00	40	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
03:00	30	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
04:00	50	9	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
05:00	180	43	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
06:00	380	121	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
07:00	560	166	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-Yes	Minor
08:00	690	195	SB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
09:00	660	180	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
10:00	710	214	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-No	160-Yes	Minor
11:00	810	216	NB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
12:00	940	242	SB	600-Yes	200-Yes	Both	900-Yes	100-Yes	Both	720-Yes	160-Yes	Both
13:00	820	242	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
14:00	840	260	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
15:00	970	302	NB	600-Yes	200-Yes	Both	900-Yes	100-Yes	Both	720-Yes	160-Yes	Both
16:00	940	367	NB	600-Yes	200-Yes	Both	900-Yes	100-Yes	Both	720-Yes	160-Yes	Both
17:00	910	363	SB	600-Yes	200-Yes	Both	900-Yes	100-Yes	Both	720-Yes	160-Yes	Both
18:00	840	270	SB	600-Yes	200-Yes	Both	900-No	100-Yes	Minor	720-Yes	160-Yes	Both
19:00	610	194	NB	600-Yes	200-No	Major	900-No	100-Yes	Minor	720-No	160-Yes	Minor
20:00	500	167	SB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-Yes	Minor
21:00	440	137	NB	600-No	200-No	---	900-No	100-Yes	Minor	720-No	160-No	---
22:00	240	72	NB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---
23:00	140	37	SB	600-No	200-No	---	900-No	100-No	---	720-No	160-No	---

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2008 A.M. Peak Hour

All Way Stop
8/13/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.0	0.5	0.1	0.5	1.5	0.2	0.1	0.3	0.1	0.1	0.3	0.0
Delay / Veh (s)	12.1	13.4	9.1	24.2	25.3	19.7	8.1	7.3	6.2	9.0	10.1	8.3
Total Stops	11	141	40	80	219	41	52	92	33	31	97	10
Travel Time (hr)	0.3	3.4	1.0	3.3	8.9	1.7	0.6	1.2	0.4	0.6	1.9	0.2
Avg Speed (mph)	29	28	29	28	28	28	22	22	22	25	25	25
Vehicles Entered	11	141	40	82	222	42	53	129	33	32	97	10
Vehicles Exited	11	140	40	79	218	41	52	128	32	31	96	10
Hourly Exit Rate	11	140	40	79	218	41	52	128	32	31	96	10
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

1: CR 6 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	3.8
Delay / Veh (s)	15.4
Total Stops	847
Travel Time (hr)	23.4
Avg Speed (mph)	27
Vehicles Entered	892
Vehicles Exited	878
Hourly Exit Rate	878
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2008 P.M. Peak Hour

All Way Stop
8/13/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	2.2	0.9	0.9	2.2	0.5	0.4	1.2	0.6	0.2	1.2	0.1
Delay / Veh (s)	32.2	29.1	26.0	32.9	36.0	31.8	19.3	19.9	17.2	17.3	19.3	13.6
Total Stops	10	271	121	95	216	57	70	210	125	49	221	22
Travel Time (hr)	0.3	7.7	3.5	4.2	9.5	2.5	1.0	3.0	1.8	1.1	4.9	0.5
Avg Speed (mph)	24	24	24	26	26	26	17	17	17	22	22	23
Vehicles Entered	10	272	121	97	221	59	70	212	127	49	220	23
Vehicles Exited	10	269	121	94	214	57	70	208	124	49	221	22
Hourly Exit Rate	10	269	121	94	214	57	70	208	124	49	221	22
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

1: CR 6 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	10.4
Delay / Veh (s)	25.3
Total Stops	1467
Travel Time (hr)	39.8
Avg Speed (mph)	24
Vehicles Entered	1481
Vehicles Exited	1459
Hourly Exit Rate	1459
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2010 A.M. Peak Hour

All Way Stop
8/13/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	All
Total Delay (hr)	0.4	0.1	0.4	1.5	0.2	0.1	0.2	0.1	0.1	0.3	3.5
Delay / Veh (s)	12.6	8.2	19.7	23.3	19.2	7.5	6.3	5.6	8.0	9.4	14.0
Total Stops	128	42	79	230	46	49	86	39	37	98	834
Travel Time (hr)	3.1	1.0	3.1	9.2	1.8	0.5	1.2	0.4	0.7	1.9	23.1
Avg Speed (mph)	29	29	29	28	28	22	22	22	25	25	28
Vehicles Entered	128	43	81	232	46	49	140	39	38	97	893
Vehicles Exited	128	42	79	230	46	49	141	39	37	98	889
Hourly Exit Rate	128	42	79	230	46	49	141	39	37	98	889
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	0.3	0.0	0.1	0.8	0.2	0.1	0.3	0.1	0.1	0.4	0.2
Delay / Veh (s)	7.9	9.3	4.6	7.1	11.9	8.3	6.5	8.8	4.5	9.7	10.7	7.3
Total Stops	41	116	9	62	239	72	40	116	40	51	138	81
Travel Time (hr)	1.1	3.2	0.2	1.4	5.8	1.7	0.5	1.5	0.5	0.6	1.5	0.9
Avg Speed (mph)	26	26	27	26	25	26	24	24	24	21	20	21
Vehicles Entered	41	119	10	62	241	72	40	116	41	52	140	82
Vehicles Exited	41	116	9	62	239	72	40	116	40	51	138	81
Hourly Exit Rate	41	116	9	62	239	72	40	116	40	51	138	81
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	2.6
Delay / Veh (s)	9.3
Total Stops	1005
Travel Time (hr)	18.9
Avg Speed (mph)	25
Vehicles Entered	1016
Vehicles Exited	1005
Hourly Exit Rate	1005
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2010 P.M. Peak Hour

All Way Stop
8/14/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	3.6	1.4	0.7	2.1	0.5	0.2	1.2	0.6	0.2	1.1	0.1	11.7
Delay / Veh (s)	42.8	38.4	24.7	30.6	27.0	11.5	19.0	16.3	12.5	16.7	13.8	26.5
Total Stops	304	130	100	250	66	62	236	134	56	228	23	1589
Travel Time (hr)	9.8	4.1	4.1	10.5	2.7	0.7	3.2	1.8	1.2	4.9	0.5	43.7
Avg Speed (mph)	21	22	28	27	27	20	17	17	24	23	23	23
Vehicles Entered	305	127	103	254	65	60	236	135	56	228	24	1593
Vehicles Exited	300	128	100	249	65	60	235	133	56	227	23	1576
Hourly Exit Rate	300	128	100	249	65	60	235	133	56	227	23	1576
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.3	4.2	0.6	0.2	1.9	0.4	0.1	1.7	0.6	0.3	1.3	0.4
Delay / Veh (s)	13.7	40.2	21.8	11.5	22.5	12.9	9.9	27.1	22.7	13.0	16.4	15.4
Total Stops	87	386	129	70	302	125	51	222	93	78	232	83
Travel Time (hr)	2.5	13.4	3.0	1.7	8.2	2.9	0.7	3.9	1.6	1.0	3.6	1.1
Avg Speed (mph)	25	20	23	25	23	24	22	17	17	19	18	18
Vehicles Entered	89	381	97	70	305	115	51	223	93	77	294	84
Vehicles Exited	87	375	95	70	300	114	50	221	92	77	289	83
Hourly Exit Rate	87	375	95	70	300	114	50	221	92	77	289	83
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	12.0
Delay / Veh (s)	23.2
Total Stops	1858
Travel Time (hr)	43.7
Avg Speed (mph)	21
Vehicles Entered	1879
Vehicles Exited	1853
Hourly Exit Rate	1853
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2030 A.M. Peak Hour

All Way Stop
8/14/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	0.6	0.1	0.7	2.5	0.3	0.1	0.4	0.1	0.1	0.4	0.0	5.5
Delay / Veh (s)	14.5	10.7	24.2	29.4	27.3	8.5	7.4	7.3	9.0	11.5	7.3	17.0
Total Stops	160	48	99	303	46	54	139	49	51	133	9	1091
Travel Time (hr)	3.9	1.2	4.1	12.8	1.9	0.6	2.0	0.6	1.0	2.7	0.2	30.8
Avg Speed (mph)	28	28	28	27	27	21	22	21	25	25	25	27
Vehicles Entered	159	48	102	313	47	54	212	50	51	133	9	1178
Vehicles Exited	160	48	99	302	46	54	212	49	51	133	9	1163
Hourly Exit Rate	160	48	99	302	46	54	212	49	51	133	9	1163
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	0.6	0.0	0.2	1.2	0.3	0.1	0.5	0.1	0.2	0.7	0.2
Delay / Veh (s)	8.9	12.1	6.7	9.2	14.5	10.6	7.3	10.7	6.5	10.7	13.1	9.2
Total Stops	52	169	10	75	292	108	51	155	53	57	181	80
Travel Time (hr)	1.4	4.7	0.3	1.8	7.4	2.7	0.6	2.0	0.7	0.7	2.1	0.9
Avg Speed (mph)	26	26	26	25	24	25	24	23	23	20	19	20
Vehicles Entered	52	170	10	75	294	110	52	155	53	58	182	82
Vehicles Exited	52	169	10	75	291	108	51	155	53	57	181	80
Hourly Exit Rate	52	169	10	75	291	108	51	155	53	57	181	80
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	4.1
Delay / Veh (s)	11.5
Total Stops	1283
Travel Time (hr)	25.4
Avg Speed (mph)	24
Vehicles Entered	1293
Vehicles Exited	1282
Hourly Exit Rate	1282
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for Existing All Way Stop

SimTraffic Performance Report
2030 P.M. Peak Hour

All Way Stop
8/14/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	24.5	9.4	1.5	4.0	0.9	0.3	2.0	1.1	0.3	2.4	0.2	46.7
Delay / Veh (s)	268.0	265.1	36.4	47.4	41.9	15.1	30.5	26.7	15.9	30.4	24.1	91.1
Total Stops	480	188	164	305	77	88	241	145	72	288	33	2081
Travel Time (hr)	31.4	12.3	6.7	14.0	3.5	1.1	4.1	2.4	1.5	7.2	0.8	84.9
Avg Speed (mph)	7	7	26	24	25	18	14	14	23	20	20	14
Vehicles Entered	352	138	154	306	76	83	245	147	68	288	34	1891
Vehicles Exited	305	119	150	297	74	82	241	144	68	287	33	1800
Hourly Exit Rate	305	119	150	297	74	82	241	144	68	287	33	1800
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	9.4	85.2	24.7	0.5	14.0	4.6	0.4	13.2	5.6	1.3	6.3	2.4
Delay / Veh (s)	322.0	665.5	1056.6	21.1	134.5	131.5	21.1	178.5	167.4	46.9	67.4	77.9
Total Stops	544	2084	357	113	504	272	92	308	138	167	301	122
Travel Time (hr)	12.0	96.5	26.8	2.4	22.1	7.4	1.1	16.0	6.9	2.2	9.0	3.4
Avg Speed (mph)	6	3	2	22	11	11	18	5	5	11	8	8
Vehicles Entered	118	539	107	89	387	128	66	278	126	102	341	113
Vehicles Exited	93	383	61	88	365	123	65	256	116	99	332	109
Hourly Exit Rate	93	383	61	88	365	123	65	256	116	99	332	109
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	1	9	2	0	0	0	0	0	0	0	0	0

2: CSAH 8 & CSAH 73 Performance by movement

Movement	All
Total Delay (hr)	167.6
Delay / Veh (s)	269.2
Total Stops	5002
Travel Time (hr)	205.8
Avg Speed (mph)	5
Vehicles Entered	2394
Vehicles Exited	2090
Hourly Exit Rate	2090
Denied Entry Before	0
Denied Entry After	12

Appendix E - LOS for All Way Stop - 2 Approach Lanes

SimTraffic Performance Report
2010 A.M. Peak Hour

9/8/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	All
Total Delay (hr)	0.4	0.0	0.3	1.0	0.1	0.1	0.2	0.1	0.1	0.2	2.5
Delay / Veh (s)	9.7	3.6	14.8	16.5	8.3	8.0	9.4	4.3	7.0	8.5	11.0
Total Stops	138	45	74	226	40	48	87	42	36	94	830
Travel Time (hr)	3.2	1.0	2.9	8.6	1.4	1.3	2.4	1.1	0.7	1.8	24.4
Avg Speed (mph)	30	31	29	30	31	27	27	27	26	26	29
Vehicles Entered	139	46	75	228	40	47	88	43	35	95	836
Vehicles Exited	138	45	74	225	40	47	87	42	36	94	828
Hourly Exit Rate	138	45	74	225	40	47	87	42	36	94	828
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	3.6
Delay / Veh (s)	15.8
Total Stops	830
Travel Time (hr)	45.8
Avg Speed (mph)	29
Vehicles Entered	837
Vehicles Exited	808
Hourly Exit Rate	808
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for All Way Stop - 2 Approach Lanes

SimTraffic Performance Report
2010 P.M. Peak Hour

9/8/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	1.1	0.2	0.5	1.2	0.2	0.2	0.8	0.3	0.2	0.7	0.0	5.5
Delay / Veh (s)	13.5	7.7	18.9	18.4	11.1	11.4	12.2	7.7	12.1	10.9	6.2	12.8
Total Stops	297	115	100	238	55	59	238	129	59	231	17	1538
Travel Time (hr)	7.2	2.7	4.0	9.2	2.1	1.3	5.4	2.8	1.2	4.6	0.3	40.8
Avg Speed (mph)	29	29	28	29	30	25	25	26	24	25	25	27
Vehicles Entered	301	117	103	245	56	59	239	130	59	232	18	1559
Vehicles Exited	297	114	100	238	55	59	238	129	59	231	17	1537
Hourly Exit Rate	297	114	100	238	55	59	238	129	59	231	17	1537
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	8.1
Delay / Veh (s)	19.1
Total Stops	1538
Travel Time (hr)	79.5
Avg Speed (mph)	29
Vehicles Entered	1559
Vehicles Exited	1500
Hourly Exit Rate	1500
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for All Way Stop - 2 Approach Lanes

SimTraffic Performance Report
2030 A.M. Peak Hour

9/8/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	0.5	0.1	0.4	1.5	0.2	0.2	0.4	0.1	0.1	0.3	0.0	3.7
Delay / Veh (s)	10.7	4.6	17.1	17.7	11.2	11.3	11.5	5.8	8.7	9.2	5.0	12.6
Total Stops	162	52	89	302	56	51	126	43	46	135	8	1070
Travel Time (hr)	3.8	1.2	3.5	11.5	2.1	1.5	3.8	1.2	0.9	2.6	0.2	32.2
Avg Speed (mph)	30	31	29	30	30	26	26	27	25	26	26	28
Vehicles Entered	162	51	90	307	58	52	128	44	46	133	8	1079
Vehicles Exited	161	52	88	302	56	51	126	43	46	134	8	1067
Hourly Exit Rate	161	52	88	302	56	51	126	43	46	134	8	1067
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	5.3
Delay / Veh (s)	18.1
Total Stops	1070
Travel Time (hr)	59.9
Avg Speed (mph)	29
Vehicles Entered	1079
Vehicles Exited	1041
Hourly Exit Rate	1041
Denied Entry Before	0
Denied Entry After	0

Appendix E - LOS for All Way Stop - 2 Approach Lanes

SimTraffic Performance Report
2030 P.M. Peak Hour

9/8/2008

1: CR 6 & CSAH 73 Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	All
Total Delay (hr)	1.6	0.4	1.1	1.8	0.3	0.5	1.3	0.6	0.3	1.1	0.1	9.1
Delay / Veh (s)	17.0	10.8	25.7	21.8	13.5	19.2	18.1	13.1	15.1	13.5	7.5	16.9
Total Stops	336	143	146	293	82	91	266	165	71	294	33	1920
Travel Time (hr)	8.5	3.5	6.0	11.6	3.1	2.8	8.0	4.8	1.5	6.0	0.7	56.6
Avg Speed (mph)	27	28	28	29	30	24	24	25	23	24	25	27
Vehicles Entered	336	145	148	300	83	93	268	167	71	296	33	1940
Vehicles Exited	335	142	145	293	82	91	266	165	71	293	33	1916
Hourly Exit Rate	335	142	145	293	82	91	266	165	71	293	33	1916
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	12.9
Delay / Veh (s)	24.3
Total Stops	1920
Travel Time (hr)	108.3
Avg Speed (mph)	28
Vehicles Entered	1940
Vehicles Exited	1862
Hourly Exit Rate	1862
Denied Entry Before	0
Denied Entry After	0

Appendix F - LOS for Signal

2010 A.M. Peak Hour
HCM Signalized Intersection Capacity Analysis

Dakota Co Intersection Feasibility Study
1: CR 6 & CSAH 73



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗		↖	↗		↖	↗	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.97		1.00	0.98		1.00	0.95		1.00	1.00	
Flt Protected		1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1801		1770	1822		1770	1778		1770	1863	
Flt Permitted		1.00		0.48	1.00		0.65	1.00		0.67	1.00	
Satd. Flow (perm)		1801		894	1822		1206	1778		1243	1863	
Volume (vph)	0	140	40	80	230	40	50	90	40	40	90	0
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)	0	152	43	87	250	43	54	98	43	43	98	0
RTOR Reduction (vph)	0	19	0	0	9	0	0	26	0	0	0	0
Lane Group Flow (vph)	0	176	0	87	284	0	54	115	0	43	98	0
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		15.0		23.1	23.1		19.2	16.0		17.0	14.9	
Effective Green, g (s)		15.6		23.7	23.7		20.4	16.6		18.2	15.5	
Actuated g/C Ratio		0.28		0.43	0.43		0.37	0.30		0.33	0.28	
Clearance Time (s)		4.6		4.6	4.6		4.6	4.6		4.6	4.6	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		511		451	785		486	537		437	525	
v/s Ratio Prot		0.10		0.01	c0.16		c0.01	c0.06		0.00	0.05	
v/s Ratio Perm				0.07			0.03			0.03		
v/c Ratio		0.35		0.19	0.36		0.11	0.21		0.10	0.19	
Uniform Delay, d1		15.6		9.6	10.6		11.2	14.3		12.6	15.0	
Progression Factor		1.00		1.00	1.00		0.93	1.00		1.00	1.00	
Incremental Delay, d2		0.4		0.2	0.3		0.1	0.9		0.1	0.8	
Delay (s)		16.1		9.8	10.8		10.6	15.3		12.7	15.8	
Level of Service		B		A	B		B	B		B	B	
Approach Delay (s)		16.1			10.6			14.0			14.8	
Approach LOS		B			B			B			B	

Intersection Summary

HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Appendix F - LOS for Signal

2010 P.M. Peak Hour SIGNALIZED
 HCM Signalized Intersection Capacity Analysis

Dakota Co Intersection Feasibility Study
 1: CR 6 & CSAH 73



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗		↖	↗		↖	↗	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.96		1.00	0.97		1.00	0.95		1.00	0.99	
Flt Protected		1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1783		1770	1807		1770	1762		1770	1840	
Flt Permitted		1.00		0.17	1.00		0.49	1.00		0.33	1.00	
Satd. Flow (perm)		1783		325	1807		913	1762		621	1840	
Volume (vph)	0	300	120	100	240	60	60	230	130	60	230	20
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)	0	326	130	109	261	65	65	250	141	65	250	22
RTOR Reduction (vph)	0	23	0	0	11	0	0	29	0	0	5	0
Lane Group Flow (vph)	0	433	0	109	315	0	65	362	0	65	267	0
Turn Type	pm+pt		pm+pt		pm+pt		pm+pt		pm+pt		pm+pt	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		18.3		27.2	27.2		24.0	21.0		24.0	21.0	
Effective Green, g (s)		18.9		27.8	27.8		25.2	21.6		25.2	21.6	
Actuated g/C Ratio		0.29		0.43	0.43		0.39	0.33		0.39	0.33	
Clearance Time (s)		4.6		4.6	4.6		4.6	4.6		4.6	4.6	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		518		248	773		401	586		304	611	
v/s Ratio Prot		c0.24		0.03	c0.17		0.01	c0.21		c0.01	0.15	
v/s Ratio Perm				0.15			0.05			0.07		
v/c Ratio		0.84		0.44	0.41		0.16	0.62		0.21	0.44	
Uniform Delay, d1		21.6		13.4	12.9		12.8	18.2		13.2	17.0	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		11.2		1.2	0.4		0.2	4.8		0.4	2.3	
Delay (s)		32.8		14.7	13.2		13.0	23.1		13.5	19.2	
Level of Service		C		B	B		B	C		B	B	
Approach Delay (s)		32.8			13.6			21.6			18.1	
Approach LOS		C			B			C			B	

Intersection Summary

HCM Average Control Delay	21.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Appendix F - LOS for Signal

2030 A.M. Peak Hour SIGNALIZED
 HCM Signalized Intersection Capacity Analysis

Dakota Co Intersection Feasibility Study
 1: CR 6 & CSAH 73



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.96		1.00	0.98		1.00	0.96		1.00	0.99	
Flt Protected		1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1797		1770	1823		1770	1797		1770	1843	
Flt Permitted		1.00		0.42	1.00		0.65	1.00		0.62	1.00	
Satd. Flow (perm)		1797		776	1823		1210	1797		1162	1843	
Volume (vph)	0	160	50	100	300	50	60	130	40	50	130	10
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)	0	174	54	109	326	54	65	141	43	54	141	11
RTOR Reduction (vph)	0	21	0	0	9	0	0	16	0	0	4	0
Lane Group Flow (vph)	0	207	0	109	371	0	65	168	0	54	148	0
Turn Type	pm+pt		pm+pt		pm+pt		pm+pt		pm+pt		pm+pt	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		15.2		24.5	24.5		22.0	17.4		21.4	17.1	
Effective Green, g (s)		15.8		25.1	25.1		23.2	18.0		22.6	17.7	
Actuated g/C Ratio		0.26		0.42	0.42		0.39	0.30		0.38	0.29	
Clearance Time (s)		4.6		4.6	4.6		4.6	4.6		4.6	4.6	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		473		412	763		516	539		487	544	
v/s Ratio Prot		0.12		0.02	c0.20		c0.01	c0.09		0.01	0.08	
v/s Ratio Perm				0.09			0.04			0.03		
v/c Ratio		0.44		0.26	0.49		0.13	0.31		0.11	0.27	
Uniform Delay, d1		18.4		11.2	12.7		11.7	16.2		12.0	16.2	
Progression Factor		1.00		1.00	1.00		0.91	1.00		1.00	1.00	
Incremental Delay, d2		0.7		0.3	0.5		0.1	1.5		0.1	1.2	
Delay (s)		19.1		11.5	13.2		10.7	17.8		12.1	17.4	
Level of Service		B		B	B		B	B		B	B	
Approach Delay (s)		19.1			12.9			15.9			16.0	
Approach LOS		B			B			B			B	

Intersection Summary

HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Appendix F - LOS for Signal

2030 P.M. Peak Hour SIGNALIZED
 HCM Signalized Intersection Capacity Analysis

Dakota Co Intersection Feasibility Study
 1: CR 6 & CSAH 73



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.96		1.00	0.97		1.00	0.94		1.00	0.99	
Flt Protected		1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1781		1770	1804		1770	1755		1770	1837	
Flt Permitted		1.00		0.14	1.00		0.37	1.00		0.22	1.00	
Satd. Flow (perm)		1781		258	1804		680	1755		412	1837	
Volume (vph)	0	340	140	150	300	80	90	270	170	70	300	30
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)	0	370	152	163	326	87	98	293	185	76	326	33
RTOR Reduction (vph)	0	19	0	0	10	0	0	28	0	0	5	0
Lane Group Flow (vph)	0	503	0	163	403	0	98	450	0	76	354	0
Turn Type	pm+pt		pm+pt		pm+pt		pm+pt		pm+pt		pm+pt	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		24.3		35.4	35.4		30.8	26.8		30.8	26.8	
Effective Green, g (s)		24.9		36.0	36.0		32.0	27.4		32.0	27.4	
Actuated g/C Ratio		0.31		0.45	0.45		0.40	0.34		0.40	0.34	
Clearance Time (s)		4.6		4.6	4.6		4.6	4.6		4.6	4.6	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		554		250	812		335	601		243	629	
v/s Ratio Prot		c0.28		c0.06	0.22		0.02	c0.26		c0.02	0.19	
v/s Ratio Perm				0.24			0.10			0.11		
v/c Ratio		0.91		0.65	0.50		0.29	0.75		0.31	0.56	
Uniform Delay, d1		26.5		17.0	15.6		15.8	23.3		16.6	21.4	
Progression Factor		1.00		1.00	1.00		1.64	1.48		1.00	1.00	
Incremental Delay, d2		18.7		6.0	0.5		0.4	7.4		0.7	3.6	
Delay (s)		45.1		23.0	16.1		26.3	41.9		17.3	25.1	
Level of Service		D		C	B		C	D		B	C	
Approach Delay (s)		45.1			18.0			39.3			23.7	
Approach LOS		D			B			D			C	

Intersection Summary			
HCM Average Control Delay	31.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Appendix G - LOS for Roundabout

CR 6 & CSAH 73 – 2010 A.M. Peak Hour

6:0-08 CR 6 CSAH 73 2010 AM									
E	(m)	3.60	3.60	3.60	3.60	TIME PERIOD	min	90	
L'	(m)	10.00	10.00	10.00	10.00	TIME SLICE	min	15	
U	(m)	3.00	3.00	3.00	3.00	RESULTS PERIOD	min	15	75
RAD	(m)	20.00	20.00	20.00	20.00	TIME COST	\$/hr	15.00	
PHI	(d)	30.00	30.00	30.00	30.00	FLOW PERIOD	min	15	75
DIA	(m)	40.00	40.00	40.00	40.00	FLOW TYPE	pcu/veh	UEH	
GRAD SEP		0	0	0	0	FLOW PEAK	am/op/pm	PM	
LEG NAME	PCU	UEH	URNS	(1st exit, 2nd..U)	FLOF	CL	FLOW RATIO	FLOW TIME	
SB 73	1.05	000	090	040 0	1.00	85	0.75 1.125 0.75	15 45 75	
EB 6	1.05	040	140	000 0	1.00	85	0.75 1.125 0.75	15 45 75	
NB 73	1.05	040	090	050 0	1.00	85	0.75 1.125 0.75	15 45 75	
WB 6	1.05	040	230	080 0	1.00	85	0.75 1.125 0.75	15 45 75	
MODE 2									
FLOW	veh	130	180	180	350			AUEDEL	s 7.7
CAPACITY	veh	629	706	721	742			LOS	SIG A
AUE DELAY	mins	0.12	0.11	0.11	0.15			LOS	UNSIG A
MAX DELAY	mins	0.16	0.15	0.14	0.21				
AUE QUEUE	veh	0	0	0	1			UEHIC HRS	1.8
MAX QUEUE	veh	0	0	0	1			COST	\$ 27

CR 6 & CSAH 73 – 2030 A.M. Peak Hour

6:0-08 CR 6 CSAH 73 2030 AM									
E	(m)	3.60	3.60	3.60	3.60	TIME PERIOD	min	90	
L'	(m)	10.00	10.00	10.00	10.00	TIME SLICE	min	15	
U	(m)	3.00	3.00	3.00	3.00	RESULTS PERIOD	min	15	75
RAD	(m)	20.00	20.00	20.00	20.00	TIME COST	\$/hr	15.00	
PHI	(d)	30.00	30.00	30.00	30.00	FLOW PERIOD	min	15	75
DIA	(m)	40.00	40.00	40.00	40.00	FLOW TYPE	pcu/veh	UEH	
GRAD SEP		0	0	0	0	FLOW PEAK	am/op/pm	PM	
LEG NAME	PCU	UEH	URNS	(1st exit, 2nd..U)	FLOF	CL	FLOW RATIO	FLOW TIME	
SB 73	1.05	010	130	050 0	1.00	85	0.75 1.125 0.75	15 45 75	
EB 6	1.05	050	160	000 0	1.00	85	0.75 1.125 0.75	15 45 75	
NB 73	1.05	040	130	060 0	1.00	85	0.75 1.125 0.75	15 45 75	
WB 6	1.05	050	300	100 0	1.00	85	0.75 1.125 0.75	15 45 75	
MODE 2									
FLOW	veh	190	210	230	450			AUEDEL	s 10.3
CAPACITY	veh	577	670	706	716			LOS	SIG B
AUE DELAY	mins	0.15	0.13	0.12	0.23			LOS	UNSIG B
MAX DELAY	mins	0.21	0.17	0.16	0.33				
AUE QUEUE	veh	0	0	0	2			UEHIC HRS	3.1
MAX QUEUE	veh	1	1	1	1			COST	\$ 47

CR 6 & CSAH 73 – 2010 P.M. Peak Hour

6:0-08 CR 6 CSAH 73 2010 PM									
E	(m)	3.60	3.60	3.60	3.60	TIME PERIOD	min	90	
L'	(m)	10.00	10.00	10.00	10.00	TIME SLICE	min	15	
U	(m)	3.00	3.00	3.00	3.00	RESULTS PERIOD	min	15	75
RAD	(m)	20.00	20.00	20.00	20.00	TIME COST	\$/hr	15.00	
PHI	(d)	30.00	30.00	30.00	30.00	FLOW PERIOD	min	15	75
DIA	(m)	40.00	40.00	40.00	40.00	FLOW TYPE	pcu/veh	UEH	
GRAD SEP		0	0	0	0	FLOW PEAK	am/op/pm	PM	
LEG NAME	PCU	UEH	URNS	(1st exit, 2nd..U)	FLOF	CL	FLOW RATIO	FLOW TIME	
SB 73	1.05	020	230	060 0	1.00	85	0.75 1.125 0.75	15 45 75	
EB 6	1.05	120	300	000 0	1.00	85	0.75 1.125 0.75	15 45 75	
NB 73	1.05	130	230	060 0	1.00	85	0.75 1.125 0.75	15 45 75	
WB 6	1.05	060	240	100 0	1.00	85	0.75 1.125 0.75	15 45 75	
MODE 2									
FLOW	veh	310	420	420	400			AUEDEL	s 16.0
CAPACITY	veh	608	613	629	665			LOS	SIG B
AUE DELAY	mins	0.20	0.32	0.30	0.23			LOS	UNSIG C
MAX DELAY	mins	0.29	0.52	0.46	0.34				
AUE QUEUE	veh	1	2	2	2			UEHIC HRS	6.9
MAX QUEUE	veh	1	3	3	2			COST	\$ 103

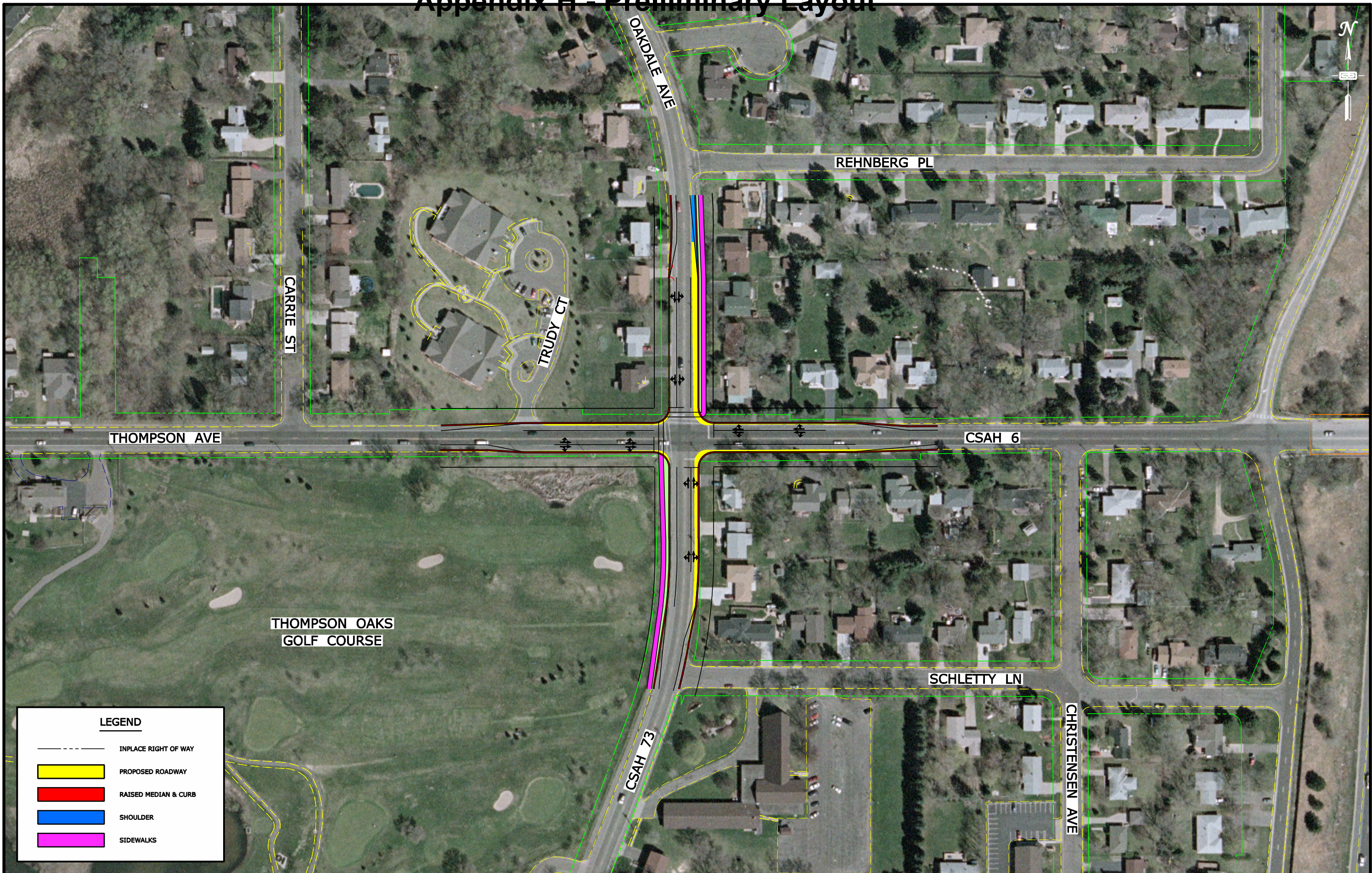
CR 6 & CSAH 73 – 2030 P.M. Peak Hour

6:0-08 CR 6 CSAH 73 2030 PM									
E	(m)	4.00	4.00	4.00	4.00	TIME PERIOD	min	90	
L'	(m)	10.00	10.00	10.00	10.00	TIME SLICE	min	15	
U	(m)	3.00	3.00	3.00	3.00	RESULTS PERIOD	min	15	75
RAD	(m)	20.00	20.00	20.00	20.00	TIME COST	\$/hr	15.00	
PHI	(d)	30.00	30.00	30.00	30.00	FLOW PERIOD	min	15	75
DIA	(m)	40.00	40.00	40.00	40.00	FLOW TYPE	pcu/veh	UEH	
GRAD SEP		0	0	0	0	FLOW PEAK	am/op/pm	PM	
LEG NAME	PCU	UEH	URNS	(1st exit, 2nd..U)	FLOF	CL	FLOW RATIO	FLOW TIME	
SB 73	1.05	030	300	070 0	1.00	85	0.75 1.125 0.75	15 45 75	
EB 6	1.05	140	340	000 0	1.00	85	0.75 1.125 0.75	15 45 75	
NB 73	1.05	170	270	090 0	1.00	85	0.75 1.125 0.75	15 45 75	
WB 6	1.05	080	300	150 0	1.00	85	0.75 1.125 0.75	15 45 75	
MODE 2									
FLOW	veh	400	480	530	530			AUEDEL	s 25.9
CAPACITY	veh	602	612	670	697			LOS	SIG C
AUE DELAY	mins	0.31	0.53	0.48	0.39			LOS	UNSIG D
MAX DELAY	mins	0.51	0.96	0.85	0.66				
AUE QUEUE	veh	2	4	4	4			UEHIC HRS	14.0
MAX QUEUE	veh	3	7	7	5			COST	\$ 210

Appendix H - Preliminary Layout



MODEL: Signal Exhibit 3
 USER: ivandrasek
 PEN TABLE: stonebrooke.tbl
 FILE: S:\PROJECTS\TRANS\0074_TDI\T-00162\Public_Display\T-00162_layout.dgn
 PLOT DATE: 9/16/2008 4:54:04 PM



LEGEND

- INPLACE RIGHT OF WAY
- PROPOSED ROADWAY
- RAISED MEDIAN & CURB
- SHOULDER
- SIDEWALKS

REV. NO.	DATE	BY	CHK	DESCRIPTION

NOT TO SCALE

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

NAME _____ LIC. NO. _____ DATE 9/16/2008

DESIGNED
 DRAWN
 CHECKED

STONEBROOKE ENGINEERING
 305 Stonebrooke Court Shakopee, MN 55379

CSAH 73/OAKDALE AVE & CSAH 6 /THOMPSON AVE
 ALL-WAY STOP INTERSECTION
 DAKOTA COUNTY TRAFFIC STUDY

SHEET
 OF

Appendix I - Preliminary Cost

STREET CONSTRUCTION COST ESTIMATE--CSAH 73 AND County Road 6				
	All-Way Stop			All-Way Stop
Item		Unit	Unit Price	Amount
COMMON EXCAVATION (CV)	3030	CY	\$11.00	\$34,000.00
REMOVE BITUMINOUS	10259	SY	\$2.08	\$22,000.00
REMOVE CURB AND GUTTER	3050	LF	\$2.05	\$6,300.00
REMOVE BITUMINOUS WALK	6194	SF	\$0.57	\$3,600.00
SAWCUT BITUMINOUS	3231	LF	\$3.00	\$9,700.00
3" WEAR COURSE TYPE SP 12.5 (4, F)	346	TON	\$52.00	\$18,000.00
3" NON WEAR COURSE TYPE SP 12.5 (3, B)	346	TON	\$45.00	\$16,000.00
BITUMINOUS MATERIAL FOR TACK COAT	105	GAL	\$2.50	\$270.00
9" AGGREGATE BASE (CV) CLASS 5	699	CY	\$20.00	\$14,000.00
24" SELECT GRANULAR BORROW (CV)	1865	CY	\$14.00	\$27,000.00
3" BITUMINOUS WALK	6194	SF	\$1.56	\$9,700.00
CONCRETE CURB AND GUTTER-B624	3015	LF	\$10.80	\$33,000.00
4" BROKEN LINE WHITE-PAINT	1679	LF	\$0.16	\$270.00
4" SOLID LINE WHITE-PAINT	2966	LF	\$0.09	\$270.00
8" SOLID LINE WHITE-EPOXY	237	LF	\$0.56	\$140.00
24" STOP LINE WHITE-EPOXY	104	LF	\$9.14	\$960.00
4" DOUBLE SOLID LINE YELLOW-PAINT	1483	LF	\$0.22	\$330.00
PAVEMENT MESSAGE (RT-THRU ARROW) EPOXY	8	EACH	\$195.00	\$1,600.00
PAVEMENT MESSAGE (LT-THRU ARROW) PAINT	8	EACH	\$195.00	\$1,600.00
TOTAL				\$200,000.00

TOTAL AREA OF NEW ROADWAY	
	All-Way Stop
Item	Area (SF)
BITUMINOUS PAVEMENT	18844

TOTAL AREA OF RIGHT OF WAY	
	All-Way Stop
	SF
RIGHT OF WAY NEEDED	7000

Estimate does not include costs for
Storm Sewer
Utility Relocation
Signing
Contingencies