

# Appendix Q

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Intersection Control Evaluation (ICE) Report

# **Intersection Control Evaluation (ICE) Phase 1 Report**

*TH 371 Corridor between Nisswa and Pine  
River*

SEH No. MNT03 103547

October 8, 2008

TH 371 Corridor between Nisswa and Pine River  
Intersection Control Evaluation (ICE)  
Phase 1 Report

SEH No. MNT03 103547

October 8, 2008

Proposed Letting Date: \_\_\_\_\_ Work Identification: \_\_\_\_\_

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.

\_\_\_\_\_  
Date: \_\_\_\_\_ Lic. No.: \_\_\_\_\_

Reviewed by: \_\_\_\_\_  
Date \_\_\_\_\_

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# Intersection Control Evaluation (ICE) Phase 1 Report

## TH 371 Corridor between Nisswa and Pine River

Prepared for Minnesota Department of Transportation District 3

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### 1.0 Background and Description of Location

Minnesota Department of Transportation (Mn/DOT) is planning safety and mobility improvements along TH 371 between Crow Wing County Road 18 in Nisswa and Cass County Road 42 in Pine River (see Figure 1) and has prepared an Environmental Impact Study (EIS) for the project. The improvements proposed for TH 371 include expansion of the existing two-lane roadway to a 4-lane divided highway. Various communities along the corridor are working with Mn/DOT to plan and develop final layouts for the future roadway expansion.

One of the communities with which Mn/DOT is working, is the City of Pequot Lakes. In 2006, the City requested Mn/DOT consider changing the preferred alternative for the TH 371 project in Pequot Lakes from the “through town option” to the “bypass option”. Since that time, Mn/DOT has been working with the City in developing a layout for the bypass option. The layout for the Pequot Lakes Bypass includes the segment of TH 371 from CSAH 29/CR 107 to CSAH 16.

In developing the TH 371 Pequot Lakes Bypass layout, Mn/DOT needs to determine the appropriate intersection control for intersections along this segment. The purpose of this study is to determine the most appropriate type of traffic control for five key intersections along the proposed TH 371 Pequot Lakes Bypass. Mn/DOT’s Intersection Control Evaluation (ICE) process will be used to investigate what type of traffic control should be provided at the following study intersections:

- CSAH 16 and TH 371
- CR 112 and TH 371
- CSAH 11 and TH 371
- CR 107/CR 168 and TH 371
- CSAH 29/CR 107 and TH 371

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It should be noted there are two existing signalized intersections along the segment of TH 371 proposed for improvements that are not included in the TH 371 Pequot Lakes Bypass Study. These intersections are the TH 371/TH 84 intersection and the TH 371/CR 18 intersection. Mn/DOT plans to continue signal control at these two intersections as part of the TH 371 upgrade project and will not complete the formal ICE report for these intersections.

The investigation included analyzing traffic operations at the key intersections during the June PM peak hour for 2010 and 2030 conditions. Crash history for the study segment was reviewed, and future crashes were estimated for the control alternatives. Though the primary focus of the alternatives analysis was to determine the most appropriate traffic control for the intersections, other improvement measures, such as adding turn lanes or lengthening turn lanes, were also considered in the analysis.

Also, two intersections with the Old TH 371 alignment are included in the study analysis due to the close proximity to the proposed TH 371 alignment in Pequot Lakes. These two intersections are:

- CR 112 and Old TH 371 alignment
- CR 168 and Old TH 371 alignment

The project location is shown in Figure 1. The seven intersections included in this study are shown in Figure 2.

Land use along the portion of TH 371, where these intersections are located, is primarily agricultural with some residential uses. The City of Pequot Lakes is not anticipating any significant change to development along the proposed TH 371 bypass in the foreseeable future. The City of Pequot Lakes is located in central Minnesota and is situated in the west central section of Crow Wing County. The 2007 United States Census Bureau population estimate for the City of Pequot Lakes is 1,910.

## **2.0 Existing Conditions**

Currently, TH 371 is a two-lane undivided roadway through the City of Pequot Lakes. TH 371 is a major north/south roadway that extends from Cass Lake south to Little Falls. To the north, TH 371 merges and terminates at US 2 in Cass Lake and to the south TH 371 merges and terminates at TH 10 in Little Falls. TH 371 is functionally classified as a Principal Arterial and is designated as a Medium Priority Interregional Corridor (IRC). Locally and regionally, TH 371 connects citizens and communities to jobs, retail centers, and recreational/tourist destinations. Tourist travel along this segment of TH 371 creates high seasonal traffic peaks. Due to this high seasonal traffic, the traffic analysis used June weekday conditions.

Currently, CR 112, CR 107/CR 168, and CSAH 29/ CR 107 are two-lane roadways with 55 mph speed limits within the study area. Existing traffic signal systems on TH 371 are located at the intersection of CSAH 11 and CSAH 16. The area surrounding TH 371 within the study area is a mixture of commercial, residential, and agriculture uses. TH 371 speed limit through Pequot Lakes is 35 mph and in rural areas has a speed limit of 55 mph.

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The existing average daily traffic (ADT) volumes for roadways in the study area are shown in Figure 4. The existing ADT data is from 2007 Mn/DOT Traffic Volume maps.

### **3.0 Future Conditions**

The planned construction for TH 371 includes building an eastern bypass for the City of Pequot Lakes. It is proposed that TH 371 be a 4-lane divided roadway between Nisswa and Pine River. Right and left turn lanes would be provided at all intersections through the study area. Mn/DOT District 3 prepared a preliminary layout for the proposed bypass. Figure 3 indicates the intersection control and geometrics for the study intersections as shown on this proposed Mn/DOT layout.

Five new intersections will be created directly from the proposed bypass alignment of TH 371 on the eastern side of Pequot Lakes and include the following:

- CR 112 and TH 371
- CSAH 11 and TH 371
- CR 107/CR 168 and TH 371
- CR 112 and Old TH 371 alignment
- CR 168 and Old TH 371 alignment

2010 and 2030 June PM peak hour traffic forecasts and 24- hour intersection approach volumes were developed based on existing 2002 turning movement volumes, previous study reports, and Mn/DOT forecast ADT. The 2010 and 2030 forecast ADT volumes for roadways in the study area are shown in Figure 4. The 2010 and 2030 June PM peak hour volumes for the study intersections are shown in Figure 5. A Technical Memorandum was prepared that describes the traffic forecasting process. This Technical Memorandum is included in Appendix A. The Technical Memorandum includes the daily approach volume data for the key study intersections for 2010 and 2030 conditions.

### **4.0 Analysis of Alternatives**

#### **4.1 Warrant Analysis**

The Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) provides guidance about when it may be appropriate to use all-way stop or signal control at an intersection. This MnMUTCD guidance is provided in the form of “warrants,” or criteria, for when all-way stop or signal control may be justified. Though all-way stop or signal control should not be installed at an intersection unless a MnMUTCD warrant is met, meeting a warrant at an intersection does not in itself require the installation of that particular type of control. Under the Mn/DOT ICE process, roundabouts are considered to be warranted if traffic volumes meet the criteria for either all-way stops or traffic signals. An engineering study that considers factors, including warrants, should be performed to determine the “best” type of control at an intersection.

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TH 371 is a designated IRC, and the use of stop signs on an IRC is discouraged. Therefore, the warrant analysis for all-way stop control at the study intersections was not performed. Furthermore, District 3 has safety concerns regarding the use of roundabouts on high-speed, multi-lane, rural trunk highways. These concerns are intensified for TH 371 due to the high volume of tourist traffic using this route. Therefore, the use of roundabouts at intersections on TH 371 was not considered appropriate. Roundabout control will only be considered for intersections off TH 371, such as the potential future TH 371/CSAH 11 ramp terminal intersections. With the all-way stop and roundabout control options removed from consideration, the warrant analysis only investigated if signal warrants were met at the five key study intersections along TH 371.

Based on the forecast 2010 and 2030 traffic volumes, one or more traffic signal warrants from the MnMUTCD were met for the TH 371 intersections with CSAH 16, CR 112, and CSAH 11 for both 2010 and 2030 conditions. Traffic signal warrants were not met at the TH 371/CR 107/CR 168 intersection or TH 371/CSAH 29/CR 107 intersection for either forecast 2010 or 2030 traffic conditions.

Table 1 provides the traffic warrant summary using the 2010 traffic volumes and Table 2 provides the traffic signal warrant summary using the 2030 traffic volumes. Warrant requirements from the MnMUTCD were reduced to 70 percent of their stated values, as allowed when the 85th percentile of the major roadway exceeds 40 mph. Due to the posted speed limit of 65 mph on TH 371, this reduction factor is applicable for the TH 371 study intersections. Also, the traffic signal warrant analysis includes removal of 100% of the right turning traffic from the minor leg since this movement typically is able to enter the traffic stream with minimal conflicts. The traffic signal warrant analysis sheets and the analysis traffic volumes for 2010 are shown in Appendix B, and the traffic signal warrant analysis sheets and the analysis traffic volumes for 2030 are shown in Appendix C.

**Table 1**  
**Signal Warrant Analysis – Forecast 2010 Traffic Volumes\***

MMUTCD Warrant	Hours Required to be Met	CSAH 16 & TH 371	CR 112 & TH 371	CSAH 11 & TH 371	CR 107/168 & TH 371	CR 107/29 & TH 371
		Warrant Met (Hours Met)				
<b>Warrant 1</b> <b>Eight Hour Vehicle Volumes</b>	-	YES	YES	YES	No	No
<b>Warrant 1A</b> <b>Minimum Vehicular Volume</b>	8	No (0)	No (7)	YES (14)	No (0)	No (0)
<b>Warrant 1B</b> <b>Interruption of Continuous Traffic</b>	8	YES (12)	YES (12)	YES (12)	No (0)	No (0)
<b>Warrant 1 A &amp; B</b> <b>Combination of Warrants</b>	8	NO (2)	YES (12)	YES (12)	No (0)	No (0)
<b>Warrant 2</b> <b>Four Hour Volumes</b>	4	YES (5)	YES (10)	YES (12)	No (0)	No (0)
<b>Warrant 3</b> <b>Peak Hour</b>	1	No (0)	YES (3)	YES (12)	No (0)	No (0)
<b>Warrant 7</b> <b>Crash Experience</b>	-	-	-	-	-	-

\*Warrant analysis was evaluated with removal of 100% of right turning traffic from side-streets

**Table 2  
Signal Warrant Analysis – Forecast 2030 Traffic Volumes\***

MMUTCD Warrant	Hours Required to be Met	CSAH 16 & TH 371	CR 112 & TH 371	CSAH 11 & TH 371	CR 107/168 & TH 371	CR 107/29 & TH 371
		Warrant Met (Hours Met)	Warrant Met (Hours)			
<b>Warrant 1 Eight Hour Vehicle Volumes</b>	-	YES	YES	YES	No	No
<b>Warrant 1A Minimum Vehicular Volume</b>	8	YES (10)	YES (14)	YES (16)	No (0)	No (0)
<b>Warrant 1B Interruption of Continuous Traffic</b>	8	YES (14)	YES (14)	YES (14)	No (0)	No (0)
<b>Warrant 1 A &amp; B Combination of Warrants</b>	8	YES (12)	YES (16)	YES (16)	No (0)	No (0)
<b>Warrant 2 Four Hour Volumes</b>	4	YES (12)	YES (13)	YES (16)	No (0)	No (0)
<b>Warrant 3 Peak Hour</b>	1	YES (12)	YES (12)	YES (13)	No (0)	No (0)
<b>Warrant 7 Crash Experience</b>	-	-	-	-	-	-

\*Warrant analysis was evaluated with removal of 100% of right turning traffic from side-streets

#### **4.2 Safety Analysis**

Crashes for the intersection of CSAH 16 and TH 371 and CSAH 29/CR 107 and TH 371 for the period of 01/01/03 to 12/31/07 were obtained from Mn/DOT. The type and severity of crashes were reviewed for each intersection, and crash and severity rates were calculated. This crash information is shown in the collision diagrams included in Appendix D.

The actual crash rates determined for the TH 371/CSAH 16 intersection and TH 371/CSAH 29/CR 107 intersection were compared to the Mn/DOT District 3 average rates for an unsignalized, rural thru/stop intersection (note the Mn/DOT District 3 average rates are based on crash data for the period 2004 - 2006 and are shown in Table 3.). Both intersections had crash rates of about 0.30 crashes/million entering vehicles (MEV) versus the District 3 average rate of 0.40 crashes/MEV for rural, thru/stop control.

**Table 3**  
**Mn/DOT District 3 Average Crash Rates**

<b>Traffic Control</b>	<b>Crash Rate (Crashes/Million Entering Vehicles)</b>
Thru/Stop	0.40
Traffic Signal	1.10

Future crash estimates were determined by applying the Mn/DOT District 3 average crash rates to the forecast 2010 and 2030 average entering traffic for the TH 371 intersections. The highest crash estimate was for signals for each of the TH 371 intersections. Tables 4 and 5 show the projected numbers of total annual crashes for each traffic control type analyzed for the forecast 2010 and forecast 2030 traffic conditions respectively.

**Table 4**  
**Future 2010 Annual Crash Estimate**

<b>Intersection</b>	<b>Total Annual Crash Estimates by Control Type</b>		<b>Intersection Entering Volume</b>
	<b>Thru/Stop</b>	<b>Traffic Signal</b>	
CSAH 16 and TH 371	2	6	13,870
CR 112 and TH 371	2	7	16,300
CSAH 11 and TH 371	3	9	22,000
CR 107/168 and TH 371	3	8	19,270
CR 29/107 and TH 371	3	8	19,620

**Table 5**  
**Future 2030 Annual Crash Estimate**

<b>Intersection</b>	<b>Total Annual Crash Estimates by Control Type</b>		<b>Intersection Entering volume</b>
	<b>Thru/Stop</b>	<b>Traffic Signal</b>	
CSAH 16 and TH 371	2	6	22,100
CR 112 and TH 371	4	11	26,600
CSAH 11 and TH 371	5	13	33,000
CR 107/168 and TH 371	4	12	29,260
CR 29/107 and TH 371	4	12	29,200

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### 4.3 Traffic Operations Analysis

Traffic operations analyses were conducted for the key intersections to determine the level of service (LOS), delay, and queuing information for 2010 and 2030 June PM peak hour conditions. LOS is a qualitative rating system used to describe the efficiency of traffic operations at an intersection. Six LOS are defined, designated by letters A through F. LOS A represents the best operating conditions (no congestion), and LOS F represents the worst operating conditions (severe congestion). For the TH 371 Pequot Lakes Bypass, it was assumed that LOS D or better represents acceptable operating conditions.

The traffic operations analyses were performed using the Synchro/SimTraffic (version 7) software package. For signalized and unsignalized intersections, Synchro uses the methods outlined in the 2000 Highway Capacity Manual (HCM). LOS for intersections is determined by the average control delay per vehicle. The range of control delay for each LOS is different for signalized and unsignalized intersections. The expectation is that a signalized intersection is designed to carry higher traffic volumes and will experience greater delays than an unsignalized intersection.

In addition to the LOS and average vehicle delay information, Synchro also provides queuing information and has a micro-level simulation program called SimTraffic (individual vehicles are modeled using the roadway system). These two additional sources of information were examined as part of the traffic operations analyses. The reason for considering this additional information is that the intersection LOS provided assumes each intersection is isolated and does not consider the effects of queue spill-back from adjacent intersections or from designated turn lanes.

Queue spill-back can have a significant impact on traffic operations, especially for closely spaced intersections and for intersections with short turn lanes. Queue spill-back through adjacent intersections blocks movements through the intersection, results in greater delays, and poorer LOS than those reported by Synchro, and indicates a greater potential for safety problems at the intersection. Queue spill-back from designated turn lanes blocks movements in the adjacent thru lane(s), which may result in greater delays and poorer LOS than those reported by Synchro and indicates a greater potential for rear-end crashes.

As noted previously, all-way stop control and roundabout control were not considered acceptable types of intersection control for the study intersections and were not evaluated for the intersections. Therefore, the traffic operations analysis investigated only two-way stop control (or one-way stop control at T-intersections) and signal control at the study intersections.

An initial review of the proposed Mn/DOT layout for TH 371 was made taking into consideration the forecast peak period volumes at the study intersections. This review suggested there would be operational and safety benefits to adding free-right turn islands at four locations. Most of these locations had substantial right turning volumes (more than 50 vehicles per hour for 2030 conditions). These free-right turn locations would also provide

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better sight lines for crossing traffic at the intersections. The improvement locations are the northbound and southbound right turn lanes on TH 371 at CR 112, the northbound right turn lane on TH 371 at CSAH 11, and the southbound right turn lane on TH 371 at CR 168. The free-right turn lane improvements were included in the models used for the traffic analysis.

Table 6 shows the traffic operations analysis results under forecast 2010 June PM peak hour traffic conditions, assuming two-way stop control is in place at all seven modeled intersections. The TH 371/CSAH 16 intersection and TH 371/CSAH 11 intersection have movements that operate at LOS E or F.

To address the poor LOS at the TH 371/CSAH 16 intersection and TH 371/CSAH 11 intersection, intersection control at these two intersections was changed to traffic signal control. The traffic operations results for 2010 conditions with this change are shown in Table 7. All intersections operate at a level of service (LOS) of C or better, and all movements at all intersections operate at LOS D or better.

Traffic operations under forecast 2030 June PM peak hour traffic conditions were investigated assuming traffic signal control at the TH 371/CSAH 16 intersection and at the TH 371/CSAH 11 intersection and two-way stop control at the other five intersections. The results of the traffic operations analysis are shown in Table 8. All intersections operate at a LOS of D or better. Even though the TH 371/CR 112, TH 371/CR 107/CR 168, and TH 371/CSAH 29/CR 107 intersections operate at an overall LOS of D or better, there are certain movements at these intersections that operate at LOS E or F. At the TH 371/CR 112 intersection, review of SimTraffic indicated that the poor operations for the eastbound CR 112 approach occasionally resulted in queue backups on the approach that reached and blocked the Old TH 371/CR 112 intersection.

Due to the low number of vehicles involved, it is questionable if mitigation measures are needed to address the poor LOS movements at the TH 371/CR 107/CR 168 intersection and TH 371/CSAH 29/CR 107 intersection. The main reason for the poor LOS for these movements is that traffic levels on this segment of TH 371 have reached a point where there are few gaps in traffic. Left-turning or crossing traffic from any side street or driveway along this segment will have a difficult time finding gaps in TH 371 traffic.

If mitigation is desired, the most efficient way to provide it is to allow a two-stage left turn or crossing movement, which involves providing a median on TH 371 wide enough to allow vehicles to safely stop and wait in the median area. The width of the TH 371 median is recommended to be a minimum of 100 feet to provide sufficient storage for a tractor trailer truck.

The intersection control at the TH 371/CR 112 intersections was changed from two-way stop control to signal control, and traffic operations for 2030 June PM peak hour traffic conditions were analyzed. The traffic analysis results are shown in Table 9. With a traffic signal, the TH 371/CR 112 intersection operates at an overall LOS C, and all movements operate at a LOS D or better. With good operating conditions at the TH 371/CR 112 intersection, the queue backup problems affecting the Old TH 371/CR 112 intersection are eliminated.

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The traffic operations analysis indicates a traffic signal is not needed at the TH 371/CR 112 intersection for 2010 conditions, but will be needed for 2030 conditions. A sensitivity analysis was completed for the TH 371/CR 112 intersection to give a better idea on how long two-way stop control will be able to sustain acceptable operations. The sensitivity analysis was an iterative process in which traffic volumes were increased in order to roughly identify a year when changing the intersection control might be required. The sensitivity test results showed a traffic signal may be needed at the TH 371/CR 112 intersection in about 2018.

As part of the traffic operations analysis, the ADT volumes for the study roadways were reviewed to provide a planning level check of the number of travel lanes needed for each roadway. The review indicated the 4-lane divided roadway proposed for TH 371 should be adequate for existing and future conditions. The 2-lane undivided roadways proposed for the side streets to TH 371 should be adequate for existing and future conditions, except for CSAH 11 under 2030 conditions. CSAH 11 is forecast to have a 2030 ADT of 10,300 west of TH 371, and a 2030 ADT of 13,600 east of TH 371. Since a 2-lane roadway capacity is in the range of 10,000 to 12,000, this suggests CSAH 11 may need to be upgraded to a 3- or 4-lane roadway to provide adequate traffic operations in 2030.

The traffic operations results suggest there is an immediate need for traffic signal control at the TH 371/CSAH 16 intersection and at the TH 371/CSAH 11 intersection when the TH 371 Bypass is built. CSAH 11 near the new TH 371 may need to be upgraded to a 3- or 4-lane roadway to perform adequately under 2030 conditions.

At the TH 371/CR 112 intersection, the intersection can initially function well under two-way stop control but, in the future, signal control will be needed. It should be noted the signal warrant analysis indicates signal warrants will be met at the TH 371/CR 112 intersection under 2010 conditions, but the traffic operations analysis indicates the intersection should function well under two-way stop control until approximately 2018.

At the TH 371/CR 107/CR 168 intersection and TH 371/CSAH 29/CR 107 intersection, two-way stop control should be sufficient for initial and future conditions, if a wide median area is provided on TH 371 at these intersections. The wide median on TH 371 will allow side street traffic to cross or turn left in a two-stage maneuver, dealing with one direction of TH 371 traffic at a time. Unconventional intersection types, such as unsignalized superstreet or unsignalized median U-turn (sketches of these intersection types are included in Appendix E), were reviewed for the TH 371/CR 107/CR 168 intersection and TH 371/CSAH 29/CR 107 intersection. However, these intersection types require special U-turn locations that add to the complexity and cost of the intersection and require significant expansion of TH 371 in the vicinity of the U-turn locations. Considering the small amount of traffic that would benefit from these unconventional intersection types, traditional two-way stop control should be given a higher priority for implementation.

**Table 6**  
**2010 June PM Hour Traffic Operations Results**

Intersection	Approach	Demand Volumes (Veh/Hour)						Delay (s/veh)						LOS By Approach		LOS By Intersection		Through		Left Turn		Right Turn	
		Left		Right		Total	Left		Thru		Right		Delay (S/Veh)		LOS	LOS	95th % Queue		Storage		95th % Queue		
		Thru	Left	Thru	Right		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Storage	95th % Queue	Storage	95th % Queue	Storage	95th % Queue	
CSAH 16 and TH 371 (stop)	EB	4	1	5	1	10	19.9	C	19.9	C	19.9	C	19.9	C			0	3	0	3	0	3	
	WB	116	4	26	26	146	36.8	E	11.7	B	11.7	B	31.6	D	A		300	72	300	300	300	3	
	NB	2	478	88	88	568	8.0	A	0.0	A	0.0	A	0.0	A		0	500	0	500	500	0		
	SB	67	326	5	5	398	8.7	A	0.0	A	0.0	A	1.5	A		500	6	500	500	500	0		
	EB	102	73	44	44	219	19.5	C	14.8	B	14.8	B	17.0	C		21	300	32	300	300	21		
	WB	18	60	9	9	87	17.1	C	16.4	C	16.4	C	16.5	C	A	4.6	500	5	300	300	17		
CSAH 11 and TH 371 (stop)	NB	85	457	28	28	570	8.3	A	0.0	A	0.0	A	1.2	A		0	500	6	500	500	0		
	SB	18	329	97	97	444	8.4	A	0.0	A	0.0	A	0.3	A		0	500	1	500	500	0		
	EB	64	136	41	41	241	240.0	F	22.5	C	22.5	C	80.3	F		62	300	135	300	300	62		
	WB	176	240	95	95	511	60.9	F	40.4	E	40.4	E	47.5	E	D	25.3	300	149	300	300	183		
	NB	101	411	121	121	633	8.3	A	0.0	A	0.0	A	1.3	A		0	500	8	500	500	0		
	SB	65	294	33	33	392	8.5	A	0.0	A	0.0	A	1.4	A		0	500	5	500	500	0		
CR 107/CR 168 and TH 371 (stop)	EB	25	1	200	200	226	21.8	C	11.8	B	11.8	B	12.9	B		30	300	9	300	300	30		
	WB	25	2	19	19	46	31.6	D	11.7	B	11.7	B	22.5	C		2	300	15	300	300	2		
	NB	200	589	3	3	792	9.3	A	0.0	A	0.0	A	2.3	A		0	560	19	560	560	0		
	SB	10	457	44	44	511	8.9	A	0.0	A	0.0	A	0.2	A		1	500	0	500	500	0		
	EB	19	3	24	24	46	14.0	B	14.0	B	14.0	B	14.0	B		6	0	6	300	300	6		
	WB	25	2	9	9	36	18.2	C	18.2	C	18.2	C	18.2	C		9	0	9	300	300	9		
CR 29/CR 107 and TH 371 (stop)	NB	33	764	19	19	816	9.3	A	0.0	A	0.0	A	0.4	A		0	500	3	560	560	0		
	SB	6	648	28	28	682	9.6	A	0.0	A	0.0	A	0.1	A		0	500	1	560	560	0		
	EB	1	149	2	2	152	0.0	A	0.1	A	0.0	A	0.1	A		0	0	0	300	300	0		
	WB	56	182	5	5	243	7.7	A	0.0	A	0.0	A	1.8	A		0	300	3	300	300	0		
	NB	2	1	66	66	69	12.6	B	9.5	A	9.5	A	9.6	A		7	300	0	300	300	7		
	SB	4	1	2	2	7	12.4	B	12.4	B	12.4	B	12.4	B		1	0	1	0	0	1		
CR 168 and Old TH 371 (stop)	EB	40	0	40	40	80	11.0	B	0.0	A	11.0	B	11.0	B		0	0	0	0	0	7		
	SB	0	186	23	23	209	0.0	A	0.0	A	0.0	A	0.0	A		0	0	0	0	0	0		
	NB	25	221	0	0	246	7.7	A	0.0	A	0.0	A	0.8	A		0	300	2	300	300	0		

**Table 7**  
**2010 June PM Peak Hour with Proposed Mitigation Measures**  
**Traffic Operations Results**

Intersection	Approach	Demand Volumes (Veh/Hour)						Delay (s/veh)						LOS By Approach		LOS By Intersection		Through		Left Turn		Right Turn			
		Left		Thru		Right		Left		Thru		Right		Delay (S/Veh)		LOS		95th % Queue		Storage		95th % Queue			
		Left	Thru	Left	Thru	Left	Thru	Left	Thru	Left	Thru	Left	Thru	Delay	LOS	Delay	LOS	95th %	Queue	Storage	95th %	Queue	Storage	95th %	
CSAH 16 and TH 371 (Signal)	EB	4	5	1	10	18.7	B	18.7	B	18.7	B	18.7	B	18.7	B	18.7	B	13	0	0	0	0	0	0	0
	WB	116	4	26	146	24.1	C	19.2	B	9.3	A	21.3	C	14.9	B	8	300	88	300	300	88	300	18	18	
	NB	2	478	88	568	25.5	C	16.3	B	5.2	A	14.6	B			133	500	6	500	500	6	500	29	29	
	SB	67	326	5	398	26.3	C	10.3	B	8.6	A	13.0	B			87	500	63	500	500	63	500	0	0	
	EB	102	73	44	219	19.5	C	14.8	B	14.8	B	17.0	C	4.5	A	21	300	32	300	300	32	300	21	21	
	WB	18	60	9	87	17.1	C	16.4	C	16.4	C	16.5	C			17	300	5	300	300	5	300	17	17	
CSAH 11 and TH 371 (Signal)	NB	85	457	28	570	8.3	A	0.0	A	0.0	A	1.2	A			0	500	6	500	0	6	500	0	0	
	SB	18	329	97	444	1.0	A	0.0	A	0.0	A	0.0	A			0	500	1	500	0	1	500	0	0	
	EB	64	136	41	241	48.8	D	40.1	D	11.6	B	37.6	D			136	300	89	300	300	89	300	29	29	
	WB	176	240	95	511	42.8	D	30.9	C	6.2	A	30.4	C	29.1	C	192	300	168	300	300	168	300	35	35	
	NB	101	411	121	633	51.2	D	25.6	C	6.2	A	26.0	C			166	500	134	500	500	134	500	43	43	
	SB	65	294	33	392	44.0	D	25.7	C	9.5	A	27.4	C			120	500	83	500	500	83	500	24	24	
CR 107/CR 168 and TH 371 (stop)	EB	25	1	200	226	21.8	C	11.8	B	11.8	B	12.9	B			30	300	9	300	300	9	300	30	30	
	WB	25	2	19	46	31.6	D	11.7	B	11.7	B	22.5	C	3.7	A	2	300	15	300	300	15	300	2	2	
	NB	200	589	3	792	9.3	A	0.0	A	0.0	A	2.3	A			0	560	19	560	0	19	560	0	0	
	SB	10	457	44	511	8.9	A	0.0	A	0.0	A	0.2	A			0	500	1	500	0	1	500	0	0	
	EB	19	3	24	46	14.0	B	14.0	B	14.0	B	14.0	B			6	0	0	0	0	0	0	0	0	
	WB	25	2	9	36	18.2	C	18.2	C	18.2	C	18.2	C	1.1	A	9	0	0	0	0	0	0	0	0	0
CR 29/CR 107 and TH 371 (stop)	NB	33	764	19	816	9.3	A	0.0	A	0.0	A	0.4	A			0	500	3	500	0	3	500	0	0	
	SB	6	648	28	682	9.6	A	0.0	A	0.0	A	0.1	A			0	500	9.6	500	0	9.6	500	0	0	
	EB	1	149	2	152	0.0	A	0.1	A	0.0	A	0.1	A			0	0	0	0	0	0	0	0	0	
	WB	56	182	5	243	7.7	A	0.0	A	0.0	A	1.8	A	2.5	A	0	300	3	0	0	3	0	0	0	
	NB	2	1	66	69	12.6	B	9.5	A	9.5	A	9.6	A			7	300	0	300	0	0	300	7	7	
	SB	4	1	2	7	12.4	B	12.4	B	12.4	B	12.4	B			1	0	1	0	0	1	0	0	1	
CR 168 and Old TH 371 (stop)	EB	40	0	40	80	11.0	B	0.0	A	11.0	B	11.0	B			0	0	7	0	0	7	0	0	7	
	WB	0	186	23	209	0.0	A	0.0	A	0.0	A	0.0	A	2.0	A	0	0	0	0	0	0	0	0	0	
	SB	25	221	0	246	7.7	A	0.0	A	0.0	A	0.8	A			0	300	2	300	0	2	300	0	0	
	NB	25	221	0	246	7.7	A	0.0	A	0.0	A	0.8	A			0	300	2	300	0	2	300	0	0	

**Table 8  
2030 June PM Peak Hour with Proposed 2010 Mitigation Measures  
Traffic Operations Results**

Intersection	Approach	Demand Volumes (Veh/Hour)						Delay (s/veh)						LOS By Approach		LOS By Intersection		Through		Left Turn		Right Turn	
		Left		Thru		Right		Left		Thru		Right		Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	95th % Queue	Storage	95th % Queue	Storage	95th % Queue	Storage
		Left	Thru	Right	Total	Delay	LOS	Delay	LOS	Delay	LOS												
CSAH 16 and TH 371 (Signal)	EB	6	8	2	16	18.9	B	18.9	B	18.9	B	18.9	B	18.9	B	19	0	0	0	0	0	0	0
	WB	185	6	41	232	33.2	C	19.7	B	7.6	A	28.3	C	21.5	C	11	300	140	300	500	300	22	37
	NB	3	773	130	906	30.0	C	24.9	C	4.9	A	22.0	C			248	500	7	500	300	500	10	10
CR 112 and TH 371 (stop)	SB	107	521	9	637	47.1	D	12.4	B	8.4	A	18.2	B			158	500	130	330	300	300	123	123
	EB	194	139	84	417	260.2	F	36.2	E	36.2	E	140.4	F	30.4	D	66	300	18	300	300	300	66	66
	WB	26	103	14	143	36.6	E	33.8	D	33.8	D	34.3	D			0	500	11	500	500	500	0	0
CSAH 11 and TH 371 (Signal)	NB	126	688	42	866	9.0	A	0.0	A	0.0	A	1.3	A			0	500	3	500	3	500	0	0
	SB	26	484	198	708	9.4	A	0.0	A	0.0	A	0.3	A			252	0	137	0	500	0	39	39
	EB	96	203	60	359	54.7	D	54.6	D	11.8	B	47.5	D			384	0	301	0	500	0	49	49
CR 107/CR 168 and TH 371 (stop)	WB	260	353	140	753	52.2	D	41.4	D	6.3	A	38.6	D	40.3	D	387	0	214	0	500	0	61	61
	NB	168	630	174	972	54.8	D	42.0	D	7.4	A	38.0	D			263	0	137	0	500	0	36	36
	SB	97	448	49	594	54.8	D	42.5	D	12.3	B	42.0	D			65	300	47	300	300	300	65	65
CR 29/CR107 and TH 371 (stop)	EB	35	2	261	318	79.9	F	16.1	C	16.1	C	23.1	C	9.1	A	4	300	140	300	300	300	4	4
	WB	33	2	26	61	+300	F	17.4	C	17.4	C	170.3	F			0	560	46	560	560	560	0	0
	NB	311	911	4	1,226	11.6	B	0.0	A	0.0	A	2.9	A			0	500	3	500	3	500	0	0
CR 112 and Old TH 371 (stop)	SB	24	661	83	768	10.4	B	0.0	A	0.0	A	0.3	A			17	0	0	0	300	0	17	17
	EB	27	5	34	66	20.5	C	20.5	C	20.5	C	20.5	C	1.6	A	30	0	0	0	300	0	30	30
	WB	33	2	12	47	37.2	E	37.2	E	37.2	E	37.2	E			0	500	7	560	560	560	0	0
CR 168 and Old TH 371 (stop)	NB	51	1187	30	1,268	11.0	B	0.0	A	0.0	A	0.4	A			0	500	1	560	560	560	0	0
	SB	9	926	40	975	12.1	B	0.0	A	0.0	A	0.1	A			0	300	0	300	300	300	0	0
	EB	1	284	2	287	0.0	A	0.0	A	0.0	A	0.0	A			0	0	0	0	300	0	300	300
CR 168 and Old TH 371 (stop)	WB	98	320	9	427	8.1	A	0.0	A	0.0	A	1.9	A	2.9	A	0	300	7	300	300	300	0	0
	NB	2	1	125	128	19.5	C	11.1	B	11.1	B	11.2	B			17	500	1	500	500	500	17	17
	SB	8	1	2	11	22.3	C	22.3	C	22.3	C	22.3	C			4	500	0	500	500	500	0	0
CR 168 and Old TH 371 (stop)	EB	40	0	40	80	13.9	B	0.0	A	13.9	B	13.9	B			0	0	11	300	300	300	11	11
	SB	0	278	32	310	0.0	A	0.0	A	0.0	A	0.0	A	2.1	A	0	0	0	0	300	0	300	300
	NB	67	329	0	396	8.1	A	0.0	A	0.0	A	1.4	A			0	300	5	300	300	300	0	0

**Table 9  
2030 June PM Peak Hour with Recommended Mitigation Measures  
Traffic Operations Results**

Intersection	Approach	Demand Volumes (Veh/hour)										Delay (s/veh)						LOS By Approach		LOS By Intersection		Through		Left Turn		Right Turn	
		Left			Thru			Right			Left		Thru		Right		Delay (s/veh)	LOS	Delay (s/veh)	LOS	95th % Queue	Storage	95th % Queue	Storage	95th % Queue	Storage	
		Leit	Thru	Right	Total	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS														
CSAH 16 and TH 371 (Signal)	EB	6	8	2	16	18.9	B	18.9	B	18.9	B	18.9	B	18.9	B	18.9	B	21.5	C	19	0	0	0	0	0	0	0
	WB	185	6	41	232	33.2	C	19.7	B	7.6	A	28.3	C	24.9	C	4.9	A	22.0	C	11	300	140	300	300	300	300	300
	NB	3	773	130	906	30.0	C	24.9	C	4.9	A	28.3	C	24.9	C	4.9	A	22.0	C	248	500	9	500	500	500	500	500
CR 112 and TH 371 (Signal)	SB	107	521	9	637	47.1	D	12.4	B	8.4	A	18.2	B	12.4	B	8.4	A	18.2	B	158	500	130	500	500	500	500	500
	EB	194	139	84	417	19.8	B	16.8	B	4.7	A	15.8	B	16.8	B	4.7	A	15.8	B	81	300	106	300	300	300	300	300
	WB	26	103	14	143	24.4	C	26.8	C	12.4	B	25.0	C	20.9	C	7.1	A	22.8	C	81	300	30	300	300	300	300	300
CSAH 11 and TH 371 (Signal)	NB	126	698	42	866	38.7	D	20.9	C	7.1	A	18.6	B	20.9	C	7.1	A	18.6	B	243	500	126	500	500	500	500	500
	SB	26	484	188	708	28.1	C	23.3	C	5.7	A	18.6	B	23.3	C	5.7	A	18.6	B	147	500	32	500	500	500	500	500
	EB	96	203	60	359	54.7	F	54.6	D	11.8	B	47.5	D	54.6	D	11.8	B	47.5	D	252	0	137	0	0	0	0	0
CR 107/CR 168 and TH 371 (stop)	WB	260	353	140	753	52.2	F	41.4	D	6.3	A	38.6	D	41.4	D	6.3	A	38.6	D	384	0	301	0	0	0	0	0
	NB	168	630	174	972	54.8	F	42.0	D	7.4	A	38.0	D	42.0	D	7.4	A	38.0	D	387	0	214	0	0	0	0	0
	SB	97	448	49	594	54.8	F	42.5	D	12.3	B	42.0	D	42.5	D	12.3	B	42.0	D	263	0	137	0	0	0	0	0
CR 29/CR107 and TH 371 (stop)	EB	35	2	281	318	79.9	F	16.1	C	16.1	C	23.1	C	16.1	C	16.1	C	23.1	C	65	300	47	300	300	300	300	300
	WB	33	2	26	61	260.0	F	17.4	C	17.4	C	143.6	F	17.4	C	17.4	C	143.6	F	4	300	140	300	300	300	300	300
	NB	311	911	4	1,226	11.6	B	0.0	A	0.0	A	2.9	A	0.0	A	0.0	A	2.9	A	0	560	46	560	560	560	560	560
CR 168 and Old TH 371 (stop)	SB	24	661	83	768	10.4	B	0.0	A	0.0	A	0.3	A	0.0	A	0.0	A	0.3	A	0	500	3	500	500	500	500	500
	EB	27	5	34	66	20.5	C	20.5	C	20.5	C	20.5	C	20.5	C	20.5	C	20.5	C	17	0	0	300	300	300	300	300
	WB	33	2	12	47	37.2	E	37.2	E	37.2	E	37.2	E	37.2	E	37.2	E	37.2	E	30	0	0	300	300	300	300	300
CR 112 and Old TH 371 (stop)	NB	51	1187	30	1,268	11.0	B	0.0	A	0.0	A	0.4	A	0.0	A	0.0	A	0.4	A	0	500	7	560	560	560	560	560
	SB	9	926	40	975	12.1	B	0.0	A	0.0	A	0.1	A	0.0	A	0.0	A	0.1	A	0	500	1	560	560	560	560	560
	EB	1	284	2	287	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0	300	0	300	300	300	300	300
CR 168 and Old TH 371 (stop)	WB	98	320	9	427	8.1	A	0.0	A	0.0	A	1.9	A	0.0	A	0.0	A	1.9	A	0	300	7	300	300	300	300	300
	NB	2	1	125	128	19.5	C	11.1	B	11.1	B	11.2	B	11.1	B	11.1	B	11.2	B	17	500	1	500	500	500	500	500
	SB	8	1	2	11	22.3	C	22.3	C	22.3	C	22.3	C	22.3	C	22.3	C	22.3	C	4	500	0	500	500	500	500	500
CR 168 and Old TH 371 (stop)	EB	40	0	40	80	11.0	B	0.0	A	0.0	A	11.0	B	0.0	A	0.0	A	11.0	B	0	0	11	300	300	300	300	300
	WB	0	278	32	310	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0	0	0	0	0	0	0	0
	NB	67	329	0	396	8.1	A	0.0	A	0.0	A	1.4	A	0.0	A	0.0	A	1.4	A	0	300	8.1	300	300	300	300	300

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#### **4.4 TH 371/CSAH 11 Grade-Separated Interchange**

There is a long-term desire to provide a grade-separated interchange at the TH 371/CSAH 11 intersection. The current budget constraints for TH 371 make it unlikely that this improvement will be part of the initial project. However, Mn/DOT plans to reserve right-of-way in the area in order to facilitate future implementation of this project.

As part of this study, an analysis was performed to determine the type of intersection control for ramp terminal intersections of the TH 371/CSAH 11 interchange. A standard diamond interchange was assumed for the intersection, and only 2030 conditions were examined for the analysis. For the two ramp terminal intersections, one-way stop control, signal control, and roundabout control were investigated. Synchro was used for reporting stop control and signal control results, while RODEL was used for roundabout control.

The traffic operations analysis results for one-way stop control and signal control are shown in Table 10, while roundabout control results are shown in Table 11. The analysis results indicate one-way stop control will not provide acceptable operations at the intersection. Signal control or roundabout control will provide acceptable operations, with roundabout control providing better operation than signal control.

**Table 10  
CSAH 11 and TH 371 Grade-Separated Interchange  
Traffic Operations Results**

Control	Intersection	Approach	Demand Volumes (Veh/Hour)						Delay (s/veh)						LOS By Approach		LOS By Intersection		Through		Left Turn		Right Turn	
			Left		Right		Total	Left		Thru		Right		Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	95th % Queue	Storage	95th % Queue	Storage	95th % Queue	Storage	
			Thru	Right	Left	Right	Total	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	95th % Queue	Storage	95th % Queue	Storage	95th % Queue	Storage	
Stop Control	CSAH 11 and TH 371 West Ramp (SB stop)	EB	0	289	60	359	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0	0	0	0	0	0	0	0
		WB	260	521	0	781	9.1	A	0.0	A	0.0	A	3.0	A	21.1	C	0	300	24	0	0	0	0	0
		SB	97	0	49	146	248.2	F	13.5	B	13.5	B	169.4	F			10	300	180	0	0	0	0	0
		EB	96	300	0	396	10.1	B	0.0	A	0.0	A	2.4	A	26.5	D	0	300	11	0	0	0	0	0
Signal Control	CSAH 11 and TH 371 West Ramp (signal)	WB	0	613	140	753	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0	0	0	0	0	0	0	0
		EB	167	0	174	341	217.9	F	12.1	B	12.1	B	112.9	F			28	300	272	0	0	0	0	0
		WB	260	521	0	781	28.5	C	7.3	A	0.0	A	14.4	B	16.4	B	174	300	174	0	0	0	0	0
		SB	97	0	49	146	25.2	C	9.0	A	0.0	A	16.7	B			26	300	77	0	0	0	0	0
Signal Control	CSAH 11 and TH 371 East Ramp (signal)	EB	96	300	0	396	40.9	D	7.1	A	0.0	A	15.3	B	18.9	B	103	300	114	0	0	0	0	0
		WB	0	613	140	753	0.0	A	27.0	C	3.2	A	22.6	C			442	0	0	0	0	300	30	0
		EB	167	0	174	341	30.5	C	7.3	A	0.0	A	14.9	B			49	300	133	0	0	0	0	0
		WB	260	521	0	781	28.5	C	7.3	A	0.0	A	14.4	B			174	300	174	0	0	0	0	0

**Table 11  
Roundabout Control Traffic Operations Results**

Intersection	Approach	2030 June PM Peak Hour		
		Delay	LOS	Max Queue* (feet)
CSAH 11 and TH 371 West Ramp	EB	5.9	A	18
	WB	9.7	A	70
	SB	6.1	A	8
	Intersection	8.3	A	-
CSAH 11 and TH 371 East Ramp	EB	4.7	A	15
	WB	5.9	A	18
	NB	15	B	120
	Intersection	10.2	B	-

\*Assumes an average vehicle size of 25 feet

## 5.0 Recommended Alternatives

Based on the information provided in this report and engineering judgment, several recommendations for improvements are made regarding the five intersections along the proposed TH 371 Pequot Lakes Bypass between CSAH 29/CR 107 and CSAH 16. These recommended improvements are shown in Figure 6 and are detailed in the following sections. It should be noted that it is assumed the current Mn/DOT layout for TH 371 is the starting point for any proposed additions or revisions.

The TH 371 Pequot Lakes Bypass construction is not currently scheduled and may not take place until 2018 or later. A Phase 2 ICE report should be completed for the study intersections when the TH 371 project reaches final design phase. The Phase 2 ICE report will include updated traffic information and should be used to finalize the type of intersection control and other improvements recommended for the study intersections.

### 5.1 TH 371 / CSAH 16

Currently, this intersection is controlled by a traffic signal, and it is recommended that traffic signal control be continued at this intersection with the proposed TH 371 project.

### 5.2 TH 371 / CR 112

This is a new intersection that will be created as part of the proposed TH 371 Bypass project. Under expected 2010 conditions, it is recommended two-way stop control (no control on the TH 371 approaches and stop sign control on the CR 112 approaches) be installed at this intersection. However, under 2030 conditions, it is predicted that traffic signal control will be needed at this intersection. Therefore, traffic volume and safety at this intersection should be periodically monitored to determine when, or if, control at this intersection should be upgraded to traffic signal control. The initial design of the intersection should take into account that intersection control may be upgraded to signal control in the future. It is also recommended that free-

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right turn islands be added to the northbound and southbound TH 371 approaches to the intersection.

### **5.3 TH 371 / CSAH 11**

This is a new intersection that will be created as part of the proposed TH 371 project, and it is recommended that traffic signal control be installed. It is also recommended that a free-right turn island be added to the northbound TH 371 approach to the intersection.

If sufficient funds are found to upgrade this intersection to a grade-separated interchange, it is recommended roundabout control be considered for the interchange ramp terminal intersections.

The 2030 forecast volumes for CSAH 11 suggest this roadway may need to be expanded in the future. Crow Wing County should consider performing a corridor study for CSAH 11 in the near future to determine the type of facility needed to meet long-term traffic demands along this corridor.

### **5.4 TH 371 at CR 107/CR 168**

This is a new intersection that will be created as part of the proposed TH 371 project, and it is recommended that two-way stop control (no control on the TH 371 approaches and stop sign control on the CR 107/CR 168 approaches) be installed at this intersection. It is also recommended that a wide median (minimum width of 100 feet) be installed on TH 371 at this intersection and that a free-right turn island be added to the southbound TH 371 approach to the intersection.

The feasibility of providing the recommended wide median on TH 371 will need to be further reviewed during the final design process. Other alternatives for this intersection could include the following:

- Use the intersection configuration indicated in the current Mn/DOT layout for TH 371, which shows a 50-foot median on TH 371. This narrower median provides sufficient space for cars and small trucks to make the two-stage crossing maneuver, but does not allow adequate storage space for large trucks or vehicles with trailers.
- Provide a superstreet or median U-turn type of intersection at this location. Careful consideration of where to provide the U-turn locations associated with these intersection types will be needed, since significant space is required for these configurations.

### **5.5 TH 371 at CSAH 29/CR 107**

Currently, this intersection is controlled by two-way stop control (no control on the TH 371 approaches and stop sign control on the CSAH 29/CR 107 approaches), and it is recommended that two-way stop control be continued at this intersection with the proposed TH 371 project. It is also recommended that a wide median (minimum width of 100 feet) be installed on TH 371 at this intersection.

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Lakes and wetlands near this intersection severely restrict the space available for any TH 371 widening. The feasibility of providing the recommended wide median on TH 371 will need to be further reviewed during the final design process.

Other alternatives for this intersection could include the following:

- Use the intersection configuration indicated in the current Mn/DOT layout for TH 371, which shows a narrow median on TH 371, and accept that side street traffic at the intersection may experience long delays at certain times of the day.
- Provide a superstreet or median U-turn type of intersection at this location. Careful consideration of where to provide the U-turn locations associated with these intersection types will be needed, since significant space is required for these configurations.

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## **List of Figures**

Figure 1 – Project Location

Figure 2 – Study Intersection Locations

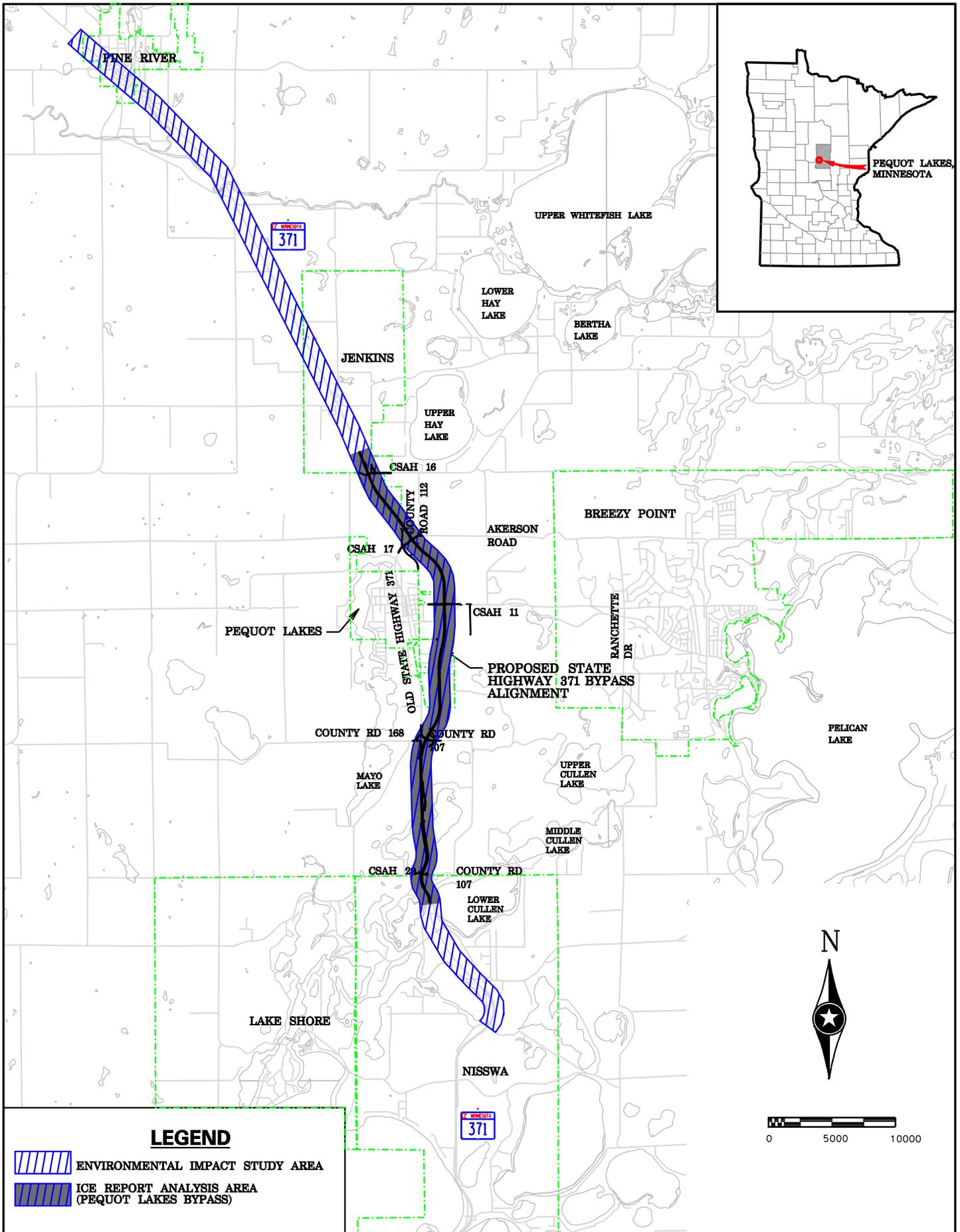
Figure 3 – Proposed Mn/DOT Corridor Layout

Figure 4 – Existing and Future Average Daily Traffic (ADT)

Figure 5 – Peak Hour Traffic Volume Forecasts

Figure 6 – Recommended Intersection Control & Geometrics

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**LEGEND**

-  ENVIRONMENTAL IMPACT STUDY AREA
-  ICE REPORT ANALYSIS AREA (PEQUOT LAKES BYPASS)

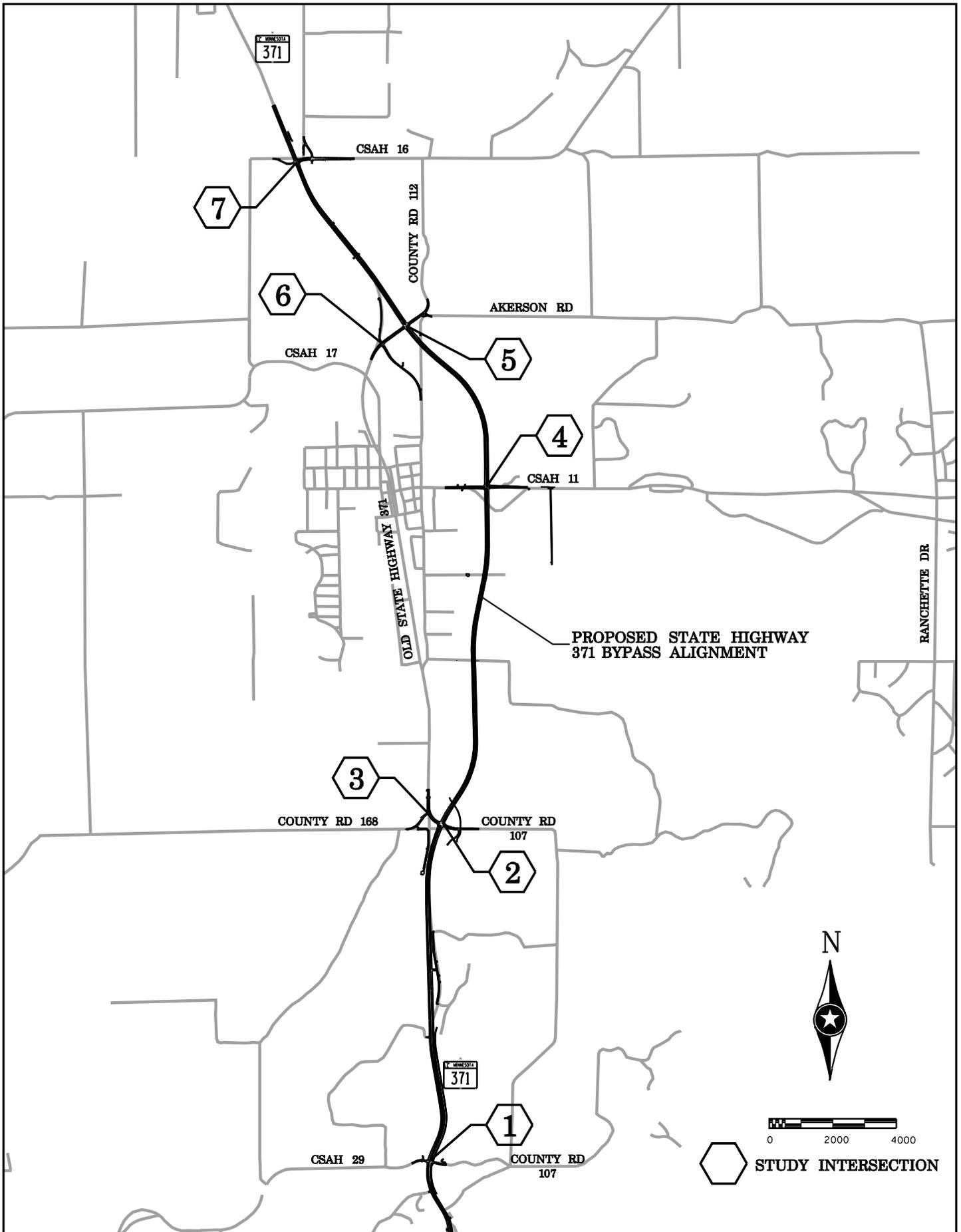


**INTERSECTION CONTROL EVALUATION  
TH 371 PEQUOT LAKES BYPASS  
PEQUOT LAKES, MN**

**PROJECT LOCATION**

**FIGURE  
NO. 1**

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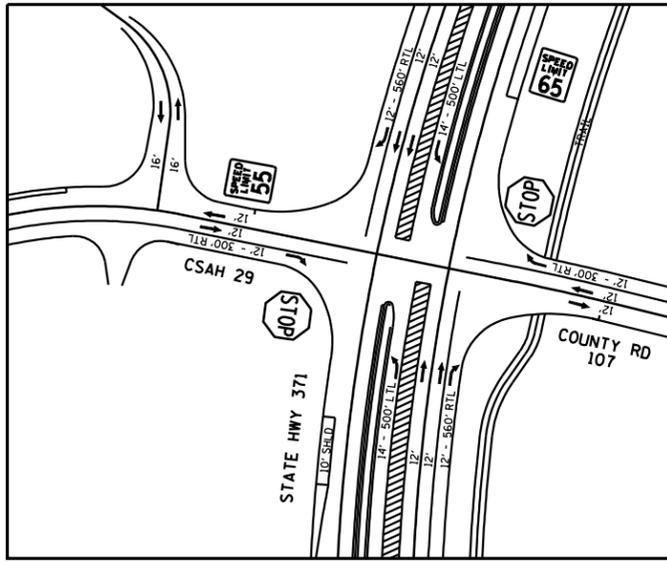


**INTERSECTION CONTROL EVALUATION  
TH 371 PEQUOT LAKES BYPASS  
PEQUOT LAKES, MN**

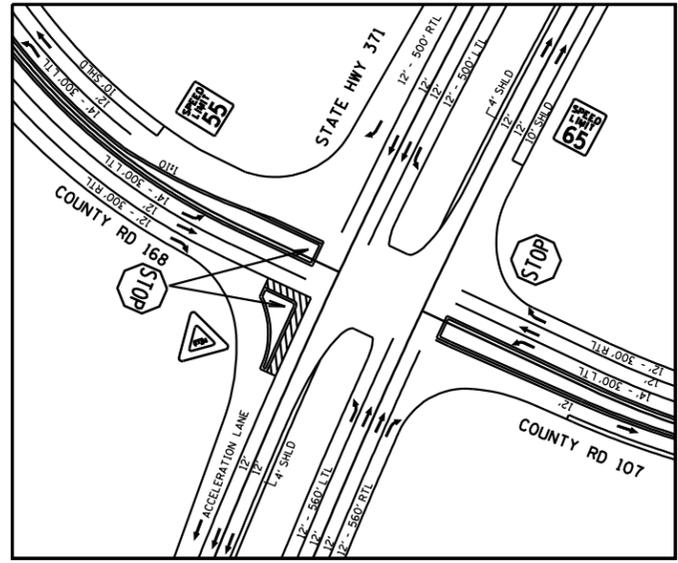
**STUDY INTERSECTION  
LOCATIONS**

**FIGURE  
NO. 2**

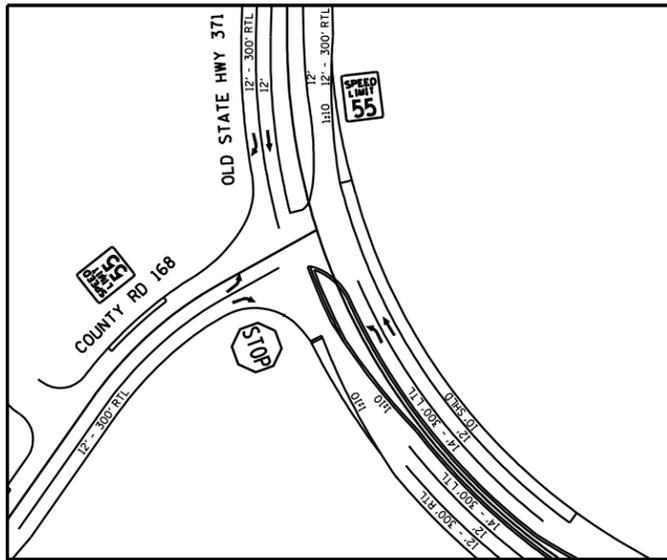
**INTERSECTION 1**  
**COUNTY RD 107/CSAH 29 & STATE HWY 371**



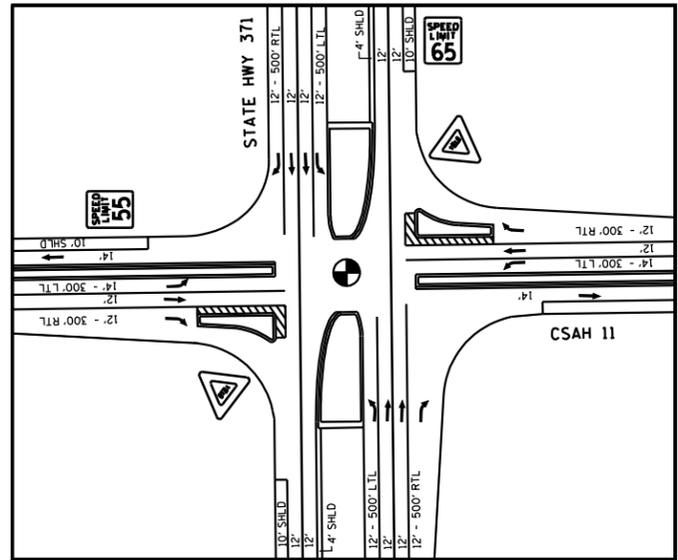
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**COUNTY RD 107/COUNTRY RD 168 & STATE HWY 371**



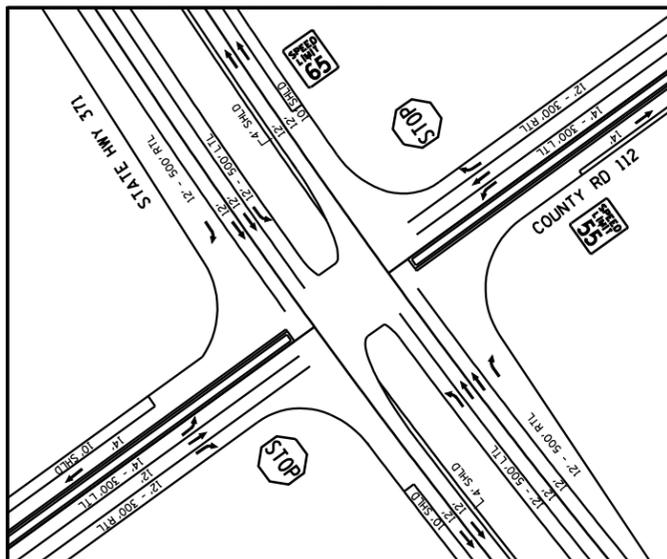
**INTERSECTION 3**  
**COUNTY RD 168 & OLD STATE HWY 371**



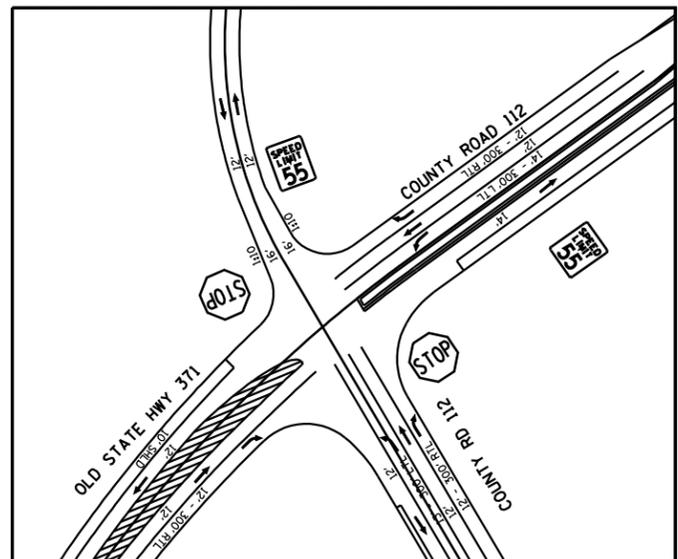
**INTERSECTION 4**  
**CSAH 11 & STATE HWY 371**



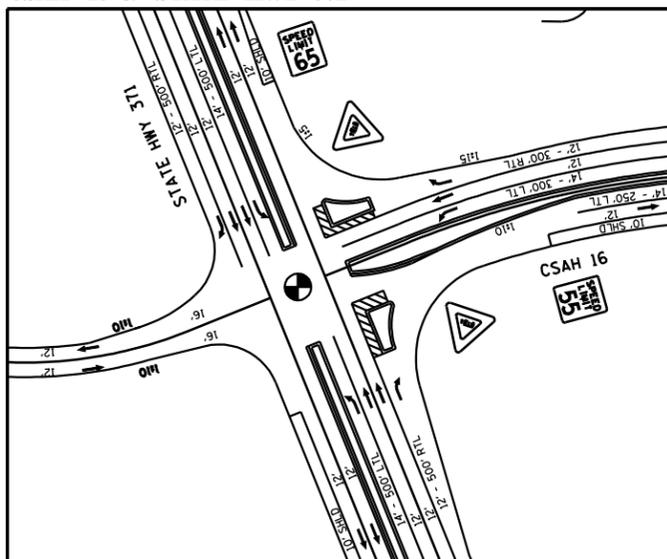
**INTERSECTION 5**  
**COUNTY RD 112 & STATE HWY 371**



**INTERSECTION 6**  
**COUNTY RD 112 & OLD STATE HWY 371**



**INTERSECTION 7**  
**CSAH 16 & STATE HWY 371**

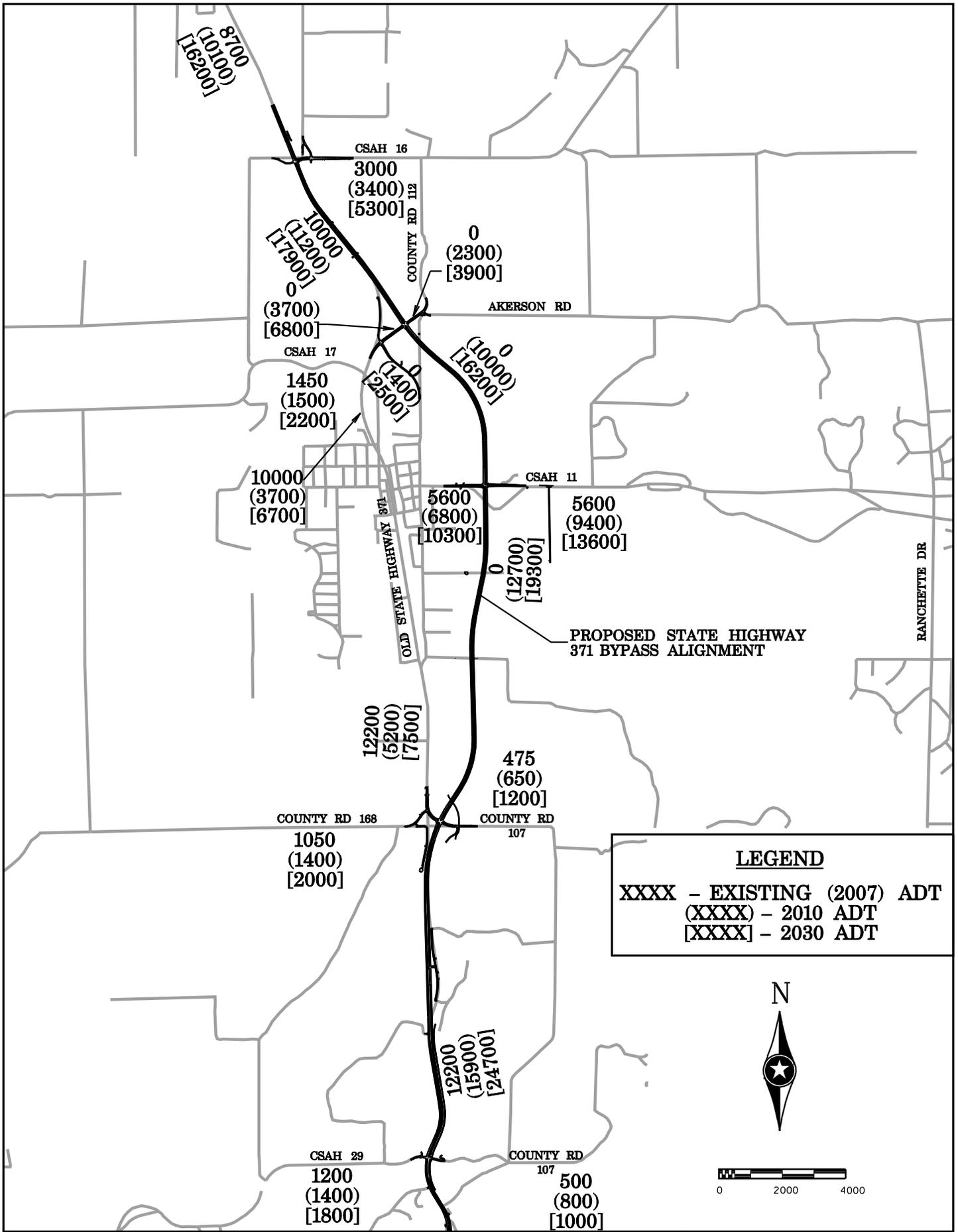


-  STOP CONTROL
-  YIELD CONTROL
-  SPEED LIMIT
-  SIGNALIZED INTERSECTION CONTROL

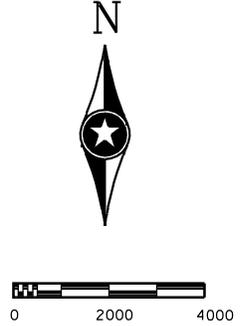


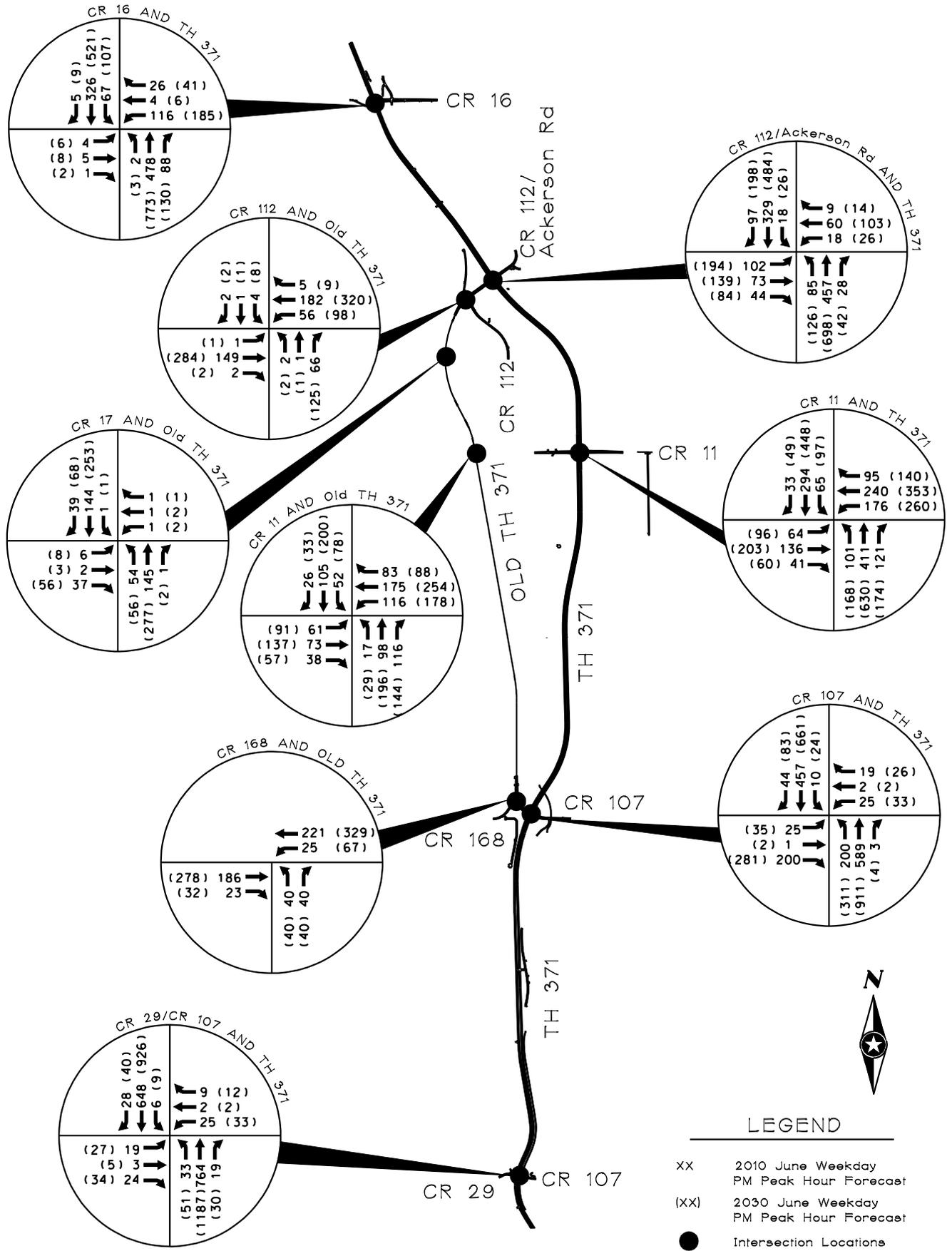
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 XXXX - EXISTING (2007) ADT  
 (XXXX) - 2010 ADT  
 [XXXX] - 2030 ADT



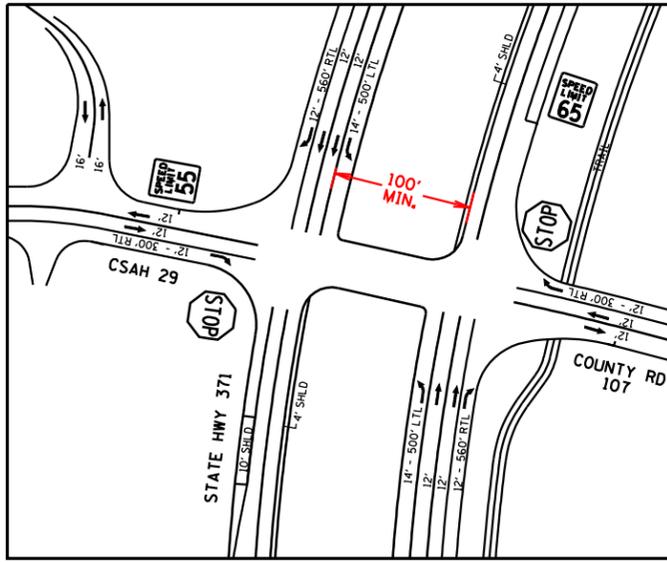


**INTERSECTION CONTROL EVALUATION  
TH 371 PEQUOT LAKES BYPASS  
PEQUOT LAKES, MN**

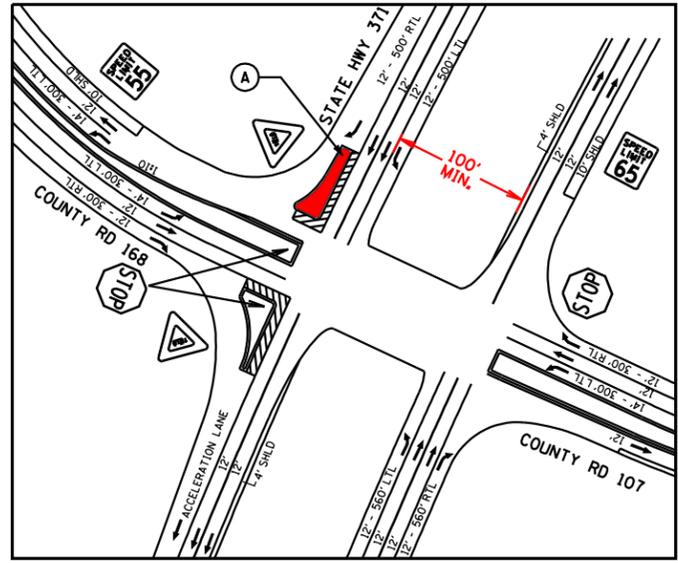
**PEAK HOUR  
TRAFFIC VOLUME  
FORECASTS**

**FIGURE  
NO. 5**

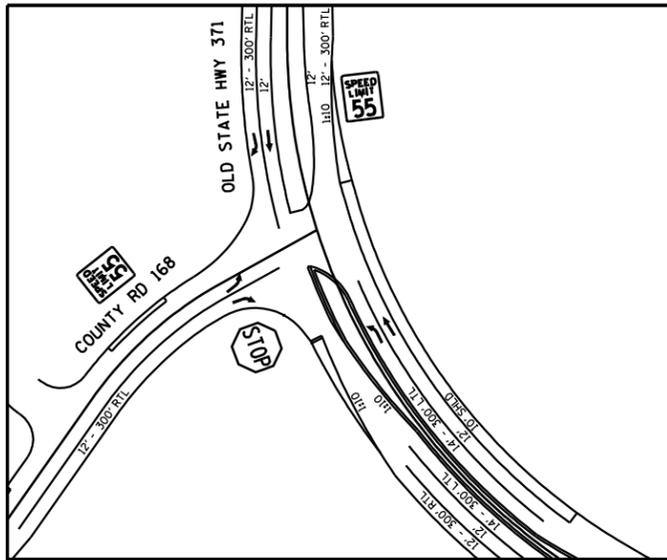
**INTERSECTION 1**  
**COUNTY RD 107/CSAH 29 & STATE HWY 371**



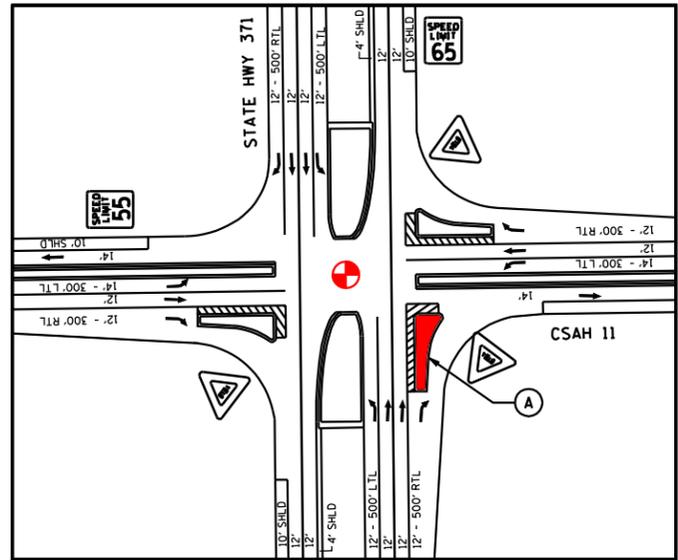
**INTERSECTION 2**  
**COUNTY RD 107/COUNTRY RD 168 & STATE HWY 371**



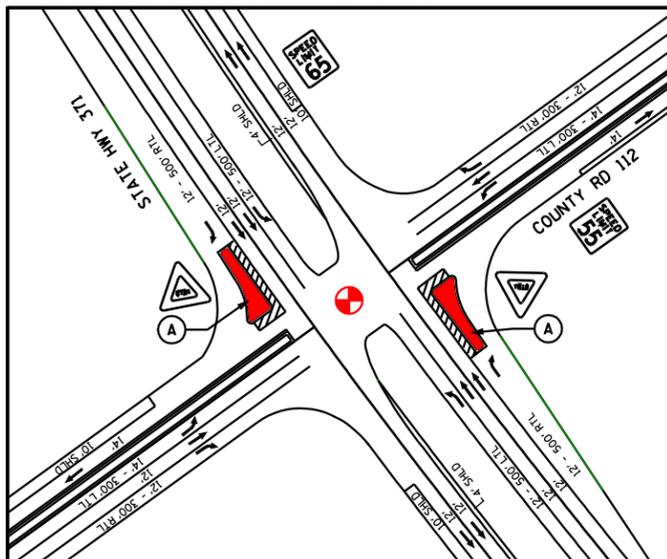
**INTERSECTION 3**  
**COUNTY RD 168 & OLD STATE HWY 371**



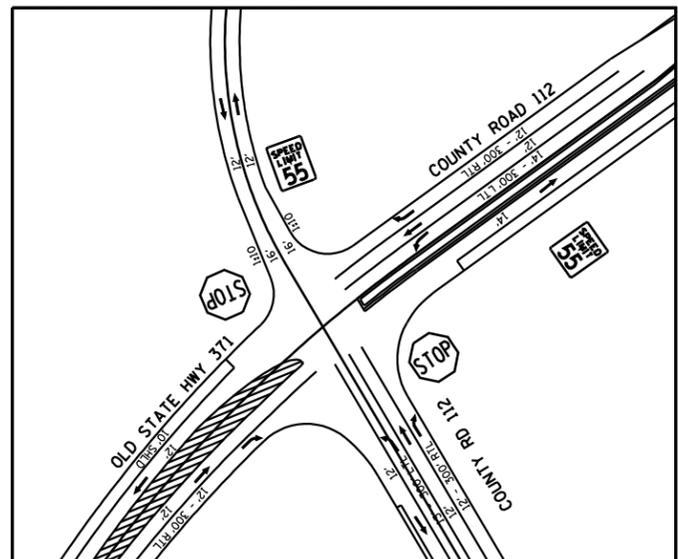
**INTERSECTION 4**  
**CSAH 11 & STATE HWY 371**



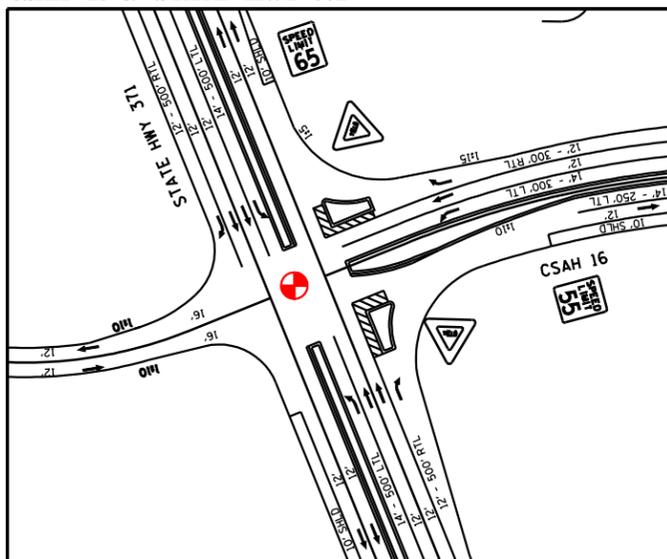
**INTERSECTION 5**  
**COUNTY RD 112 & STATE HWY 371**



**INTERSECTION 6**  
**COUNTY RD 112 & OLD STATE HWY 371**



**INTERSECTION 7**  
**CSAH 16 & STATE HWY 371**



- (A) ADDITIONAL IMPROVEMENTS TO PROPOSED MN/DOT LAYOUT
- ⊕ RECOMMENDED SIGNALIZED INTERSECTION CONTROL
- STOP STOP CONTROL
- ▽ YIELD CONTROL
- SPEED LIMIT SPEED LIMIT



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## **Appendix A**

### Traffic Forecasting Memorandum



## TECHNICAL MEMORANDUM

TO: Tim Bray, Mn/DOT D3

FROM: George Calebaugh, PE  
Jerilyn Swenson, EIT

DATE: August 21, 2008

RE: Traffic Forecasts - TH 371 Corridor between Nisswa and Pine River  
Pequot Lakes, Crow Wing County, MN  
SEH No. MNT03 103547 14

### OVERVIEW

Reconstruction of (TH) 371 is proposed by Mn/DOT between Nisswa and Pine River in Crow Wing County, Minnesota. Currently, SEH is in the process of preparing an Intersection Control Evaluation (ICE) report for several TH 371 study intersections. Part of the ICE process is to prepare the traffic forecasts for the corridor. This Technical Memorandum provides the methodology and assumptions used to forecast traffic to June weekday 2010 and 2030 peak hour conditions. The forecasts presented in this Technical Memorandum will be used in the analysis of the study intersections for the ICE report.

Traffic forecasts were prepared for the following TH 371 intersections:

- CSAH 16 and TH 371
- CR 112 and TH 371
- CSAH 11 and TH 371
- CR 107/CR 168 and TH 371
- CR 29/CR 107 and TH 371

Also, two intersections with the old TH 371 alignment are included in the study intersection due to the close proximity to the proposed TH 371 intersections. The two other study intersection include:

- CR 112 and old TH 371 alignment
- CR 168 and old TH 371 alignment

## **ESTIMATE EXISTING TRAFFIC CONDITIONS**

Five new intersections will be created directly from the proposed alignment of TH 371 on the east side of Pequot Lakes, Minnesota and include the following:

- CR 112 and TH 371
- CSAH 11 and TH 371
- CR 107/CR 168 and TH 371
- CR 112 and old TH 371 alignment
- CR 168 and the old TH 371 alignment

Therefore, existing turning movement volumes do not exist for these intersections and were estimated based on available area traffic data. Turning movement counts were collected in 2002 throughout the City of Pequot Lakes. See Table 1 for the 2002 turning movement volumes. Also, an origin-destination study was performed by Transfo, a traffic data collection company, and the results from the study are documented in a report titled "Pequot Lakes, Minnesota Origin-Destination Survey" published November 2002.

This origin-destination report determined that about 61 percent of vehicles entering from the south on TH 371 continue straight through Pequot Lakes, 71 percent of vehicles entering from the north on TH 371 continue straight through Pequot Lakes, and about 42 percent of vehicles entering from the east on County Road 11 continue straight through Pequot Lakes. This information was also used to estimate existing traffic conditions for the five newly created intersections.

Also, an estimated travel time savings between the proposed TH 371 and the old TH 371 alignment was used to estimate the proportion of drivers who prefer to utilize the new alignment versus the old TH 371 alignment when traveling into the Pequot Lakes downtown area. Based on the travel time savings of the proposed alignment, we estimated 65 percent of the vehicles entering from the south that are heading to downtown Pequot Lakes would utilize the CR 107/CR 168 intersection and the other 35 percent would use the CSAH 11 and TH 371 intersection.

Likewise, we estimated 65 percent of vehicles entering from the north destined for downtown Pequot Lakes would use the CR 112 and TH 371 intersection and the other 35 percent would use the new CSAH 11 and TH 371 intersection.

The estimated existing traffic conditions for the five proposed intersections created from the proposed TH 371 alignment were used to forecast traffic to 2010 and 2030 traffic conditions.

## **FORECAST METHODOLOGY**

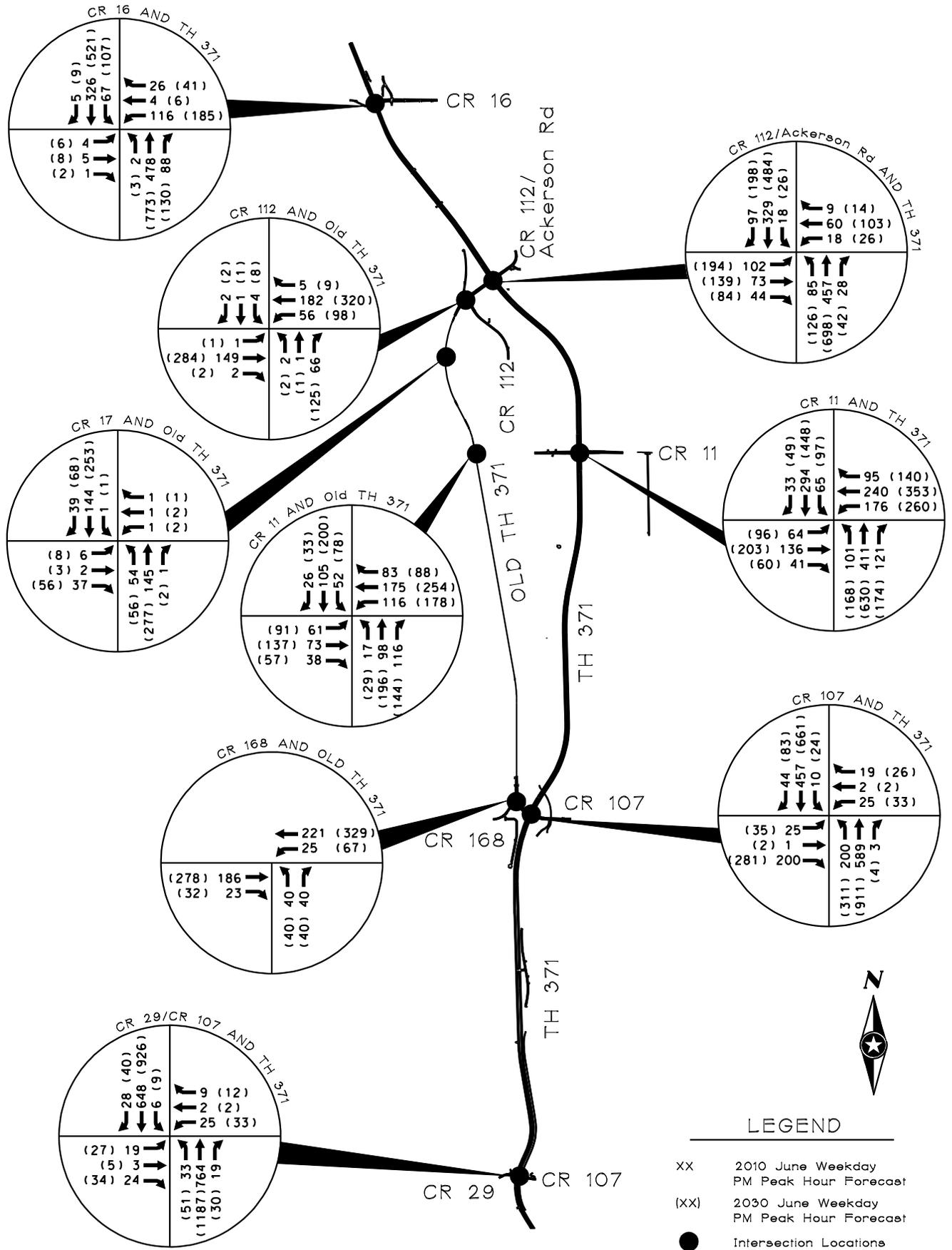
The following steps were taken in this study process:

- Collected existing 2008 peak hour turning movement counts at the intersection of CR 112 and Akerson Road and TH 371 and CR 29/CR 107.
- Assembled June 2002 PM peak hour turning movement counts surrounding the study intersections.
- Estimated base turning movement volumes for the proposed five intersections created directly from the proposed TH 371 alignment.
- Determined the forecast year 2010 and 2030 annual growth rates for the study intersections based on existing average daily traffic (ADT) and the forecast June weekday 2010 and 2030 ADT documented in a Mn/DOT November 29, 2007 handout.
- Applied annual growth rates to existing turning movement volumes to forecast the June weekday 2010 and 2030 turning movement counts for the study intersections.
- Converted June weekday 2010 and 2030 turning movement volumes for the study intersections into 24-hour traffic volumes based on existing 2002 24-hour traffic volumes.
- Converted June weekday 2010 and 2030 turning movement volumes for the study intersections into forecast 2010 and 2030 ADTs.
- Traffic forecasts were evaluated for reasonableness.

The annual growth rates for the TH 371 corridor were applied to the existing traffic turning movement volumes for all of the seven study intersections to forecast the June weekday 2010 and 2030 turning movement volumes. The 2010 and 2030 June weekday PM peak hour traffic forecasts are shown in Figure 1 and Figure 2 shows the 2010 and 2030 June ADT forecasts.

**Table 1**  
**June 2002 Weekday PM Peak hour Turning Volumes**

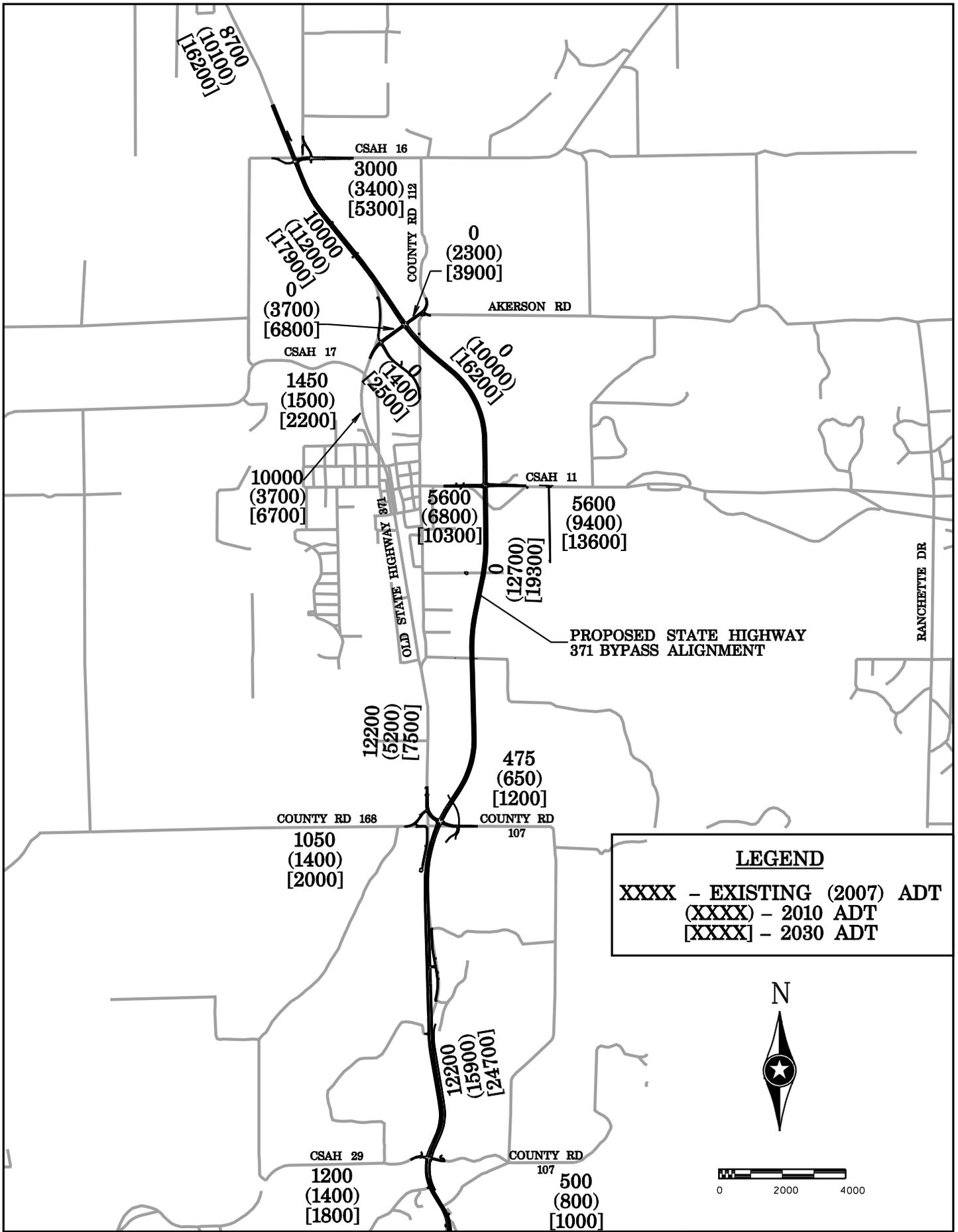
Intersection	Eastbound			Westbound			Northbound			Southbound		
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Hwy 371 & CR 18	8	23	3	198	21	22	6	487	210	21	403	14
Hwy 371 & CR 107/168	22	1	15	14	1	11	22	539	2	10	523	44
Hwy 371 & W Lake Rd	58		40				24	494			460	44
Hwy 371 & Woodman	24	12	34	9	7	9	23	513	16	11	460	25
Hwy 371 & CR 11	55	116	35	157	99	85	50	375	121	65	305	23
Hwy 371 & Sibley St	10	10	16	13	16	26	28	480	7	16	364	56
Hwy 371 & CR 17	5	2	34	1	1	2	58	457	1	1	401	10
CR 11 & Gov't Dr	35	256	12	5	299	18	16	5	14	15	7	26
CR 11 & CR 112	57	213	16	10	251	21	24	27	28	32	12	47
Hwy 371 & CR 16	3	4	1	97	3	21	2	447	76	56	271	5
Hwy 371 & CR 115/145	14	5	14	19	10	18	27	429	17	13	298	13
Hwy 371 & CR 15	0	0	0	27	0	2	0	410	51	8	298	0
Hwy 371 & CR 44	0	11	0	20	1	17	2	311	52	10	279	0
Hwy 371 & CR 1	37	7	21	4	8	12	20	366	8	17	331	44
Hwy 371 & Norway				29		17		397	18	14	362	
Hwy 371 & Hwy 84	9	17	4	92	15	64	6	300	108	55	281	4
Hwy 371 & Jefferson				28		17		349	24	2	311	
Hwy 371 & CR 2/42	36	8	9	8	3	59	14	335	18	110	297	49
Hwy 84 & Second St	24	142	14	9	137	14	4	8	13	23	13	31



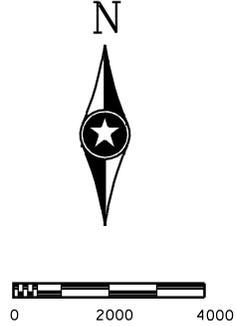
**INTERSECTION CONTROL EVALUATION  
TH 371 PEQUOT LAKES BYPASS  
PEQUOT LAKES, MN**

**PEAK HOUR  
TRAFFIC VOLUME  
FORECASTS**

**FIGURE  
NO. 1**



**LEGEND**  
 XXXX - EXISTING (2007) ADT  
 (XXXX) - 2010 ADT  
 [XXXX] - 2030 ADT



## ESTIMATED 24-HOUR APPROACH VOLUMES

The June weekday 2010 and 2030 turning movement volumes were converted to 24-hour traffic volumes based on an existing 2002 24-hour traffic count, which was located on TH 371 south of CSAH 16. Since 24-hour traffic distribution for the side street is not available, the 24-hour traffic distribution was assumed to be the combined average of the TH 371 northbound and southbound 24-hour distribution. Table 2 provides the hourly distribution breakdown used to determine the estimated 24-hour approach volumes.

The estimated 24-hour traffic approach volumes will be used for the warrant analysis for each of the TH 371 intersections. The estimated forecast 2010 and forecast 2030 24-hour approach volumes for the TH 371 study intersections are shown in Table 3 through Table 7.

**Table 2**

### June 2002 weekday 24-hour distribution

Hour	TH 371		Side Streets
	Southbound	Northbound	
1	0.63%	0.89%	0.76%
2	0.27%	0.38%	0.33%
3	0.32%	0.31%	0.32%
4	0.22%	0.31%	0.27%
5	0.71%	0.40%	0.56%
6	1.56%	0.80%	1.19%
7	3.73%	2.06%	2.91%
8	7.07%	4.48%	5.80%
9	6.77%	5.06%	5.92%
10	7.02%	5.06%	6.05%
11	6.80%	6.03%	6.42%
12	6.95%	5.70%	6.34%
13	6.61%	6.92%	6.77%
14	7.12%	7.01%	7.07%
15	6.92%	7.67%	7.29%
16	7.09%	7.78%	7.43%
17	7.14%	8.96%	8.04%
18	6.48%	8.82%	7.64%
19	4.99%	6.23%	5.60%
20	3.49%	4.03%	3.76%
21	2.70%	4.08%	3.38%
22	2.36%	3.37%	2.85%
23	1.92%	2.30%	2.11%
24	1.12%	1.33%	1.22%

**Table 3**  
**CSAH 16 and TH 371**

Hour	Estimated 24-hour approach volumes							
	Forecast 2010				Forecast 2030			
	SB	NB	EB	WB	SB	NB	EB	WB
1	35	56	1	14	56	90	1	22
2	15	24	0	6	24	39	1	9
3	18	20	0	6	29	32	1	9
4	12	20	0	5	20	32	1	8
5	40	25	1	10	63	41	1	16
6	87	51	1	21	139	81	2	34
7	208	130	4	52	333	208	6	84
8	394	284	7	104	630	453	11	167
9	377	320	7	107	603	511	12	171
10	391	320	7	109	626	511	12	175
11	379	382	8	116	606	610	13	185
12	387	361	8	114	620	576	13	183
13	369	439	8	122	590	700	13	195
14	397	444	9	127	635	709	14	204
15	386	486	9	131	617	776	14	210
16	395	493	9	134	632	786	15	214
17	398	568	10	145	637	906	16	232
18	361	559	9	138	578	892	15	220
19	278	394	7	101	444	629	11	161
20	195	255	5	68	311	407	7	108
21	150	259	4	61	240	412	7	97
22	131	213	4	51	210	340	6	82
23	107	146	3	38	171	233	4	61
24	62	84	2	22	100	134	2	35
Total	5572	6336	123	1803	8914	10107	198	2884

**Table 4**

**CR 112 and TH 371**

Hour	Estimated 24-hour approach volumes							
	Forecast 2010				Forecast 2030			
	SB	NB	EB	WB	SB	NB	EB	WB
1	39	57	21	8	62	86	39	13
2	17	24	9	4	27	37	17	6
3	20	20	9	3	32	30	17	6
4	14	20	7	3	22	30	14	5
5	44	26	15	6	71	39	29	10
6	97	51	32	13	155	78	62	21
7	232	131	79	31	370	199	151	52
8	440	285	158	63	701	433	301	103
9	421	322	161	64	671	489	307	105
10	437	322	165	65	696	489	314	108
11	423	384	175	69	674	583	333	114
12	432	363	173	69	689	551	329	113
13	411	440	184	73	656	669	351	120
14	443	446	193	76	706	677	367	126
15	430	488	199	79	686	741	378	130
16	441	495	202	80	703	751	385	132
17	444	570	219	87	708	866	417	143
18	403	561	208	83	642	853	396	136
19	310	396	152	61	494	601	290	100
20	217	256	102	41	346	389	195	67
21	168	260	92	37	267	394	175	60
22	147	214	78	31	234	325	148	51
23	119	146	57	23	190	222	109	37
24	70	84	33	13	111	128	63	22
Total	6218	6359	2724	1082	9915	9661	5187	1779

**Table 5**  
**CSAH 11 and TH 371**

Hour	Estimated 24-hour approach volumes							
	Forecast 2010				Forecast 2030			
	SB	NB	EB	WB	SB	NB	EB	WB
1	34	63	23	48	52	96	34	71
2	15	27	10	21	23	42	15	31
3	18	22	10	20	27	34	14	30
4	12	22	8	17	18	34	12	25
5	39	28	17	36	59	43	25	52
6	86	57	36	75	130	87	53	111
7	205	145	87	185	310	223	130	272
8	388	317	174	368	588	486	259	543
9	372	357	178	377	563	548	265	555
10	385	357	181	385	584	548	270	567
11	373	426	193	408	566	654	287	602
12	382	403	190	403	578	618	283	594
13	363	489	203	430	550	751	302	634
14	391	495	212	449	593	760	316	662
15	380	542	219	463	576	832	326	683
16	389	549	223	472	590	843	332	696
17	392	633	241	511	594	972	359	753
18	356	623	229	485	539	957	341	715
19	274	440	168	356	415	675	250	524
20	192	284	113	239	291	437	168	352
21	148	288	101	215	224	442	151	316
22	129	238	86	181	196	365	127	267
23	105	163	63	134	159	250	94	197
24	61	94	37	78	93	144	55	114
Total	5490	7062	2998	6356	8319	10843	4465	9366

**Table 6**  
**CR 107/168 and TH 371**

Hour	Estimated 24-hour approach volumes							
	Forecast 2010				Forecast 2030			
	SB	NB	EB	WB	SB	NB	EB	WB
1	45	79	21	4	67	122	30	6
2	19	34	9	2	29	52	13	2
3	23	28	9	2	35	43	13	2
4	16	28	7	2	24	43	11	2
5	51	35	16	3	77	55	22	4
6	112	71	33	7	168	110	47	9
7	267	182	82	17	401	281	115	22
8	506	396	163	33	761	613	229	44
9	484	447	167	34	728	692	234	45
10	502	447	170	35	755	692	239	46
11	487	533	181	37	732	825	254	49
12	498	504	178	36	748	780	251	48
13	473	612	190	39	711	947	268	51
14	510	619	199	40	766	959	280	54
15	495	678	205	42	744	1050	288	55
16	507	687	209	42	763	1064	294	56
17	511	792	226	46	768	1,226	318	61
18	464	780	215	44	697	1207	302	58
19	357	550	157	32	536	852	221	42
20	250	356	106	21	376	551	149	29
21	193	361	95	19	290	558	134	26
22	169	297	80	16	254	460	113	22
23	137	203	59	12	206	315	83	16
24	80	117	34	7	120	181	48	9
Total	7156	8835	2811	572	10756	13677	3955	759

**Table 7**

**CR 29/107 and TH 371**

Hour	Estimated 24-hour approach volumes							
	Forecast 2010				Forecast 2030			
	SB	NB	EB	WB	SB	NB	EB	WB
1	60	81	4	3	86	126	6	4
2	26	35	2	1	37	54	3	2
3	31	29	2	1	44	44	3	2
4	21	29	2	1	30	44	2	2
5	68	37	3	3	97	57	5	3
6	149	73	7	5	213	113	10	7
7	356	187	17	13	510	291	24	17
8	676	408	33	26	966	634	48	34
9	646	460	34	27	924	715	49	35
10	671	460	35	27	959	715	50	35
11	650	549	37	29	929	854	53	38
12	664	519	36	28	950	807	52	37
13	632	630	39	30	903	979	56	40
14	680	638	40	32	973	992	58	41
15	661	699	42	33	945	1085	60	43
16	677	708	42	33	968	1100	61	43
17	682	816	46	36	975	1,268	66	47
18	619	803	44	34	885	1248	63	45
19	476	567	32	25	681	881	46	33
20	334	367	21	17	477	570	31	22
21	258	371	19	15	368	577	28	20
22	225	306	16	13	322	476	23	17
23	183	210	12	9	262	326	17	12
24	107	121	7	5	153	187	10	7
Total	9551	9103	572	448	13655	14145	821	585

---

## **Appendix B**

Forecast 2010 Warrant Summary

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CSAH 16\_2010**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **6,333**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **5,572**

**Minor Street Approaches**

**Eastbound: CSAH 16**

Number of Lanes: **1**  
  
Total Approach Volume: **110**

**Westbound: CSAH 16**

Number of Lanes: **2**  
  
Total Approach Volume: **1,485**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume ..... Not Satisfied**

Required volumes reached for 0 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic ..... Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants ..... Not Satisfied**

Required volumes reached for 2 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 Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

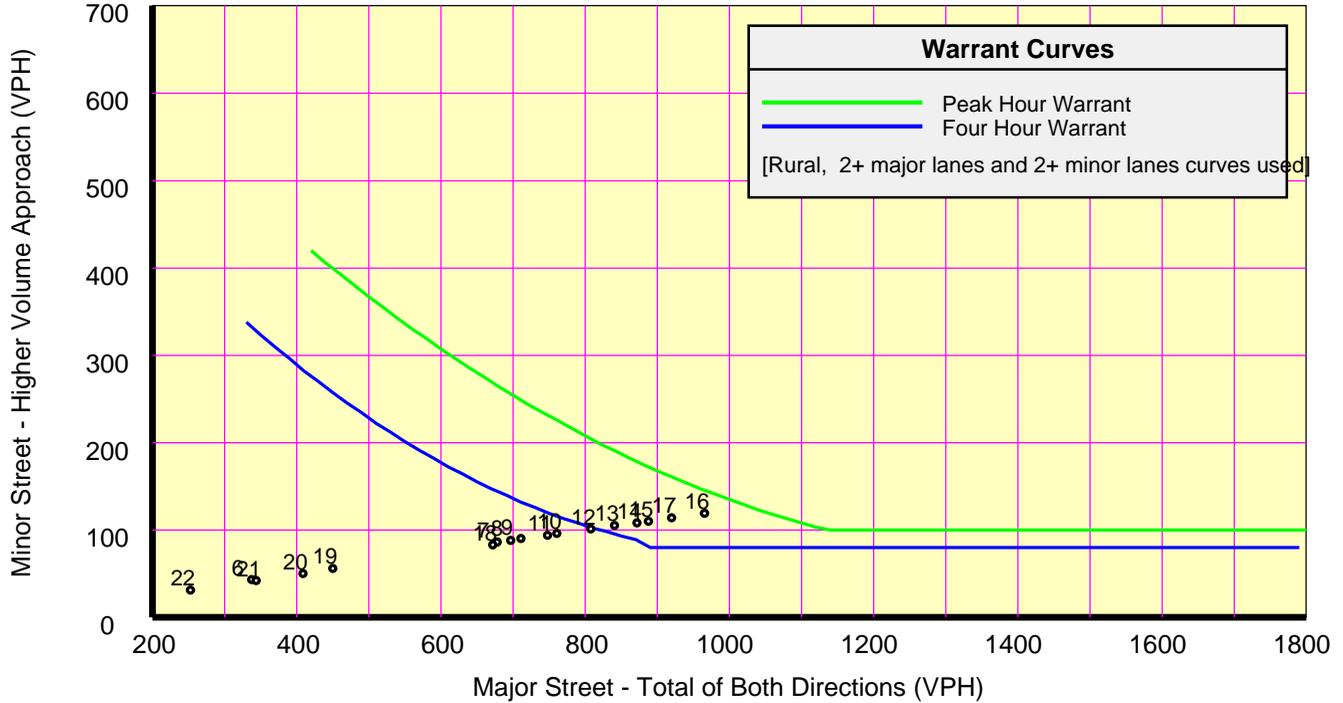
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : **CSAH 16\_2010**

Study Date : **07/29/08**

Page No. : **2**

## 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	91	12	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	39	5	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	38	5	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	32	4	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	65	8	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	138	17	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	338	43	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
07:00	678	86	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
08:00	697	88	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
09:00	711	90	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
10:00	761	96	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
11:00	748	94	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
12:00	808	101	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
13:00	841	105	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
14:00	872	108	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
15:00	888	110	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
16:00	966	119	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	920	114	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	672	83	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
19:00	450	56	WB	420-Yes	140-No	Major	630-No	70-No	---	504-No	112-No	---
20:00	409	50	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
21:00	344	42	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
22:00	253	31	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
23:00	146	18	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR 112\_2010**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **6,361**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **6,219**

**Minor Street Approaches**

**Eastbound: CR 112**

Number of Lanes: **2**  
  
Total Approach Volume: **2,176**

**Westbound: CR 112**

Number of Lanes: **2**  
  
Total Approach Volume: **971**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume ..... Not Satisfied**

Required volumes reached for 7 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic ..... Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants ..... Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 2 - Four Hour Volumes ..... Satisfied**

Number of hours (10) volumes exceed minimum >= minimum required (4).

**Warrant 3 - Peak Hour ..... 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 ..... Satisfied**

Volumes exceed minimums for at least one hour.

**Warrant 4 - Pedestrian Volumes ..... Not Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

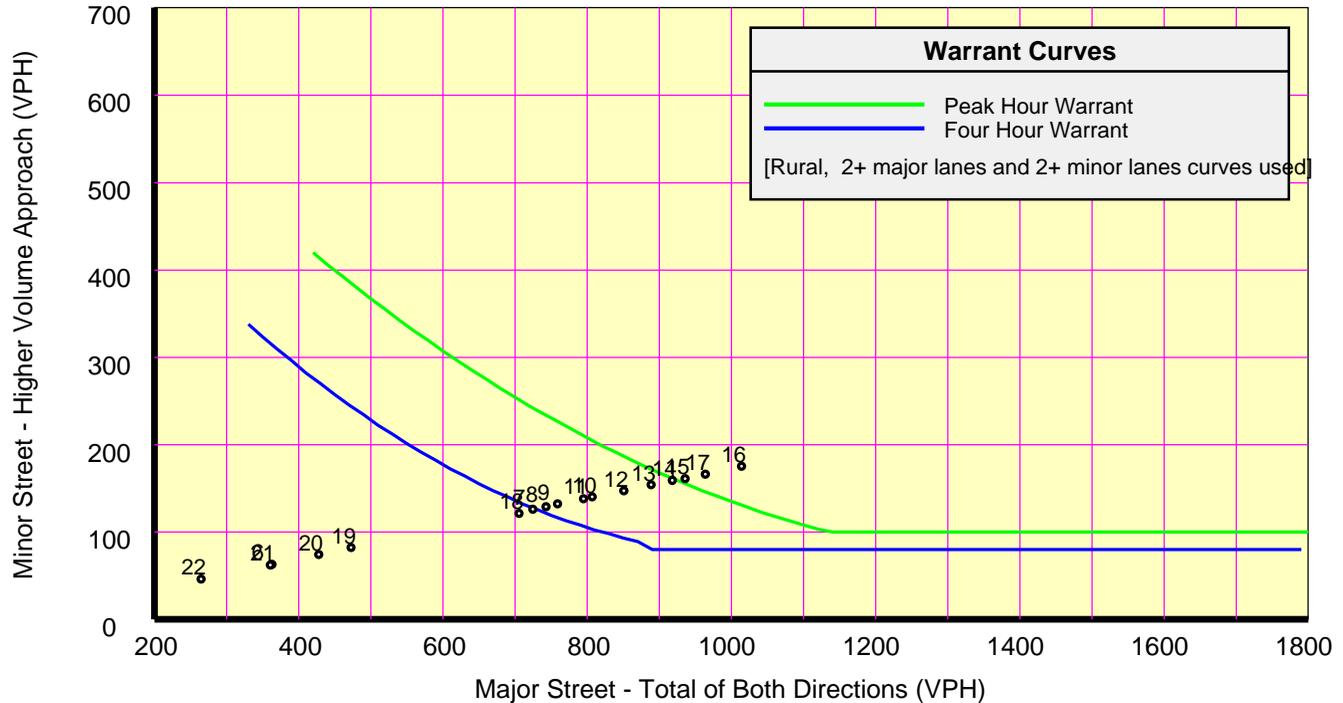
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR 112\_2010

Study Date : 07/29/08

Page No. : 2

## 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	96	17	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	41	7	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	40	7	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	34	6	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	70	12	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	148	26	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	363	63	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
07:00	725	126	EB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
08:00	743	129	EB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
09:00	759	132	EB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
10:00	807	140	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
11:00	795	138	EB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
12:00	851	147	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
13:00	889	154	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
14:00	918	159	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
15:00	936	161	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
16:00	1,014	175	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	964	166	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	706	121	EB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
19:00	473	82	EB	420-Yes	140-No	Major	630-No	70-Yes	Minor	504-No	112-No	---
20:00	428	74	EB	420-Yes	140-No	Major	630-No	70-Yes	Minor	504-No	112-No	---
21:00	361	62	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
22:00	265	46	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
23:00	154	26	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CSAH 11\_2010**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **7,062**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **5,489**

**Minor Street Approaches**

**Eastbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **2,490**

**Westbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **5,174**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume .....Satisfied**

Required volumes reached for 14 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic .....Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants .....Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 2 - Four Hour Volumes ..... Satisfied**

Number of hours (12) volumes exceed minimum >= minimum required (4).

**Warrant 3 - Peak Hour ..... 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 .....Satisfied**

Volumes exceed minimums for at least one hour.

**Warrant 4 - Pedestrian Volumes ..... Not Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

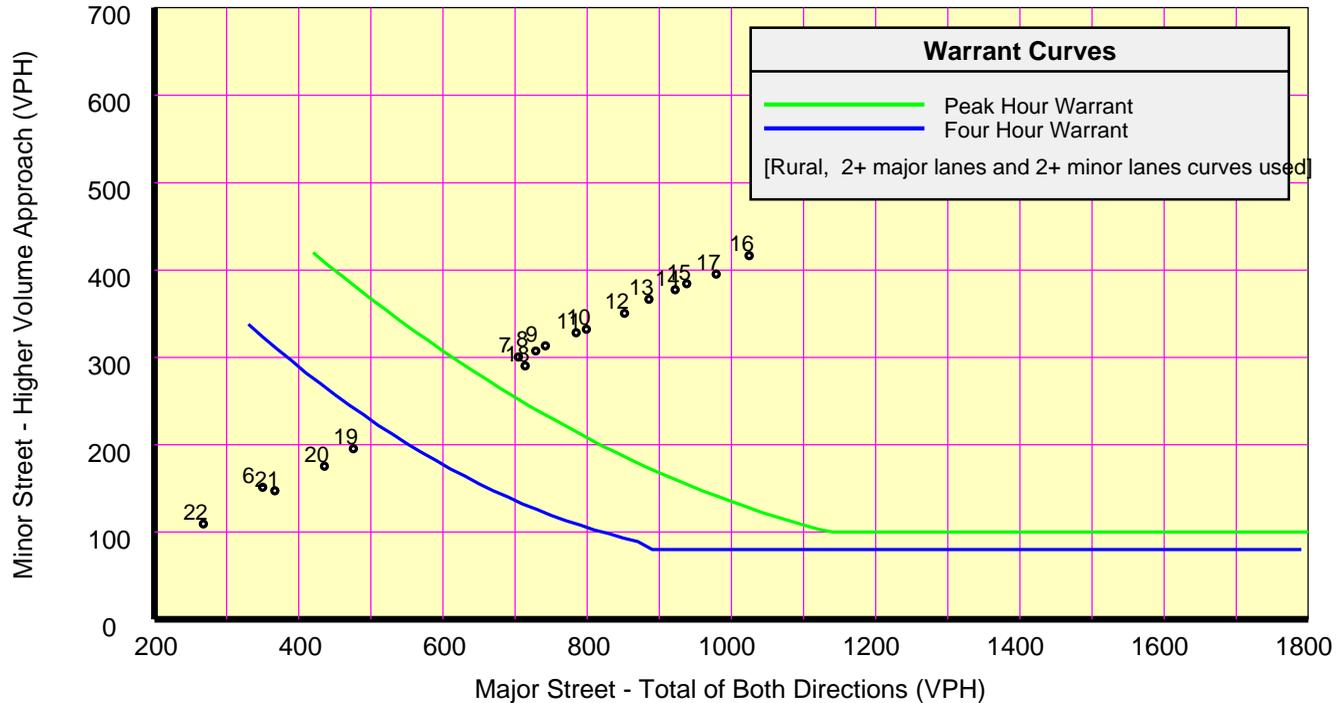
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : **CSAH 11\_2010**

Study Date : **07/29/08**

Page No. : **2**

## 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	97	39	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	42	17	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	40	16	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	34	14	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	67	29	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	143	61	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	350	151	WB	420-No	140-Yes	Minor	630-No	70-Yes	Minor	504-No	112-Yes	Minor
07:00	705	300	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
08:00	729	307	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
09:00	742	313	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
10:00	799	332	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
11:00	785	328	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
12:00	852	350	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
13:00	886	366	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
14:00	922	377	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
15:00	938	384	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
16:00	1,025	416	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	979	395	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	714	290	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
19:00	476	195	WB	420-Yes	140-Yes	Both	630-No	70-Yes	Minor	504-No	112-Yes	Minor
20:00	436	175	WB	420-Yes	140-Yes	Both	630-No	70-Yes	Minor	504-No	112-Yes	Minor
21:00	367	147	WB	420-No	140-Yes	Minor	630-No	70-Yes	Minor	504-No	112-Yes	Minor
22:00	268	109	WB	420-No	140-No	---	630-No	70-Yes	Minor	504-No	112-No	---
23:00	155	63	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR107\_168\_2010**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **8,836**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **7,156**

**Minor Street Approaches**

**Eastbound: CSAH 11**

Number of Lanes: **1**  
  
Total Approach Volume: **324**

**Westbound: CSAH 11**

Number of Lanes: **1**  
  
Total Approach Volume: **513**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Not Satisfied**

**Warrant 1A - Minimum Vehicular Volume .....Not Satisfied**

Required volumes reached for 0 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 0 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 Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

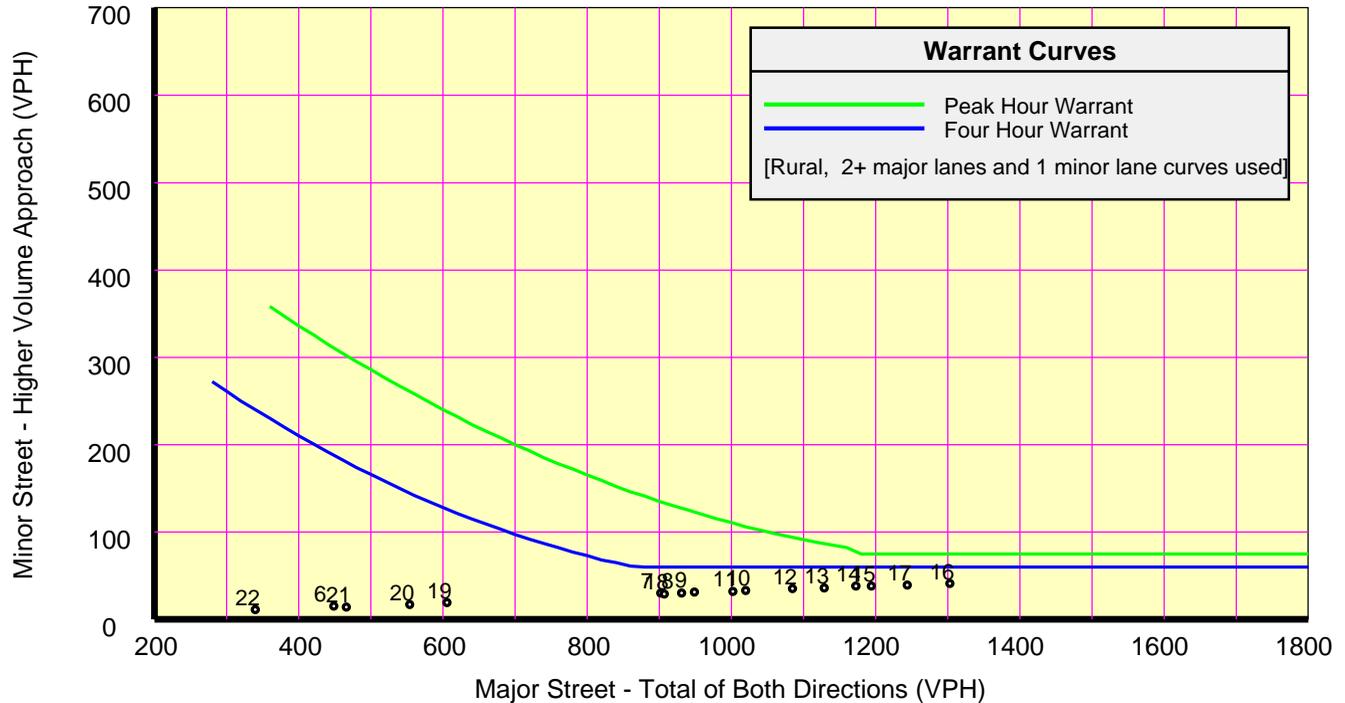
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR107\_168\_2010

Study Date : 07/29/08

Page No. : 2

## 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	124	4	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
01:00	53	2	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
02:00	51	2	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
03:00	44	2	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
04:00	86	3	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
05:00	183	6	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
06:00	449	15	WB	420-Yes	105-No	Major	630-No	53-No	---	504-No	84-No	---
07:00	902	30	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
08:00	931	30	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
09:00	949	31	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
10:00	1,020	33	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
11:00	1,002	32	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
12:00	1,085	35	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
13:00	1,129	36	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
14:00	1,173	38	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
15:00	1,194	38	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
16:00	1,303	41	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
17:00	1,244	39	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
18:00	907	29	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
19:00	606	19	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
20:00	554	17	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
21:00	466	14	WB	420-Yes	105-No	Major	630-No	53-No	---	504-No	84-No	---
22:00	340	11	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
23:00	197	6	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR107\_29\_2010**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **9,103**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **9,552**

**Minor Street Approaches**

**Eastbound: CR 29**

Number of Lanes: **1**  
  
Total Approach Volume: **273**

**Westbound: CR 107**

Number of Lanes: **1**  
  
Total Approach Volume: **347**

**Warrant Summary (Rural values apply.)**

<b>Warrant 1 - Eight Hour Vehicular Volumes</b> .....	<b>Not Satisfied</b>
<b>Warrant 1A - Minimum Vehicular Volume</b> .....	<b>Not Satisfied</b>
Required volumes reached for 0 hours, 8 are needed	
<b>Warrant 1B - Interruption of Continuous Traffic</b> .....	<b>Not Satisfied</b>
Required volumes reached for 0 hours, 8 are needed	
<b>Warrant 1 A&amp;B - Combination of Warrants</b> .....	<b>Not Satisfied</b>
Required volumes reached for 0 hours, 8 are needed	
<b>Warrant 2 - Four Hour Volumes</b> .....	<b>Not Satisfied</b>
Number of hours (0) volumes exceed minimum < minimum required (4).	
<b>Warrant 3 - Peak Hour</b> .....	<b>Not Satisfied</b>
<b>Warrant 3A - Peak Hour Delay</b> .....	<b>Not Satisfied</b>
Total approach volumes and delays on minor street do not exceed minimums for any hour.	
<b>Warrant 3B - Peak Hour Volumes</b> .....	<b>Not Satisfied</b>
Volumes do not exceed minimums for any hour.	
<b>Warrant 4 - Pedestrian Volumes</b> .....	<b>Not Evaluated</b>
<b>Warrant 5 - School Crossing</b> .....	<b>Not Evaluated</b>
<b>Warrant 6 - Coordinated Signal System</b> .....	<b>Not Evaluated</b>
<b>Warrant 7 - Crash Experience</b> .....	<b>Not Evaluated</b>
<b>Warrant 8 - Roadway Network</b> .....	<b>Not Evaluated</b>

# Short Elliot Hendrickson Inc.

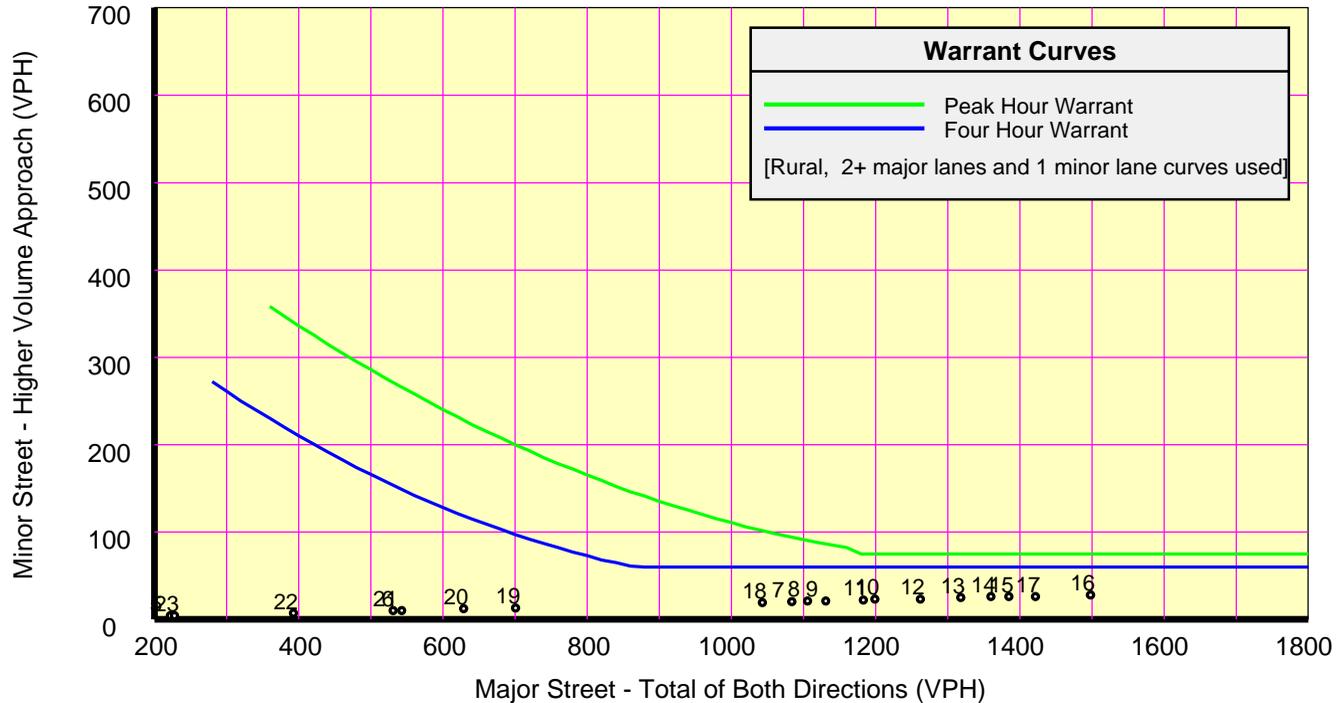
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR107\_29\_2010

Study Date : 07/29/08

Page No. : 2

## Signal Warrants - Summary



### Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor		War-1A			War-1B			War-1A&B		
		Vol	Dir	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	141	2	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
01:00	61	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
02:00	60	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
03:00	50	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
04:00	105	2	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
05:00	222	4	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
06:00	543	10	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
07:00	1,084	20	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
08:00	1,106	21	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
09:00	1,131	21	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
10:00	1,199	23	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
11:00	1,183	22	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
12:00	1,262	23	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
13:00	1,318	25	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
14:00	1,360	26	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
15:00	1,385	26	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
16:00	1,498	28	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
17:00	1,422	26	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
18:00	1,043	19	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
19:00	701	13	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
20:00	629	12	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
21:00	531	10	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
22:00	393	7	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
23:00	228	4	WB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---

---

## **Appendix C**

Forecast 2030 Warrant Summary

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CSAH 16\_2030**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **10,108**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **8,914**

**Minor Street Approaches**

**Eastbound: CSAH 16**

Number of Lanes: **1**  
  
Total Approach Volume: **174**

**Westbound: CSAH 16**

Number of Lanes: **2**  
  
Total Approach Volume: **2,374**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume .....Satisfied**

Required volumes reached for 10 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic .....Satisfied**

Required volumes reached for 14 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants .....Satisfied**

Required volumes reached for 12 hours, 8 are needed

**Warrant 2 - Four Hour Volumes ..... Satisfied**

Number of hours (12) volumes exceed minimum >= minimum required (4).

**Warrant 3 - Peak Hour ..... 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 .....Satisfied**

Volumes exceed minimums for at least one hour.

**Warrant 4 - Pedestrian Volumes ..... Not Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

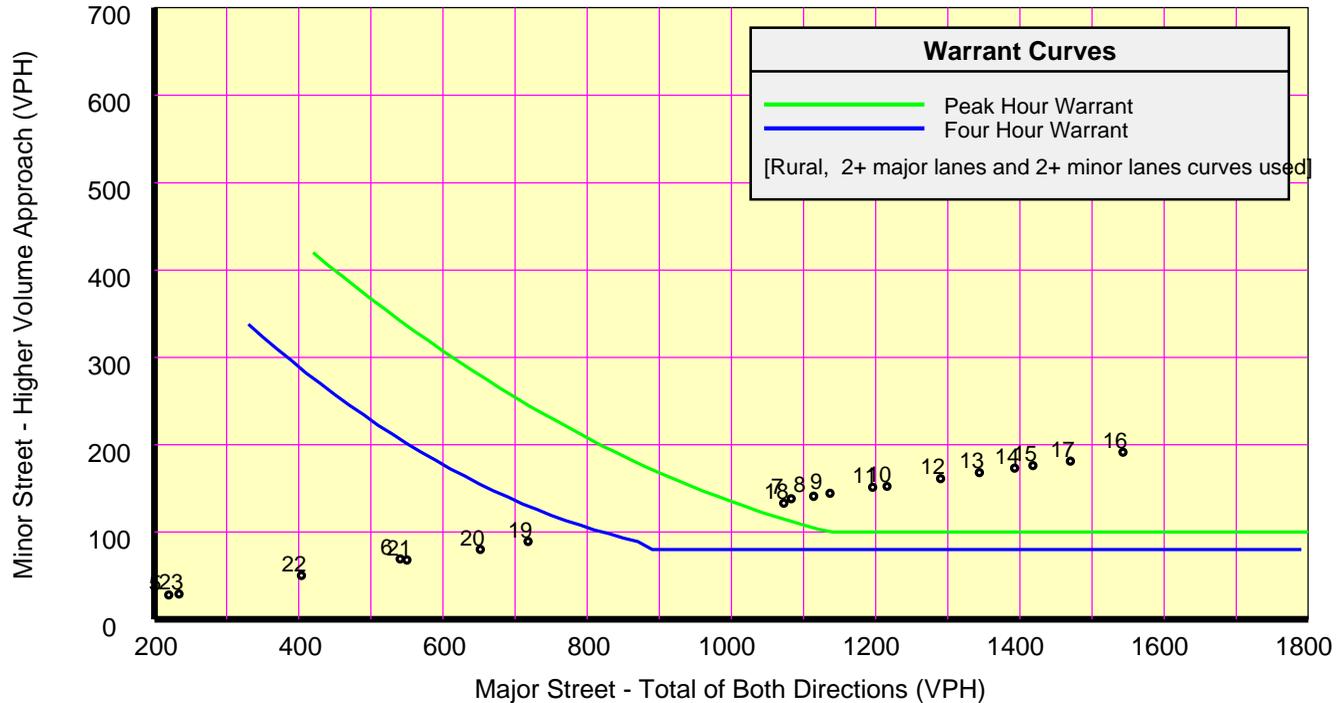
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : **CSAH 16\_2030**

Study Date : **07/29/08**

Page No. : **2**

## 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	146	18	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	63	7	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	61	7	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	52	7	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	104	13	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	220	28	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	541	69	WB	420-Yes	140-No	Major	630-No	70-No	---	504-Yes	112-No	Major
07:00	1,083	138	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
08:00	1,114	141	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
09:00	1,137	144	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
10:00	1,216	152	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
11:00	1,196	151	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
12:00	1,290	161	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
13:00	1,344	168	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
14:00	1,393	173	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
15:00	1,418	176	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
16:00	1,543	191	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	1,470	181	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	1,073	133	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
19:00	718	89	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
20:00	652	80	WB	420-Yes	140-No	Major	630-Yes	70-Yes	Both	504-Yes	112-No	Major
21:00	550	68	WB	420-Yes	140-No	Major	630-No	70-No	---	504-Yes	112-No	Major
22:00	404	50	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
23:00	234	29	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR 112\_2030**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **9,660**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **9,913**

**Minor Street Approaches**

**Eastbound: CR 112**

Number of Lanes: **2**  
  
Total Approach Volume: **4,143**

**Westbound: CR 112**

Number of Lanes: **2**  
  
Total Approach Volume: **1,605**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume .....Satisfied**

Required volumes reached for 14 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic .....Satisfied**

Required volumes reached for 14 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants .....Satisfied**

Required volumes reached for 16 hours, 8 are needed

**Warrant 2 - Four Hour Volumes ..... Satisfied**

Number of hours (13) volumes exceed minimum >= minimum required (4).

**Warrant 3 - Peak Hour ..... 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 .....Satisfied**

Volumes exceed minimums for at least one hour.

**Warrant 4 - Pedestrian Volumes ..... Not Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

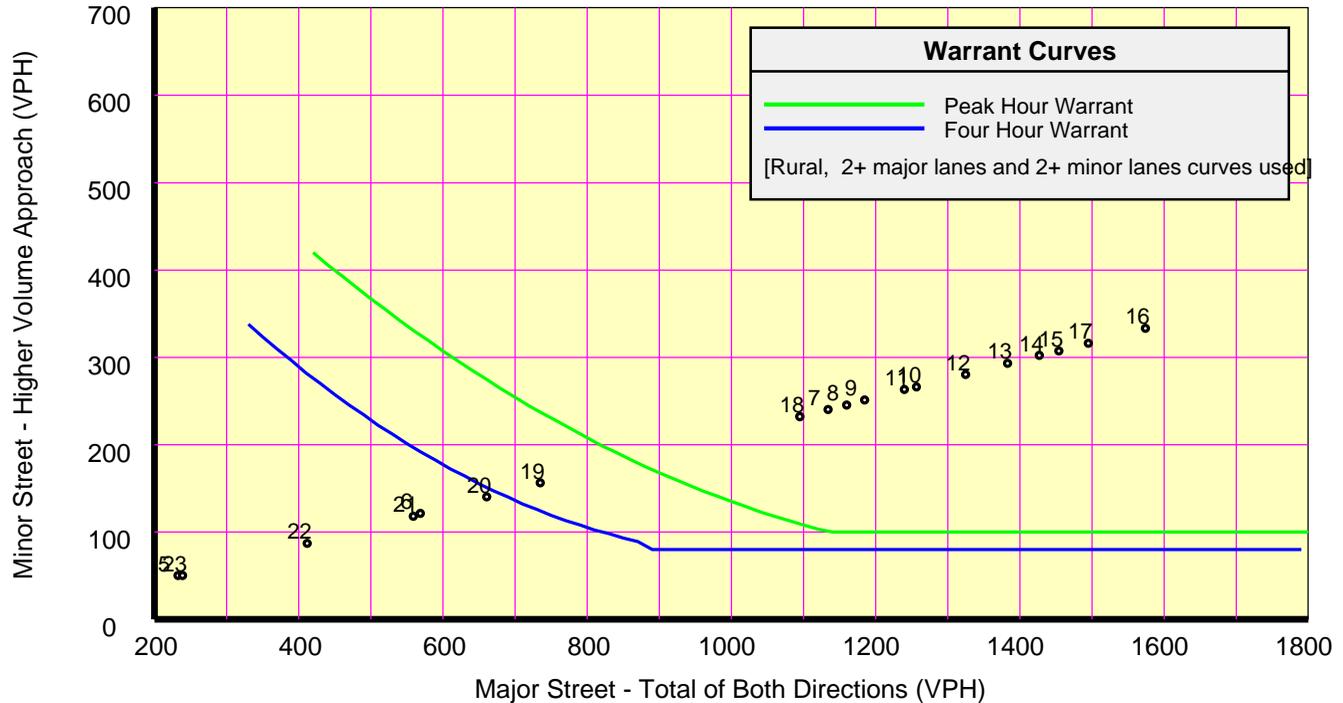
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR 112\_2030

Study Date : 07/29/08

Page No. : 2

## 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	148	31	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	64	14	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	62	14	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	52	11	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	110	23	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	233	50	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	569	121	EB	420-Yes	140-No	Major	630-No	70-Yes	Minor	504-Yes	112-Yes	Both
07:00	1,134	240	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
08:00	1,160	245	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
09:00	1,185	251	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
10:00	1,257	266	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
11:00	1,240	263	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
12:00	1,325	280	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
13:00	1,383	293	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
14:00	1,427	302	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
15:00	1,454	307	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
16:00	1,574	333	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	1,495	316	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	1,095	232	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
19:00	735	156	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
20:00	661	140	EB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
21:00	559	118	EB	420-Yes	140-No	Major	630-No	70-Yes	Minor	504-Yes	112-Yes	Both
22:00	412	87	EB	420-No	140-No	---	630-No	70-Yes	Minor	504-No	112-No	---
23:00	239	50	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CSAH 11\_2030**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **10,841**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **8,318**

**Minor Street Approaches**

**Eastbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **3,723**

**Westbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **7,624**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Satisfied**

**Warrant 1A - Minimum Vehicular Volume .....Satisfied**

Required volumes reached for 16 hours, 8 are needed

**Warrant 1B - Interruption of Continuous Traffic .....Satisfied**

Required volumes reached for 14 hours, 8 are needed

**Warrant 1 A&B - Combination of Warrants .....Satisfied**

Required volumes reached for 16 hours, 8 are needed

**Warrant 2 - Four Hour Volumes ..... Satisfied**

Number of hours (16) volumes exceed minimum >= minimum required (4).

**Warrant 3 - Peak Hour ..... 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 .....Satisfied**

Volumes exceed minimums for at least one hour.

**Warrant 4 - Pedestrian Volumes ..... Not Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

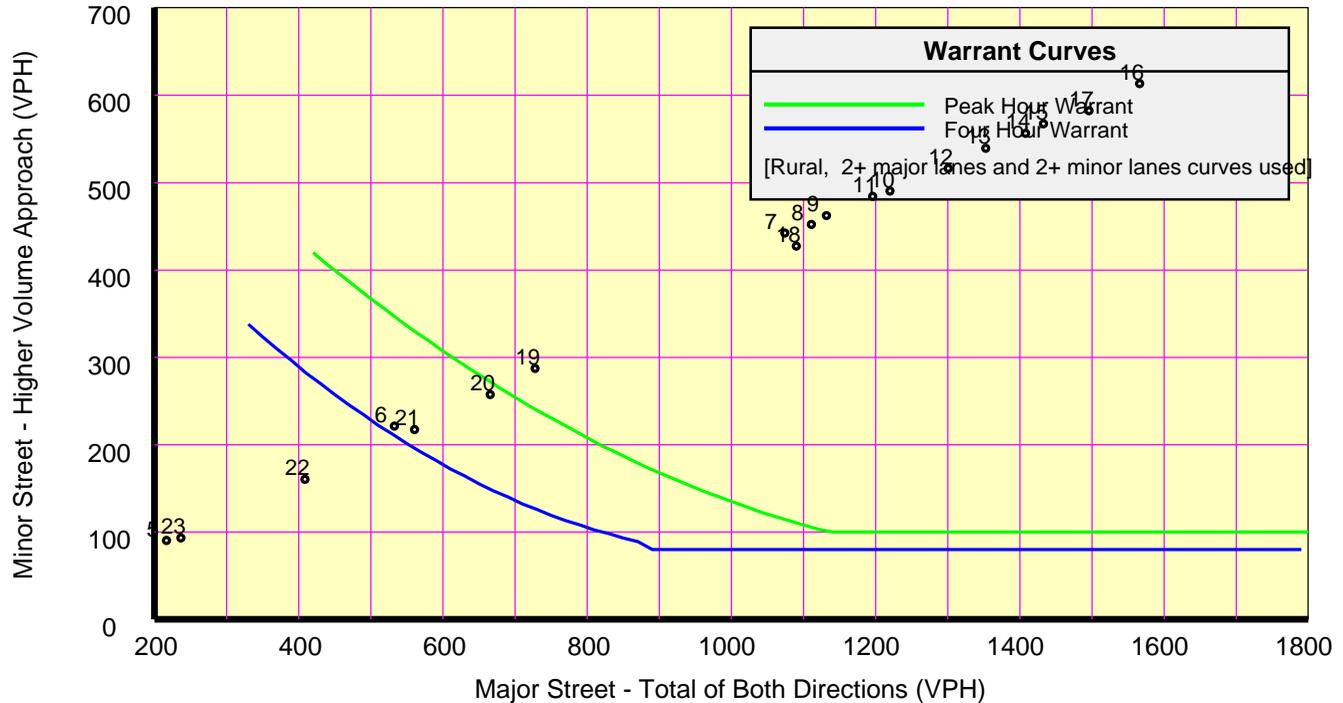
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : **CSAH 11\_2030**

Study Date : **07/29/08**

Page No. : **2**

## 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	148	58	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	65	25	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	61	24	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	52	20	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	102	42	WB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	217	90	WB	420-No	140-No	---	630-No	70-Yes	Minor	504-No	112-No	---
06:00	533	221	WB	420-Yes	140-Yes	Both	630-No	70-Yes	Minor	504-Yes	112-Yes	Both
07:00	1,074	442	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
08:00	1,111	452	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
09:00	1,132	462	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
10:00	1,220	490	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
11:00	1,196	484	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
12:00	1,301	516	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
13:00	1,353	539	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
14:00	1,408	556	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
15:00	1,433	567	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
16:00	1,566	613	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
17:00	1,496	582	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
18:00	1,090	427	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
19:00	728	287	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
20:00	666	257	WB	420-Yes	140-Yes	Both	630-Yes	70-Yes	Both	504-Yes	112-Yes	Both
21:00	561	217	WB	420-Yes	140-Yes	Both	630-No	70-Yes	Minor	504-Yes	112-Yes	Both
22:00	409	160	WB	420-No	140-Yes	Minor	630-No	70-Yes	Minor	504-No	112-Yes	Minor
23:00	237	93	WB	420-No	140-No	---	630-No	70-Yes	Minor	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR107\_168\_2030**

Study Date : **07/29/08**

Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **13,678**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **10,756**

**Minor Street Approaches**

**Eastbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **462**

**Westbound: CSAH 11**

Number of Lanes: **2**  
  
Total Approach Volume: **434**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Not Satisfied**

**Warrant 1A - Minimum Vehicular Volume ..... Not Satisfied**

Required volumes reached for 0 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 0 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 Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

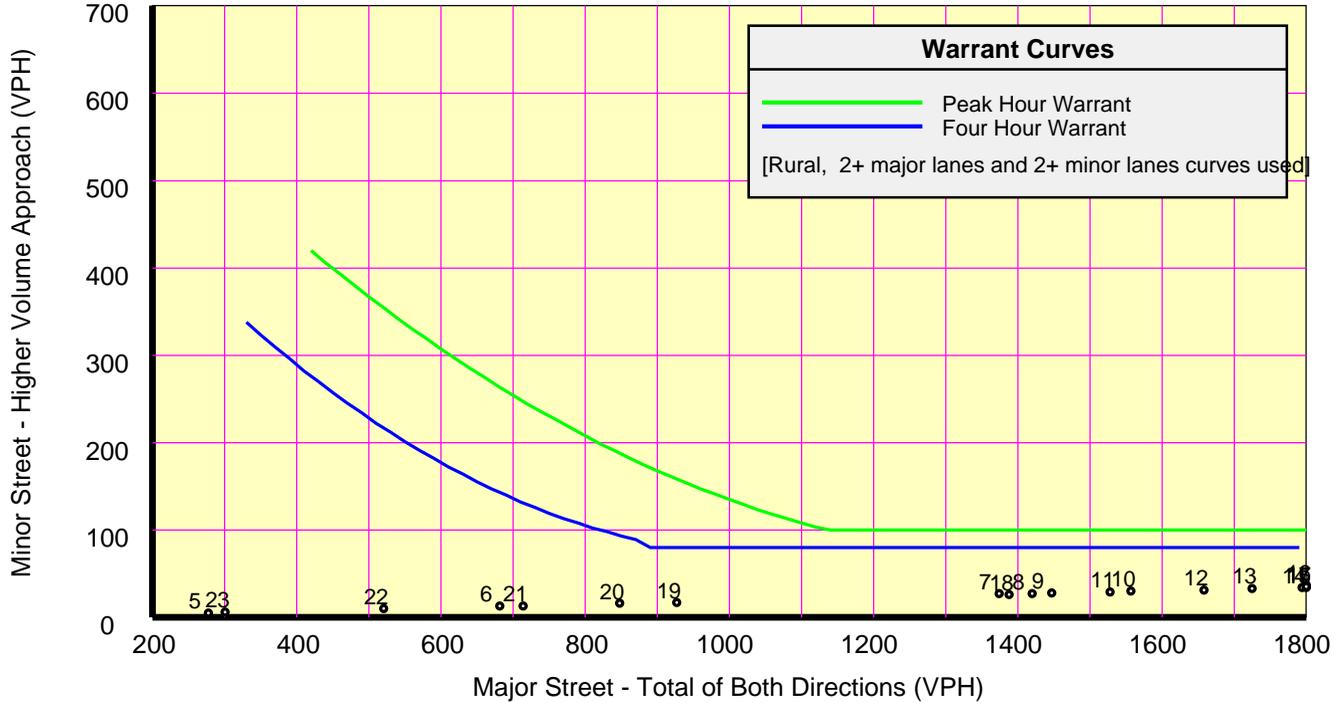
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR107\_168\_2030

Study Date : 07/29/08

Page No. : 2

## Signal Warrants - Summary



### Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor		War-1A			War-1B			War-1A&B		
		Vol	Dir	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	189	3	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
01:00	81	2	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
02:00	78	2	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
03:00	67	1	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
04:00	132	3	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
05:00	278	5	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---
06:00	682	13	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
07:00	1,374	27	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
08:00	1,420	27	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
09:00	1,447	28	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
10:00	1,557	30	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
11:00	1,528	29	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
12:00	1,658	31	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
13:00	1,725	33	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
14:00	1,794	34	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
15:00	1,827	34	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
16:00	1,994	37	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
17:00	1,904	35	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
18:00	1,388	26	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
19:00	927	17	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
20:00	848	16	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
21:00	714	13	EB	420-Yes	140-No	Major	630-Yes	70-No	Major	504-Yes	112-No	Major
22:00	521	10	EB	420-Yes	140-No	Major	630-No	70-No	---	504-Yes	112-No	Major
23:00	301	6	EB	420-No	140-No	---	630-No	70-No	---	504-No	112-No	---

**Short Elliot Hendrickson Inc.**

1200 25th Avenue South  
PO Box 1717  
St. Cloud, MN 56302-1717  
320-229-4300

Study Name : **CR107\_29\_2030**  
Study Date : **07/29/08**  
Page No. : **1**

**Signal Warrants - Summary**

**Major Street Approaches**

**Northbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **14,143**

**Southbound: TH 371**

Number of Lanes: **2**  
Approach Speed: **65**  
Total Approach Volume: **13,657**

**Minor Street Approaches**

**Eastbound: CR 29**

Number of Lanes: **1**  
  
Total Approach Volume: **399**

**Westbound: CR 107**

Number of Lanes: **1**  
  
Total Approach Volume: **436**

**Warrant Summary (Rural values apply.)**

**Warrant 1 - Eight Hour Vehicular Volumes ..... Not Satisfied**

**Warrant 1A - Minimum Vehicular Volume ..... Not Satisfied**

Required volumes reached for 0 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 0 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 Evaluated**

**Warrant 5 - School Crossing ..... Not Evaluated**

**Warrant 6 - Coordinated Signal System ..... Not Evaluated**

**Warrant 7 - Crash Experience ..... Not Evaluated**

**Warrant 8 - Roadway Network ..... Not Evaluated**

# Short Elliot Hendrickson Inc.

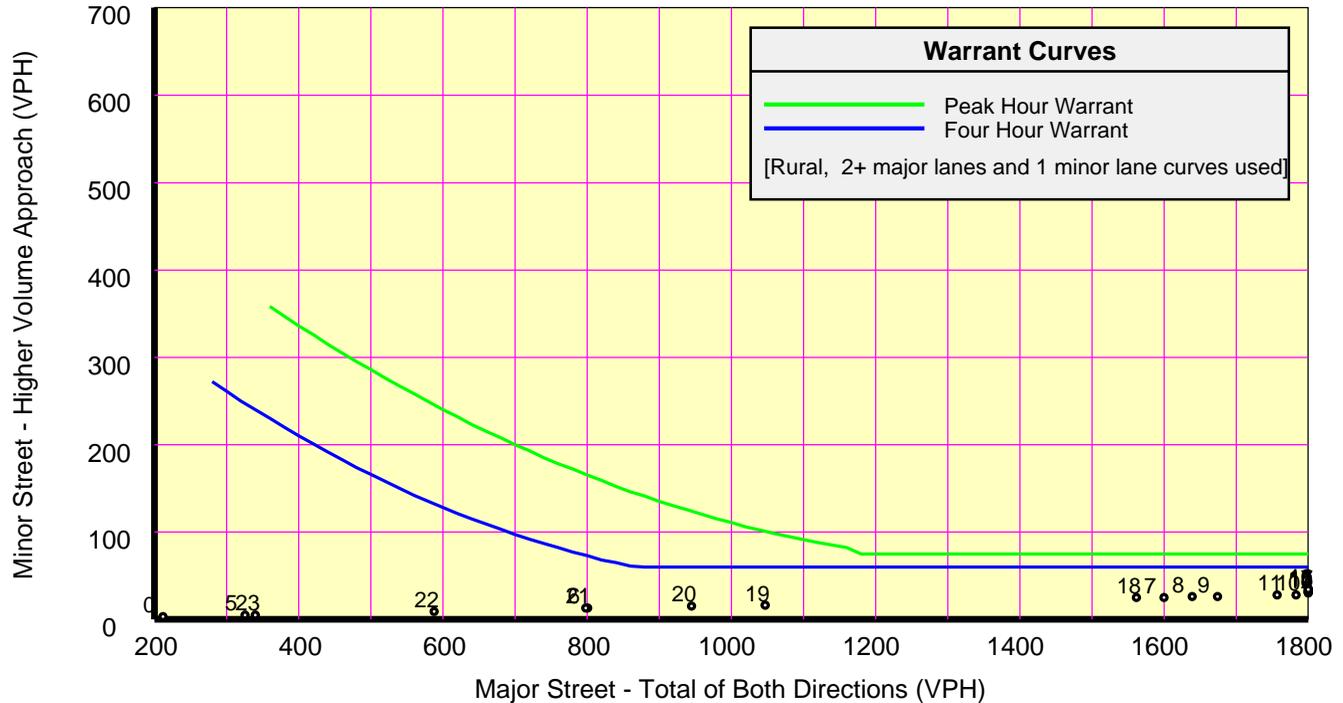
1200 25th Avenue South  
 PO Box 1717  
 St. Cloud, MN 56302-1717  
 320-229-4300

Study Name : CR107\_29\_2030

Study Date : 07/29/08

Page No. : 2

## Signal Warrants - Summary



### Analysis of 8-Hour Volume Warrants:

Hour Begin	Major Total	Higher Minor		War-1A			War-1B			War-1A&B		
		Vol	Dir	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?	Major Crit	Minor Crit	Meets?
00:00	212	3	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
01:00	91	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
02:00	88	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
03:00	74	1	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
04:00	154	2	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
05:00	326	5	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---
06:00	801	13	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
07:00	1,600	25	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
08:00	1,639	26	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
09:00	1,674	26	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
10:00	1,783	28	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
11:00	1,757	28	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
12:00	1,882	30	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
13:00	1,965	31	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
14:00	2,030	32	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
15:00	2,068	32	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
16:00	2,243	35	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
17:00	2,133	34	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
18:00	1,562	25	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
19:00	1,047	16	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
20:00	945	15	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
21:00	798	13	WB	420-Yes	105-No	Major	630-Yes	53-No	Major	504-Yes	84-No	Major
22:00	588	9	WB	420-Yes	105-No	Major	630-No	53-No	---	504-Yes	84-No	Major
23:00	340	5	EB	420-No	105-No	---	630-No	53-No	---	504-No	84-No	---

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## **Appendix D**

### Intersection Collision Diagrams

# Collision Diagram

## Pequot Lakes, Minnesota

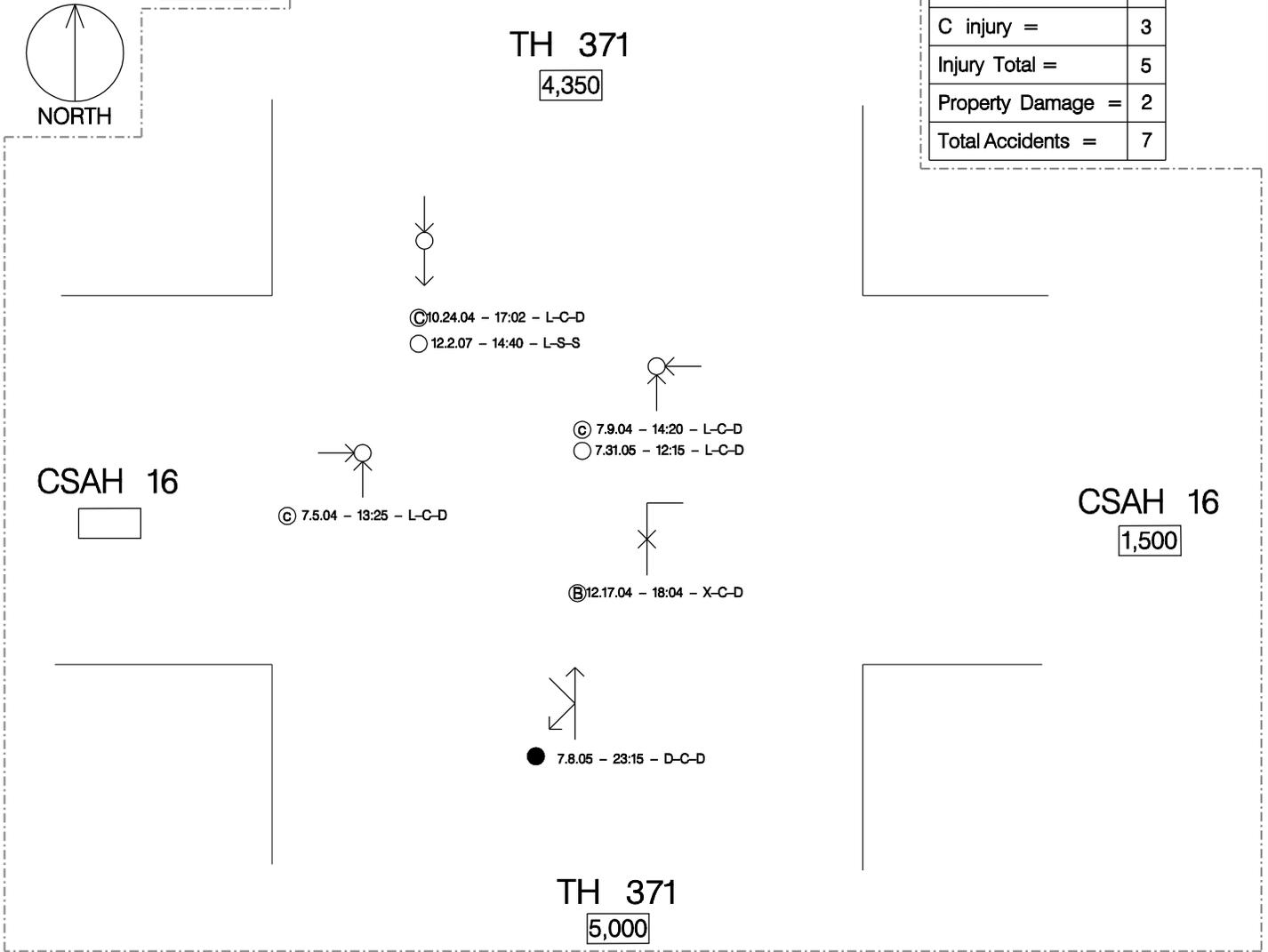
Location: CSAH 16 @ Trunk Highway 371

Time Period: 1/1/03 - 12/31/07 Date: 8/14/08

Prepared By: GTJ

No. of Accidents

Fatal =	1
A injury =	0
B injury =	1
C injury =	3
Injury Total =	5
Property Damage =	2
Total Accidents =	7



KEY	
	Motor Vehicle Backing Up
	Motor Vehicle Out of Control
	Motor Vehicle Ahead
*	Details Unclear
	Pedestrian
	Fixed Object
	Fatal Accident
	A Injury Accident
	B Injury Accident
	C Injury Accident
	Property Damage Accident
	6300 → Entering ADT
	Sideswipe
	Left Turn
	Rear End / Property Damage
	Right Angle B Injury

NOTES		
[1] ENTERING ADT = 10,850 [3] SEVERITY RATE = 0.7		
[2] CRASH RATE = 0.3		
<b>Light:</b> L = Daylight (1) DN = Dawn (2) DU = Dusk (3) DL = Dark, Lighted (4) DO = Dark, Lights Off (5) D = Dark, Unlighted (6) X = Unknown (0, 90, 99)	<b>Weather:</b> C = Clear or Cloudy (1, 2) R = Rain (3) S = Snow or Sleet (4, 5) F = Fog, Smog, Smoke (6) B = Blowing Sand /Dust (7) W = Severe Crosswinds (8) X = Other or Unknown (0, 90, 99)	<b>Surface:</b> D = Dry (1) W = Wet or Water (2, 6) S = Snow, Slush, or Ice (3, 4, 5) M = Muddy (7) Db = Debris (8) O = Oily (9) X = Other or Unknown (0, 90, 99)
Other Vehicle	Injury Type	[Date] — [Time (hrs)] — [Light-Weather-Surface]

August 14, 2008

COLLISION DIAGRAM

FIGURE  
D-1

# Collision Diagram

## Pequot Lakes, Minnesota

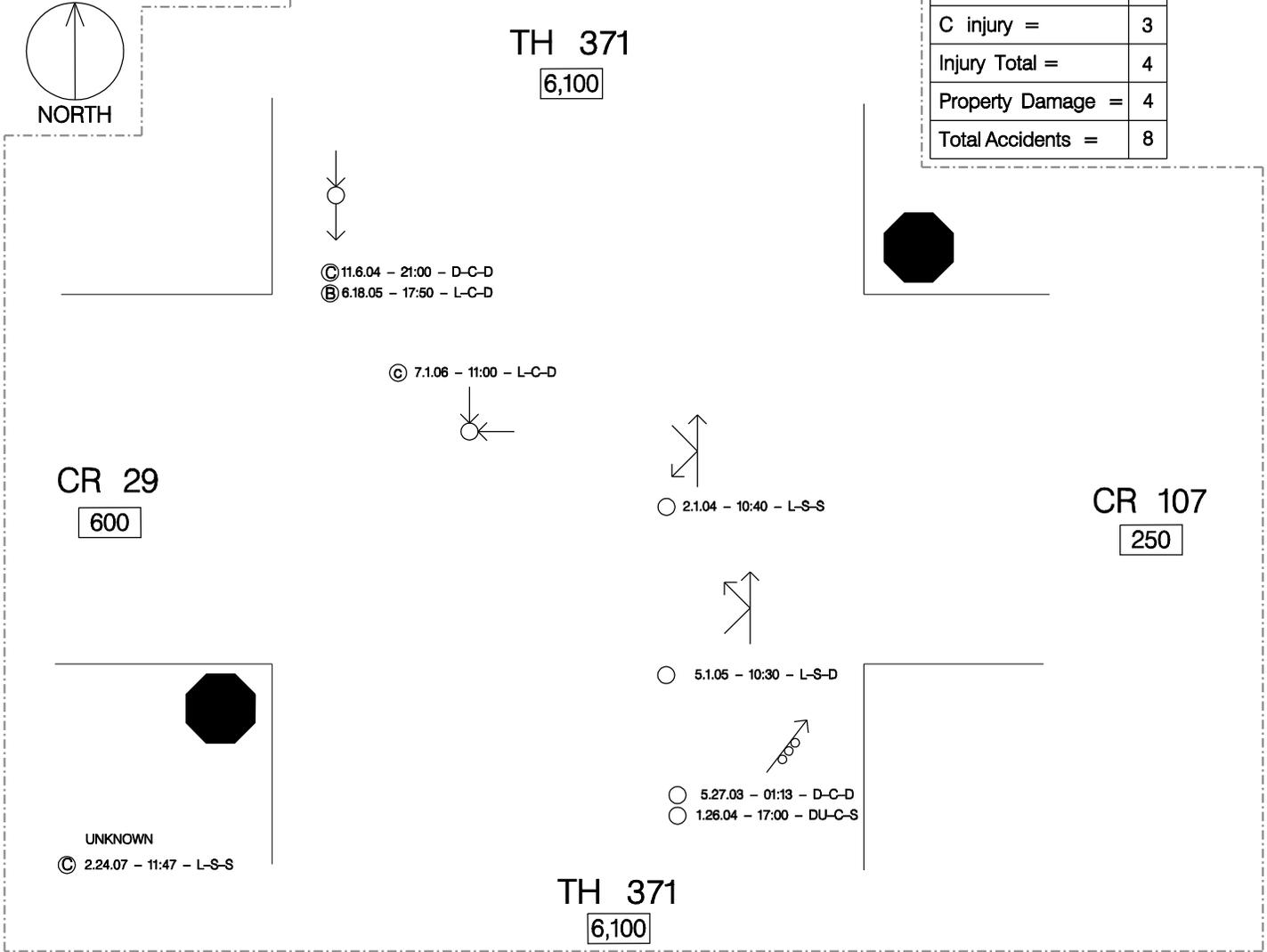
Location: CR 29/CR 107 @ Trunk Highway 371

Time Period: 1/1/03 – 12/31/07 Date: 8/14/08

Prepared By: GTJ

No. of Accidents

Fatal =	0
A injury =	0
B injury =	1
C injury =	3
Injury Total =	4
Property Damage =	4
Total Accidents =	8



**KEY**

- ←→ Motor Vehicle Backing Up
- Motor Vehicle Out of Control
- Motor Vehicle Ahead
- \* Details Unclear
- Pedestrian
- Fixed Object
- Fatal Accident
- Ⓐ A Injury Accident
- Ⓑ B Injury Accident
- Ⓒ C Injury Accident
- Property Damage Accident
- ↘ Sideswipe
- ↙ Left Turn
- ↔ Rear End / Property Damage
- ↗ Right Angle B Injury
- Entering ADT

**NOTES**

[1] ENTERING ADT = 13,050 [3] SEVERITY RATE = 0.5  
[2] CRASH RATE = 0.3

**Light:**

- L = Daylight (1)
- DN = Dawn (2)
- DU = Dusk (3)
- DL = Dark, Lighted (4)
- DO = Dark, Lights Off (5)
- D = Dark, Unlighted (6)
- X = Unknown (0, 90, 99)

**Weather:**

- C = Clear or Cloudy (1, 2)
- R = Rain (3)
- S = Snow or Sleet (4, 5)
- F = Fog, Smog, Smoke (6)
- B = Blowing Sand /Dust (7)
- W = Severe Crosswinds (8)
- X = Other or Unknown (0, 90, 99)

**Surface:**

- D = Dry (1)
- W = Wet or Water (2, 6)
- S = Snow, Slush, or Ice (3, 4, 5)
- M = Muddy (7)
- Db = Debris (8)
- O = Oily (9)
- X = Other or Unknown (0, 90, 99)

Other Vehicle

Injury Type

[Date] — [Time (hrs)] — [Light-Weather-Surface]

August 14, 2008

COLLISION DIAGRAM

FIGURE  
D-2

---

## **Appendix E**

### Superstreet and Median U-Turn Intersection Sketches

# Unsignalized Median U-Turn

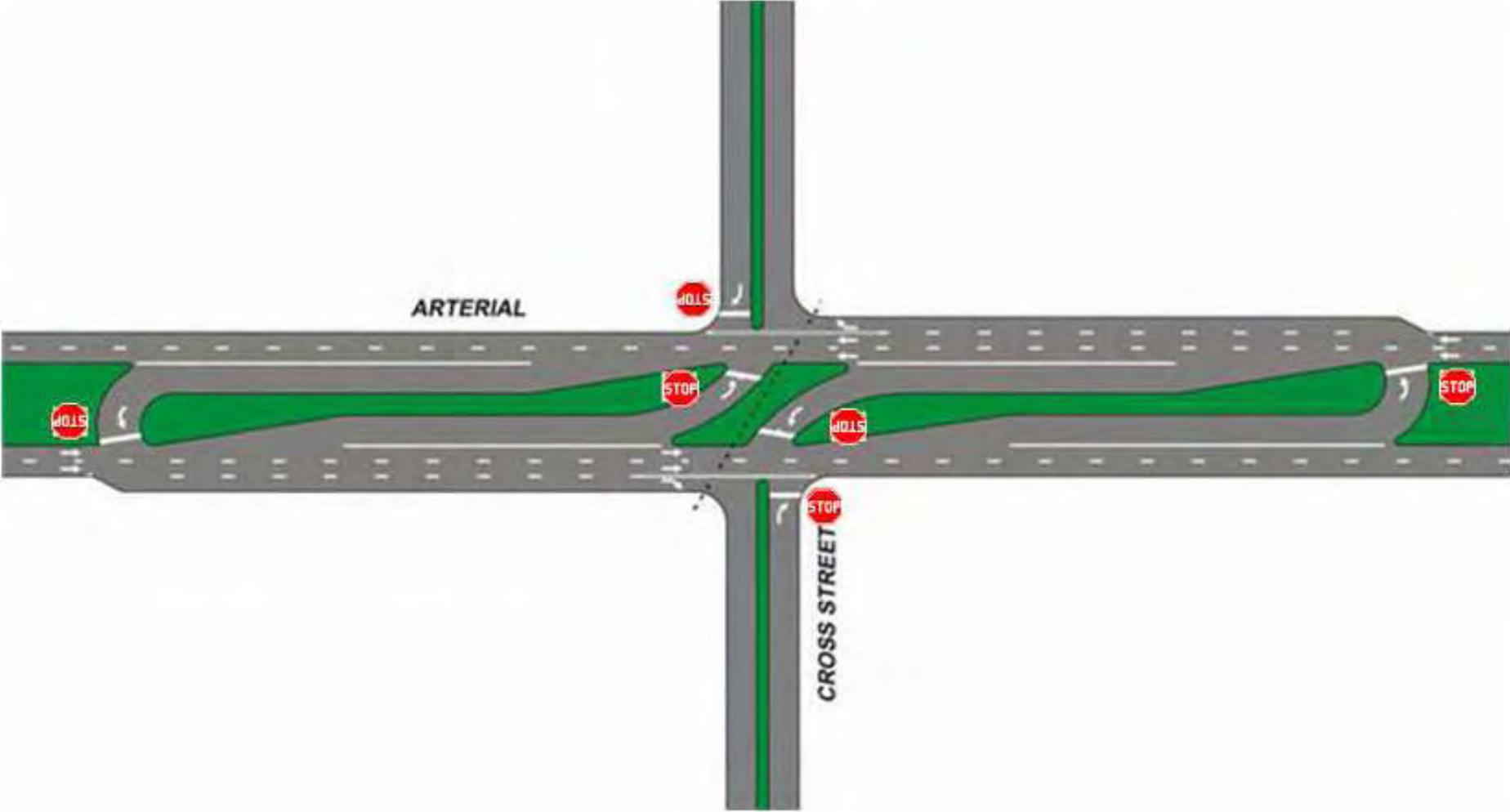
## Design Description



This intersection design is conceptual.  
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# Unsignalized Superstreet

## Design Description



This intersection design is conceptual.  
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