Intersection Traffic Control Feasibility Study

- CSAH 9 at Highview Avenue
- CSAH 9 at CSAH 60 (185th Avenue)

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Executive Summary

The Dakota County Transportation Department (Dakota County) has identified a need to conduct an Intersection Traffic Control Feasibility Study for the following two intersections:

- County State Aid Highway (CSAH) 9 at Highview Avenue
- CSAH 9 at CSAH 60 (185th Avenue)

The purpose of this Intersection Traffic Control Feasibility Study is to:

- Document the existing geometric, traffic operation and safety characteristics.
- Document and develop the future year 2030 traffic forecasts based upon the Metropolitan Council, City of Lakeville Transportation Plan and the Dakota County Transportation Plan.
- Develop conceptual roadway alternatives to accommodate the forecast 2030 traffic demands at both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections.
- Conduct a traffic operation analysis of each alternative.
- Develop a matrix comparing preliminary cost estimates, right of way and other factors to help determine the most optimal intersection lane geometrics and appropriate level of traffic control.
- Identify the preferred alternatives and document an implementation plan assessing the estimated year a traffic control device change is needed.

Elements of Study

The following elements are included in the Intersection Traffic Control Feasibility Study:

- Introduction (Section 1.0)
- Existing Conditions (Section 2.0)
- Future Conditions (Section 3.0)
- Analysis of Alternatives (Section 4.0)
- Recommendations (Section 5.0)
- Appendices (Section 6.0)

Alternatives Analysis

Traffic control alternatives and conceptual layouts were analyzed to coincide with the proposed CSAH 9 reconstruction project (year 2010) and a long term forecast horizon

(year 2030). The following documents the three traffic control alternatives considered at both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections.

- All-way Stop Control.
- Traffic Signal Control.
- Roundabout.

A total of two concept layout alternatives were developed at the CSAH 9/Highview Avenue intersection:

- **Concept Layout 1a – Roundabout**. The CSAH 9/Highview Avenue Concept Layout 1a is illustrated in **Figure 7**.
- **Concept Layout 2a – Four-lane divided roadway with exclusive turn lanes**. Concept Layout 2a would employ either an all-way stop control or traffic signal system and is consistent with the Dakota County 2008-2012 Capital Improvement Plan project. The CSAH 9/Highview Avenue Concept Layout 2a is illustrated in **Figure 8**.

A total of four concept layout alternatives were developed at the CSAH 9/CSAH 60 intersection:

- **Concept Layout 1b – Interim.** Concept Layout 1b would employ either an all-way stop control or traffic signal system during the interim period before CSAH 60 is extended. The CSAH 9/CSAH 60 Concept Layout 1b is illustrated in **Figure 9.** It should be noted, a dual eastbound left turn lane would not be used in conjunction with an all-way stop control.
- **Concept Layout 2b – Four-lane divided roadway with double eastbound left turn.** Concept Layout 2b would employ a traffic signal system following the extension of CSAH 60. The CSAH 9/CSAH 60 Concept Layout 2b is illustrated in **Figure 10.**
- **Concept Layout 3b – Four-lane divided roadway with single eastbound left turn.** Concept Layout 3b would employ either an all-way stop control or traffic signal system following the extension of CSAH 60. The CSAH 9/CSAH 60 Concept Layout 3b is illustrated in **Figure 11.**
- **Concept Layout 4b – Roundabout**. The CSAH 9/CSAH 60 Concept Layout 4b is illustrated in **Figure 12**.

Preferred Alternatives

The preferred alternative at the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections were selected based upon; discussions with the TAC, results of the traffic

operation analysis and safety analysis, and consideration of the key objectives evaluated in the comparison matrix (see Section 4.4).

CSAH 9 at Highview Avenue

The preferred alternative selected at the CSAH 9/Highview Avenue intersection is the roundabout, Concept Layout 1a (refer to **Figure 7**). The roundabout intersection was selected based on the following:

- With the 2008-2012 Capital Improvement Plan project, the intersection is being re-aligned and fully reconstructed. This is the most cost-effective opportunity to build a roundabout. Based on the preliminary cost estimate, the roundabout is expected to result in a net comparable or even less initial cost than a traditional intersection. This is due to the overall less pavement area (approaching roadway segments are narrowed) and reduced right of way needs with the roundabout option. In addition, the long term cost of a roundabout is reduced as the annual maintenance and operation costs are less than a traffic signal.
- The roundabout option will require small triangles of additional right of way on the southwest, southeast and northwest quadrants. However, overall the right of way impact is less than a traditional intersection. Additional right of way along Highview Avenue, south of CSAH 9 will not be required to the same extent as Concept Layout 2a (see **Figure 8**).
- The roundabout alternative will require the lowering of the Highview Avenue and CSAH 9 alignment profiles (to reduce approach grades and to provide a level circle). However, since the intersection is being fully reconstructed, this same consideration would have been made for a traditional intersection.
- Emissions and air quality impacts are expected to be improved with the roundabout option. The traffic analysis found greatly reduced vehicle delays with the roundabout intersection over the traffic signal option. A reduction in motorist delay directly correlates with lowering vehicle emission and fuel consumption.
- The roundabout is expected to provide an immediate benefit and reduction in motorist delay. The roundabout also provides a an immediate and much improved 24-hour solution versus an all-way stop control or a traffic signal system, which was not found needed until year 2023.
- The CSAH 9/Highview Avenue intersection is isolated; therefore does not benefit from coordinated arterial operations. A system or network impact is not expected with the implementation of a roundabout.
- Based on the safety analysis, a roundabout is expected to result in less overall intersection crashes than a traffic signal.

CSAH 9 at CSAH 60

At the CSAH 9/CSAH 60 intersection, the following alternatives were selected:

- ***Short Term***: The preferred short-term alternative is signalized intersection control with a dual eastbound left turn, Concept Layout 1b (see **Figure 9**).
- ***Long Term***: The preferred long-term alternative (with CSAH 60 extension) is the traditional signalized intersection control with single left turn lanes, Concept Layout 3b (see **Figure 11**).

The signalized intersection control was selected based on the following:

- The traffic operation analysis shows the intersection is expected to need a traffic control change by year 2012. The installation of signalized intersection control prior to the CSAH 60 extension can be implemented with little or no impact to right of way and carry only the cost of the capital to install the signal and the recurring maintenance and operation costs. No additional environmental or utility impacts are expected. A roundabout would require full intersection reconstruction and may not be a feasible option to fund in the interim.
- The signalized intersection control and traditional intersection design maximizes the use of existing infrastructure and previous project investments.
- An existing traffic signal is in operation at Ipava Avenue (a quarter-mile to the west). The development of the CSAH 60 extension to the east is anticipated to result in a signalized arterial corridor. The installation of a traffic signal system at CSAH 60 is most consistent and best fits with the arterial and network characteristics of the corridor.
- The completed four-leg traditional intersection design and traffic signal system is expected to cost approximately 75 percent less than the roundabout option.
- The overall estimated right of way need between the traditional intersection and a roundabout are expected to be the same. The roundabout option could result in less right of way dedication on the east side of CSAH 9, depending upon how the corridor develops. However, at this time the corridor right of way width of 150 feet would accommodate both designs.

Recommendations

CSAH 9 at Highview Avenue

- Construct a multi-lane roundabout intersection. (See Concept Layout 1a, illustrated in **Figure 7**).

- Realign CSAH 9 to the north to develop 90 degree approach angles and appropriate approach deflection radii.
- Lower the roadway profile and approach grades on both CSAH 9 and Highview Avenue to reduce the vertical curves, balance earthwork and provide a level roundabout circle.
- Utilize the existing CSAH 9 pavement, abandoned with the realignment, to develop a short frontage road in re-establishing access to the private residential home on the southwest quadrant. The frontage road would access CSAH 9 (right-in/right-out) at a determined appropriate distance upstream from Highview Avenue.
- Acquire sufficient right of way on each intersection quadrant to allow for the flexibility to widen the Highview Avenue entrance/exit flares to two lanes each. This will provide potential and flexibility to extend the design life, if in the future, unforeseen land use changes or traffic patterns occur and additional capacity is found needed.

CSAH 9 at CSAH 60

- Prior to the extension of CSAH 60, program the installation of a traffic signal system. As part of the signal installation, the eastbound approach should be re-striped to include two eastbound left turn movements. (See Concept Layout 1b, illustrated in **Figure 9**).
- The traffic signal system should be designed and equipment located to require minimal hardware modifications when the future CSAH 60 extension is completed.
- Evaluate the need to obtain a small triangular piece of right of way on the southwest corner. The right of way need will be governed by the final pedestrian ramp and traffic signal pole locations.
- As part of the CSAH 60 extension project, the westbound leg should be constructed as a four-lane divided section with exclusive left and right turn lanes. A southbound left turn and northbound right turn lane should be constructed. (See Concept Layout 3b, illustrated in **Figure 11**).
- The final design should ensure acceptable approach sightlines are maintained.
- The intersection traffic signal phasing will be determined by Dakota County Staff through the final design process. It should be noted, Concept Layout 3b (see **Figure 11**) assumes eastbound/westbound protected/permissive left turn phasing. The installation of protected only left turn phasing is expected to necessitate a dual eastbound left turn lane, Concept Layout 2b (see **Figure 10**).

1.0 Introduction

The Dakota County Transportation Department (Dakota County) has identified a need to conduct an Intersection Traffic Control Feasibility Study for the following two intersections:

- County State Aid Highway (CSAH) 9 at Highview Avenue
- CSAH 9 at CSAH 60 (185th Avenue)

1.1 Purpose and Need

The *2025 Dakota County Transportation Plan*[1] and the *City of Lakeville Transportation Plan*[2] identify future capacity deficiencies and the need to improve CSAH 9 between the limits of 183rd Street and CSAH 23 (Cedar Avenue). Due to the poor roadway geometrics and operation of the current traffic control device, peak period congestion at the CSAH 9/Highview Avenue intersection currently exists. To address the immediate and future needs, the 2008-2012 Dakota County Capital Improvement Plan identifies the reconstruction of County State Aid Highway (CSAH) 9 (Dodd Boulevard) to a four-lane divided roadway between the limits of 183rd Street and Hayes Avenue. Dakota County is currently in the process of preparing the preliminary engineering documents for this project and anticipates construction will begin in 2010.

Although not currently programmed, the 2025 Dakota County Transportation Plan also identifies the extension of CSAH 60 to the east. In 2005, Dakota County reconstructed the CSAH 9/CSAH 60 intersection. The reconstruction project widened CSAH 9 to a four-lane divided roadway and re-built CSAH 60 (west of CSAH 9) to a width compatible with a future four-lane divided roadway extension. Dakota County is seeking to identify the appropriate future intersection design and traffic control device; and to also identify interim strategies to manage traffic growth at this intersection prior to the extension project.

The purpose of this Intersection Traffic Control Feasibility Study is to:

- Document the existing geometric, traffic operation and safety characteristics.
- Document and develop the future year 2030 traffic forecasts based upon the Metropolitan Council, City of Lakeville Transportation Plan and the Dakota County Transportation Plan.

[1] 2025 Dakota County Transportation Plan, July 2004
[2] City of Lakeville Transportation Plan, October 2008

- Develop conceptual roadway alternatives to accommodate the forecast 2030 traffic demands at both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections.
- Conduct a traffic operation analysis of each alternative.
- Develop a matrix comparing preliminary cost estimates, right of way and other factors to help determine the most optimal intersection lane geometrics and appropriate level of traffic control.
- Identify the preferred alternatives and document an implementation plan assessing the estimated year a traffic control device change is needed.

1.2 Description of Location

The proposed roadway geometric and traffic control revisions are located at the intersections of CSAH 9 at Highview Avenue and CSAH 9 at CSAH 60 in the City of Lakeville, Dakota County, Minnesota. Generally, the study intersections are located east of Interstate (I)-35W, west of CSAH 23 (Cedar Avenue) south of CSAH 42 and north of CSAH 70. **Figure 1** illustrates the study intersections as well as their proximity to major roadways. The Metropolitan Council year 2007 population estimate for the City of Lakeville is 53,829.

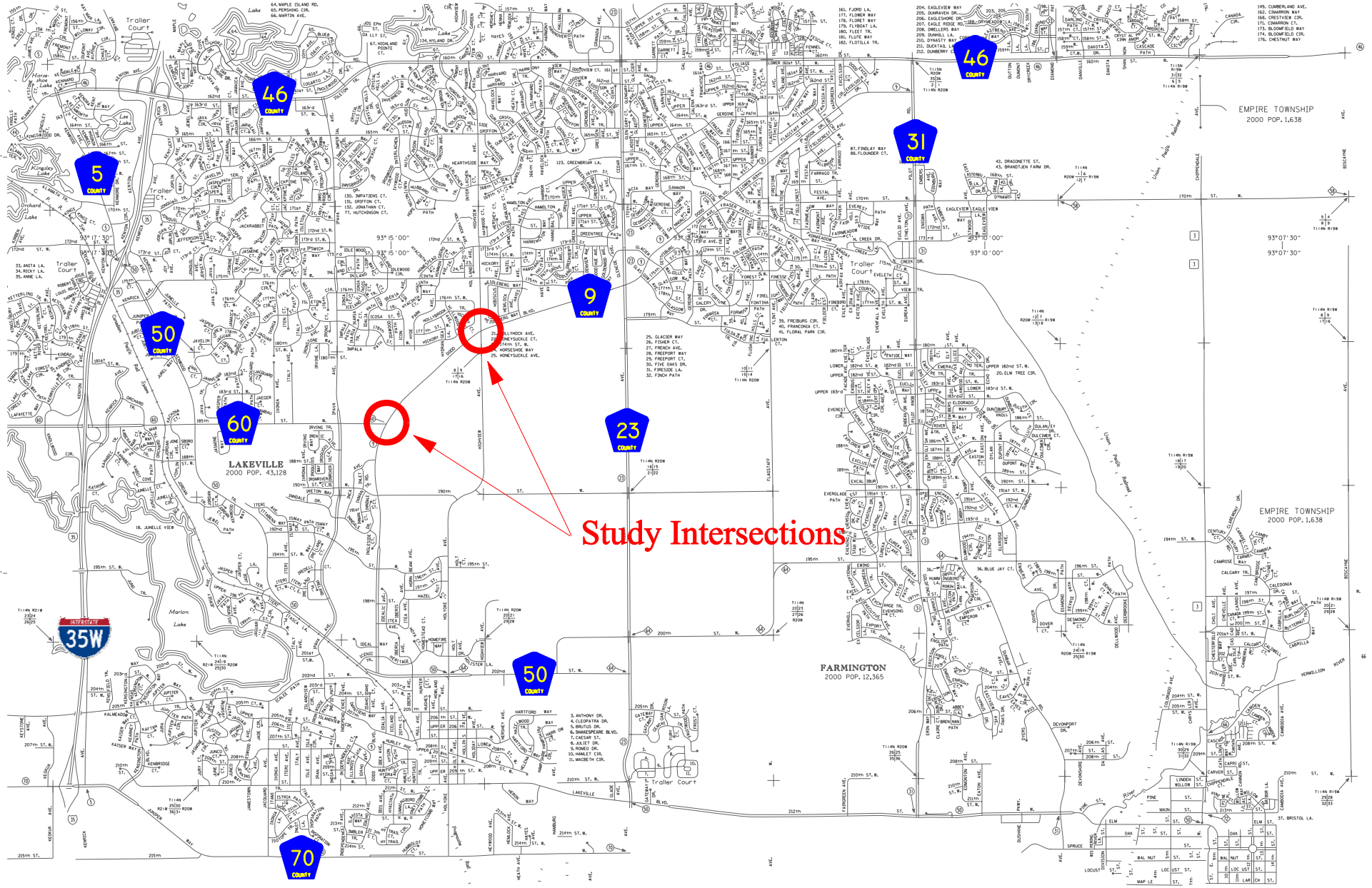
1.3 Technical Advisory Committee

The project was guided by a Technical Advisory Committee (TAC) including representation from the City of Lakeville Engineering and the Dakota County Transportation Department. The role of the TAC was to assist in identifying the project issues, identification of alternatives, provide input on the alternatives analysis and to provide input regarding the preferred alternatives and recommendations. Three TAC meetings were held over the course of the project.

1.4 Elements of Study

The following elements are included in the Intersection Traffic Control Feasibility Study:

- Existing Conditions (Section 2.0)
- Future Conditions (Section 3.0)
- Analysis of Alternatives (Section 4.0)
- Recommendations (Section 5.0)
- Appendices (Section 6.0)



Intersection Traffic Control Feasibility Study

Figure 1
Project Location

Alliant Engineering

2.0 Existing Conditions

The following sections document the existing conditions.

2.1 Existing Roadway and Traffic Control Characteristics

The existing roadway characteristics are summarized below:

- ***CSAH 9***. CSAH 9 serves as an "A Minor Expander" roadway and generally consists of an undivided two lane section. CSAH 9 has a rural roadway design with an approximate six foot paved shoulder. Exclusive right turn lanes are provided at most major street intersections. At CSAH 60, CSAH 9 has been widened to a four-lane undivided roadway with exclusive turn lanes. The posted speed limit along the length of CSAH 9 is 55 miles per hour (mph).
- ***Highview Avenue***. Highview Avenue is a two-lane undivided "Major Collector" roadway with no exclusive turn lanes. Highview Avenue has a rural roadway design averages approximately two to four foot gravel shoulders. North of CSAH 9, Highview Avenue serves residential neighborhood street intersections, has exclusive right turn lanes at major intersections and has a posted 45 mph speed limit. South of CSAH 9, Highview Avenue serves rural land uses, has no exclusive turn lanes and a posted speed limit of 55 mph.
- ***CSAH 60***. CSAH 60 is a four-lane divided roadway with an "A Minor Expander" classification and an urban roadway design. Local access control is managed along the corridor and exclusive left and right turn lanes are provided at all major intersections. The posted speed limit is 45 mph.

Currently, both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections are all-way stop controlled. The existing intersection lane geometrics and traffic control are illustrated in **Figure 2**.

2.2 Right of Way

Right of way and parcel property information was provided by Dakota County. The purpose of the right of way is to document the cross-sectional width available for infrastructure improvements at each intersection. To the extent feasible, future design alternatives and conceptual layouts will be developed within the right of way to minimize environmental and land acquisition impacts. However, where this is not possible, the

comparison of the right of way needs between each alternative will serve as a useful objective.

The right of way provided at the CSAH 9/CSAH 60 intersection varies between sources – Dakota County GIS Property Records versus the recent CSAH 9/CSAH 60 reconstruction project. An accurate depiction of the existing right of way will require a full survey. However, for the purposes of the Intersection Traffic Control Feasibility Study, the existing right of way at the CSAH 9/CSAH 60 intersection is estimated based on as-built design drawings. It is not the intention this study be used as the sole basis for determining exact right of way acquisition needs, but rather to assess the estimated impacts and to itemize the potential needs.

2.3 Existing Traffic Volumes

Dakota County provided the existing AM and PM peak hour intersection turning movement volumes and the hourly approach volumes for both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections. The CSAH 9 and Highview Avenue data was collected in June 2007 and the CSAH 9/CSAH 60 intersection data was collected in July 2007 (PM peak) and October 2007 (AM Peak). The existing AM and PM peak hour intersection turning movement volumes are shown in **Figure 3**.

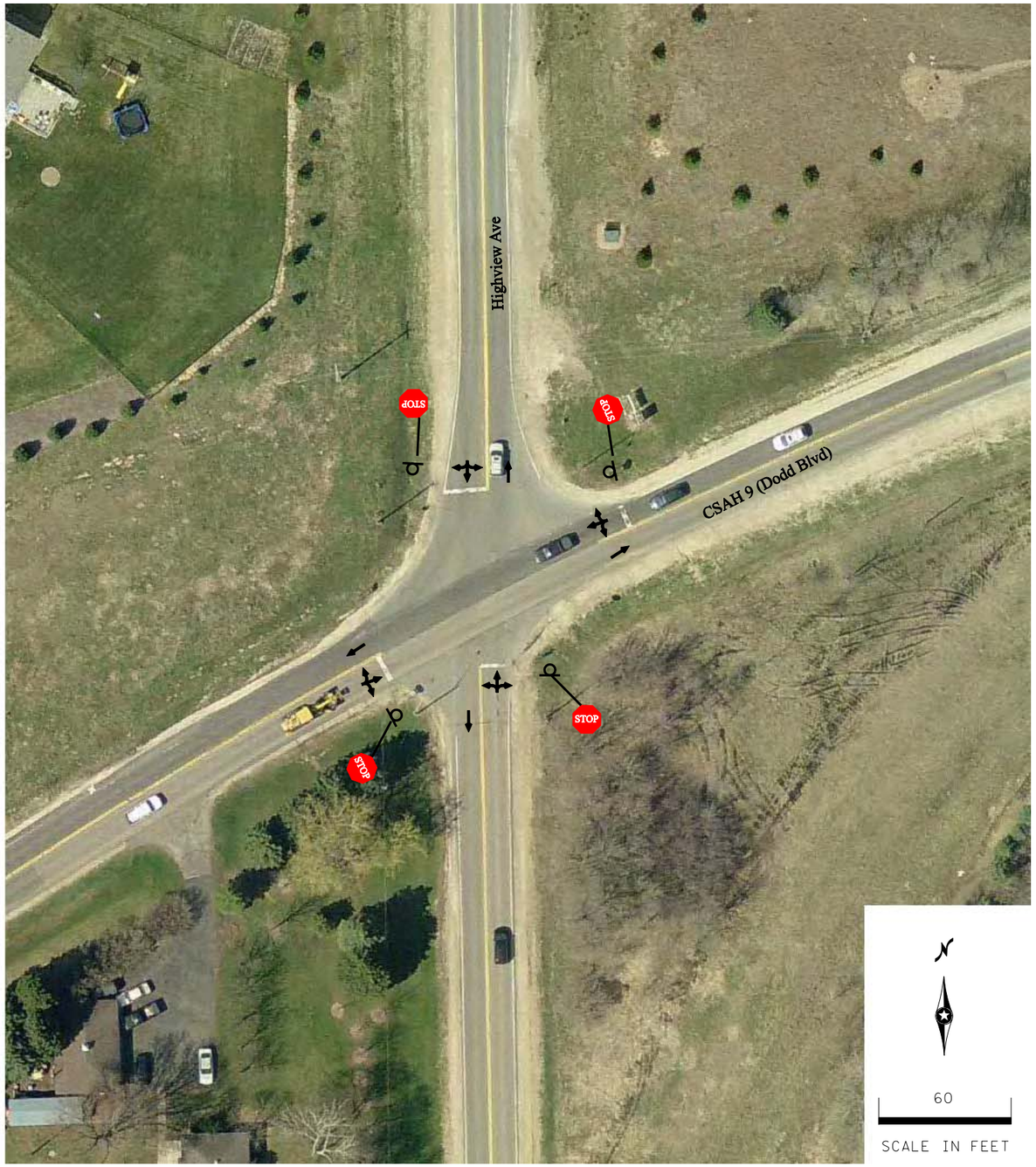
The City of Lakeville and Dakota County record and tabulate the Average Daily Traffic (ADT) volumes at locations along CSAH 9, CSAH 60 and Highview Avenue. The ADT volumes consist of the seasonally adjusted total two-way 24-hour traffic volume. **Table 1** documents the existing year 2007 ADT for the key roadway segments within the study area.

Table 1. Existing Year 2007 ADT Volumes

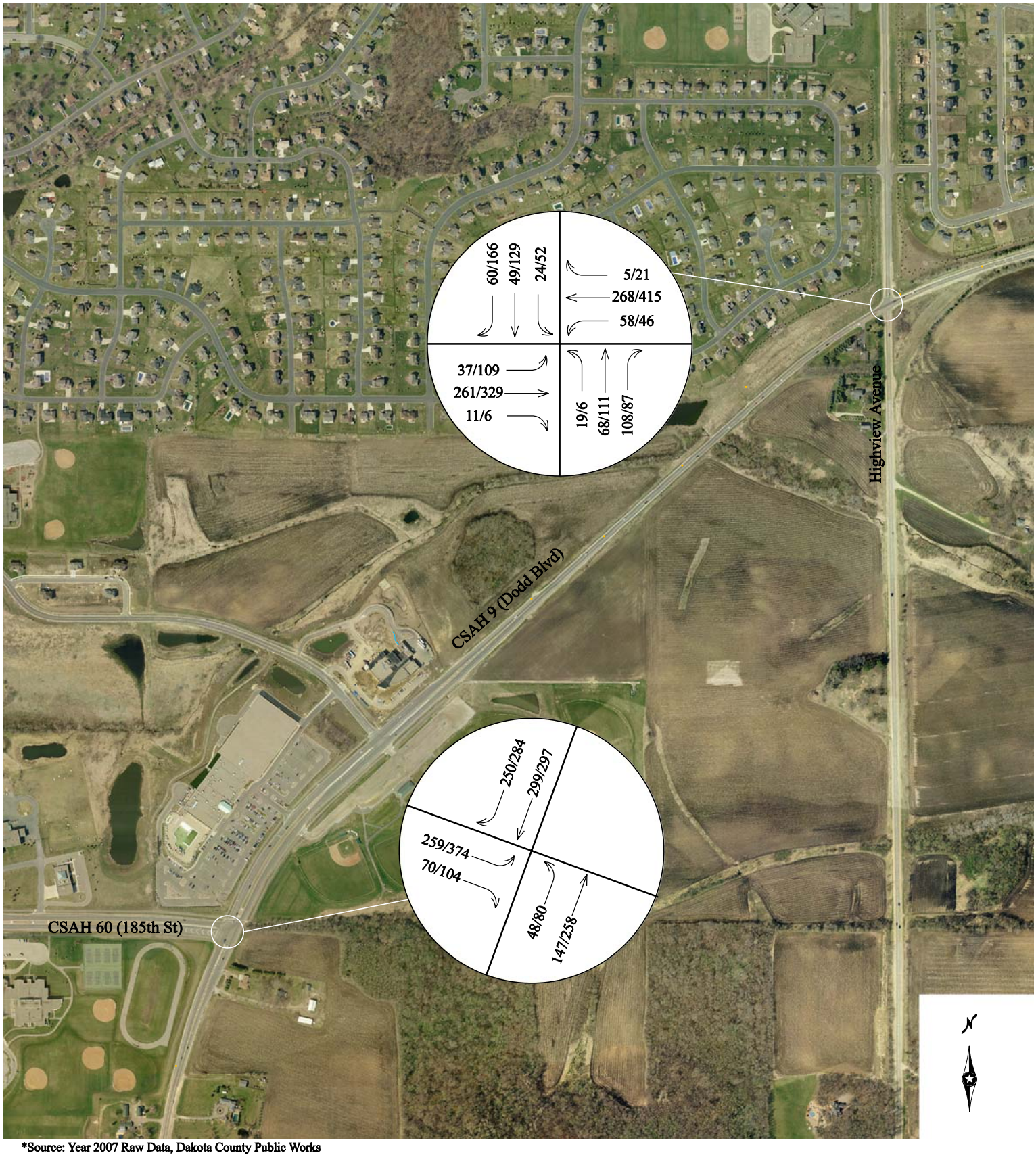
Roadway	Segment	Existing 2007
CSAH 9	195th Street to CSAH 60	8,700
CSAH 9	CSAH 60 to Highview Avenue	11,200
CSAH 9	Highview Avenue to CSAH 23 (Cedar Avenue)	11,800
CSAH 60	West of CSAH 9	7,600
CSAH 60	East of CSAH 9	--
Highview Avenue	North of CSAH 9	5,100
Highview Avenue	South of CSAH 9	3,100

Source: Dakota County Transportation Department

CSAH 9 (Dodd Blvd) at CSAH 60 (185th St)



CSAH 9 (Dodd Blvd) at Highview Avenue



*Source: Year 2007 Raw Data, Dakota County Public Works

XX/XX AM Peak Hour Volume/PM Peak Hour Volume

Figure 3
Existing Intersection Traffic Volumes

2.4 Existing Crash Experience

Dakota County provided crash data for the dates between January 2005 and December 2007. Based on the crash data provided there have been zero reported crashes at the CSAH 9/CSAH 60 intersection. At the CSAH 9/Highview Avenue intersection there have been two reported crashes and one deer hit. The crashes included the following contributing factors:

- Crash 1. Crash 1 involved three motor vehicles. The southbound right turn motorist violated the traffic control device and right angled an eastbound and westbound vehicle.
- Crash 2. An eastbound vehicle lost control and struck a fixed object. Road conditions were dry and the crash occurred during daylight hours.
- Deer Hit. A northbound vehicle struck a deer. Road conditions were dry and the crash occurred during night-time hours.

The crash diagram for CSAH 9/Highview Avenue intersection is provided in **Appendix A**.

A key factor in the safety analysis is the crash rate. The crash rate for any intersection is defined as the number of crashes occurring per million entering vehicles (MEV). **Table 2** summarizes the existing crash rate for each intersection compared to the statewide average for similar traffic control types. Although three total crashes occurred at the CSAH 9/Highview Avenue intersection, only two are considered correctable crashes and included in the crash rate calculation. Dakota County does not consider deer hit crashes to be correctable through engineering resources; therefore, are not included.

Table 2. 2005 - 2007 Crash Rate Summary

Intersection	Total Crashes[1]	MEV	Crash Rate	Statewide Average[2]
CSAH 9 at CSAH 60	0	16,861,905	0.00	0.60
CSAH 9 at Highview Avenue	2	19,659,630	0.10	0.60

MEV - Million Entering Vehicles

[1] Source: Dakota County Transportation Department, 2005-2007

[2] Source: Traffic Safety Fundamentals Handbook p. A-15, August 2008

The review of the existing crash experience and intersection crash rates finds both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections are operating significantly better than the statewide average. An existing safety hazard or crash pattern at either intersection currently does not exist.

2.5 Key Design Considerations

Based on a review of the existing intersection characteristics, the following summarizes several key geometric or design considerations needed to be evaluated as part of the alternatives analysis. The following existing geometric and design considerations at the CSAH 9/Highview Avenue intersection include:

- The CSAH 9/Highview Avenue intersection is currently located atop a crest vertical curve. All four approaches to the intersection approach with an uphill grade. The northbound and eastbound directions approach with a fairly moderate slope. The Highview Avenue approach grades may reduce sightline visibility of oncoming motorists.
- Eastbound CSAH 9 approaches Highview Avenue on a horizontal curve. The horizontal curve coupled with the vertical profile reduces sightlines for northbound Highview Avenue motorists looking to the west.
- CSAH 9 and Highview Avenue currently intersect at a skew. Significant right of way exists in the northwest quadrant of the intersection, which will allow for realignment.
- Significant grade change exists in the southeast quadrant and may be a factor in developing appropriate clear zone slopes.
- An existing single-family residential home exists in the southwest quadrant. Intersection design and alignments should look to minimize impact to the property. Reconstruction of the driveway access may need to be required.

The following existing geometric and design considerations at the CSAH 9/CSAH 60 intersection include:

- The CSAH 9/CSAH 60 intersection was reconstructed in 2005. The reconstruction rebuilt both roadways to a four-lane divided cross-section with exclusive turn lanes. CSAH 60 was built to be compatible with a future four-lane divided roadway extension to the east.
- The re-use of existing pavement and curbs should be maximized.

3.0 Future Conditions

As identified in Dakota County's 2008-2012 Capital Improvement Plan, Dakota County is currently preparing preliminary engineering documents for the reconstruction of CSAH 9 between 183rd Street and Hayes Avenue. In addition, the City of Lakeville is in the process of finalizing their 2030 Transportation Plan. Based on these documents and the 2025 Dakota County Transportation Plan, several infrastructure and demographic changes are anticipated over the next 20 years. A few key items include:

- Reconstruction of CSAH 9 to a four-lane divided roadway between 183rd Street and Hayes Avenue. Construction is anticipated to begin in 2010.
- Extension of CSAH 60 to the east. Although not currently programmed for construction, the extension project is expected to occur prior to 2030.
- Over the next 20 years, the City of Lakeville is estimating their population will increase by 50 percent[2] and the number of households and number of persons employed within the City will double[2].

The increase in vehicle traffic and re-distribution of traffic patterns resulting from the expected infrastructure projects and demographic changes will influence the long term operation of the existing CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections.

The Intersection Traffic Control Feasibility Study evaluates intersection geometric and traffic control needs based upon the forecast year 2010 and 2030 design horizons.

3.1 ADT and Background Traffic Forecasts

Several forecast ADT volumes have been developed for CSAH 9 and the key study intersections. Forecasts are available through the Metropolitan Council, the 2025 Dakota County Transportation Plan and the City of Lakeville Transportation Plan. The forecasts were developed based upon population, land use and employment assumptions. **Table 4** compares the available background forecast ADT volumes.

[2] City of Lakeville Transportation Plan, October 2008

Table 3. Comparison of Background 2030 Forecast ADT Volumes

Roadway	Segment	County/City Forecast Models			
		Existing	Dakota County Forecast[1]	Met Council Forecast[2]	City of Lakeville Forecast[3]
		2007	2025	2030	2030
CSAH 9	195th Street to CSAH 60	8,700	15,000	14,200	--
CSAH 9	CSAH 60 to Highview Avenue	11,200	17,100	15,600	27,000
CSAH 9	Highview Avenue to CSAH 23 (Cedar Avenue)	11,800	17,800	12,400	21,000
CSAH 60	West of CSAH 9	7,600	24,500	17,100	29,000
CSAH 60	East of CSAH 9	--	14,700	9,400	18,000
Highview Avenue	North of CSAH 9	5,100	--	8,800	6,700
Highview Avenue	South of CSAH 9	3,100	--	5,700	6,700

[1] 2025 Forecasts Provided by Dakota County Transportation Department. (2025 Transportation Plan)

[2] 2030 Forecasts provided by Metropolitan Council and assume a 2-lane undivided minor arterial for the CSAH 60 extension

[3] 2030 Forecasts provided by City of Lakeville 2030 Transportation Plan, October 2008.

After review of the background traffic forecasts and discussion with the TAC, Dakota County directed Alliant Engineering to use the 2025 Dakota County Traffic forecasts. The annualized background growth rate was used in determination of the 2010 forecast ADT and the State Aid Project Factor (annualized growth rate of 2.3 percent per year) was used to extrapolate the 2025 ADT forecasts to year 2030. **Table 5** documents the forecast year 2010 and 2030 ADT volumes and the segment annualized background growth rates used in the Intersection Traffic Control Feasibility Study.

Table 4. Forecast Year 2010 and 2030 ADT Volumes

Roadway	Segment			MnDOT State Aid 20 Year Projection Factor	Annual Growth Rate
		Forecast[2]	Forecast[3]		
		2010	2030		
CSAH 9	195th Street to CSAH 60	**9,500**	**16,870**	1.6	**2.9%**
CSAH 9	CSAH 60 to Highview Avenue	**12,100**	**19,230**	1.6	**2.4%**
CSAH 9	Highview Avenue to CSAH 23 (Cedar Avenue)	**12,700**	**20,000**	1.6	**2.3%**
CSAH 60	West of CSAH 9[1]	**8,300**	**27,500**	1.6	**2.8%**
CSAH 60	East of CSAH 9	**--**	**16,500**	--	**--**
Highview Avenue	North of CSAH 9	**5,300**	**6,700**	1.4	**1.2%**
Highview Avenue	South of CSAH 9	**3,500**	**6,700**	1.4	**3.4%**

[1] Annual growth rate (pre-CSAH 60 extension) is based upon the average annual growth rate for CSAH 9

[2] Year 2010 ADT based upon annual growth rate between 2025 and year 2007.

[3] Year 2030 ADT based upon 1.6 Project Factor (2.3% per year) growth applied between year 2025 and 2030.

3.2 Forecast Peak Hour Intersection Traffic Volumes

Forecast AM and PM peak hour intersection turning movement volumes were developed for the following conditions:

- Year 2010 (Without CSAH 60 Extension)
- Year 2030 (Without CSAH 60 Extension)
- Year 2030 (With CSAH 60 Extension)

At Highview Avenue, the forecast year 2010 and 2030 intersection traffic volumes were obtained by applying the intersections annualized growth rate to each of the movements. At CSAH 60, the forecast year 2010 and 2030 (without CSAH 60 extension) were developed in a similar manor. The intersections annualized growth rate was applied to each movement. To develop the year 2030 (with CSAH 60 extension) intersection volumes, the following general process was followed for both the AM and PM peak hours:

- The forecast 2030 segment ADT was converted to an hourly inbound/outbound flow by applying the existing peak hour factor (i.e., PM peak represents between 8 and 10 percent of the daily) and the existing directional factor.
- The individual turn movements were estimated by developing percentages for each movement based upon the proportions of each approaches inbound and outbound volumes (determined in previous step).
- Since the forecast ADT volumes do not balance at the intersection, the movement volumes were modified slightly to better balance the turn proportions. A key consideration included reducing illogical movements. For example, the southbound left turn and the westbound right turn are expected to be lower volumes, as both movements produce back tracking routes; therefore, they were reduced. The eastbound right turn movement was also reduced, as the current volume likely reflects motorists using 190th Street or 202nd Street, where the CSAH 60 extension may become a more attractive route for the east or southeast bound trips.

The forecast year 2010 AM and PM peak hour intersection turning movement volumes used in the traffic operation analysis are illustrated in **Figure 4**. The forecast year 2030 AM and PM peak hour intersection turning movement volumes without the CSAH 60 extension are illustrated in **Figure 5**. The forecast year 2030 AM and PM peak hour intersection turning movement volumes with the CSAH 60 extension are illustrated in **Figure 6.**

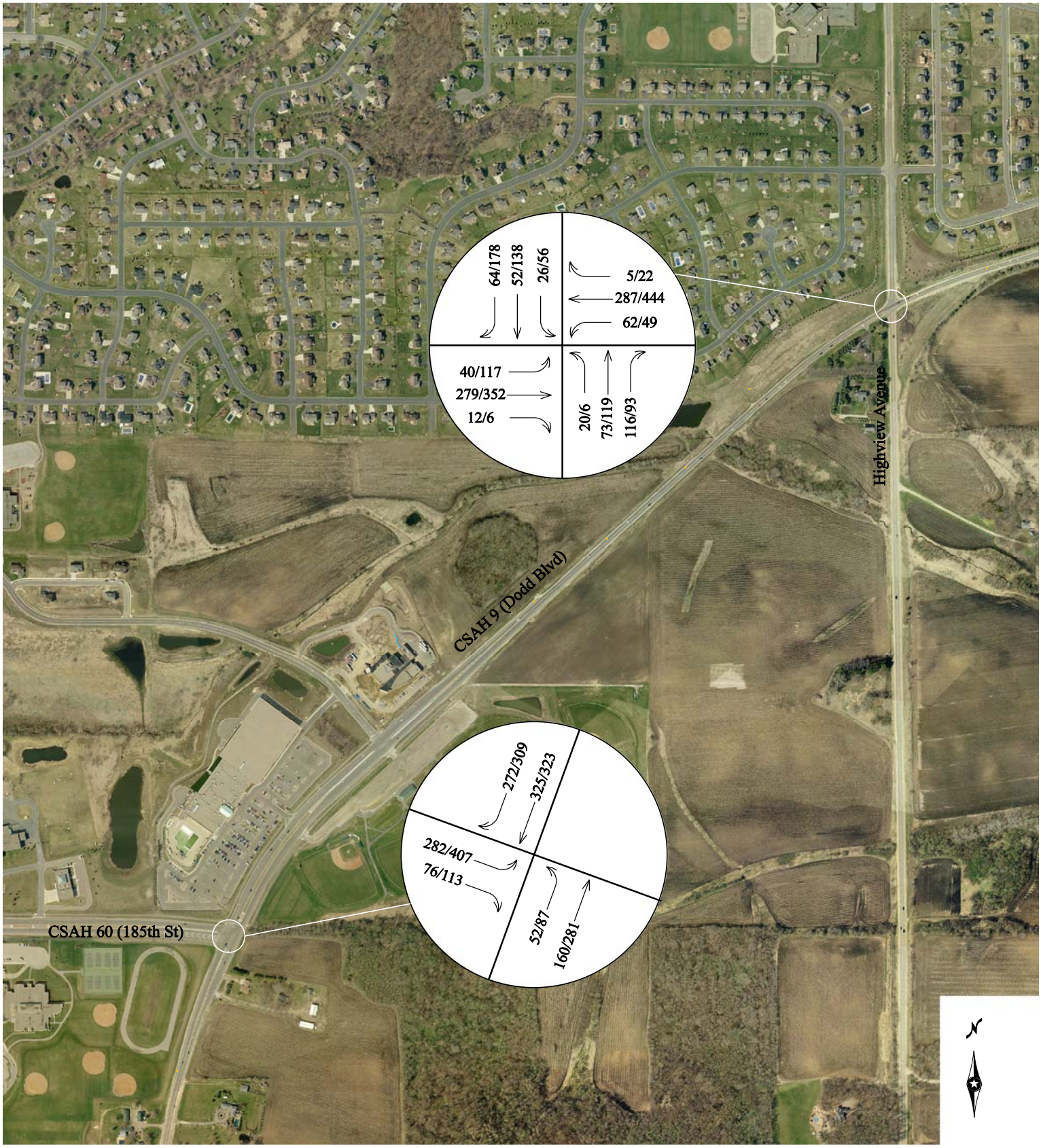
3.3 Forecast Hourly Approach Volumes

Forecast year 2010 and 2030 hourly approach volumes were developed for use with the signal warrant analysis. The following methodology was used to develop the hourly approach volumes:

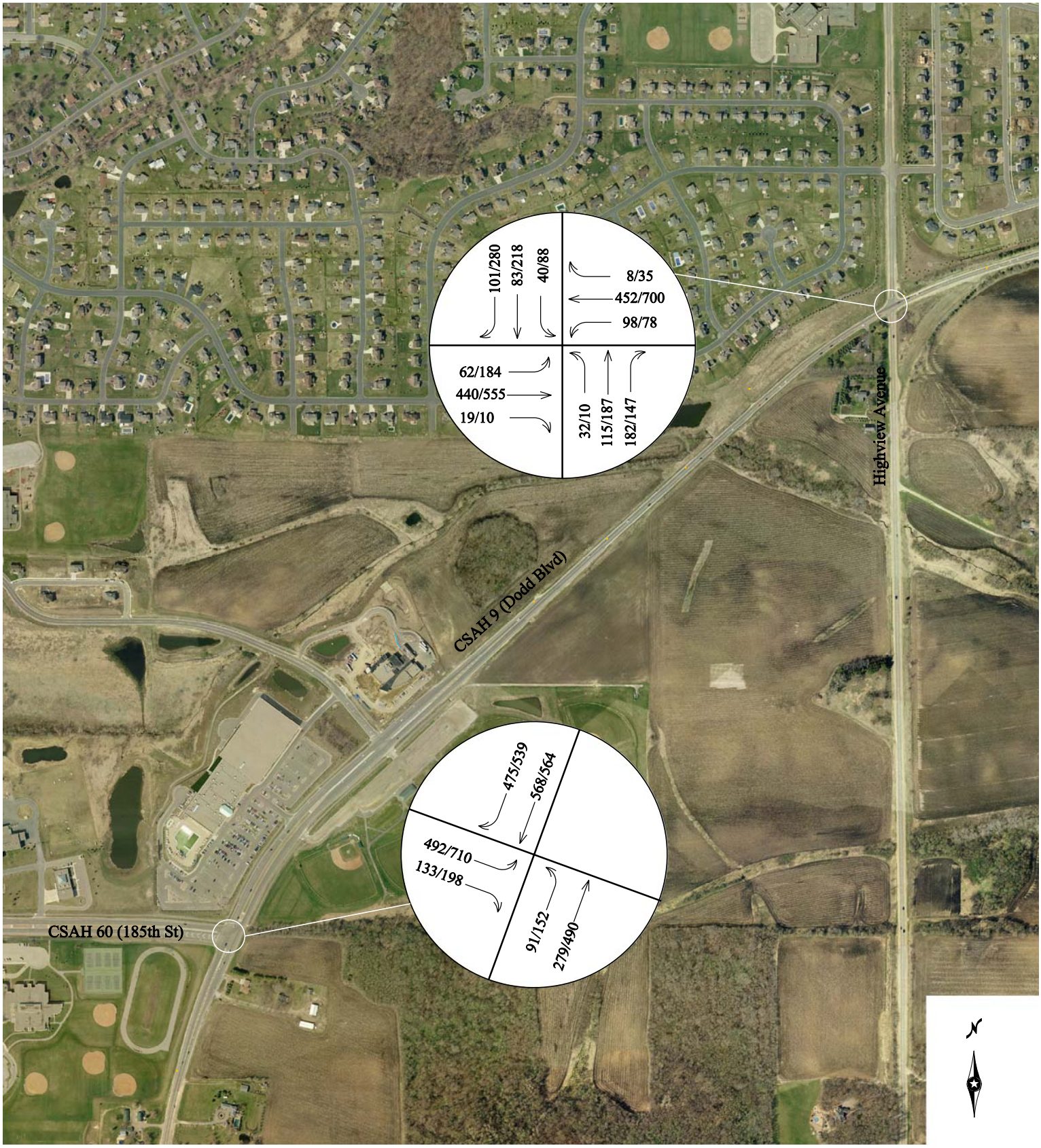
- Existing hourly approach counts were obtained from Dakota County. The existing hourly volume distribution percentages were assumed constant for each approach under all forecast years.
- The annualized background growth rate (see Table 5) was applied to each approach and the existing hourly volume distribution to obtain the forecast year 2010 and 2030 volumes.
- The right turn volumes were factored out on minor street approaches with exclusive right turn lanes based upon the recommended procedures documented in *Mn/DOT Technical Memorandum 07-02-T-01*[3]. Reductions were made to the hourly volumes by applying the respective AM or PM peak hour right turn movement volume percentage.

The forecast year 2010 and 2030 hourly approach volumes for use in the signal warrant analysis are provided in **Appendix B**.

[3] Technical Memorandum 07-02-T-01, Mn/DOT Engineering Services Division, Intersection Control Evaluation, March 2007

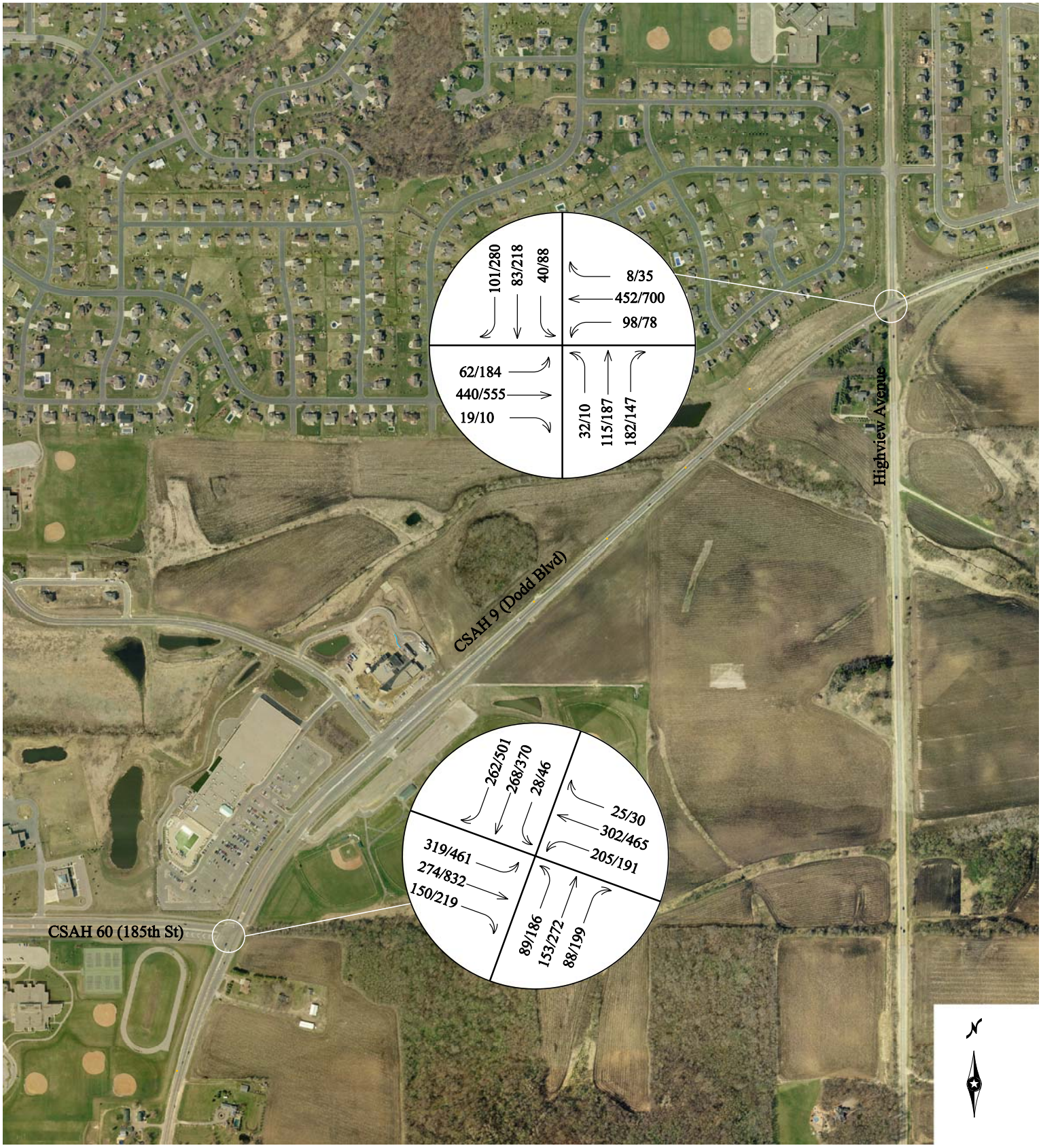


XX/XX AM Peak Hour Volume/PM Peak Hour Volume



XX/XX AM Peak Hour Volume/PM Peak Hour Volume

Figure 5
Forecast Year 2030
(Without CSAH 60 Extension)
Intersection Traffic Volumes



XX/XX AM Peak Hour Volume/PM Peak Hour Volume

4.0 Analysis of Alternatives

Traffic control alternatives and conceptual layouts were analyzed to coincide with the proposed CSAH 9 reconstruction project (year 2010) and a long term forecast horizon (year 2030). As part of the alternatives analysis, the following was completed:

- Signal warrant analysis completed to assess if a change in traffic control to a traffic signal system may be an appropriate alternative.
- Safety analysis was conducted to compare the relative safety difference between each traffic control alternative.
- Development of conceptual geometric layouts
- A traffic operation analysis to assess the performance of each conceptual alternative.
- Development of a comparison matrix to evaluate the concept layout alternatives.

4.1 Traffic Control Alternatives

The following documents the three traffic control alternatives considered for the study area.

- All-way Stop Control.
- Traffic Signal Control.
- Roundabout.

Other intersection control treatments or non-traditional intersection geometric design configurations (e.g., continuous flow, median U-turns or grade separation) were not considered. The installation of traditional intersection control and design (all-way stop, traffic signal or roundabout) are expected to provide sufficient capacity.

4.1.1 Signal Warrant Analysis

A traffic signal warrant analysis was performed to determine the feasibility of installing a traffic signal at the intersections of CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections. The warrant analysis is conducted in accordance with the *Minnesota*

Manual on Uniform Traffic Control Devices (MMUTCD)[4]. The following are the eight MMUTCD traffic signal warrants:

- Warrant 1 – Eight Hour Vehicle Volume
- Warrant 2 – Four-hour Vehicle Volume
- Warrant 3 – Peak Hour Volume
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Roadway Network

Warrant 1, Warrant 2 and Warrant 3 were reviewed using the year 2010 and year 2030 forecast hourly approach volumes (see **Appendix B**). The remaining warrants (Warrant 4 to Warrant 8) were not reviewed, since most do not apply or insufficient data is available to conduct an appropriate analysis. **Table 5** and **Table 6** present a summary of the MMUTCD warrant analysis results for the forecast year 2010 and year 2030 at the CSAH 9/Highview and CSAH 9/CSAH 60 intersections, respectively. The detailed signal warrant analysis results are included in **Appendix C**.

Table 5. Signal Warrant Analysis Result Summary – CSAH 9 at Highview Avenue

Scenario	Warrant 1 - Eight Hour Vehicle Volume				Warrant 2 - Four Hour Volume		Warrant 3 - Peak Hour Volume		
	1A (Hours)	1B (Hours)	1C (Hours)	Warrant Met / Not Met	Hours	Warrant Met / Not Met	3A[1] (Hours)	3B (Hours)	Warrant Met / Not Met
Year 2010 Forecast	2 Hours	14 Hours	3 Hours	**Met (1B)**	4 Hours	**Met**	NA	2 Hours	**Met**
Year 2030 Forecast	13 Hours	15 Hours	14 Hours	**Met (1A, 1B, 1C)**	15 Hours	**Met**	NA	14 Hours	**Met**

[1] Warrant 3A was not evaluated, since the requirement of Warrant 3B and other warrants were satisfied.

Source: 2005 Minneosta Manual on Uniform Traffic Control Devices

Table 6. Signal Warrant Analysis Result Summary – CSAH 9 at CSAH 60

Scenario	Warrant 1 - Eight Hour Vehicle Volume				Warrant 2 - Four Hour Volume		Warrant 3 - Peak Hour Volume		
	1A (Hours)	1B (Hours)	1C (Hours)	Warrant Met / Not Met	Hours	Warrant Met / Not Met	3A[1] (Hours)	3B (Hours)	Warrant Met / Not Met
Year 2010 Forecast	14 Hours	12 Hours	14 Hours	**Met (1A, 1B, 1C)**	14 Hours	**Met**	NA	4 Hours	**Met**
Year 2030 Forecast (Without CSAH 60 Extension)	17 Hours	16 Hours	16 Hours	**Met (1A, 1B, 1C)**	16 Hours	**Met**	NA	16 Hours	**Met**
Year 2030 Forecast (With CSAH 60 Extension)	17 Hours	16 Hours	16 Hours	**Met (1A, 1B, 1C)**	16 Hours	**Met**	NA	16 Hours	**Met**

[1] Warrant 3A was not evaluated, since the requirement of Warrant 3B and other warrants were satisfied.

Source: 2005 Minneosta Manual on Uniform Traffic Control Devices

[4] Minnesota Manual on Uniform Traffic Control Devices, May 2005.

As shown above, Warrant 1B, Warrant 2 and Warrant 3 are met at the CSAH 9/Highview Avenue intersection under forecast year 2010 approach volumes. Under the forecast year 2030 approach volumes, Warrant 1A, 1B, 1C, 2 and 3 are expected to be met. At the CSAH 9/CSAH 60 intersection Warrant 1A, 1B, 1C, 2 and 3 are expected to be met under both the forecast year 2010 and year 2030 approach volumes. Although signal warrants are met under the forecast 2010 approach volumes, this alone may not justify the immediate installation of a traffic signal system. Other considerations, including a capacity analysis, will be made to determine the appropriate control device and the estimated year a traffic signal installation would be required (see Section 4.1.1).

4.1.2 Safety Analysis

The forecast year 2030 ADT volumes and the standard average crash rates by control type were used to estimate the annual numbers of crashes for each traffic control alternative. Based on the *Traffic Safety Fundamentals Handbook*[5], the statewide average crash rate is 0.6 crashes per MEV for an all-way stop control and 0.8 crashes per MEV for a traffic signal. The *Federal Highway Administration (FHWA) Roundabouts: An Information Guide*[6] documents the safety experience of roundabout intersections through research and before and after studies. According to the FHWA Roundabout Information Guide a roundabout has been found to reduce the total intersection crashes by approximately 40 percent compared to traditional intersections and control. Therefore, a standard intersection crash rate of 0.48 crashes per MEV is used in the safety analysis. **Table 7** compares the estimated crashes per year expected with each traffic control device at the CSAH 9/Highview Avenue intersection. **Table 8** compares the estimated crashes per year expected with each traffic control device at the CSAH 9/CSAH 60 intersection.

Table 7. Forecast Annual Crash Comparison – CSAH 9 at Highview Avenue

Alternative	Existing Average Crashes / Year[1]	Existing Crash Rate	Statewide Average Crash Rate[2]	Projected Crashes / Year (2030)
All-Way Stop	1	0.10	0.60	1 - 6[3]
Traffic Signal	--	--	0.80	8
Roundabout	--	--	0.48	5

[1] Source: Dakota County Transportation Department, 2005-2007
[2] Source: Traffic Safety Fundamentals Handbook p. A-15, August 2008. Roundabout crash rates are approximately 40% of a traffic signal based on data provided in Roundabouts Informational Guide, FHWA Publication No. FHWA-RD-00-067
[3] This intersection has had 2 correctable crashes for the years 2005-2007. The existing crash rate is 0.10 compared to the statewide average rate of 0.6. Using the existing crash rate of 0.10 and the statewide average rate of 0.6, the range of expected yearly crashes is 1 to 6.

[5] Traffic Safety Fundamentals Handbook, August 2008
[6] Roundabouts: An Information Guide, FHWA, Publication No. FHWA-RD-00-067, June 2000

Table 8. Forecast Annual Crash Comparison – CSAH 9 at CSAH 60

Alternative	Existing Average Crashes / Year[1]	Existing Crash Rate	Statewide Average Crash Rate[2]	Projected Crashes / Year (2030)
All-Way Stop (Without Extension)	0	0.00	0.60	0 - 7[3]
Traffic Signal (Without Extension)	--	--	0.80	9
Roundabout (Without Extension)	--	--	0.48	6
All-Way Stop (With Extension)	--	--	0.60	0 - 9[3]
Traffic Signal (With Extension)	--	--	0.80	12
Roundabout (With Extension)	--	--	0.48	7

[1] Source: Dakota County Transportation Department, 2005-2007
[2] Source: Traffic Safety Fundamentals Handbook p. A-15, August 2008. Roundabout crash rates are approximately 40% of a traffic signal based on data provided in Roundabouts Informational Guide, FHWA Publication No. FHWA-RD-00-067
[3] This intersection has had 0 reported crashes for the years 2005-2007. The existing crash rate is 0 compared to the statewide average rate of 0.6. Using the existing crash rate and the statewide average rate, the range of expected yearly crashes is 0 to 7 or 0 to 9.

Although the comparison of the projected crashes per year for each traffic control device are estimated based upon the statewide average rate, the actual intersection crash rate is expected to be less. The historical intersection crash experience, and the anticipated geometric design features (e.g., provision of turn lanes and acceptable sight lines) and using current design standards lends to this conclusion. **Table 9** provides a summary comparison of the key crash types and crash severity expected with each traffic control type.

Table 9. Crash Type and Crash Severity Comparison by Traffic Control Device

	All-way Stop[1]	Traffic Signal[1]	Roundabout[2]
Crash Types	■ Most common crash types are rear end and right angle	■ Predominant crash types are rear end, right angle and left turn collisions	■ Most common crash types include failure to yield at entry and single-vehicle run off road.
Crash Severity	■ Injury related crashes represent approximately 30% of the total reported intersection crashes.	■ Injury related crashes represent approximately 35% of the total reported intersection crashes.	■ Injury related crashes are typically reduced by 50% compared to traditional intersections.

[1] Traffic Safety Fundamentals Handbook, August 2008.
[2] Roundabouts: An Information Guide, FHWA, Publication No. FHWA-RD-00-067, June 2000

The crash severity at roundabout intersections is often reduced due to the slower vehicle speeds forced by the yield at entry and geometric characteristics and the conflicts being changed from high-speed crossing maneuvers to low-speed merging conflicts.

4.2 Concept Layout Alternatives

Utilizing the forecast 2030 PM peak hour volumes, a screening analysis was completed to identify the required intersection lane geometrics and to assess the initial feasibility for each traffic control device. In addition to the traffic operation review, minimum intersection geometry guidelines were also employed based upon roadway speed and design characteristics (e.g., shoulders, turn bay lengths and minimum approach lanes). In developing the conceptual layouts a number of key considerations were made:

- Each conceptual layout was preliminary engineered in accordance with the requirements and guidelines specified in the *Mn/DOT Road Design Manual*[7].
- An urban roadway design is assumed.
- Sidewalk and pedestrian curb ramps are to be located on each corner of each intersection.
- Intersections are designed to accommodate a WB-62 truck.
- The conceptual layouts and roadway alignments were developed to best balance operational performance, safety, right of way and construction costs.

A total of two concept layout alternatives were developed at the CSAH 9/Highview Avenue intersection:

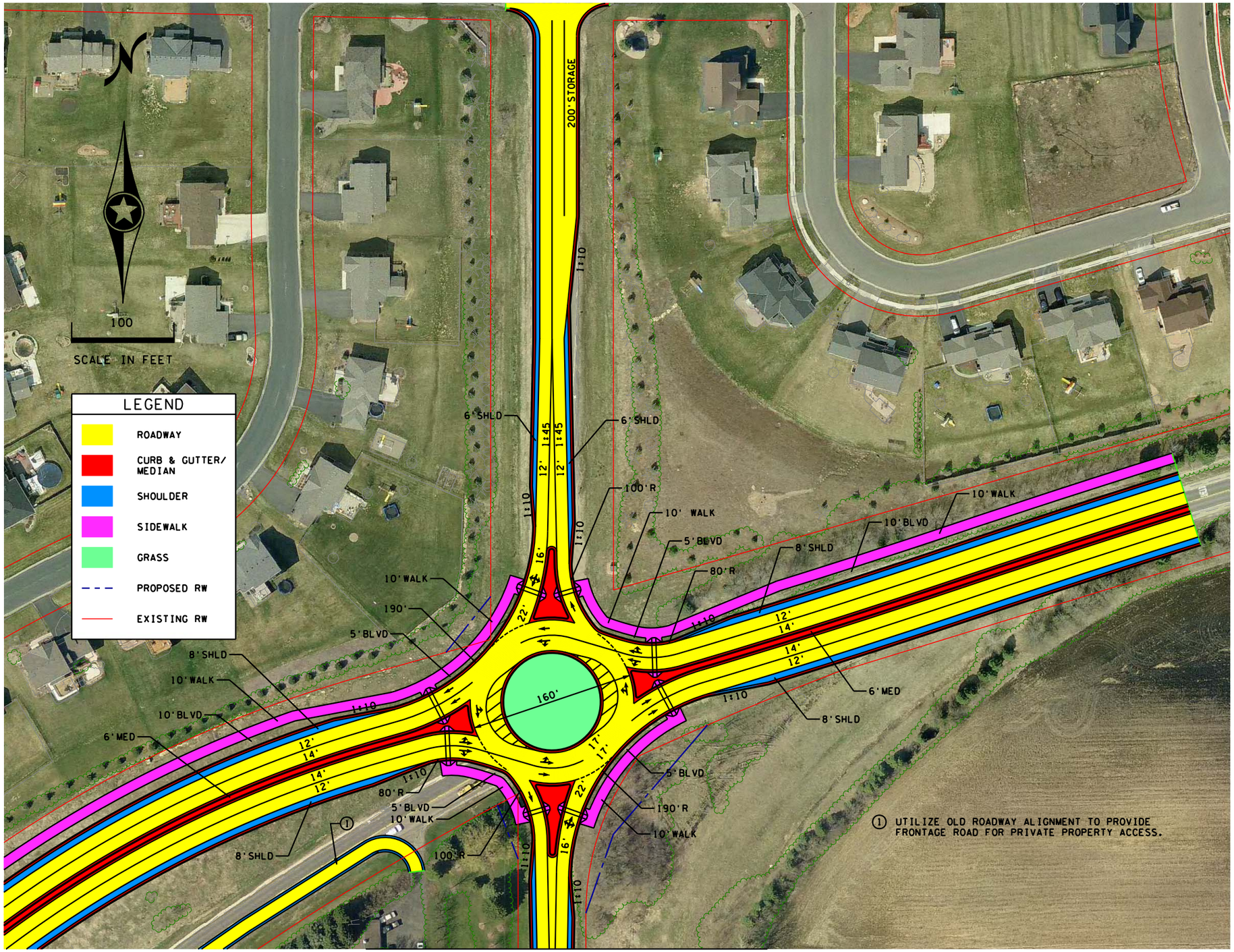
- **Concept Layout 1a – Roundabout**. The minimum geometrics were found to require a multi-lane roundabout containing two circulatory lanes with two lanes of approach along CSAH 9 and one lane of approach on Highview Avenue. The CSAH 9/Highview Avenue Concept Layout 1a is illustrated in **Figure 7**.
- **Concept Layout 2a – Four-lane divided roadway with exclusive turn lanes**. Concept Layout 2a would employ either an all-way stop control or traffic signal system and is consistent with the Dakota County 2008-2012 Capital Improvement Plan project. Four lanes of approach (including left and right turn lanes) would be provided along CSAH 9 in each direction and three lanes of approach along Highview Avenue (including left and right turn lanes). Protected left turn signal phasing and eight-phase operation was evaluated under the traffic signal control. Typically protected left turn phases are provided with roadway approaches exceeding 50 mph. However, if sight lines are acceptable, protected/permissive phasing should be used. If this option were to move into final design and upon development of final roadway profiles, the sight lines should be further reviewed for phasing determination. The CSAH 9/Highview Avenue Concept Layout 2a is illustrated in **Figure 8**.

[7] Mn/DOT Road Design Manual, Part I and Part II

A total of four concept layout alternatives were developed at the CSAH 9/CSAH 60 intersection:

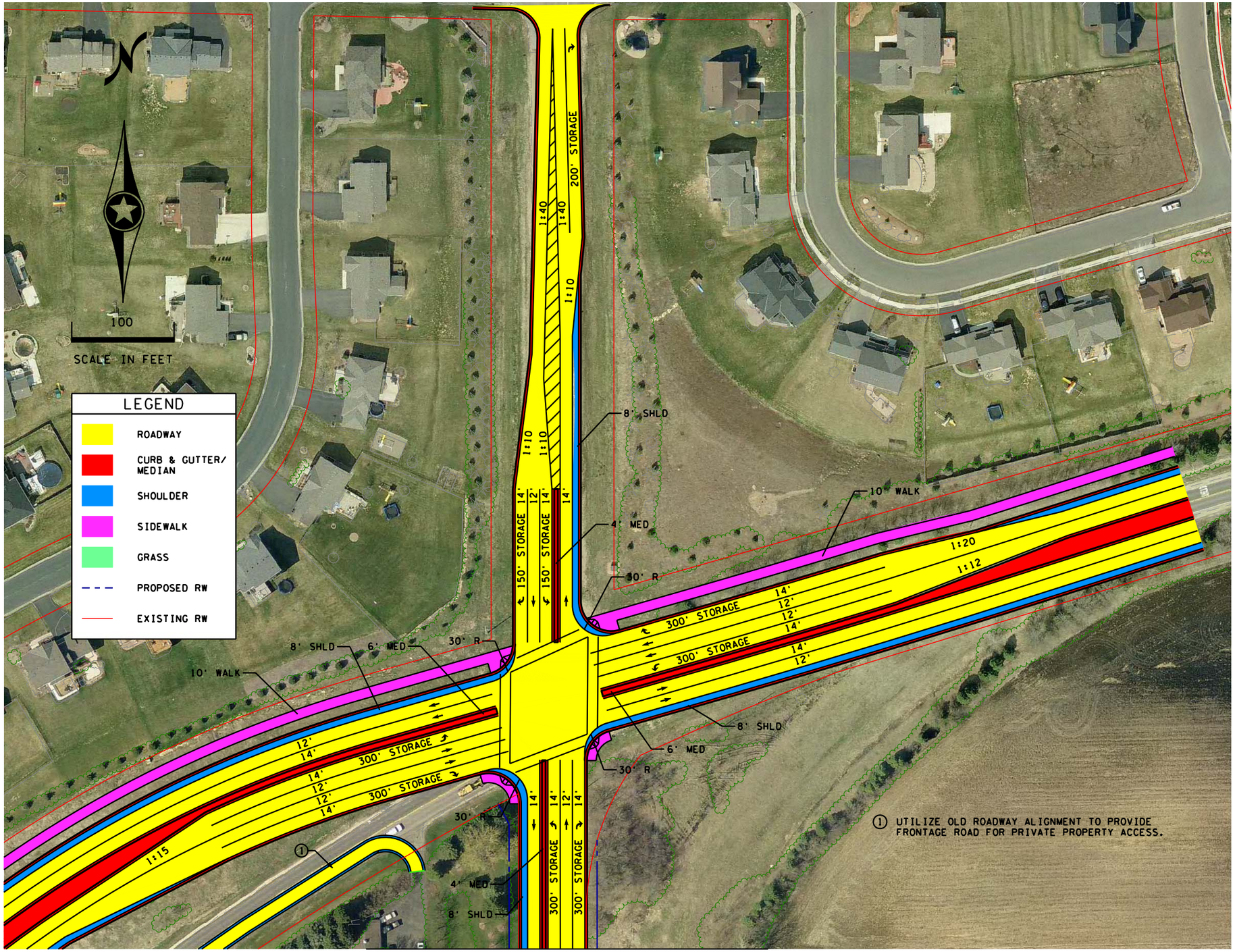
- **Concept Layout 1b – Interim.** Concept Layout 1b would employ either an all-way stop control or traffic signal system during the interim period before CSAH 60 is extended. The eastbound approach would be re-striped to provide a double left turn lane. No other geometric changes would occur at the intersection. The CSAH 9/CSAH 60 Concept Layout 1b is illustrated in **Figure 9.** It should be noted, a dual eastbound left turn would not be provided under all-way stop control. Dakota County Staff expressed concern with the potential safety and operation confusion that may be presented under such lane geometrics and the wide intersection.
- **Concept Layout 2b – Four-lane divided roadway with double eastbound left turn.** Concept Layout 2b would employ a traffic signal system following the extension of CSAH 60. CSAH 9 and CSAH 60 would be four-lane divided roadways with exclusive left and right turn lanes. The eastbound approach would include a double left turn lane. In accordance with the Mn/DOT Protected Only Left Turn Phasing Guidelines[8], the dual left turn lane requires protected left turn signal phasing. Eight phase operation and protected left turn phasing is assumed in the traffic analysis. In addition, a southbound right turn overlap phase (operate concurrent with eastbound left turn phase) is included. The CSAH 9/CSAH 60 Concept Layout 2b is illustrated in **Figure 10.**
- **Concept Layout 3b – Four-lane divided roadway with single eastbound left turn.** Concept Layout 3b would employ either an all-way stop control or traffic signal system following the extension of CSAH 60. CSAH 9 and CSAH 60 would be four-lane divided roadways with exclusive left and right turn lanes. Eight phase signal operation is used in the traffic analysis. To efficiently operate a single left turn lane, eastbound/westbound protected/permissive left turn signal phasing would be used. In addition, a southbound right turn overlap phase (operate concurrent with eastbound left turn phase) is included. If sightlines are maintained with the CSAH 60 extension, the protected/permissive phasing will meet most requirements of the Mn/DOT Left Turn Phasing Guidelines. Based on the 2030 traffic volume forecasts, the combination of the left turn/opposing through volume and the 45 mph posted speed may violate the guidelines. The CSAH 9/CSAH 60 Concept Layout 3b is illustrated in **Figure 11.**
- **Concept Layout 4b – Roundabout**. The minimum geometrics were found to require a multi-lane roundabout containing two circulatory lanes with two lanes of approach along both CSAH 9 and CSAH 60. The CSAH 9/CSAH 60 Concept Layout 4b is illustrated in **Figure 12**.

[8] Mn/DOT Signal Design Manual, Chapter 2. Traffic Signal Phasing and Operations, Section 2.3.2, June 2008.



MATCH LINE

MATCH LINE



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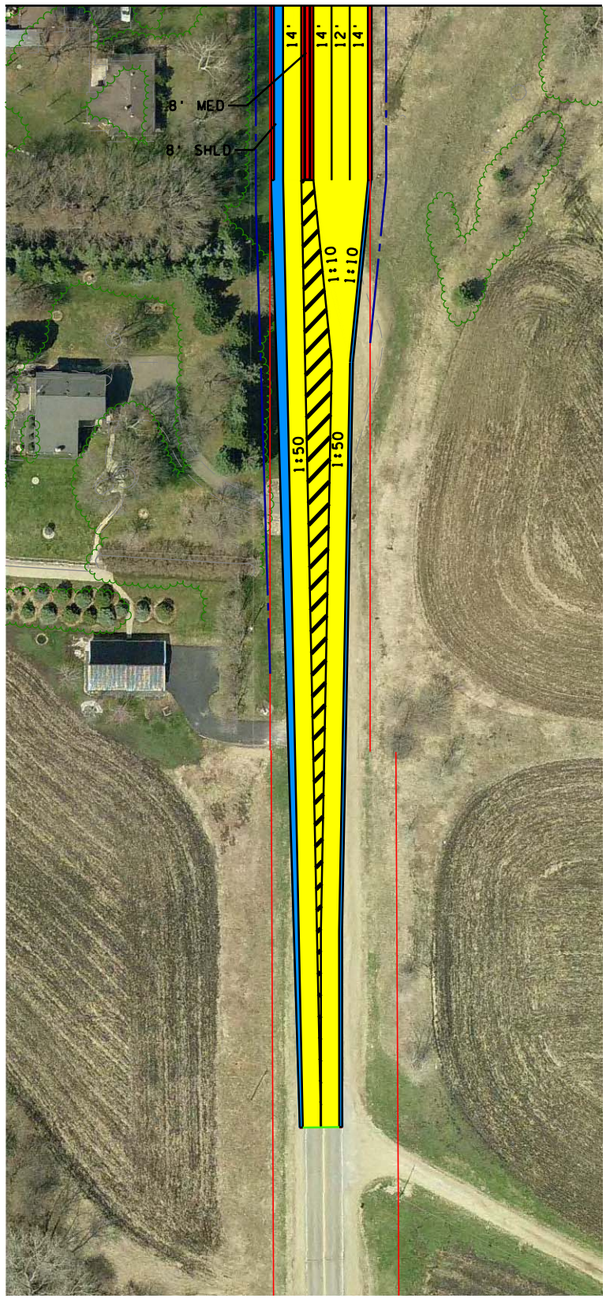
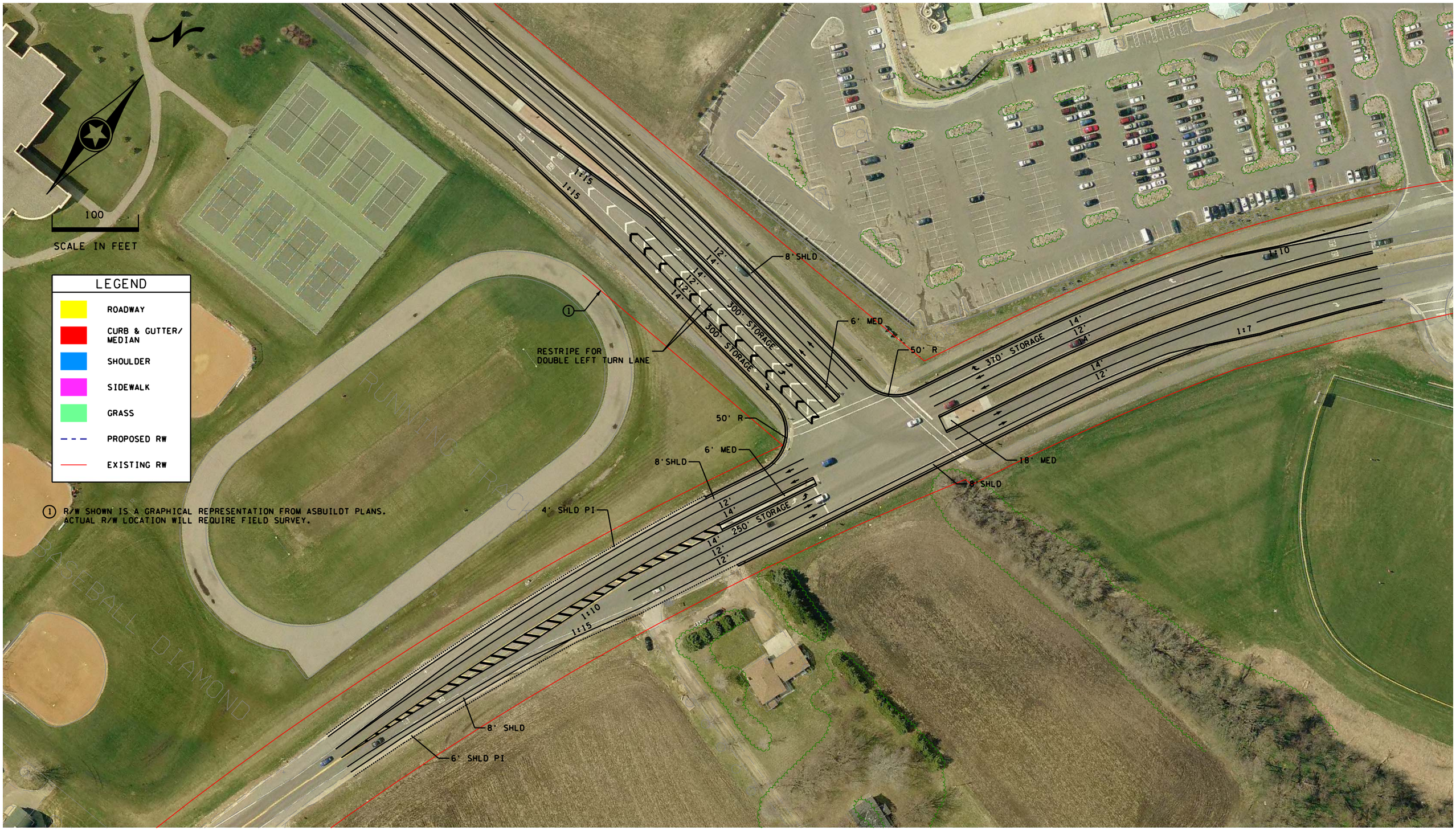
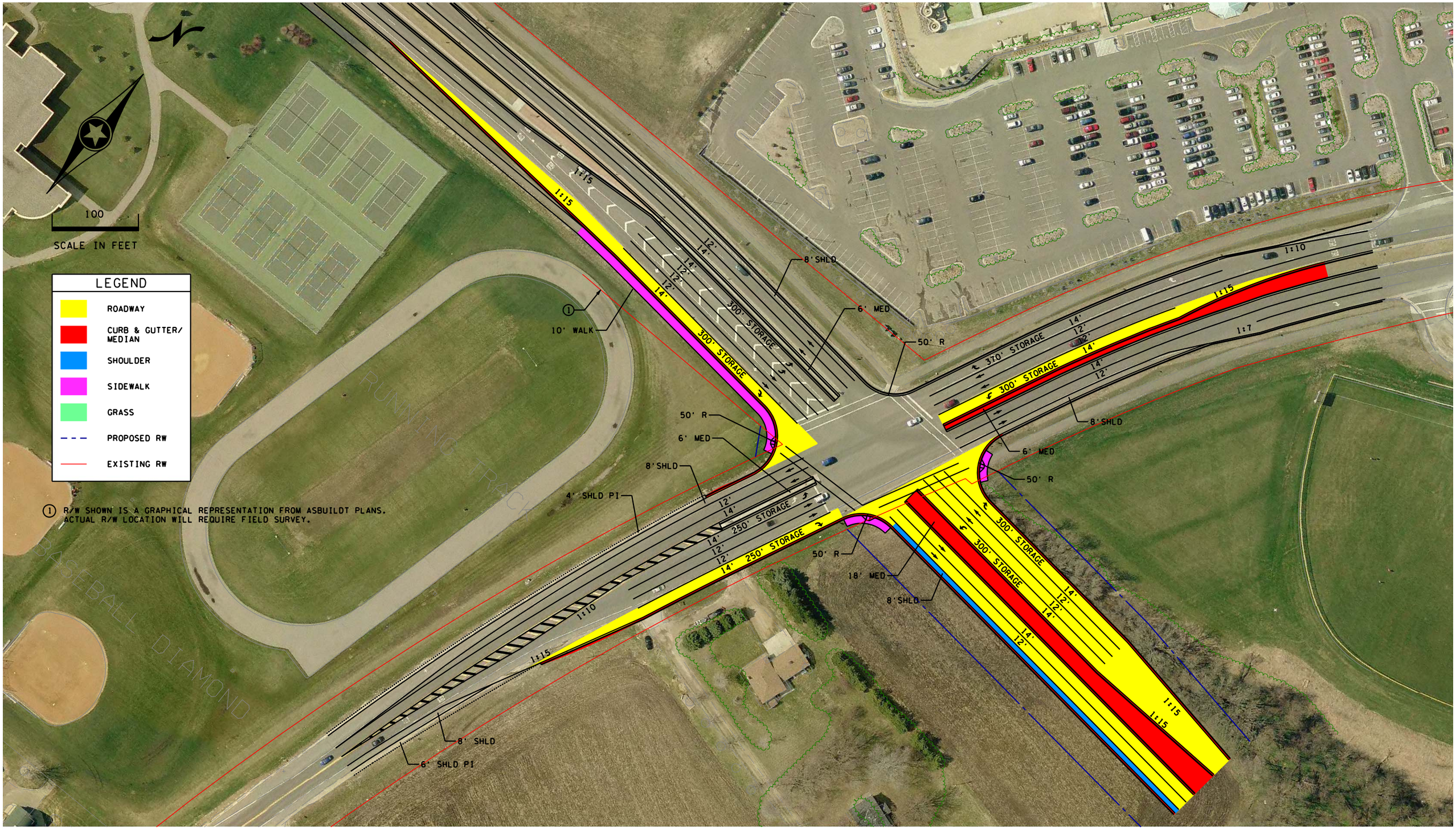




INTERSECTION TRAFFIC CONTROL FEASIBILITY STUDY

Alliant Engineering

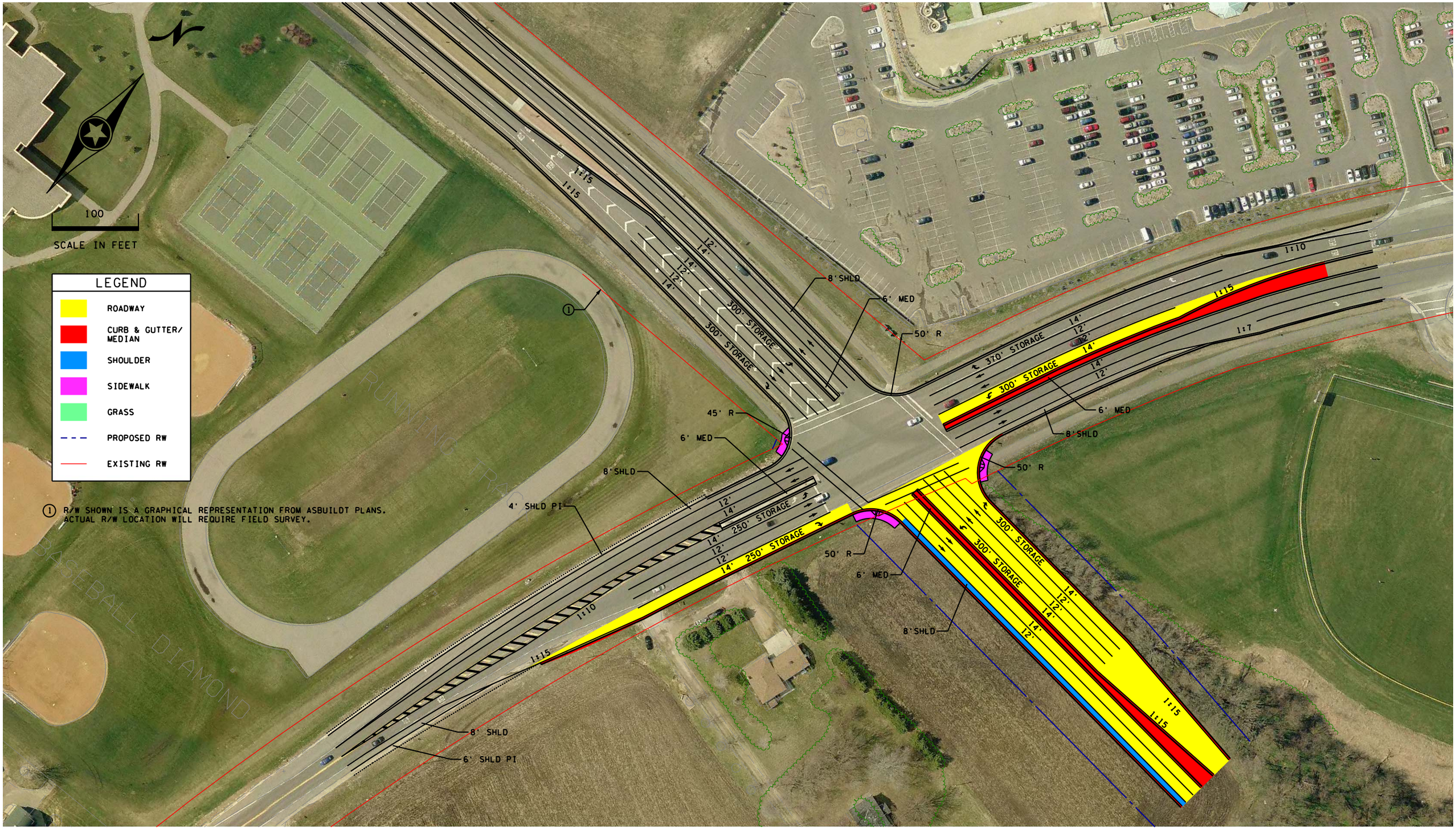
FIGURE 9
CONCEPT LAYOUT 1b
CSAH 9 & CSAH 60



INTERSECTION TRAFFIC CONTROL FEASIBILITY STUDY

Alliant Engineering

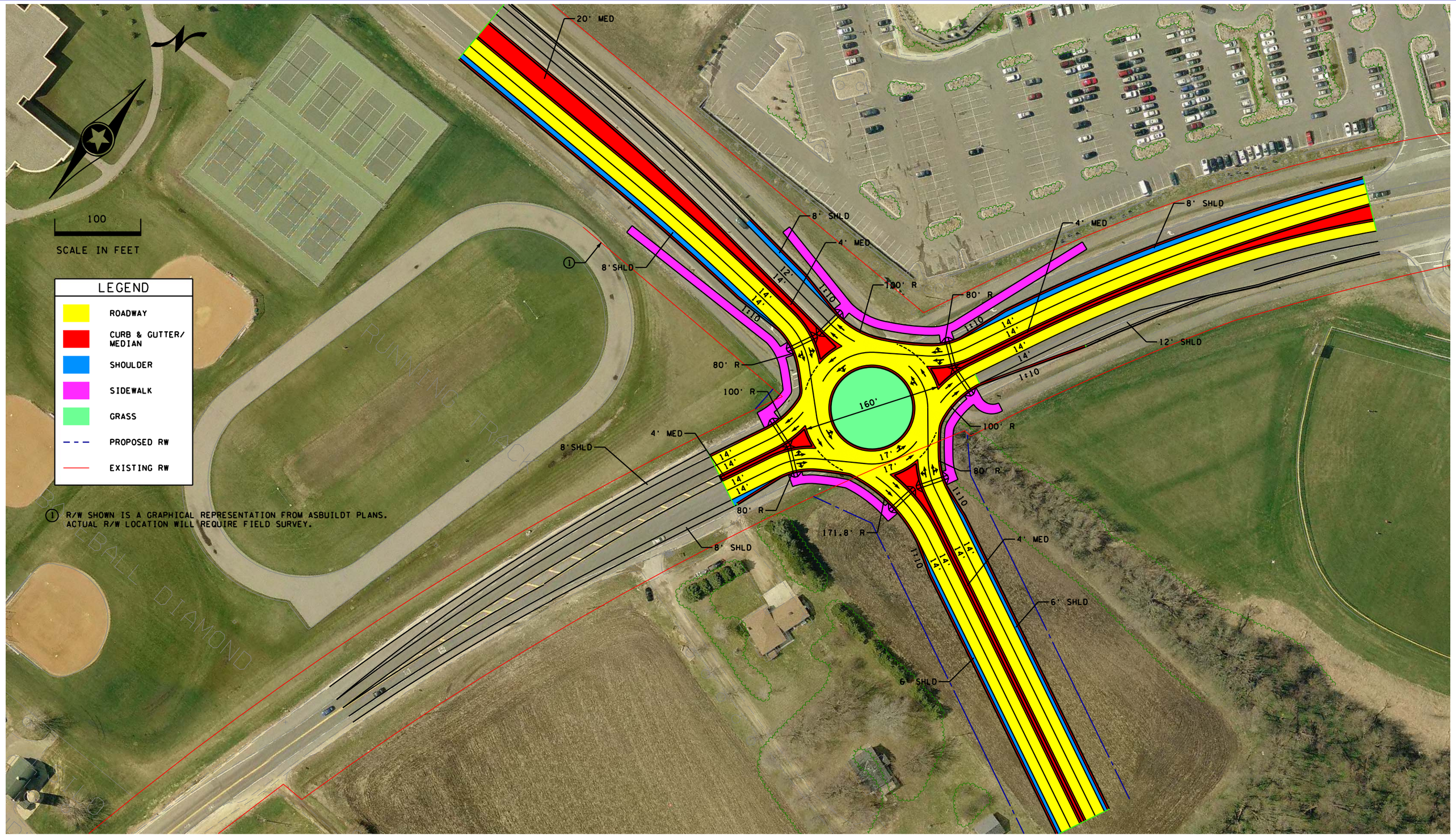
FIGURE 10
CONCEPT LAYOUT 2b
CSAH 9 & CSAH 60



INTERSECTION TRAFFIC CONTROL FEASIBILITY STUDY

Alliant Engineering

FIGURE 11
CONCEPT LAYOUT 3b
CSAH 9 & CSAH 60



INTERSECTION TRAFFIC CONTROL FEASIBILITY STUDY

Alliant Engineering

FIGURE 12
CONCEPT LAYOUT 4b
CSAH 9 & CSAH 60

4.3 Traffic Operations Analysis

A traffic operation analysis was conducted to evaluate the operational performance of each concept layout versus the forecast 2010 and 2030 traffic volumes and the traffic control alternatives. **Table 10** and **Table 11** summarize the scenarios evaluated for the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections, respectively. The traffic operation analysis conducted for the CSAH 9/CSAH 60 intersection considered two primary conditions – without the CSAH 60 extension and with the CSAH 60 extension. The CSAH 60 extension was evaluated under only the forecast year 2030 traffic volumes.

Table 10. Analysis Scenarios Summary – CSAH 9 at Highview Avenue

Analysis Scenario	Forecast Year	Intersection Geometry Condition	Traffic Control Device	Traffic Signal Operation	Concept Layout
1	2007	Existing	All-way Stop	--	--
2	2010	Existing (no-build)	All-way Stop	--	--
3	2030	Existing (no-build)	All-way Stop	--	--
4	2030	See Concept Layout 2. CSAH 9 - 4-lane divided with turn bays Highview - 2-lane with turn bays	All-way Stop	--	**Concept Layout 2a**
5	2030	See Concept Layout 2. CSAH 9 - 4-lane divided with turn bays Highview - 2-lane with turn bays	Traffic Signal	8-Phase with protected left turn phasing	**Concept Layout 2a**
6	2030	See Concept Layout 1. Multi-lane roundabout	Roundabout	--	**Concept Layout 1a**
7	2010	See Concept Layout 2. CSAH 9 - 4-lane divided with turn bays Highview - 2-lane with turn bays	All-way Stop	--	**Concept Layout 2a**
8	2010	See Concept Layout 2. CSAH 9 - 4-lane divided with turn bays Highview - 2-lane with turn bays	Traffic Signal	8-Phase with protected left turn phasing	**Concept Layout 2a**
9	2010	See Concept Layout 1. Multi-lane roundabout	Roundabout	--	**Concept Layout 1a**
10	2010	Single-lane roundabout	Roundabout	--	**--**

Table 11. Analysis Scenarios Summary – CSAH 9 at CSAH 60

Analysis Scenario	Forecast Year	Intersection Geometry Condition	Traffic Control Device	Traffic Signal Operation	Concept Layout
CSAH 9 at CSAH 60 -- Without CSAH 60 Extension					
1	2007	Existing	All-way Stop	--	**--**
2	2010	Existing (no-build)	All-way Stop	--	**--**
3	2010	Existing (no-build)	Traffic Signal	4-Phase with protected left turn phasing	**--**
4	2030	Existing (no-build)	All-way Stop	--	**--**
5	2030	Existing (no-build)	Traffic Signal	4-Phase with protected left turn phasing	**--**
6	2030	See Concept Layout 1. Existing geometry. Modify eastbound pavement markings to provide a dual left turn.	Traffic Signal	4-Phase with protected left turn phasing	**Concept Layout 1b**

Table 11. Analysis Scenarios Summary – CSAH 9 at CSAH 60 Cont'd

Analysis Scenario	Forecast Year	Intersection Geometry Condition	Traffic Control Device	Traffic Signal Operation	Concept Layout
CSAH 9 at CSAH 60 -- With CSAH 60 Extension					
1	2030	See Concept Layout 3 Existing + westbound approach leg (two thru lanes and turn bays)	All-way Stop	--	**Concept Layout 3b**
2	2030	See Concept Layout 2 Existing + Westbound approach leg (two thru lanes and turn bays) + Eastbound double left turn	Traffic Signal	8-Phase with protected left turn phasing. Southbound right turn is overlap phase with eastbound left turn.	**Concept Layout 2b**
3	2030	See Concept Layout 3 Existing + westbound approach leg (two thru lanes and turn bays)	Traffic Signal	8-Phase with eastbound/westbound protected-permissive left turn phasing. Northbound/southbound is protected left turn phasing. Southbound right turn is overlap phase with eastbound left turn.	**Concept Layout 3b**
4	2030	See Concept Layout 4. Multi-lane roundabout	Roundabout	--	**Concept Layout 4b**

4.3.1 Analysis Tools

The traffic operation analysis performed for the existing conditions and the traffic control/geometric alternatives was conducted using the following tools:

- SimTraffic7.0
- RODEL
- VISSIM5.1

SimTraffic7.0 is a microscopic simulation tool and was used to evaluate the operational performance of the stop controlled and traffic signal control options. SimTraffic7.0 was selected based upon its ability to better replicate the traffic peaking behavior and the operation of an unsignalized intersection. RODEL is the current accepted analysis tool for evaluating roundabouts. RODEL is based upon operational research of existing roundabouts from which empirical relationships between geometric parameters and entering/circulating traffic characteristics have been established to evaluate capacity, delay (LOS) and vehicle queue lengths. VISSIM is a more refined microscopic simulation tool and is gap theory based. VISSIM will be used only if a roundabout is considered a preferred alternative and will be used to validate the geometrics and operational performance.

4.3.2 Level of Service Definition

The term level of service (LOS), as taken from the, *Highway Capacity Manual, 2000 Edition (HCM)*[9]refers to the ability of an intersection to process traffic volumes. It is defined as the delay to vehicles caused by the traffic control at the intersection. The results of this MOE are typically presented in the form of a letter grade (A-F) that provides a qualitative indication of the operational efficiency or effectiveness. By definition, LOS A conditions represents high-quality operations and LOS F conditions represent very poor operations. The general relationship between delay and LOS are graphically displayed in **Table 12**. The LOS D/E boundary is considered acceptable operating conditions in the Twin Cities Metro Area. Although traffic simulation models arrive at the seconds of delay per vehicle differently than the HCM procedures, the thresholds presented in **Table 12** are applicable.

Table 12. LOS Definition

Level of Service	Description	Delay per Vehicle (Seconds)	
		Signalized Intersection	Un-signalized Intersection
A	**Free Flow.** Low volumes and no delays.	0 - 10	0 - 10
B	**Stable Flow.** Speeds restricted by travel conditions, minor delays.	>10 - 20	>10 - 15
C	**Stable Flow.** Speeds and manueverability closely controlled due to higher volumes.	>20 - 35	>15 - 25
D	**Stable Flow.** Speeds considerably affected by change in operating conditions. High density traffic restricts manueverability, volume near capacity.	>35 - 55	>25 - 35
E	**Unstable Flow.** Low speeds, considerable delay, volume at or slightly over capacity.	>55 - 80	>35 - 50
F	**Forced Flow.** Very low speeds, volumes exceed capacity, long delays with stop and go traffic.	>80	>50

Source: Highway Capacity Manual, 2000 Edition, Transportation Research Board, Exhibit 16-2 for Signalized Intersections and Exhibit 17-2 for Unsignalized Intersections.

4.3.3 Analysis Results

The traffic operation analysis was completed for all scenarios (see **Table 10** and **Table 11**). Intersection movement delays and vehicle queue lengths reported using SimTraffic7.0 represent an average of five recorded random number seeds.

The key Measures of Effectiveness (MOE) evaluated include; movement and overall intersection delay, LOS, and the average and maximum vehicle queue length. The existing year 2007, forecast year 2010 and forecast year 2030 traffic operation analysis results for the CSAH 9/Highview Avenue intersection is shown in **Table 13**, **Table 14**

[9] Highway Capacity Manual, 2000 Edition, Transportation Research Board

and **Table 15**, respectively. The RODEL output for the roundabout scenarios are attached for reference in **Appendix D**.

Table 13. Year 2007 Traffic Analysis Results Summary – CSAH 9 at Highview Avenue

AM Peak Hour

Intersection	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (Existing Conditions)	LOS	A	B	A	A	B	A	A	B	A	A	A	A	B
	Delay (sec)	8.1	13.1	6.5	8.6	13.5	6.9	5.9	10.5	4.6	5.8	9.6	3	10.4
	Avg Queue (ft)	50	50	50	52	52	52	29	29	29	22	22	22	-
	Max Queue (ft)	116	116	116	116	116	116	86	86	86	51	51	51	-
	Storage (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--

PM Peak Hour

Intersection	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (Existing Conditions)	LOS	D	D	D	**F**	**F**	**F**	A	B	A	C	C	C	**E**
	Delay (sec)	29.2	31.7	32.7	59.1	65	51.5	7.4	14.4	6.8	21.6	22.6	17.5	36.3
	Avg Queue (ft)	131	131	131	261	261	261	40	40	40	84	84	84	-
	Max Queue (ft)	362	362	362	597	597	597	102	102	102	236	236	236	-
	Storage (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: Analysis results obtained using SimTraffic Software (Average of 5 random seeds)

Table 14. Year 2010 Traffic Analysis Results Summary – CSAH 9 at Highview Avenue

AM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 2 (No build)	LOS	B	C	A	B	B	A	A	B	A	A	B	A	B
	Delay (sec/veh)	11.1	18	8.8	10.3	14.8	9.1	7.3	11.9	7.8	6.5	11	3.8	13
	Avg Queue (ft)	64	64	64	57	57	57	38	38	38	27	27	27	-
	Max Queue (ft)	216	216	216	162	162	162	130	130	130	80	80	80	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 7 (All-Way Stop) **Concept Layout 2a**	LOS	A	B	A	A	B	A	A	B	A	A	B	A	A
	Delay (sec)	4.2	11	3.1	5.2	10.8	2.8	9	10.8	8.7	9.8	10.4	7.2	9.6
	Avg Queue (ft)	7	29	6	11	30	3	8	13	7	8	12	4	-
	Max Queue (ft)	29	59	32	46	62	24	22	53	43	20	39	26	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 8 (Traffic Signal) **Concept Layout 2a**	LOS	C	B	A	C	B	A	D	C	A	C	C	A	B
	Delay (sec/veh)	30.2	11.3	1.7	27.5	10.1	1.7	35.5	25.4	9.1	34.4	28	7.9	14.9
	Avg Queue (ft)	12	39	2	25	40	2	10	24	6	11	20	4	-
	Max Queue (ft)	60	104	21	104	102	19	39	71	55	53	64	29	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 9 (Roundabout) **Concept Layout 1a**	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	2.4	2.4	2.4	2.4	2.4	2.4	3.6	3.6	3.6	3	3	3	2.6
	Avg Queue (ft)	0	0	0	0	0	0	0	0	0	0	0	0	-
	Max Queue (ft)	0	0	0	0	0	0	0	0	0	0	0	0	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 10 (1-Lane Roundabout)	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3
	Avg Queue (ft)	0	0	0	0	0	0	0	0	0	0	0	0	-
	Max Queue (ft)	0	0	0	0	0	0	0	0	0	0	0	0	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 14. Year 2010 Traffic Analysis Results Summary – CSAH 9 at Highview Avenue – Cont'd

PM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 2 (No build)	LOS	**F**	**F**	**F**	**F**	**F**	**F**	B	C	A	D	D	C	**F**
	Delay (sec/veh)	54	55.4	55.9	135.2	144.6	125.3	13.2	16	9	28.7	29.1	22	70.5
	Avg Queue (ft)	231	231	231	569	569	569	45	45	45	107	107	107	-
	Max Queue (ft)	495	495	495	1040	1040	1040	127	127	127	287	287	287	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 7 (All-Way Stop) **Concept Layout 2a**	LOS	A	B	A	A	C	A	B	C	A	B	C	B	B
	Delay (sec)	9	13.7	3.8	7.7	15.5	4.8	13.4	15.1	8.7	14.8	16	10.6	13.2
	Avg Queue (ft)	21	40	5	13	49	12	2	22	4	19	27	16	-
	Max Queue (ft)	57	87	25	46	107	33	22	64	26	50	84	63	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 8 (Traffic Signal) **Concept Layout 2a**	LOS	C	B	A	C	B	A	D	C	A	D	C	A	B
	Delay (sec/veh)	33.6	15.5	2.2	33.9	19.6	3.6	43.8	27.5	8.8	40.7	23.8	9.7	20
	Avg Queue (ft)	51	57	2	27	75	7	3	42	4	28	42	16	-
	Max Queue (ft)	128	130	24	88	157	35	26	134	29	76	113	68	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 9 (Roundabout) **Concept Layout 1a**	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	2.4	2.4	2.4	3	3	3	4.2	4.2	4.2	4.8	4.8	4.8	3.3
	Avg Queue (ft)	0	0	0	0	0	0	0	0	0	25	25	25	-
	Max Queue (ft)	0	0	0	0	0	0	0	0	0	25	25	25	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 10 (1-Lane Roundabout)	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	6	6	6	6	6	6	4.8	4.8	4.8	6.6	6.6	6.6	6
	Avg Queue (ft)	25	25	25	25	25	25	0	0	0	25	25	25	-
	Max Queue (ft)	25	25	25	25	25	25	0	0	0	25	25	25	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Average vehicle delay obtained using SimTraffic 7.0 (Results based upon average of 5 random seeds)

[2] Roundabout Measures of Effectiveness obtained using Rodel.

Table 15. Year 2030 Traffic Analysis Results Summary – CSAH 9 at Highview Avenue

AM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 3 (No build)	LOS	**F**	**F**	**F**	**F**	**F**	**F**	**E**	**F**	**F**	B	C	A	**F**
	Delay (sec/veh)	230.2	198.5	200.8	162.3	111.3	103.3	43.2	53	73.1	13.7	15.8	9.3	117.8
	Avg Queue (ft)	763	763	763	504	504	504	194	194	194	48	48	48	-
	Max Queue (ft)	1849	1849	1849	1746	1746	1746	681	681	681	100	100	100	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 4 (All-Way Stop) **Concept Layout 2a**	LOS	A	C	A	B	B	A	B	C	B	B	B	A	B
	Delay (sec)	8	16	4.9	11.1	14.9	4	13.1	16.6	14.8	13.7	14.1	9.4	14.2
	Avg Queue (ft)	12	48	9	20	50	5	9	23	23	14	18	9	-
	Max Queue (ft)	44	102	37	92	114	26	23	88	123	45	51	31	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 5 (Traffic Signal) **Concept Layout 2a**	LOS	C	B	A	D	B	A	D	C	B	D	C	A	B
	Delay (sec/veh)	34.9	17	3.1	37.2	15.5	2	46.2	27.2	12.3	37	29.9	9	19.6
	Avg Queue (ft)	29	71	5	45	73	2	16	38	21	20	32	8	-
	Max Queue (ft)	90	144	27	170	178	20	61	95	110	76	92	39	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 6 (Roundabout) **Concept Layout 1a**	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	2.4	2.4	2.4	3	3	3	4.8	4.8	4.8	4.2	4.2	4.2	3.3
	Avg Queue (ft)	0	0	0	0	0	0	0	0	0	0	0	0	-
	Max Queue (ft)	0	0	0	0	0	0	25	25	25	0	0	0	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 15. Year 2030 Traffic Analysis Results Summary – CSAH 9 at Highview Avenue – Cont'd

PM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 3 (No build)	LOS	**F**	**F**	**F**	**F**	**F**	**F**	**E**	**E**	**E**	**F**	**F**	**F**	**F**
	Delay (sec/veh)	569.6	573.1	557.1	592.6	593.5	582.7	47.4	47	39.9	740.5	652.8	742.3	502.6
	Avg Queue (ft)	1837	1837	1837	1813	1813	1813	148	148	148	795	795	795	-
	Max Queue (ft)	1883	1883	1883	1840	1840	1840	430	430	430	858	858	858	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
Scenario 4 (All-Way Stop) **Concept Layout 2a**	LOS	D	D	A	**F**	**F**	**F**	C	**E**	B	D	D	C	**F**
	Delay (sec)	32.3	31	7.2	290.5	497.7	275.6	17.5	36.9	14.1	27.1	33.4	19.5	157.7
	Avg Queue (ft)	61	97	6	300	1153	202	4	64	17	33	70	48	-
	Max Queue (ft)	145	207	31	400	1812	400	19	184	79	108	211	146	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	-
Scenario 5 (Traffic Signal) **Concept Layout 2a**	LOS	D	C	A	D	C	A	**E**	C	B	D	C	B	C
	Delay (sec/veh)	43.2	22.2	6.8	44.7	31.4	5.4	56	34.4	11.2	51.7	30.1	15.6	28.1
	Avg Queue (ft)	95	112	4	45	166	12	5	78	13	57	90	49	-
	Max Queue (ft)	210	191	35	145	291	40	26	200	62	145	253	140	-
	Storage (ft)	300	-	300	300	-	300	300	-	300	150	-	150	0
Scenario 6 (Roundabout) **Concept Layout 1a**	LOS	A	A	A	A	A	A	A	A	A	B	B	B	A
	Delay (sec)	3.6	3.6	3.6	3.6	3.6	3.6	6.6	6.6	6.6	10.2	10.2	10.2	5.7
	Avg Queue (ft)	25	25	25	25	25	25	25	25	25	50	50	50	-
	Max Queue (ft)	25	25	25	25	25	25	25	25	25	50	50	50	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Average vehicle delay obtained using SimTraffic 7.0 (Results based upon average of 5 random seeds)

[2] Roundabout Measures of Effectiveness obtained using Rodel.

The following summarizes the results of the traffic operation analysis completed for the CSAH 9/Highview Avenue intersection:

- The existing intersection control (all-way stop) currently operates at an acceptable LOS B during the AM peak hour. During the PM peak hour, the westbound approach operates at a LOS F, with overall intersection operating at a LOS E.
- Under Concept Layout 1a (see **Figure 7**), a roundabout intersection is expected to provide LOS A operations under both the forecast year 2010 and 2030 traffic volumes.
- Under Concept Layout 2a (see **Figure 8**), an all-way stop control is expected to provide acceptable traffic operations under year 2010 volumes. However by year 2030, an all-way stop control is expected to be an insufficient level of traffic control.
- A traffic signal is expected to provide an acceptable LOS C or better under both 2010 and 2030 forecast traffic volumes and Concept Layout 2a.

The traffic operation analysis conducted for the CSAH 9/CSAH 60 intersection considered two primary conditions – without the CSAH 60 extension and with the CSAH 60 extension. The existing year 2007 traffic operation analysis results for the CSAH 9/CSAH 60 intersection are shown in **Table 16**. The forecast year 2010 and 2030 traffic operation results under the without CSAH 60 extension are shown in **Table 17** and **Table 18,** respectively. The forecast year 2030 traffic operation results under the with CSAH 60 extension are shown in **Table 19**. The RODEL output for the roundabout scenarios are attached for reference in **Appendix D**.

Table 16. Year 2007 Traffic Analysis Results Summary – CSAH 9 at CSAH 60

AM Peak Hour

Intersection	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (Existing Conditions)	LOS	A	-	A	-	-	-	A	A	-	-	B	A	A
	Delay (sec/veh)	8.4	-	2.1	-	-	-	6.1	9.1	-	-	14.3	5.1	9.0
	Avg Queue (ft)	54	-	24	-	-	-	25	32	-	-	58	40	-
	Max Queue (ft)	113	-	41	-	-	-	60	58	-	-	148	79	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

PM Peak Hour

Intersection	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (Existing Conditions)	LOS	C	-	A	-	-	-	A	B	-	-	C	A	B
	Delay (sec/veh)	22.9	-	2.9	-	-	-	9.8	11.3	-	-	18.5	5.2	14.0
	Avg Queue (ft)	104	-	29	-	-	-	33	43	-	-	73	46	-
	Max Queue (ft)	266	-	65	-	-	-	76	72	-	-	168	82	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

Note: Analysis results obtained using SimTraffic Software (Average of 5 random seeds)

Table 17. Year 2010 Traffic Analysis Results Summary – CSAH 9 at CSAH 60 (Without CSAH 60 Extension)

AM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 2 (No build)	LOS	B	-	A	-	-	-	A	A	-	-	C	A	B
	Delay (sec/veh)	13.6	-	6.5	-	-	-	5.4	9.2	-	-	22.6	4.8	12.5
	Avg Queue (ft)	50	-	25	-	-	-	16	12	-	-	76	42	-
	Max Queue (ft)	115	-	47	-	-	-	41	40	-	-	253	81	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 3 (Traffic Signal)	LOS	B	-	A	-	-	-	C	A	-	-	B	A	B
	Delay (sec)	17.8	-	6	-	-	-	29.4	5.8	-	-	16.3	2.8	11.9
	Avg Queue (ft)	61	-	20	-	-	-	23	11	-	-	81	33	-
	Max Queue (ft)	111	-	38	-	-	-	70	48	-	-	206	73	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

PM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 2 (No build)	LOS	**F**	-	A	-	-	-	B	B	-	-	D	A	D
	Delay (sec/veh)	56.8	-	7.9	-	-	-	10.9	11.5	-	-	26.6	6.3	25.9
	Avg Queue (ft)	178	-	30	-	-	-	25	20	-	-	84	49	-
	Max Queue (ft)	373	-	58	-	-	-	64	52	-	-	237	104	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 3 (Traffic Signal)	LOS	B	-	A	-	-	-	C	A	-	-	B	A	B
	Delay (sec)	18.9	-	6.1	-	-	-	30	7.5	-	-	19.2	3.6	13.5
	Avg Queue (ft)	86	-	25	-	-	-	40	23	-	-	92	41	-
	Max Queue (ft)	153	-	44	-	-	-	110	88	-	-	198	84	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

* Average vehicle delay obtained using SimTraffic 7.0 (Results based upon average of 5 random seeds)

Table 18. Year 2030 Traffic Analysis Results Summary – CSAH 9 at CSAH 60 (Without CSAH 60 Extension)

AM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 4 (No build)	LOS	**F**	-	D	-	-	-	C	B	-	-	**F**	C	**F**
	Delay (sec/veh)	324.4	-	30.3	-	-	-	16.3	11.7	-	-	61.8	17.5	102.7
	Avg Queue (ft)	1092	-	35	-	-	-	28	21	-	-	198	117	-
	Max Queue (ft)	1604	-	69	-	-	-	81	51	-	-	547	435	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 5 (Traffic Signal)	LOS	C	-	B	-	-	-	D	D	-	-	D	A	C
	Delay (sec)	34.4	-	13.4	-	-	-	40.6	51.4	-	-	51.4	8.3	29
	Avg Queue (ft)	211	-	29	-	-	-	44	34	-	-	210	72	-
	Max Queue (ft)	386	-	88	-	-	-	130	104	-	-	526	294	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 6 (Traffic Signal) **Concept Layout 1b**	LOS	C	-	A	-	-	-	C	A	-	-	C	A	B
	Delay (sec/veh)	23	-	8.4	-	-	-	30.2	7.3	-	-	26	6.9	17.3
	Avg Queue (ft)	109	-	30	-	-	-	39	22	-	-	131	61	-
	Max Queue (ft)	182	-	71	-	-	-	106	72	-	-	337	150	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

PM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 4 (No build)	LOS	**F**	-	**F**	-	-	-	**F**	D	-	-	**E**	D	**F**
	Delay (sec/veh)	2278.8	-	1725.5	-	-	-	193.9	28.1	-	-	39.1	28.3	551.6
	Avg Queue (ft)	1607	-	37	-	-	-	129	135	-	-	140	163	-
	Max Queue (ft)	1630	-	74	-	-	-	232	217	-	-	402	380	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 5 (Traffic Signal)	LOS	**F**	-	**E**	-	-	-	D	D	-	-	D	A	D
	Delay (sec)	109.2	-	69.8	-	-	-	45.4	49.6	-	-	49.6	9.7	52.8
	Avg Queue (ft)	357	-	44	-	-	-	95	83	-	-	208	90	-
	Max Queue (ft)	400	-	108	-	-	-	201	205	-	-	365	240	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-
Scenario 6 (Traffic Signal) **Concept Layout 1b**	LOS	C	-	B	-	-	-	D	B	-	-	C	A	C
	Delay (sec/veh)	27.1	-	10.1	-	-	-	38.9	11.5	-	-	32.1	9.3	21.1
	Avg Queue (ft)	158	-	41	-	-	-	82	64	-	-	156	88	-
	Max Queue (ft)	237	-	81	-	-	-	184	152	-	-	305	215	-
	Storage (ft)	300	-	300	-	-	-	250	-	-	-	-	420	-

* Average vehicle delay obtained using SimTraffic 7.0 (Results based upon average of 5 random seeds)

Table 19. Year 2030 Traffic Analysis Results Summary – CSAH 9 at CSAH 60 (With CSAH 60 Extension)

AM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (All-Way Stop) **Concept Layout 3b**	LOS	**F**	D	B	**E**	D	A	D	B	A	B	**E**	B	**E**
	Delay (sec/veh)	141	27.4	11.9	36.8	27.3	8.4	31.2	15	4.6	14.1	43.2	10.3	41.2
	Avg Queue (ft)	279	236	39	86	67	14	39	17	12	14	77	46	-
	Max Queue (ft)	400	656	74	256	128	42	136	50	46	42	234	164	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 2 (Traffic Signal - Protected Lefts) **Concept Layout 2b**	LOS	D	C	B	D	C	A	D	C	A	D	C	A	C
	Delay (sec)	37.6	29	10.6	40.2	27	9.4	36.2	22	3.1	39.7	31.4	5	25.8
	Avg Queue (ft)	85	73	33	110	76	11	48	25	9	20	83	30	-
	Max Queue (ft)	153	134	66	249	143	37	143	71	39	79	188	102	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 3 (Traffic Signal - EB/WB Prot/Perm Left) **Concept Layout 3b**	LOS	C	C	A	C	C	A	D	C	A	D	D	A	C
	Delay (sec/veh)	27	24.6	9.9	23.6	28.9	8.2	39.4	27.8	2.9	47.1	38.8	5.3	24.0
	Avg Queue (ft)	117	69	31	74	81	11	50	31	9	21	96	31	-
	Max Queue (ft)	267	134	61	161	155	38	154	92	66	75	236	88	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 4 (Roundabout) **Concept Layout 4b**	LOS	A	A	A	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	3	3	3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.7
	Avg Queue (ft)	25	25	25	0	0	0	0	0	0	0	0	0	-
	Max Queue (ft)	25	25	25	0	0	0	0	0	0	25	25	25	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 19. Year 2030 Traffic Analysis Results Summary – CSAH 9 at CSAH 60 (With CSAH 60 Extension) – Cont'd

PM Peak Hour

Alternative	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Scenario 1 (All-Way Stop) **Concept Layout 3b**	LOS	**F**	**F**	**F**	**F**	**F**	**E**	**F**	**E**	C	**F**	**F**	**F**	**F**
	Delay (sec/veh)	1505.7	1315.1	1037.3	115.5	201.2	49.3	645.3	41.8	23.1	717.9	882	322.9	707.7
	Avg Queue (ft)	393	1603	301	211	379	83	349	513	32	160	1361	509	-
	Max Queue (ft)	400	1633	400	379	973	277	350	534	107	400	1641	520	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 2 (Traffic Signal - Protected Lefts) **Concept Layout 2b**	LOS	**E**	D	C	**E**	D	B	D	C	B	D	D	C	D
	Delay (sec)	63.3	51	21.9	59.8	39.3	11.5	53.3	31.2	11.4	53.9	54.9	20.5	42.3
	Avg Queue (ft)	157	252	58	134	141	15	130	62	46	29	150	161	-
	Max Queue (ft)	252	429	268	253	230	46	287	175	148	82	270	371	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 3 (Traffic Signal - EB/WB Prot/Perm Left) **Concept Layout 3b**	LOS	**E**	D	C	D	D	A	**E**	C	B	**E**	**E**	B	D
	Delay (sec/veh)	58.4	48.9	21.9	43.4	47	9.6	68.2	34.4	14.3	67.3	61.4	17.7	43.0
	Avg Queue (ft)	267	259	58	103	161	15	152	66	53	32	165	143	-
	Max Queue (ft)	399	484	272	222	274	34	310	210	178	104	306	346	-
	Storage (ft)	300	-	300	300	-	300	250	-	250	300	-	420	-
Scenario 4 (Roundabout) **Concept Layout 4b**	LOS	B	B	B	A	A	A	A	A	A	A	A	A	A
	Delay (sec)	11.4	11.4	11.4	3.6	3.6	3.6	6	6	6	4.2	4.2	4.2	7.4
	Avg Queue (ft)	125	125	125	25	25	25	25	25	25	25	25	25	-
	Max Queue (ft)	150	150	150	25	25	25	25	25	25	25	25	25	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Average vehicle delay obtained using SimTraffic 7.0 (Results based upon average of 5 random seeds)
[2] Roundabout Measures of Effectiveness obtained using Rodel.

The following summarizes the results of the traffic operation analysis completed for the CSAH 9/CSAH 60 intersection:

- The existing intersection control (all-way stop) currently operates at an acceptable LOS B or better during both the AM and PM peak hours.
- Prior to the extension of CSAH 60, an all-way stop control is expected to provide acceptable traffic operations (LOS D or better) under the 2010 forecast traffic volumes. By 2030, an all-way stop control will be deficient without geometric improvements.
- The installation of a traffic signal is expected to provide acceptable traffic operations prior to the CSAH 60 extension. A dual eastbound left turn lane will be required to address potential queuing issues. (Concept Layout 1b, **Figure 9**).
- With the extension of CSAH 60 and considering forecast year 2030 traffic volumes, an all-way stop control is an insufficient level of traffic control.
- A traffic signal system is expected to improve the overall intersection operation to a LOS D or better. The type of signal phasing selected for eastbound/westbound CSAH 60 approaches will influence the required intersection geometrics. Protected/permissive left turn phasing is expected to provide acceptable traffic operations and maintains a single left turn lane design (Concept Layout 3b, **Figure 11**). If protected left turn phasing is to be considered, the construction of an eastbound dual left turn lane will be required (Concept Layout 2b, **Figure 10**)
- A multi-lane roundabout is expected to provide LOS A or better traffic operations under the forecast year 2030 traffic volumes.

4.4 Evaluation of Alternatives

The conceptual layouts developed for both the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections were evaluated based upon the following key objectives:

- Operational Efficiency
- Intersection Safety
- Preliminary Cost
- Right of Way Impact
- Utility Impact
- Environmental Impact
- Pedestrian/Bicycle Friendliness
- Other Design Considerations

To support the alternatives evaluation and selection of the preferred alternative, a comparison matrix was developed to quantitatively and qualitatively assess the above listed key objectives. The operational efficiency comparison is based upon 2030 PM peak hour analysis. However, an evaluation was conducted to determine the anticipated year a traffic control change may be needed (see Section 4.4.1). Preliminary costs for comparison purposes were developed for each alternative and are based upon the following key features:

- Removals
- Earthwork
- Roadway Surface Features
- Drainage

Right of way impacts are estimated based upon square foot area of required acquisition. The value per square foot is unknown at this time; therefore, a reasonable quantification of dollar cost cannot be made. However, the area of impact will provide a useful comparison between alternatives. Other design considerations, environmental, utility or pedestrian/bicycle impacts are discussed qualitatively and as appropriate for each alternative.

Table 20 and **Table 21** present the comparison evaluation matrix for each concept layout under consideration at the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections, respectively.

Table 20. Comparison Evaluation Matrix - CSAH 9 at Highview Avenue

	Objective	2030 Concept Layout 2a (All-Way Stop)	2030 Concept Layout 2a (Traffic Signal)	2030 Concept Layout 1a (Roundabout)
Operations	**Overall Intersection Delay (sec / veh)**[1] **LOS**	157.7 F **See Footnote (5)**	28.1 C	5.7 A
Safety	**Forecast Crashes**[2] **(average total crashes /** **Crash Types / Severity**	1 - 6[3] ■ Most common crash types are rear end and right angle ■ Injury related crashes represent approximately 30% of the total reported intersection crashes.	8 ■ Predominant crash types are rear end, right angle and left turn collisions ■ Injury related crashes represent approximately 35% of the total reported intersection crashes.	5 ■ Most common crash types include failure to yield at entry and single-vehicle run off road. ■ Injury related crashes are typically reduced by 50% compared to traditional intersections.
Cost	**Construction**[4] **Hardware** **Total Cost**	$1,435,000 -- **$1,435,000**	$1,435,000 $175,000 **$1,610,000**	$1,185,000 -- **$1,185,000**
Right of Way	**Required Acquisition (square feet)**	6,804	6,804	5,229
Utilities	**Impacts**	High (Requires longer construction limits and widening along Highview Avenue)	High (Requires longer construction limits and widening along Highview Avenue)	Medium (Highview Avenue construction limits/widening is reduced)
Environment	**Emissions / Air Quality** **Other Impacts**	High Low	Medium Low	Low Medium (Requires additional corner right of way and clearing of trees in the southeast quadrant)
Pedestrian / Bicycle	**Safety Consideration**	■ Pedestrian related crashes are generally low	■ Pedestrian related crashes are generally low	■ The incidence and severity of pedestrian related crashes are typically reduced versus other intersection control devices. ■ The primary pedestrian disadvantage is due to the crosswalk location and approaching vehicles being required to yield right of way (typically beyond the crosswalk). The operation is similar to a mid-block crossing.
Other Considerations	**Comments**	■ All-way stop control is deficient. ■ Large intersections with multiple lanes of approach can result in inefficient and confusing all-way stop operation.	■ The traffic operation analysis evaluted the traffic signal with 8-phase control and protected left turn phases (worst-case). This may result in unnecessary inefficiency during off-peak periods. ■ Typically protected left turn phases are provided with roadway approaches exceeding 50 mph. However, if sight lines are acceptable, protected/permissive phasing should be used. As roadway profiles are developed, the sight lines should be evaluated. Protected/permissive phasing will increase the overall intersection efficiency.	■ Construction staging presents a much greater challenge and interim traffic impact. Could result in additional construction costs. ■ Uphill approach grades require lowering the roadway profile. ■ Intersection will operate isolated and is not expected to benefit from or be tied into a signalized coordinated zone. ■ May provide for better 24-hour solution and overall intersection efficiency ■ Retaining wall or additional ROW required on the southeast corner.

[1] The PM peak hour represents the worst case scenario.
[2] Forecast crashes estimated based on statewide average rates (0.6 for all-way, 0.8 for traffic signal and 0.48 for roundabout).
[3] This intersection has had 2 correctable crashes for the years 2005-2007. The existing crash rate is 0.10 compared to the statewide average rate of 0.6. Using the existing crash rate of 0.10 and the statewide average rate of 0.6, the range of expected yearly crashes is 1 to 6.
[4] Construction costs are for comparison only and not intended to represent the total construction cost of each Alternative. Items computed for comparision analysis include Removals, Earthwork, Roadway Surface Features, and Drainage.
[4] All-way stop control is expected to operate at acceptable conditions until Year 2023. Year 2023 represents the point where the westbound approach exceeds its acceptable peak hour capacity.

Table 21. Comparison Evaluation Matrix - CSAH 9 at CSAH 60

	Objective	2030 - Without Extension No-Build (All-Way Stop)	2030 - Without Extension Concept Layout 1b (Traffic Signal)	2030 - With Extension Concept Layout 3b (All-Way Stop)	2030 - With Extension Concept Layout 2b (Traffic Signal)	2030 - With Extension Concept Layout 3b (Traffic Signal)	2030 - With Extension Concept Layout 4b (Roundabout)
Operations	**Overall Intersection Delay (sec / veh)[1]** **LOS**	551.6 F Intersection delay based on the existing 1-eastbound Left Turn Lane. **See Footnotes (2) and (3)**	21.1 C	707.7 F	42.3 D	43.0 D	7.4 A
Safety	**Forecast Crashes[4] (crashes / year)** **Crash Types / Severity**	7 ▪ Most common crash types are rear end and right angle ▪ Injury related crashes represent approximately 30% of the total reported intersection crashes.	9 ▪ Predominant crash types are rear end, right angle and left turn collisions ▪ Injury related crashes represent approximately 35% of the total reported intersection crashes.	9 ▪ Most common crash types are rear end and right angle ▪ Injury related crashes represent approximately 30% of the total reported intersection crashes.	12 ▪ Predominant crash types are rear end, right angle and left turn collisions ▪ Injury related crashes represent approximately 35% of the total reported intersection crashes.	12 ▪ Predominant crash types are rear end, right angle and left turn collisions ▪ Injury related crashes represent approximately 35% of the total reported intersection crashes.	7 ▪ Most common crash types include failure to yield at entry and single-vehicle run off road. ▪ Injury related crashes are typically reduced by 50% compared to traditional intersections.
Cost	**Construction[5]** **Hardware** **Miscellaneous** **Total Cost**	-- -- **$0**	-- $175,000 (Designed to accommodate future extension) **$175,000**	$365,000 -- **$365,000**	$460,000 $25,000 (Signal Modification to add 4th Leg) **$485,000**	$365,000 $25,000 (Signal Modification to add 4th Leg) **$390,000**	$900,000 -- **$900,000**
Right of Way	**Required Acquisition (square feet)**	0	0	525	525	525	525
Utilities	**Impacts**	None	None	Low (CSAH 9 southeast edge line)	Medium (CSAH 9 southeast edge line) (CSAH 60 southwest Edge line)	Low	Medium (Intersection Only)
Environmental	**Emissions / Air Quality** **Other Impacts**	High None	Low / Medium None	High Medium (East Leg Extension will require clearing of trees and addition of pavement)	Medium Medium (East Leg Extension will require clearing of trees and addition of pavement)	Medium Medium (East Leg Extension will require clearing of trees and addition of pavement)	Low Low (East Leg Extension could avoid trees and requires less pavement width)
Pedestrian / Bicycle	**Safety Consideration**	▪ Pedestrian related crashes are generally low	▪ Pedestrian related crashes are generally low	▪ All-way stop control is deficient. ▪ Large intersections with multiple lanes of approach can result in inefficient and confusing all-way stop operation.	▪ Pedestrian related crashes are generally low	▪ Pedestrian related crashes are generally low	▪ The incidence and severity of pedestrian related crashes are typically reduced versus other intersection control devices. ▪ The primarypedestrian disadvantage is due to the crosswalk location and approaching vehicles being required to yield right of way (typically beyond the crosswalk). The operation is similar to a mid-block crossing.
Other Considerations	**Comments**	▪ All-way stop control is deficient. ▪ Large intersections with multiple lanes of approach can result in inefficient and confusing all-way stop operation.	▪ Due to roadway speeds, the traffic signal will be an 8-phase control with protected left turn phases. This may result in unnecessary inefficiency during off-peak periods. ▪ Cost-effective interim solution until CSAH 60 is extended.	▪ All-way stop control is deficient.	▪ The addition of a double left turn lane requires roadway widening and protected left turn phasing. Double left turn lane may not be necessary outside of the PM peak period.	▪ Maximizes the use of the existing roadway infrastructure ▪ The eastbound and westbound roadway approaches are 45 mph. The roadway profile is not expected to change. Based on the expected horizontal alignment, sight lines are expected to be acceptable. Protected/permissive phasing should be used.	▪ Implementation of a roundabout requires full reconstruction of all four approach legs ▪ Construction staging is expected to have a much greater impact to traffic conditions and be far more costly. (Cost not included in estimate) ▪ Will need further consideration of future land use and character of CSAH 60 to the east of CSAH 9 ▪ A traffic signal exists 1/4-mile to the west. CSAH 60 may be developing as a signalized arterial.

[1] The PM peak hour represents the worst case scenario.
[2] The year 2030 PM peak hour intersection delay is reduced to 41.8 seconds (78 seconds for eastbound left turn) if the eastbound approach was re-striped to include a double left turn lane (Concept Layout 1).
[3] The year 2010 eastbound left turn is expected to operate at its capacity during the PM peak hour (a LOS E/F with a maximum queue length approaching the available storage). Year 2012/2013 represents the threshold where the eastbound left turn is expected to begin to significantly exceed its peak hour capacity.
[4] Forecast crashes estimated based on statewide average rates (0.6 for all-way, 0.8 for traffic signal and 0.48 for roundabout).
[5] Construction costs are for comparison only and not intended to represent the total construction cost of each Alternative. Items computed for comparision analysis include Removals, Earthwork, Roadway Surface Features, and Drainage.

4.4.1 Traffic Control Change Timeline

The results of the signal warrant analysis, safety analysis and the traffic operation analysis were used to estimate the year a traffic control change may be required. The following summarizes the conclusions of the analysis conducted at the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections.

CSAH 9 at Highview Avenue

- The signal warrant analysis found signal Warrant 1B, Warrant 2 and Warrant 3 are expected to be satisfied under the forecast year 2010 approach volumes.
- Based on the existing crash experience and the estimated future annual crashes (see **Table 7**), a specific safety characteristic warranting a traffic control change is not expected.
- The traffic operation analysis found the existing all-way stop control and Concept Layout 2a (see **Figure 8**) is expected to provide acceptable LOS B or better operations under the forecast year 2010 traffic volumes.
- By year 2030, the all-way stop control and Concept Layout 2a (see **Figure 8**) is expected to be deficient.
- Using the annualized background growth rate, the all-way stop control is expected to provide acceptable peak period traffic operations until year 2023. By year 2023, the westbound approach is expected to experience LOS F operations.

Although signal warrants are met in 2010, the operations analysis does not find that signalized intersection control would be an appropriate alternative until year 2023.

CSAH 9 at CSAH 60

- The signal warrant analysis found signal Warrant 1A, 1B, 1C, Warrant 2 and Warrant 3 are expected to be satisfied under the forecast year 2010 approach volumes.
- Based on the existing crash experience and the estimated future annual crashes (see **Table 8**), a specific safety characteristic warranting a traffic control change is not expected.
- The traffic operation analysis found the existing all-way stop control and existing intersection geometrics is expected to provide acceptable LOS D or better operations under the forecast year 2010 traffic volumes. However, the

eastbound left turn is expected to begin experiencing longer delays and queue lengths during the PM peak hour.

- The re-striping of the eastbound approach to a double left turn lane, Concept Layout 1b (see **Figure 9**), and maintaining the existing all-way stop control is expected to provide acceptable traffic operations until year 2028, or likely until the CSAH 60 extension project occurs.
- However, the operation of a dual eastbound left turn movement and an all-way stop control may not be a practical alternative due to the safety and operation concerns of such lane geometrics at a large intersection. If the existing geometrics are maintained, the eastbound left turn movement and the all-way stop control are expected to become deficient by year 2012.

Traffic signal warrants are expected to be met in year 2010. The operation analysis finds a traffic control change is expected to be needed by the year 2012.

4.4.2 Selection of Preferred Alternative

The preferred alternative at the CSAH 9/Highview Avenue and CSAH 9/CSAH 60 intersections were selected based upon; discussions with the TAC, results of the traffic operation analysis and safety analysis, and consideration of the key objectives evaluated in the comparison matrix.

CSAH 9 at Highview Avenue

The preferred alternative selected at the CSAH 9/Highview Avenue intersection is the roundabout, Concept Layout 1a (refer to **Figure 7**). The roundabout intersection was selected based on the following:

- With the 2008-2012 Capital Improvement Plan project, the intersection is being re-aligned and fully reconstructed. This is the most cost-effective opportunity to build a roundabout. Based on the preliminary cost estimate, the roundabout is expected to result in a net comparable or even less initial cost than a traditional intersection. This is due to the overall less pavement area (approaching roadway segments are narrowed) and reduced right of way needs with the roundabout option. In addition, the long term cost of a roundabout is reduced as the annual maintenance and operation costs are less than a traffic signal.
- The roundabout option will require small triangles of additional right of way on the southwest, southeast and northwest quadrants. However, overall the right of way impact is less than a traditional intersection. Additional right of way along Highview Avenue, south of CSAH 9 will not be required to the same extent as Concept Layout 2a (see **Figure 8**).

- The roundabout alternative will require the lowering of the Highview Avenue and CSAH 9 alignment profiles (to reduce approach grades and to provide a level circle). However, since the intersection is being fully reconstructed, this same consideration would have been made for a traditional intersection.
- Emissions and air quality impacts are expected to be improved with the roundabout option. The traffic analysis found greatly reduced vehicle delays with the roundabout intersection over the traffic signal option. A reduction in motorist delay directly correlates with lowering vehicle emission and fuel consumption.
- The roundabout is expected to provide an immediate benefit and reduction in motorist delay. The roundabout also provides a an immediate and much improved 24-hour solution versus an all-way stop control or a traffic signal system, which was not found needed until year 2023.
- The CSAH 9/Highview Avenue intersection is isolated; therefore does not benefit from coordinated arterial operations. A system or network impact is not expected with the implementation of a roundabout.
- Based on the safety analysis, a roundabout is expected to result in less overall intersection crashes than a traffic signal.

To validate the preferred roundabout geometrics, a more detailed traffic operation analysis using VISSIM was conducted. The VISSIM analysis evaluated the forecast 2030 PM peak hour traffic volumes. **Table 22** illustrates the results.

Table 22. Preferred Alternative 2030 PM Peak Hour VISSIM Analysis – CSAH 9 at Highview Avenue

	MOE	EB Approach			WB Approach			NB Approach			SB Approach			Intersection Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
VISSIM	LOS	A	A	A	A	A	A	A	A	A	C	C	C	A
	Delay (sec)	3.7	2.3	1.8	5.6	4.7	5.6	6.6	9.6	8.4	24.8	23.4	22.4	9.0
	Avg Queue (ft)	7	7	7	12	12	12	15	15	15	83	83	83	-
	Max Queue (ft)	135	135	135	180	180	180	219	219	219	639	639	639	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-
RODEL	LOS	A	A	A	A	A	A	A	A	A	B	B	B	A
	Delay (sec)	3.6	3.6	3.6	3.6	3.6	3.6	6.6	6.6	6.6	10.2	10.2	10.2	5.7
	Avg Queue (ft)	25	25	25	25	25	25	25	25	25	50	50	50	-
	Max Queue (ft)	25	25	25	25	25	25	25	25	25	50	50	50	-
	Storage (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-

CSAH 9 at CSAH 60

At the CSAH 9/CSAH 60 intersection, the following alternatives were selected:

- ***Short Term***: The preferred short-term alternative is signalized intersection control with a dual eastbound left turn, Concept Layout 1b (see **Figure 9**).

- ***Long Term***: The preferred long-term alternative (with CSAH 60 extension) is the traditional signalized intersection control with single left turn lanes, Concept Layout 3b (see **Figure 11**).

The signalized intersection control was selected based on the following:

- The traffic operation analysis shows the intersection is expected to need a traffic control change by year 2012. The installation of signalized intersection control prior to the CSAH 60 extension can be implemented with little or no impact to right of way and carry only the cost of the capital to install the signal and the recurring maintenance and operation costs. No additional environmental or utility impacts are expected. A roundabout would require full intersection reconstruction and may not be a feasible option to fund in the interim.
- The signalized intersection control and traditional intersection design maximizes the use of existing infrastructure and previous project investments.
- An existing traffic signal is in operation at Ipava Avenue (a quarter-mile to the west). The development of the CSAH 60 extension to the east is anticipated to result in a signalized arterial corridor. The installation of a traffic signal system at CSAH 60 is most consistent and best fits with the arterial and network characteristics of the corridor.
- The completed four-leg traditional intersection design and traffic signal system is expected to cost approximately 75 percent less than the roundabout option.
- The overall estimated right of way need between the traditional intersection and a roundabout are expected to be the same. The roundabout option could result in less right of way dedication on the east side of CSAH 9, depending upon how the corridor develops. However, at this time the corridor right of way width of 150 feet would accommodate both designs.

5.0 Recommendations

Based on the information provided in this Intersection Traffic Control Feasibility Study and the alternative analysis detailed in Section 4.0, the following recommendations are made:

5.1 CSAH 9 at Highview Avenue

- Construct a multi-lane roundabout intersection. (See Concept Layout 1a, illustrated in **Figure 7**).
- Realign CSAH 9 to the north to develop 90 degree approach angles and appropriate approach deflection radii.
- Lower the roadway profile and approach grades on both CSAH 9 and Highview Avenue to reduce the vertical curves, balance earthwork and provide a level roundabout circle.
- Utilize the existing CSAH 9 pavement, abandoned with the realignment, to develop a short frontage road in re-establishing access to the private residential home on the southwest quadrant. The frontage road would access CSAH 9 (right-in/right-out) at a determined appropriate distance upstream from Highview Avenue.
- Acquire sufficient right of way on each intersection quadrant to allow for the flexibility to widen the Highview Avenue entrance/exit flares to two lanes each. This will provide potential and flexibility to extend the design life, if in the future, unforeseen land use changes or traffic patterns occur and additional capacity is found needed.

5.2 CSAH 9 at CSAH 60

- Prior to the extension of CSAH 60, program the installation of a traffic signal system. As part of the signal installation, the eastbound approach should be re-striped to include two eastbound left turn movements. (See Concept Layout 1b, illustrated in **Figure 9**).
- The traffic signal system should be designed and equipment located to require minimal hardware modifications when the future CSAH 60 extension is completed.
- Evaluate the need to obtain a small triangular piece of right of way on the southwest corner. The right of way need will be governed by the final pedestrian ramp and traffic signal pole locations.

- As part of the CSAH 60 extension project, the westbound leg should be constructed as a four-lane divided section with exclusive left and right turn lanes. A southbound left turn and northbound right turn lane should be constructed. (See Concept Layout 3b, illustrated in **Figure 11**).
- The final design should ensure acceptable approach sightlines are maintained.
- The intersection traffic signal phasing will be determined by Dakota County Staff through the final design process. It should be noted, Concept Layout 3b (see **Figure 11**) assumes eastbound/westbound protected/permissive left turn phasing. The installation of protected only left turn phasing is expected to necessitate a dual eastbound left turn lane, Concept Layout 2b (see **Figure 10**).

6.0 Appendices

Appendix A: Collision Diagram – CSAH 9 at Highview Avenue

Appendix B: 24-hour Hourly Approach Volumes

Appendix C: Traffic Signal Warrant Analysis

Appendix D: RODEL Output Files

Appendix A:
Collision Diagram

Dakota County Highway Department

NORTH

MSAS 107
Highview Ave
R.P.: 1.115

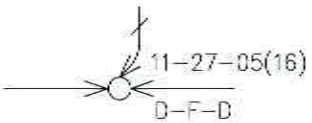
CSAH 9
Dodd Blvd
R.P.: 8.567

Collision Diagram

ACCIDENT TOTALS

2005.....1
2006.....1
2007.....1

DATE PREPARED: 01-28-09
PREPARED BY: PV



ACCIDENTS SUMMARY

3 ACCIDENTS . . . 3 YEARS

1 . . . PERSONAL INJURY
2 . . . PROPERTY DAMAGE

1 . . NB	2 . . EB	1 . . DAY
1 . . SB	1 . . WB	2 . . NIGHT

2 . . CLEAR	3 . . DRY
1 . . FOG	0 . . WET
0 . . SNOW	0 . . ICE
0 . . FOG	0 . . SNOW

ACCIDENTS SUMMARY

1 . . . RIGHT TURN
1 . . . RAN OFF ROAD
1 . . . COLLISION WITH DEER

Standard Symbols

- M V BACKING UP
- MOTOR VEHICLE STOPPED
- PARTY AT FAULT
- OUT OF CONTROL
- OVERTURN
- REAR END
- RIGHT ANGLE
- SCHOOL BUS
- FATAL ACCIDENT
- Ⓐ Ⓑ Ⓒ PERSONAL INJURY
- PROPERTY DAMAGE
- PEDESTRIAN
- BICYCLE
- MOTORCYCLE
- PARKING
- FIXED OBJECT
- ANIMAL

LIGHT:	WEATHER:	SURFACE:
L = DAYLIGHT	C = CLEAR	D = DRY
D = DARK	R = RAINING	W = WET
S = DARK W/ STREET LIGHTS	S = SNOWING	S = SNOW
	F = FOG	I = ICE

INTERSECTION · CSAH 9 & HIGHVIEW AVE · IN LAKEVILLE
FROM 01-01-05 TO 12-31-07 SOURCE MNDOT PRINTOUT

Appendix B:
24-hour Hourly Approach Volumes

Table B-1
CSAH 9 at Highview Avenue
Existing 2007

Raw Approach Volume

Begin Time	NB	SB	EB	WB	Total	NB	SB	EB	WB	Total
12:00 AM	10	16	40	39	105	0.4%	0.5%	0.6%	0.6%	0.6%
1:00 AM	16	4	19	23	62	0.7%	0.1%	0.3%	0.4%	0.3%
2:00 AM	7	3	11	20	41	0.3%	0.1%	0.2%	0.3%	0.2%
3:00 AM	5	3	12	13	33	0.2%	0.1%	0.2%	0.2%	0.2%
4:00 AM	13	8	17	22	60	0.6%	0.3%	0.3%	0.4%	0.3%
5:00 AM	24	39	55	88	206	1.0%	1.2%	0.9%	1.4%	1.1%
6:00 AM	46	85	232	195	558	2.0%	2.7%	3.7%	3.1%	3.1%
7:00 AM	124	186	321	310	941	5.4%	5.9%	5.1%	5.0%	5.2%
8:00 AM	126	170	337	348	981	5.5%	5.4%	5.4%	5.6%	5.5%
9:00 AM	114	162	318	310	904	5.0%	5.2%	5.1%	5.0%	5.0%
10:00 AM	121	187	389	353	1050	5.3%	6.0%	6.2%	5.7%	5.8%
11:00 AM	144	170	344	356	1014	6.3%	5.4%	5.5%	5.7%	5.6%
12:00 PM	151	177	349	384	1061	6.6%	5.6%	5.6%	6.2%	5.9%
1:00 PM	132	179	366	371	1048	5.8%	5.7%	5.8%	5.9%	5.8%
2:00 PM	131	157	372	380	1040	5.7%	5.0%	5.9%	6.1%	5.8%
3:00 PM	156	190	419	433	1198	6.8%	6.0%	6.7%	6.9%	6.7%
4:00 PM	188	242	429	482	1341	8.2%	7.7%	6.8%	7.7%	7.5%
5:00 PM	218	378	471	539	1606	9.5%	12.0%	7.5%	8.6%	8.9%
6:00 PM	156	287	432	481	1356	6.8%	9.1%	6.9%	7.7%	7.6%
7:00 PM	124	171	387	339	1021	5.4%	5.4%	6.2%	5.4%	5.7%
8:00 PM	140	157	436	332	1065	6.1%	5.0%	6.9%	5.3%	5.9%
9:00 PM	85	94	276	216	671	3.7%	3.0%	4.4%	3.5%	3.7%
10:00 PM	39	50	159	137	385	1.7%	1.6%	2.5%	2.2%	2.1%
11:00 PM	20	27	90	70	207	0.9%	0.9%	1.4%	1.1%	1.2%
Total	**2290**	**3142**	**6281**	**6241**	**17954**					
Right Turn Percent	**44.3%**	**45.7%**	**2.0%**	**4.6%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	EB	NB RT	WB	SB RT	
12:00 AM	40	4	39	7	
1:00 AM	19	7	23	2	
2:00 AM	11	3	20	1	
3:00 AM	12	2	13	1	
4:00 AM	17	6	22	4	
5:00 AM	55	11	88	18	
6:00 AM	232	20	195	39	
7:00 AM	321	55	310	85	
8:00 AM	337	56	348	78	
9:00 AM	318	50	310	74	
10:00 AM	389	54	353	86	
11:00 AM	344	64	356	78	
12:00 PM	349	67	384	81	
1:00 PM	366	58	371	82	
2:00 PM	372	58	380	72	
3:00 PM	419	69	433	87	
4:00 PM	429	83	482	111	
5:00 PM	471	96	539	173	**Less than 70% Capacity**
6:00 PM	432	69	481	131	
7:00 PM	387	55	339	78	
8:00 PM	436	62	332	72	
9:00 PM	276	38	216	43	
10:00 PM	159	17	137	23	
11:00 PM	90	9	70	12	

CSAH 9 at Highview Avenue Approach Volumes - Signal Warrant Analysis

Begin Time	NB	SB	EB	WB
12:00 AM	6	9	40	39
1:00 AM	9	2	19	23
2:00 AM	4	2	11	20
3:00 AM	3	2	12	13
4:00 AM	7	4	17	22
5:00 AM	13	21	55	88
6:00 AM	26	46	232	195
7:00 AM	69	101	321	310
8:00 AM	70	92	337	348
9:00 AM	64	88	318	310
10:00 AM	67	101	389	353
11:00 AM	80	92	344	356
12:00 PM	84	96	349	384
1:00 PM	74	97	366	371
2:00 PM	73	85	372	380
3:00 PM	87	103	419	433
4:00 PM	105	131	429	482
5:00 PM	122	205	471	539
6:00 PM	87	156	432	481
7:00 PM	69	93	387	339
8:00 PM	78	85	436	332
9:00 PM	47	51	276	216
10:00 PM	22	27	159	137
11:00 PM	11	15	90	70

Table B-2
CSAH 9 at Highview Avenue
Forecast 2010

2010 Approach Volume

Growth Rate	3.4%	1.2%	2.4%	2.3%						
Begin Time	**NB**	**SB**	**EB**	**WB**	**Total**	**NB**	**SB**	**EB**	**WB**	**Total**
12:00 AM	11	17	43	42	112	0.4%	0.5%	0.6%	0.6%	0.6%
1:00 AM	18	4	20	25	67	0.7%	0.1%	0.3%	0.4%	0.3%
2:00 AM	8	3	12	21	44	0.3%	0.1%	0.2%	0.3%	0.2%
3:00 AM	6	3	13	14	35	0.2%	0.1%	0.2%	0.2%	0.2%
4:00 AM	14	8	18	24	64	0.6%	0.3%	0.3%	0.4%	0.3%
5:00 AM	27	40	59	94	220	1.0%	1.2%	0.9%	1.4%	1.1%
6:00 AM	51	88	249	209	597	2.0%	2.7%	3.7%	3.1%	3.1%
7:00 AM	137	193	344	332	1006	5.4%	5.9%	5.1%	5.0%	5.2%
8:00 AM	139	176	362	373	1050	5.5%	5.4%	5.4%	5.6%	5.5%
9:00 AM	126	168	341	332	967	5.0%	5.2%	5.1%	5.0%	5.0%
10:00 AM	134	194	417	378	1123	5.3%	6.0%	6.2%	5.7%	5.8%
11:00 AM	159	176	369	381	1086	6.3%	5.4%	5.5%	5.7%	5.7%
12:00 PM	167	183	374	411	1136	6.6%	5.6%	5.6%	6.2%	5.9%
1:00 PM	146	185	393	397	1122	5.8%	5.7%	5.8%	5.9%	5.8%
2:00 PM	145	163	399	407	1114	5.7%	5.0%	5.9%	6.1%	5.8%
3:00 PM	172	197	450	464	1283	6.8%	6.0%	6.7%	6.9%	6.7%
4:00 PM	208	251	460	516	1435	8.2%	7.7%	6.8%	7.7%	7.5%
5:00 PM	241	392	505	577	1716	9.5%	12.0%	7.5%	8.6%	8.9%
6:00 PM	172	297	464	515	1449	6.8%	9.1%	6.9%	7.7%	7.5%
7:00 PM	137	177	415	363	1093	5.4%	5.4%	6.2%	5.4%	5.7%
8:00 PM	155	163	468	356	1141	6.1%	5.0%	6.9%	5.3%	5.9%
9:00 PM	94	97	296	231	719	3.7%	3.0%	4.4%	3.5%	3.7%
10:00 PM	43	52	171	147	412	1.7%	1.6%	2.5%	2.2%	2.1%
11:00 PM	22	28	97	75	222	0.9%	0.9%	1.4%	1.1%	1.2%
Total	**2532.175**	**3255.8419**	**6739.8437**	**6685.641**	**19213.5016**					
Right Turn Percent	**44.3%**	**45.7%**	**2.0%**	**4.6%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	EB	NB RT	WB	SB RT	
12:00 AM	43	5	42	8	
1:00 AM	20	8	25	2	
2:00 AM	12	3	21	1	
3:00 AM	13	2	14	1	
4:00 AM	18	6	24	4	
5:00 AM	59	12	94	18	
6:00 AM	249	23	209	40	
7:00 AM	344	61	332	88	
8:00 AM	362	62	373	81	
9:00 AM	341	56	332	77	
10:00 AM	417	59	378	89	
11:00 AM	369	70	381	81	
12:00 PM	374	74	411	84	
1:00 PM	393	65	397	85	
2:00 PM	399	64	407	74	
3:00 PM	450	76	464	90	
4:00 PM	460	92	516	115	
5:00 PM	505	107	577	179	**Less than 70% Capacity**
6:00 PM	464	76	515	136	
7:00 PM	415	61	363	81	
8:00 PM	468	69	356	74	
9:00 PM	296	42	231	45	
10:00 PM	171	19	147	24	
11:00 PM	97	10	75	13	

CSAH 9 at Highview Avenue Approach Volumes - Signal Warrant Analysis

Begin Time	**NB**	**SB**	**EB**	**WB**
12:00 AM	6	9	43	42
1:00 AM	10	2	20	25
2:00 AM	4	2	12	21
3:00 AM	3	2	13	14
4:00 AM	8	4	18	24
5:00 AM	15	22	59	94
6:00 AM	28	48	249	209
7:00 AM	76	105	344	332
8:00 AM	78	96	362	373
9:00 AM	70	91	341	332
10:00 AM	75	105	417	378
11:00 AM	89	96	369	381
12:00 PM	93	100	374	411
1:00 PM	81	101	393	397
2:00 PM	81	88	399	407
3:00 PM	96	107	450	464
4:00 PM	116	136	460	516
5:00 PM	134	213	505	577
6:00 PM	96	161	464	515
7:00 PM	76	96	415	363
8:00 PM	86	88	468	356
9:00 PM	52	53	296	231
10:00 PM	24	28	171	147
11:00 PM	12	15	97	75

Note: Northbound/southbound right turn volume is excluded

Table B-3
CSAH 9 at Highview Avenue
Forecast 2030

2010 Approach Volume

Growth Rate	3.4%	1.2%	2.4%	2.3%						
Begin Time	**NB**	**SB**	**EB**	**WB**	**Total**	**NB**	**SB**	**EB**	**WB**	**Total**
12:00 AM	22	21	69	66	105	0.4%	0.5%	0.6%	0.6%	0.6%
1:00 AM	35	5	33	39	62	0.7%	0.1%	0.3%	0.4%	0.3%
2:00 AM	15	4	19	34	41	0.3%	0.1%	0.2%	0.3%	0.2%
3:00 AM	11	4	21	22	33	0.2%	0.1%	0.2%	0.2%	0.2%
4:00 AM	28	11	29	37	60	0.6%	0.3%	0.3%	0.4%	0.3%
5:00 AM	52	51	94	149	206	1.0%	1.2%	0.9%	1.4%	1.1%
6:00 AM	99	112	398	331	558	2.0%	2.7%	3.7%	3.1%	3.1%
7:00 AM	268	244	551	525	941	5.4%	5.9%	5.1%	5.0%	5.2%
8:00 AM	272	223	579	590	981	5.5%	5.4%	5.4%	5.6%	5.5%
9:00 AM	246	213	546	525	904	5.0%	5.2%	5.1%	5.0%	5.0%
10:00 AM	262	246	668	598	1050	5.3%	6.0%	6.2%	5.7%	5.8%
11:00 AM	311	223	591	603	1014	6.3%	5.4%	5.5%	5.7%	5.6%
12:00 PM	326	233	599	651	1061	6.6%	5.6%	5.6%	6.2%	5.9%
1:00 PM	285	235	628	629	1048	5.8%	5.7%	5.8%	5.9%	5.8%
2:00 PM	283	206	639	644	1040	5.7%	5.0%	5.9%	6.1%	5.8%
3:00 PM	337	250	719	734	1198	6.8%	6.0%	6.7%	6.9%	6.7%
4:00 PM	406	318	737	817	1341	8.2%	7.7%	6.8%	7.7%	7.5%
5:00 PM	471	497	809	914	1606	9.5%	12.0%	7.5%	8.6%	8.9%
6:00 PM	337	377	742	815	1356	6.8%	9.1%	6.9%	7.7%	7.6%
7:00 PM	268	225	664	575	1021	5.4%	5.4%	6.2%	5.4%	5.7%
8:00 PM	303	206	749	563	1065	6.1%	5.0%	6.9%	5.3%	5.9%
9:00 PM	184	123	474	366	671	3.7%	3.0%	4.4%	3.5%	3.7%
10:00 PM	84	66	273	232	385	1.7%	1.6%	2.5%	2.2%	2.1%
11:00 PM	43	35	155	119	207	0.9%	0.9%	1.4%	1.1%	1.2%
Total	**4949.3548**	**4127.7255**	**10784.253**	**10577.966**	**17954**					
Right Turn Percent	**44.3%**	**45.7%**	**2.0%**	**4.6%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	EB	NB RT	WB	SB RT	
12:00 AM	69	10	66	10	
1:00 AM	33	15	39	2	
2:00 AM	19	7	34	2	
3:00 AM	21	5	22	2	
4:00 AM	29	12	37	5	
5:00 AM	94	23	149	23	
6:00 AM	398	44	331	51	
7:00 AM	551	119	525	112	
8:00 AM	579	121	590	102	
9:00 AM	546	109	525	97	
10:00 AM	668	116	598	112	
11:00 AM	591	138	603	102	
12:00 PM	599	144	651	106	
1:00 PM	628	126	629	108	
2:00 PM	639	125	644	94	
3:00 PM	719	149	734	114	
4:00 PM	737	180	817	145	
5:00 PM	809	209	914	227	**Less than 70% Capacity**
6:00 PM	742	149	815	172	
7:00 PM	664	119	575	103	
8:00 PM	749	134	563	94	
9:00 PM	474	81	366	56	
10:00 PM	273	37	232	30	
11:00 PM	155	19	119	16	

CSAH 9 at Highview Avenue Approach Volumes - Signal Warrant Analysis

Begin Time	**NB**	**SB**	**EB**	**WB**
12:00 AM	12	11	69	66
1:00 AM	19	3	33	39
2:00 AM	8	2	19	34
3:00 AM	6	2	21	22
4:00 AM	16	6	29	37
5:00 AM	29	28	94	149
6:00 AM	55	61	398	331
7:00 AM	149	133	551	525
8:00 AM	152	121	579	590
9:00 AM	137	115	546	525
10:00 AM	146	133	668	598
11:00 AM	173	121	591	603
12:00 PM	182	126	599	651
1:00 PM	159	128	628	629
2:00 PM	158	112	639	644
3:00 PM	188	135	719	734
4:00 PM	226	173	737	817
5:00 PM	263	269	809	914
6:00 PM	188	205	742	815
7:00 PM	149	122	664	575
8:00 PM	169	112	749	563
9:00 PM	102	67	474	366
10:00 PM	47	36	273	232
11:00 PM	24	19	155	119

Note: Northbound/southbound right turn volume is excluded

Table B-4
CSAH 9 at CSAH 60
Existing 2007

Raw Approach Volume

Begin Time	NB	SB	EB	WB	Total	NB	SB	EB	WB	
12:00 AM	20	47	23	0	90	0.5%	0.7%	0.5%	0.0%	0.6%
1:00 AM	8	14	7	0	29	0.2%	0.2%	0.2%	0.0%	0.2%
2:00 AM	15	19	19	0	53	0.4%	0.3%	0.4%	0.0%	0.3%
3:00 AM	7	11	4	0	22	0.2%	0.2%	0.1%	0.0%	0.1%
4:00 AM	18	13	15	0	46	0.5%	0.2%	0.3%	0.0%	0.3%
5:00 AM	70	62	81	0	213	1.8%	0.9%	1.8%	0.0%	1.4%
6:00 AM	147	240	146	0	533	3.7%	3.4%	3.3%	0.0%	3.5%
7:00 AM	222	384	230	0	836	5.6%	5.5%	5.1%	0.0%	5.4%
8:00 AM	230	330	255	0	815	5.9%	4.7%	5.7%	0.0%	5.3%
9:00 AM	247	297	279	0	823	6.3%	4.2%	6.2%	0.0%	5.3%
10:00 AM	231	386	202	0	819	5.9%	5.5%	4.5%	0.0%	5.3%
11:00 AM	223	392	261	0	876	5.7%	5.6%	5.8%	0.0%	5.7%
12:00 PM	247	427	250	0	924	6.3%	6.1%	5.6%	0.0%	6.0%
1:00 PM	217	422	224	0	863	5.5%	6.0%	5.0%	0.0%	5.6%
2:00 PM	200	399	257	0	856	5.1%	5.7%	5.7%	0.0%	5.6%
3:00 PM	240	455	285	0	980	6.1%	6.5%	6.4%	0.0%	6.4%
4:00 PM	278	488	358	0	1124	7.1%	7.0%	8.0%	0.0%	7.3%
5:00 PM	335	586	433	0	1354	8.5%	8.4%	9.7%	0.0%	8.8%
6:00 PM	303	528	386	0	1217	7.7%	7.5%	8.6%	0.0%	7.9%
7:00 PM	212	429	235	0	876	5.4%	6.1%	5.3%	0.0%	5.7%
8:00 PM	230	520	220	0	970	5.9%	7.4%	4.9%	0.0%	6.3%
9:00 PM	118	276	158	0	552	3.0%	3.9%	3.5%	0.0%	3.6%
10:00 PM	75	168	98	0	341	1.9%	2.4%	2.2%	0.0%	2.2%
11:00 PM	38	105	44	0	187	1.0%	1.5%	1.0%	0.0%	1.2%
Total	**3931**	**6998**	**4470**	**0**	**15399**					
Right Turn Percent	**0.0%**	**47.0%**	**21.8%**	**0.0%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	NB	WB RT	SB	EB RT	
12:00 AM	20	0	47	5	
1:00 AM	8	0	14	2	
2:00 AM	15	0	19	4	
3:00 AM	7	0	11	1	
4:00 AM	18	0	13	3	
5:00 AM	70	0	62	18	
6:00 AM	147	0	240	32	
7:00 AM	222	0	384	50	
8:00 AM	230	0	330	56	
9:00 AM	247	0	297	61	
10:00 AM	231	0	386	44	
11:00 AM	223	0	392	57	
12:00 PM	247	0	427	54	
1:00 PM	217	0	422	49	
2:00 PM	200	0	399	56	
3:00 PM	240	0	455	62	
4:00 PM	278	0	488	78	
5:00 PM	335	0	586	94	**Less than 70% Capacity**
6:00 PM	303	0	528	84	
7:00 PM	212	0	429	51	
8:00 PM	230	0	520	48	
9:00 PM	118	0	276	34	
10:00 PM	75	0	168	21	
11:00 PM	38	0	105	10	

CSAH 9 at CSAH 60 Approach Volumes - Signal Warrant Analysis

Begin Time	NB	SB	EB	WB
12:00 AM	20	47	18	0
1:00 AM	8	14	5	0
2:00 AM	15	19	15	0
3:00 AM	7	11	3	0
4:00 AM	18	13	12	0
5:00 AM	70	62	63	0
6:00 AM	147	240	114	0
7:00 AM	222	384	180	0
8:00 AM	230	330	199	0
9:00 AM	247	297	218	0
10:00 AM	231	386	158	0
11:00 AM	223	392	204	0
12:00 PM	247	427	196	0
1:00 PM	217	422	175	0
2:00 PM	200	399	201	0
3:00 PM	240	455	223	0
4:00 PM	278	488	280	0
5:00 PM	335	586	339	0
6:00 PM	303	528	302	0
7:00 PM	212	429	184	0
8:00 PM	230	520	172	0
9:00 PM	118	276	124	0
10:00 PM	75	168	77	0
11:00 PM	38	105	34	0

Table B-5
CSAH 9 at CSAH 60
Forecast 2010 - Without CSAH 60 Extension

Raw Approach Volume

Growth Rate	3.0%	2.6%	3.0%							
Begin Time	**NB**	**SB**	**EB**	**WB**	**Total**	**NB**	**SB**	**EB**	**WB**	
12:00 AM	22	51	25	0	98	0.5%	0.7%	0.5%	0.0%	0.6%
1:00 AM	9	15	8	0	32	0.2%	0.2%	0.2%	0.0%	0.2%
2:00 AM	16	21	21	0	58	0.4%	0.3%	0.4%	0.0%	0.3%
3:00 AM	8	12	4	0	24	0.2%	0.2%	0.1%	0.0%	0.1%
4:00 AM	20	14	16	0	50	0.5%	0.2%	0.3%	0.0%	0.3%
5:00 AM	76	67	88	0	232	1.8%	0.9%	1.8%	0.0%	1.4%
6:00 AM	161	259	159	0	579	3.7%	3.4%	3.3%	0.0%	3.5%
7:00 AM	242	415	251	0	908	5.6%	5.5%	5.1%	0.0%	5.4%
8:00 AM	251	357	278	0	886	5.9%	4.7%	5.7%	0.0%	5.3%
9:00 AM	270	321	305	0	895	6.3%	4.2%	6.2%	0.0%	5.3%
10:00 AM	252	417	221	0	890	5.9%	5.5%	4.5%	0.0%	5.3%
11:00 AM	244	424	285	0	952	5.7%	5.6%	5.8%	0.0%	5.7%
12:00 PM	270	461	273	0	1,004	6.3%	6.1%	5.6%	0.0%	6.0%
1:00 PM	237	456	245	0	937	5.5%	6.0%	5.0%	0.0%	5.6%
2:00 PM	218	431	281	0	930	5.1%	5.7%	5.7%	0.0%	5.6%
3:00 PM	262	492	311	0	1,065	6.1%	6.5%	6.4%	0.0%	6.4%
4:00 PM	304	527	391	0	1,222	7.1%	7.0%	8.0%	0.0%	7.3%
5:00 PM	366	633	473	0	1,472	8.5%	8.4%	9.7%	0.0%	8.8%
6:00 PM	331	570	422	0	1,323	7.7%	7.5%	8.6%	0.0%	7.9%
7:00 PM	231	463	257	0	952	5.4%	6.1%	5.3%	0.0%	5.7%
8:00 PM	251	562	240	0	1,053	5.9%	7.4%	4.9%	0.0%	6.3%
9:00 PM	129	298	173	0	600	3.0%	3.9%	3.5%	0.0%	3.6%
10:00 PM	82	182	107	0	370	1.9%	2.4%	2.2%	0.0%	2.2%
11:00 PM	41	113	48	0	203	1.0%	1.5%	1.0%	0.0%	1.2%
Total	**4,292**	**7,560**	**4,882**	**0**	**16,735**					
Right Turn Percent	**0.0%**	**47.0%**	**21.8%**	**0.0%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	NB	WB RT	SB	EB RT	
12:00 AM	22	0	51	5	
1:00 AM	9	0	15	2	
2:00 AM	16	0	21	5	
3:00 AM	8	0	12	1	
4:00 AM	20	0	14	4	
5:00 AM	76	0	67	19	
6:00 AM	161	0	259	35	
7:00 AM	242	0	415	55	
8:00 AM	251	0	357	61	
9:00 AM	270	0	321	66	
10:00 AM	252	0	417	48	
11:00 AM	244	0	424	62	
12:00 PM	270	0	461	60	
1:00 PM	237	0	456	53	
2:00 PM	218	0	431	61	
3:00 PM	262	0	492	68	
4:00 PM	304	0	527	85	
5:00 PM	366	0	633	103	**Less than 70% Capacity**
6:00 PM	331	0	570	92	
7:00 PM	231	0	463	56	
8:00 PM	251	0	562	52	
9:00 PM	129	0	298	38	
10:00 PM	82	0	182	23	
11:00 PM	41	0	113	10	

CSAH 9 at CSAH 60 Approach Volumes - Signal Warrant Analysis

Begin Time	**NB**	**SB**	**EB**	**WB**
12:00 AM	22	51	20	0
1:00 AM	9	15	6	0
2:00 AM	16	21	16	0
3:00 AM	8	12	3	0
4:00 AM	20	14	13	0
5:00 AM	76	67	69	0
6:00 AM	161	259	125	0
7:00 AM	242	415	196	0
8:00 AM	251	357	218	0
9:00 AM	270	321	238	0
10:00 AM	252	417	173	0
11:00 AM	244	424	223	0
12:00 PM	270	461	214	0
1:00 PM	237	456	191	0
2:00 PM	218	431	220	0
3:00 PM	262	492	243	0
4:00 PM	304	527	306	0
5:00 PM	366	633	370	0
6:00 PM	331	570	330	0
7:00 PM	231	463	201	0
8:00 PM	251	562	188	0
9:00 PM	129	298	135	0
10:00 PM	82	182	84	0
11:00 PM	41	113	38	0

Note: Eastbound right turn volume is excluded

Table B-6
CSAH 9 at CSAH 60
Forecast 2030 - Without CSAH 60 Extension

Raw Approach Volume

Growth Rate	3.0%	2.6%	3.0%							
Begin Time	**NB**	**SB**	**EB**	**WB**	**Total**	**NB**	**SB**	**EB**	**WB**	
12:00 AM	39	85	45	0	169	0.5%	0.7%	0.5%	0.0%	0.6%
1:00 AM	16	25	14	0	55	0.2%	0.2%	0.2%	0.0%	0.2%
2:00 AM	29	34	37	0	101	0.4%	0.3%	0.4%	0.0%	0.3%
3:00 AM	14	20	8	0	41	0.2%	0.2%	0.1%	0.0%	0.1%
4:00 AM	35	24	29	0	88	0.5%	0.2%	0.3%	0.0%	0.3%
5:00 AM	137	112	159	0	409	1.8%	0.9%	1.8%	0.0%	1.4%
6:00 AM	289	434	287	0	1,010	3.7%	3.4%	3.3%	0.0%	3.5%
7:00 AM	436	695	452	0	1,582	5.6%	5.5%	5.1%	0.0%	5.4%
8:00 AM	451	597	501	0	1,549	5.9%	4.7%	5.7%	0.0%	5.3%
9:00 AM	485	537	548	0	1,570	6.3%	4.2%	6.2%	0.0%	5.4%
10:00 AM	453	698	397	0	1,548	5.9%	5.5%	4.5%	0.0%	5.3%
11:00 AM	438	709	513	0	1,660	5.7%	5.6%	5.8%	0.0%	5.7%
12:00 PM	485	772	491	0	1,748	6.3%	6.1%	5.6%	0.0%	6.0%
1:00 PM	426	763	440	0	1,629	5.5%	6.0%	5.0%	0.0%	5.6%
2:00 PM	393	722	505	0	1,619	5.1%	5.7%	5.7%	0.0%	5.6%
3:00 PM	471	823	560	0	1,854	6.1%	6.5%	6.4%	0.0%	6.4%
4:00 PM	546	883	703	0	2,132	7.1%	7.0%	8.0%	0.0%	7.3%
5:00 PM	658	1,060	851	0	2,568	8.5%	8.4%	9.7%	0.0%	8.8%
6:00 PM	595	955	758	0	2,308	7.7%	7.5%	8.6%	0.0%	7.9%
7:00 PM	416	776	462	0	1,654	5.4%	6.1%	5.3%	0.0%	5.7%
8:00 PM	451	940	432	0	1,824	5.9%	7.4%	4.9%	0.0%	6.3%
9:00 PM	232	499	310	0	1,041	3.0%	3.9%	3.5%	0.0%	3.6%
10:00 PM	147	304	193	0	644	1.9%	2.4%	2.2%	0.0%	2.2%
11:00 PM	75	190	86	0	351	1.0%	1.5%	1.0%	0.0%	1.2%
Total	**7,716**	**12,657**	**8,784**	**0**	**29,157**					
Right Turn Percent	**0.0%**	**47.0%**	**21.8%**	**0.0%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	NB	WB RT	SB	EB RT	
12:00 AM	39	0	85	10	
1:00 AM	16	0	25	3	
2:00 AM	29	0	34	8	
3:00 AM	14	0	20	2	
4:00 AM	35	0	24	6	
5:00 AM	137	0	112	35	
6:00 AM	289	0	434	63	
7:00 AM	436	0	695	98	
8:00 AM	451	0	597	109	
9:00 AM	485	0	537	119	
10:00 AM	453	0	698	87	
11:00 AM	438	0	709	112	
12:00 PM	485	0	772	107	
1:00 PM	426	0	763	96	
2:00 PM	393	0	722	110	
3:00 PM	471	0	823	122	
4:00 PM	546	0	883	153	
5:00 PM	658	0	1060	185	**More than 70% Capacity**
6:00 PM	595	0	955	165	
7:00 PM	416	0	776	101	
8:00 PM	451	0	940	94	
9:00 PM	232	0	499	68	
10:00 PM	147	0	304	42	
11:00 PM	75	0	190	19	

CSAH 9 at CSAH 60 Approach Volumes - Signal Warrant Analysis

Begin Time	**NB**	**SB**	**EB**	**WB**
12:00 AM	39	85	40	0
1:00 AM	16	25	12	0
2:00 AM	29	34	33	0
3:00 AM	14	20	7	0
4:00 AM	35	24	26	0
5:00 AM	137	112	142	0
6:00 AM	289	434	256	0
7:00 AM	436	695	403	0
8:00 AM	451	597	446	0
9:00 AM	485	537	488	0
10:00 AM	453	698	354	0
11:00 AM	438	709	457	0
12:00 PM	485	772	438	0
1:00 PM	426	763	392	0
2:00 PM	393	722	450	0
3:00 PM	471	823	499	0
4:00 PM	546	883	627	0
5:00 PM	658	1060	758	0
6:00 PM	595	955	676	0
7:00 PM	416	776	411	0
8:00 PM	451	940	385	0
9:00 PM	232	499	277	0
10:00 PM	147	304	172	0
11:00 PM	75	190	77	0

Note: 50% of the eastbound right turn volume is included

Table B-7
CSAH 9 at CSAH 60
Forecast 2030 - With CSAH 60 Extension

Raw Approach Volume

Forecast App. ADT	8,435	9,615	13,750	9,100						
Begin Time	**NB**	**SB**	**EB**	**WB**	**Total**	**NB**	**SB**	**EB**	**WB**	
12:00 AM	43	65	71	47	225	0.5%	0.7%	0.5%	0.5%	0.6%
1:00 AM	17	19	22	14	72	0.2%	0.2%	0.2%	0.2%	0.2%
2:00 AM	32	26	58	39	155	0.4%	0.3%	0.4%	0.4%	0.4%
3:00 AM	15	15	12	8	51	0.2%	0.2%	0.1%	0.1%	0.1%
4:00 AM	39	18	46	31	133	0.5%	0.2%	0.3%	0.3%	0.3%
5:00 AM	150	85	249	165	649	1.8%	0.9%	1.8%	1.8%	1.6%
6:00 AM	315	330	449	297	1,392	3.7%	3.4%	3.3%	3.3%	3.4%
7:00 AM	476	528	707	468	2,180	5.6%	5.5%	5.1%	5.1%	5.3%
8:00 AM	494	453	784	519	2,250	5.9%	4.7%	5.7%	5.7%	5.5%
9:00 AM	530	408	858	568	2,364	6.3%	4.2%	6.2%	6.2%	5.8%
10:00 AM	496	530	621	411	2,059	5.9%	5.5%	4.5%	4.5%	5.0%
11:00 AM	479	539	803	531	2,351	5.7%	5.6%	5.8%	5.8%	5.7%
12:00 PM	530	587	769	509	2,395	6.3%	6.1%	5.6%	5.6%	5.9%
1:00 PM	466	580	689	456	2,191	5.5%	6.0%	5.0%	5.0%	5.4%
2:00 PM	429	548	791	523	2,291	5.1%	5.7%	5.7%	5.7%	5.6%
3:00 PM	515	625	877	580	2,597	6.1%	6.5%	6.4%	6.4%	6.3%
4:00 PM	597	670	1,101	729	3,097	7.1%	7.0%	8.0%	8.0%	7.6%
5:00 PM	719	805	1,332	882	3,737	8.5%	8.4%	9.7%	9.7%	9.1%
6:00 PM	650	725	1,187	786	3,349	7.7%	7.5%	8.6%	8.6%	8.2%
7:00 PM	455	589	723	478	2,246	5.4%	6.1%	5.3%	5.3%	5.5%
8:00 PM	494	714	677	448	2,333	5.9%	7.4%	4.9%	4.9%	5.7%
9:00 PM	253	379	486	322	1,440	3.0%	3.9%	3.5%	3.5%	3.5%
10:00 PM	161	231	301	200	893	1.9%	2.4%	2.2%	2.2%	2.2%
11:00 PM	82	144	135	90	451	1.0%	1.5%	1.0%	1.0%	1.1%
Total	**8,435**	**9,615**	**13,750**	**9,100**	**40,900**					
Right Turn Percent	**29.1%**	**51.7%**	**16.4%**	**4.5%**						
Remove RT	**Yes**									

Right Turn Capacity Check

Begin Time	EB	NB RT	WB	SB RT	
12:00 AM	71	12	47	33	
1:00 AM	22	5	14	10	
2:00 AM	58	9	39	14	
3:00 AM	12	4	8	8	
4:00 AM	46	11	31	9	
5:00 AM	249	44	165	44	
6:00 AM	449	92	297	171	
7:00 AM	707	139	468	273	
8:00 AM	784	144	519	235	
9:00 AM	858	154	568	211	
10:00 AM	621	144	411	274	
11:00 AM	803	139	531	279	
12:00 PM	769	154	509	303	
1:00 PM	689	135	456	300	
2:00 PM	791	125	523	284	
3:00 PM	877	150	580	323	
4:00 PM	1101	173	729	347	
5:00 PM	1332	209	882	416	**More than 70% Capacity**
6:00 PM	1187	189	786	375	
7:00 PM	723	132	478	305	
8:00 PM	677	144	448	370	
9:00 PM	486	74	322	196	
10:00 PM	301	47	200	119	
11:00 PM	135	24	90	75	

CSAH 9 at CSAH 60 Approach Volumes - Signal Warrant Analysis

Begin Time	**NB**	**SB**	**EB**	**WB**
12:00 AM	37	48	71	47
1:00 AM	15	14	22	14
2:00 AM	28	19	58	39
3:00 AM	13	11	12	8
4:00 AM	33	13	46	31
5:00 AM	128	63	249	165
6:00 AM	270	244	449	297
7:00 AM	407	391	707	468
8:00 AM	422	336	784	519
9:00 AM	453	303	858	568
10:00 AM	424	393	621	411
11:00 AM	409	399	803	531
12:00 PM	453	435	769	509
1:00 PM	398	430	689	456
2:00 PM	367	406	791	523
3:00 PM	440	463	877	580
4:00 PM	510	497	1101	729
5:00 PM	614	597	1332	882
6:00 PM	556	538	1187	786
7:00 PM	389	437	723	478
8:00 PM	422	530	677	448
9:00 PM	216	281	486	322
10:00 PM	138	171	301	200
11:00 PM	70	107	135	90

Note: 50% of the northbound and southbound right turn volume is included

Appendix C:
Traffic Signal Warrant Analysis

TABLE C-1
SIGNAL WARRANT ANALYSIS - 2010 FORECAST
WARRANT 1
LOCATION: **CSAH 9 at Highview Avenue**

Count Date: **2010 Forecast**
Source: See Footnote
Factor: 1.00
Population < 10,000? NO
Speed over 40 mph? YES

APPROACH	DESCRIPTION	NUMBER OF LANES	SPEED (MPH)
Major Approach 1	CSAH 9, West Approach, EB	4	55
Major Approach 3	CSAH 9, East Approach, WB	4	55
Minor Approach 2	Highview Avenue, South Approach, NB	2	55
Minor Approach 4	Highview Avenue, North Approach, SB	2	45

If population is less than 10,000; or the major street speed is over 40 mph, seventy percent factor can be applied. Apply seventy percent factor? YES

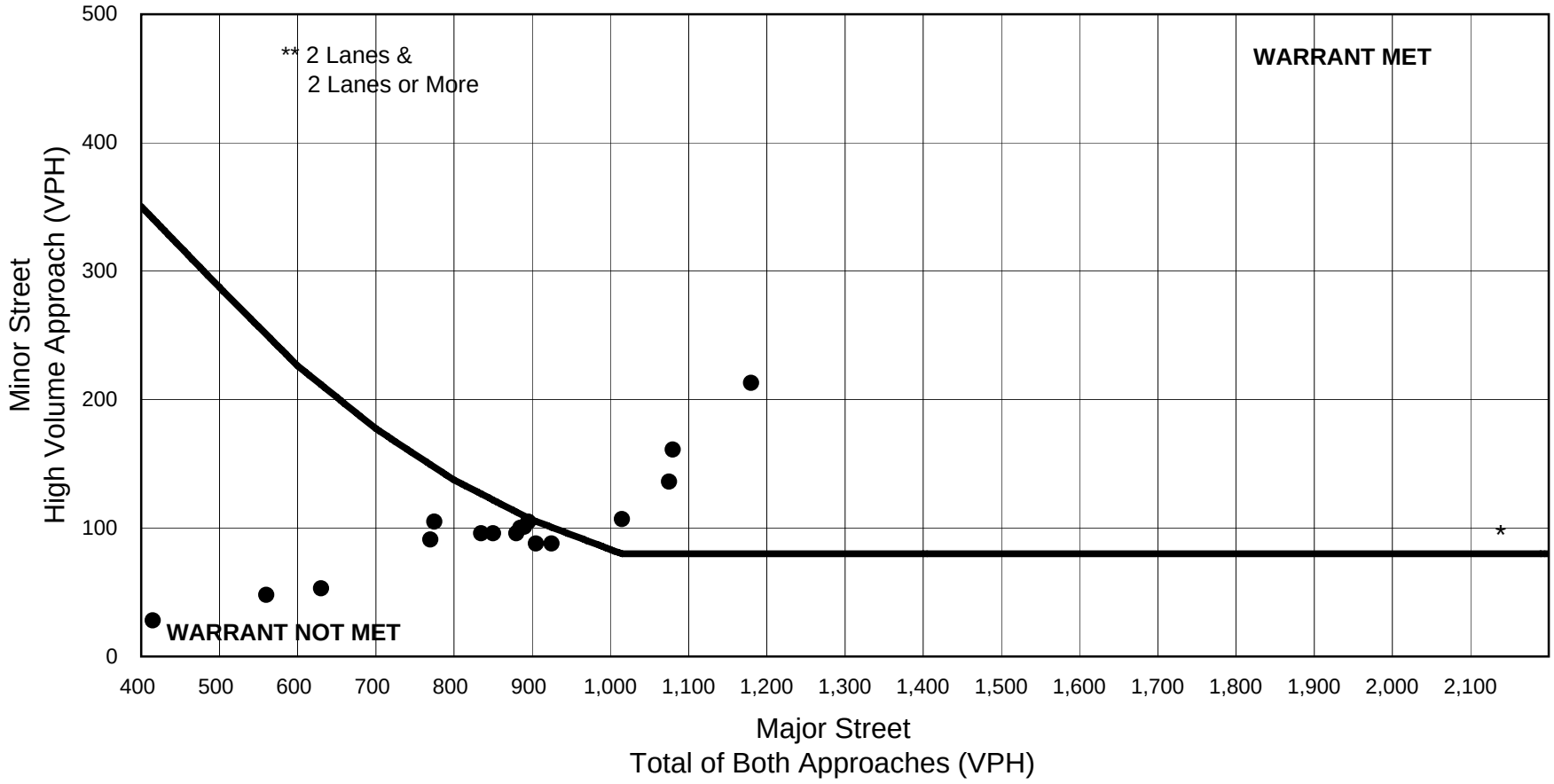
	MAJOR STREET							MINOR STREET									WARRANT MET SAME HOURS ON MAJOR AND MINOR STREETS			
	APPROACH VOLUME			WARRANT MET *				APPROACH VOLUME		WARRANT MET APPROACH 2 *				WARRANT MET APPROACH 4 *						
				Cond. A	Cond. B	7 & (A&B) Comb.				Cond. A	Cond. B	7 & (A&B) Comb.		Cond. A	Cond. B	7 & (A&B) Comb.				
			TOTAL			80% of A	80% of B					80% of A	80% of B			80% of A	80% of B			7 & (A&B) Comb.
HOUR	1	3	1 + 3	420	630	336	504	2	4	140	70	112	56	140	70	112	56	Cond. A	Cond. B	80% of A	80% of B
12 - 1 AM	43	42	85					6	9												
1 - 2 AM	20	25	45					10	2												
2 - 3 AM	12	21	33					4	2												
3 - 4 AM	13	14	27					3	2												
4 - 5 AM	18	24	42					8	4												
5 - 6 AM	59	94	153					15	22												
6 - 7 AM	249	209	458	X		X		28	48												
7 - 8 AM	344	332	677	X	X	X	X	76	105		X		X		X		X		X		X
8 - 9 AM	362	373	734	X	X	X	X	78	96		X		X		X		X		X		X
9 - 10 AM	341	332	673	X	X	X	X	70	91		X		X		X		X		X		X
10 - 11 AM	417	378	796	X	X	X	X	75	105		X		X		X		X		X		X
11 - Noon	369	381	750	X	X	X	X	89	96		X		X		X		X		X		X
12 - 1 PM	374	411	786	X	X	X	X	93	100		X		X		X		X		X		X
1 - 2 PM	393	397	790	X	X	X	X	81	101		X		X		X		X		X		X
2 - 3 PM	399	407	806	X	X	X	X	81	88		X		X		X		X		X		X
3 - 4 PM	450	464	913	X	X	X	X	96	107		X		X		X		X		X		X
4 - 5 PM	460	516	977	X	X	X	X	116	136		X	X	X		X	X	X		X	X	X
5 - 6 PM	505	577	1,083	X	X	X	X	134	213		X	X	X	X	X	X	X	X	X	X	X
6 - 7 PM	464	515	979	X	X	X	X	96	161		X		X	X	X	X	X	X	X	X	X
7 - 8 PM	415	363	778	X	X	X	X	76	96		X		X		X		X		X		X
8 - 9 PM	468	356	824	X	X	X	X	86	88		X		X		X		X		X		X
9 - 10 PM	296	231	528	X		X	X	52	53												
10 - 11 PM	171	147	317					24	28												
11 - Midnight	97	75	172					12	15												

SUMMARY OF RESULTS:

Warrant 1 - Cond. A was	not met:	2	hours satisfied requirements
Warrant 1 - Cond. B was	met:	14	hours satisfied requirements
Warrant 1 - Combine A & B was	not met:	3	hours satisfied requirements

Note:
* Warrant volume requirements are from the 2005 Minnesota Manual on Uniform Traffic Control Devices.

Source: Alliant Engineering, Inc. and using background growth rates provided by Dakota County.



Warrant Met for 4 Hours

* NOTE: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

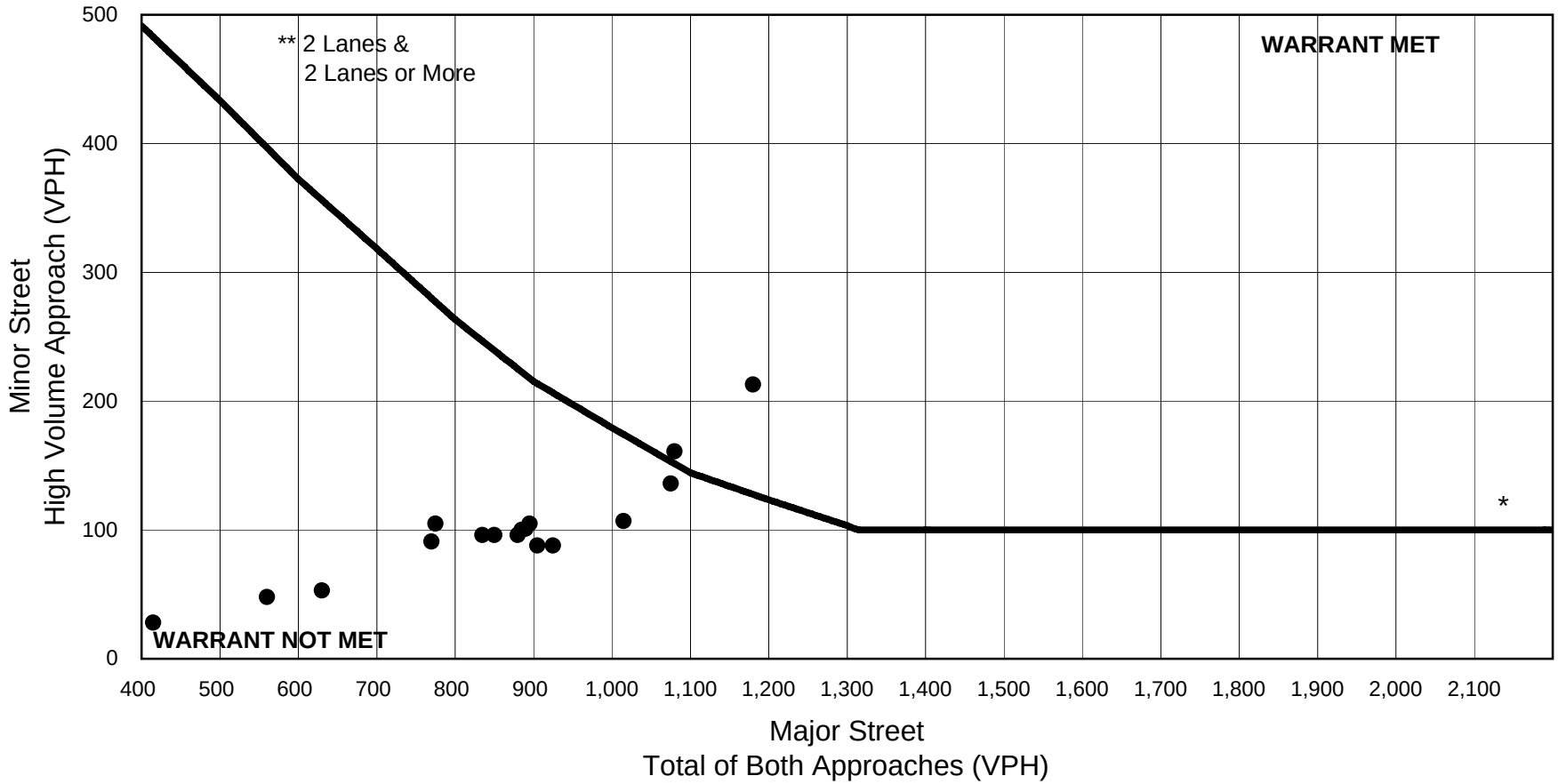
** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at Highview Avenue
SIGNAL WARRANT ANALYSIS
Forecast 2010 Weekday Volume

TABLE C-2
WARRANT 2
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

2010 Warrant Analysis_9 at Highview.xls(4Hr70%), 2/25/2009



Warrant Met for 2 Hours

* NOTE: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at Highview Avenue
SIGNAL WARRANT ANALYSIS
Forecast 2010 Weekday Volume

TABLE C-3
WARRANT 3
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

2010 Warrant Analysis_9 at Highview.xls(PkHr70%), 2/25/2009

TABLE C-4
SIGNAL WARRANT ANALYSIS - 2030 FORECAST
WARRANT 1
LOCATION: **CSAH 9 at Highview Avenue**

Count Date: **2030 Forecast**
Source: See Footnote
Factor: 1.00
Population < 10,000? NO
Speed over 40 mph? YES

APPROACH	DESCRIPTION	NUMBER OF LANES	SPEED (MPH)
Major Approach 1	CSAH 9, West Approach, EB	4	55
Major Approach 3	CSAH 9, East Approach, WB	4	55
Minor Approach 2	Highview Avenue, South Approach, NB	2	55
Minor Approach 4	Highview Avenue, North Approach, SB	2	45

If population is less than 10,000; or the major street speed is over 40 mph, seventy percent factor can be applied. Apply seventy percent factor? YES

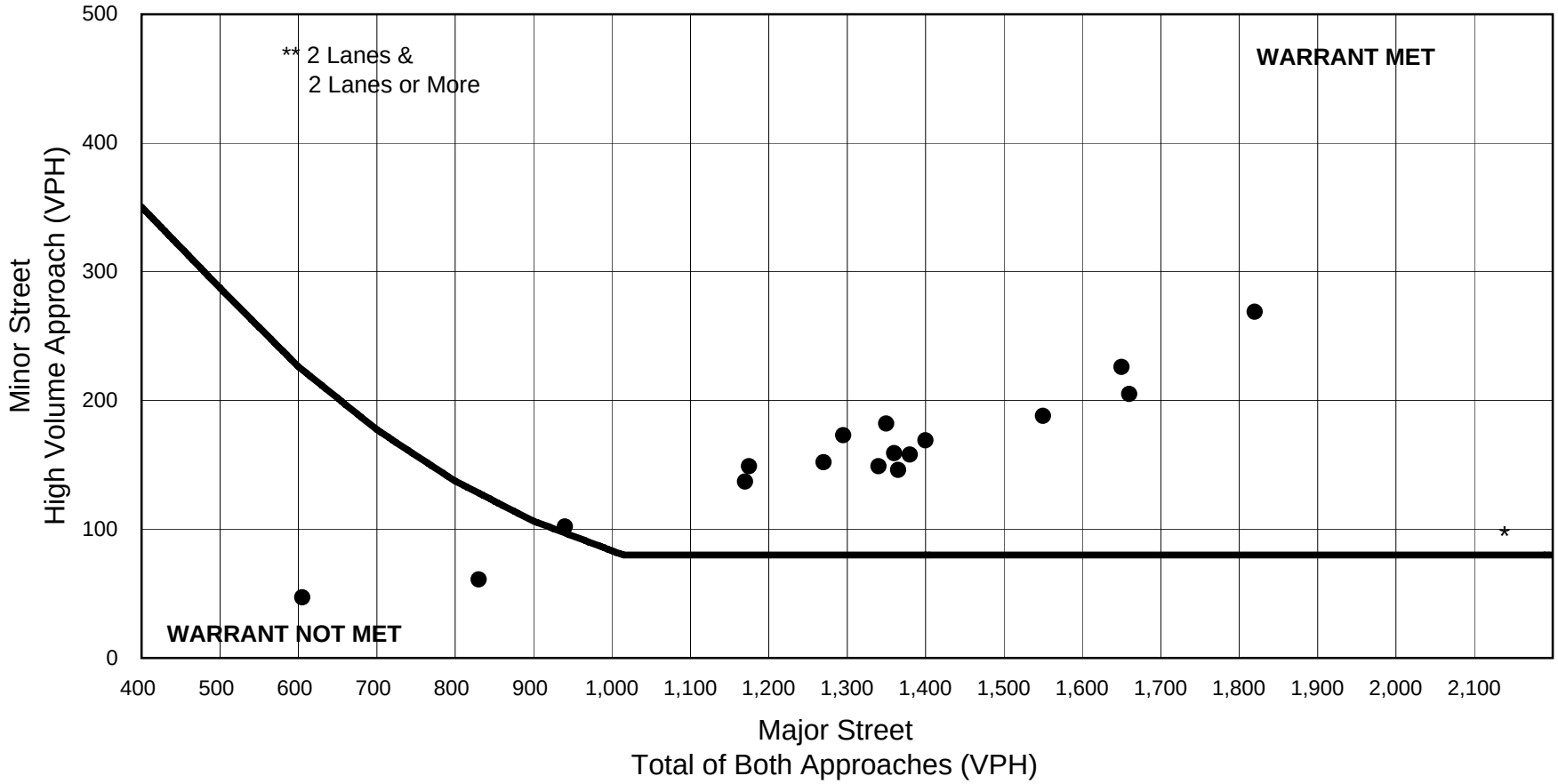
	MAJOR STREET							MINOR STREET									WARRANT MET SAME HOURS ON MAJOR AND MINOR STREETS			
	APPROACH VOLUME			WARRANT MET *				APPROACH VOLUME		WARRANT MET APPROACH 2 *				WARRANT MET APPROACH 4 *						
				Cond. A	Cond. B	7 & (A&B) Comb.				Cond. A	Cond. B	7 & (A&B) Comb.		Cond. A	Cond. B	7 & (A&B) Comb.				
			TOTAL			80% of A	80% of B					80% of A	80% of B			80% of A	80% of B			7 & (A&B) Comb.
HOUR	1	3	1 + 3	420	630	336	504	2	4	140	70	112	56	140	70	112	56	Cond. A	Cond. B	80% of A	80% of B
12 - 1 AM	69	66	135					12	11												
1 - 2 AM	33	39	72					19	3												
2 - 3 AM	19	34	53					8	2												
3 - 4 AM	21	22	43					6	2												
4 - 5 AM	29	37	66					16	6												
5 - 6 AM	94	149	244					29	28												
6 - 7 AM	398	331	729	X	X	X	X	55	61								X				X
7 - 8 AM	551	525	1,077	X	X	X	X	149	133	X	X	X	X		X	X	X	X	X	X	X
8 - 9 AM	579	590	1,168	X	X	X	X	152	121	X	X	X	X		X	X	X	X	X	X	X
9 - 10 AM	546	525	1,071	X	X	X	X	137	115		X	X	X		X	X	X		X	X	X
10 - 11 AM	668	598	1,266	X	X	X	X	146	133	X	X	X	X		X	X	X	X	X	X	X
11 - Noon	591	603	1,194	X	X	X	X	173	121	X	X	X	X		X	X	X	X	X	X	X
12 - 1 PM	599	651	1,250	X	X	X	X	182	126	X	X	X	X		X	X	X	X	X	X	X
1 - 2 PM	628	629	1,257	X	X	X	X	159	128	X	X	X	X		X	X	X	X	X	X	X
2 - 3 PM	639	644	1,283	X	X	X	X	158	112	X	X	X	X		X		X	X	X	X	X
3 - 4 PM	719	734	1,453	X	X	X	X	188	135	X	X	X	X		X	X	X	X	X	X	X
4 - 5 PM	737	817	1,554	X	X	X	X	226	173	X	X	X	X	X	X	X	X	X	X	X	X
5 - 6 PM	809	914	1,722	X	X	X	X	263	269	X	X	X	X	X	X	X	X	X	X	X	X
6 - 7 PM	742	815	1,557	X	X	X	X	188	205	X	X	X	X	X	X	X	X	X	X	X	X
7 - 8 PM	664	575	1,239	X	X	X	X	149	122	X	X	X	X		X	X	X	X	X	X	X
8 - 9 PM	749	563	1,311	X	X	X	X	169	112	X	X	X	X		X		X	X	X	X	X
9 - 10 PM	474	366	840	X	X	X	X	102	67		X		X				X		X		X
10 - 11 PM	273	232	505	X		X	X	47	36												
11 - Midnight	155	119	273					24	19												

SUMMARY OF RESULTS:

Warrant 1 - Cond. A was	met:	13	hours satisfied requirements
Warrant 1 - Cond. B was	met:	15	hours satisfied requirements
Warrant 1 - Combine A & B was	met:	14	hours satisfied requirements

Note:
* Warrant volume requirements are from the 2005 Minnesota Manual on Uniform Traffic Control Devices.

Source: Alliant Engineering, Inc. and using background growth rates provided by Dakota County.



Warrant Met for 15 Hours

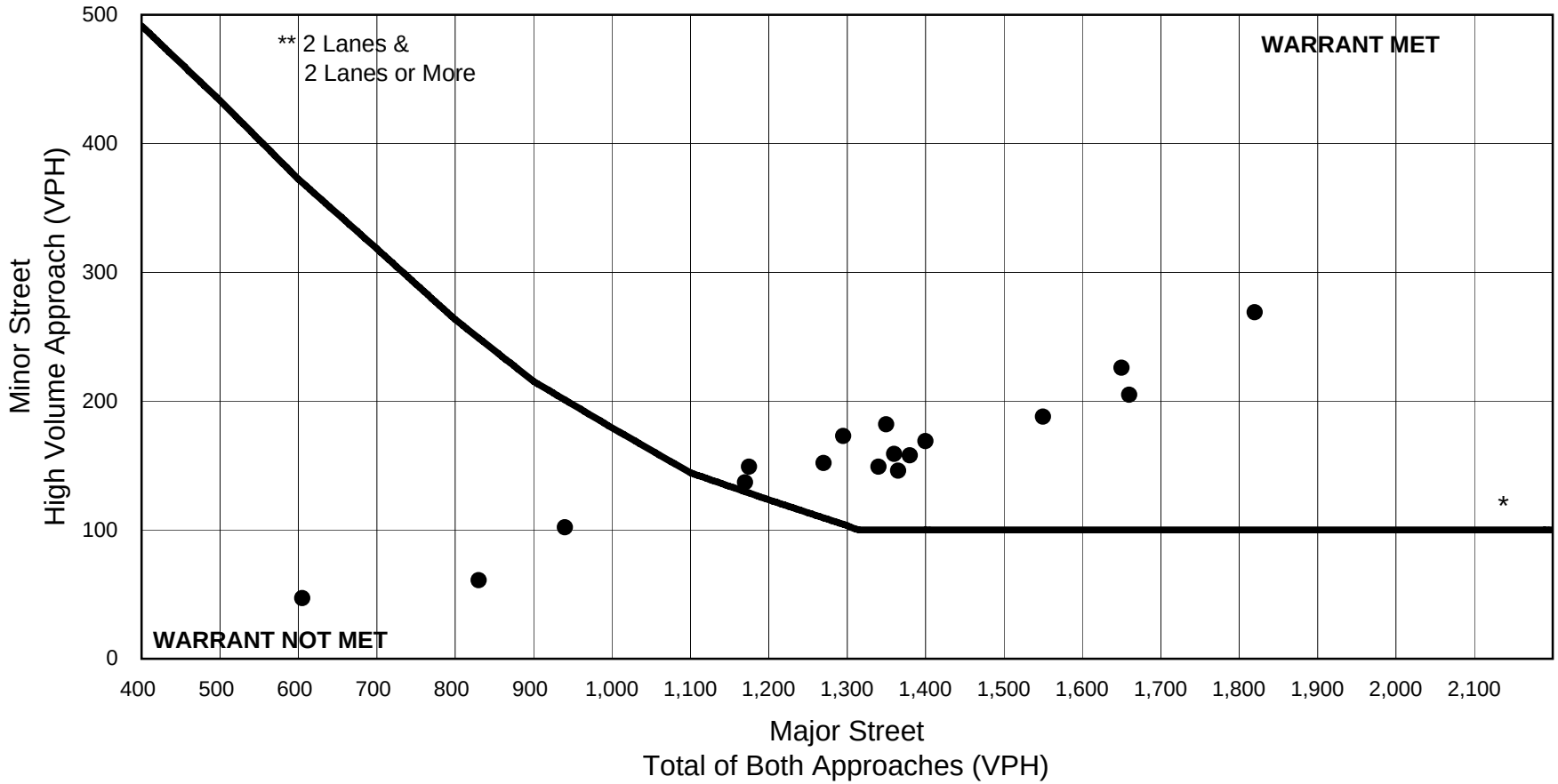
* NOTE: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at Highview Avenue
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-5
WARRANT 2
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD



Warrant Met for 14 Hours

* NOTE: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at Highview Avenue
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-6
WARRANT 3
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

TABLE C-7
SIGNAL WARRANT ANALYSIS - 2010 FORECAST WITHOUT EXTENSION
WARRANT 1
LOCATION: **CSAH 9 at CSAH 60**

Count Date: **2010 Forecast - Without Extension**
Source: See Footnote
Factor: 1.00
Population < 10,000? NO
Speed over 40 mph? YES

APPROACH	DESCRIPTION	NUMBER OF LANES	SPEED (MPH)
Major Approach 1	CSAH 9, South Approach, NB	3	55
Major Approach 3	CSAH 9, North Approach, SB	3	55
Minor Approach 2	CSAH 60, West Approach, EB	2	45
Minor Approach 4	--		

If population is less than 10,000; or the major street speed is over 40 mph, seventy percent factor can be applied. Apply seventy percent factor? YES

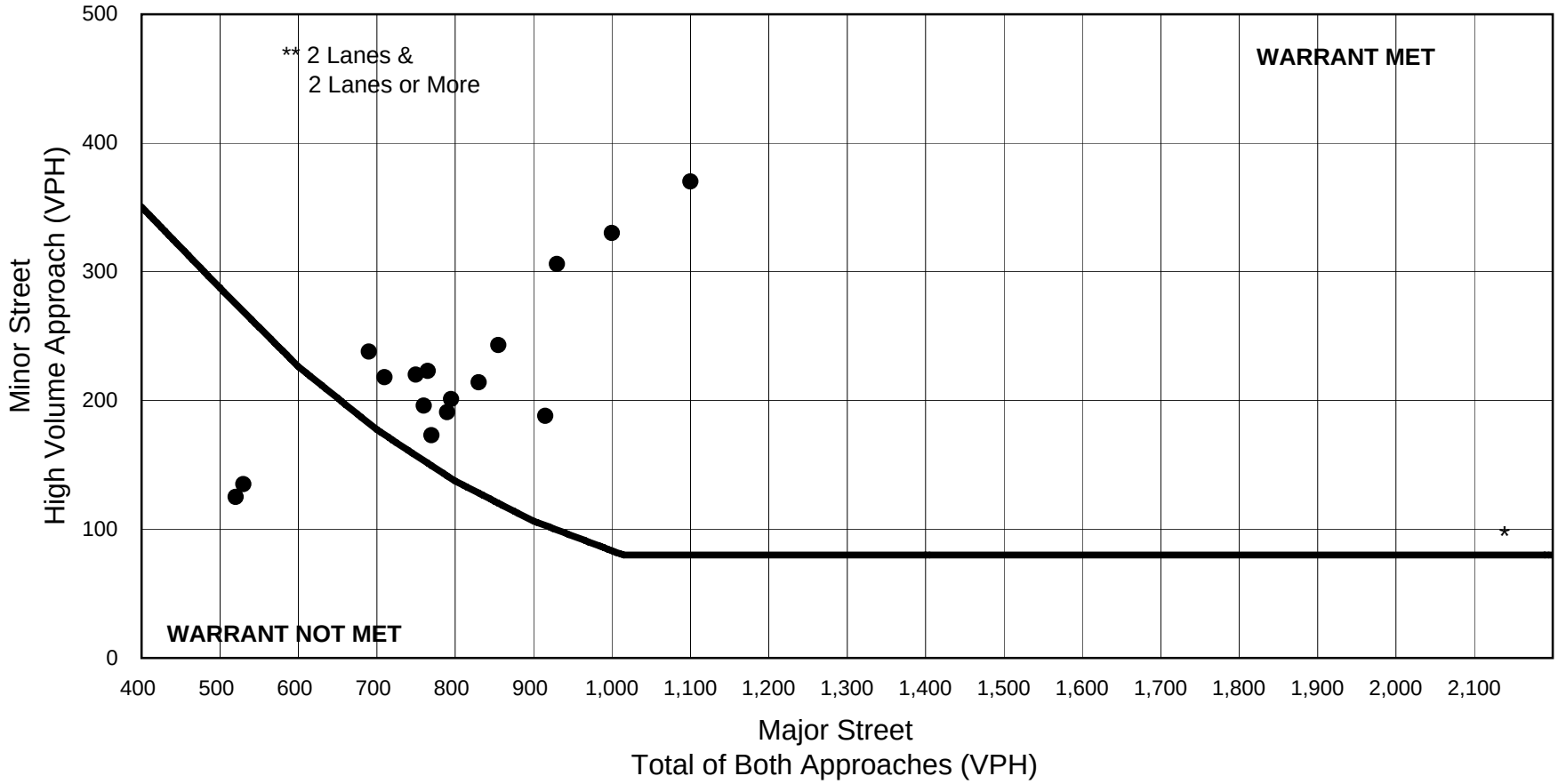
	MAJOR STREET							MINOR STREET									WARRANT MET SAME HOURS ON MAJOR AND MINOR STREETS			
	APPROACH VOLUME			WARRANT MET *				APPROACH VOLUME		WARRANT MET APPROACH 2 *				WARRANT MET APPROACH 4 *						
				Cond. A	Cond. B	7 & (A&B) Comb.				Cond. A	Cond. B	7 & (A&B) Comb.		Cond. A	Cond. B	7 & (A&B) Comb.				7 & (A&B) Comb.
			TOTAL			80% of A	80% of B					80% of A	80% of B			80% of A	80% of B			
HOUR	1	3	1 + 3	420	630	336	504	2	4	140	70	112	56	105	53	84	42.4	Cond. A	Cond. B	80% of A	80% of B
12 - 1 AM	22	51	73					20	0												
1 - 2 AM	9	15	24					6	0												
2 - 3 AM	16	21	37					16	0												
3 - 4 AM	8	12	20					3	0												
4 - 5 AM	20	14	34					13	0												
5 - 6 AM	76	67	143					69	0				X								
6 - 7 AM	161	259	420			X		125	0		X	X	X							X	
7 - 8 AM	242	415	657	X	X	X	X	196	0	X	X	X	X					X	X	X	X
8 - 9 AM	251	357	608	X		X	X	218	0	X	X	X	X					X		X	X
9 - 10 AM	270	321	591	X		X	X	238	0	X	X	X	X					X		X	X
10 - 11 AM	252	417	669	X	X	X	X	173	0	X	X	X	X					X	X	X	X
11 - Noon	244	424	667	X	X	X	X	223	0	X	X	X	X					X	X	X	X
12 - 1 PM	270	461	731	X	X	X	X	214	0	X	X	X	X					X	X	X	X
1 - 2 PM	237	456	693	X	X	X	X	191	0	X	X	X	X					X	X	X	X
2 - 3 PM	218	431	649	X	X	X	X	220	0	X	X	X	X					X	X	X	X
3 - 4 PM	262	492	754	X	X	X	X	243	0	X	X	X	X					X	X	X	X
4 - 5 PM	304	527	831	X	X	X	X	306	0	X	X	X	X					X	X	X	X
5 - 6 PM	366	633	999	X	X	X	X	370	0	X	X	X	X					X	X	X	X
6 - 7 PM	331	570	901	X	X	X	X	330	0	X	X	X	X					X	X	X	X
7 - 8 PM	231	463	695	X	X	X	X	201	0	X	X	X	X					X	X	X	X
8 - 9 PM	251	562	813	X	X	X	X	188	0	X	X	X	X					X	X	X	X
9 - 10 PM	129	298	427	X		X		135	0		X	X	X							X	
10 - 11 PM	82	182	263					84	0		X		X								
11 - Midnight	41	113	155					38	0												

SUMMARY OF RESULTS:

Warrant 1 - Cond. A was	met:	14	hours satisfied requirements
Warrant 1 - Cond. B was	met:	12	hours satisfied requirements
Warrant 1 - Combine A & B was	met:	14	hours satisfied requirements

Note:
* Warrant volume requirements are from the 2005 Minnesota Manual on Uniform Traffic Control Devices.

Source: Alliant Engineering, Inc. and using background growth rates provided by Dakota County.



Warrant Met for 14 Hours

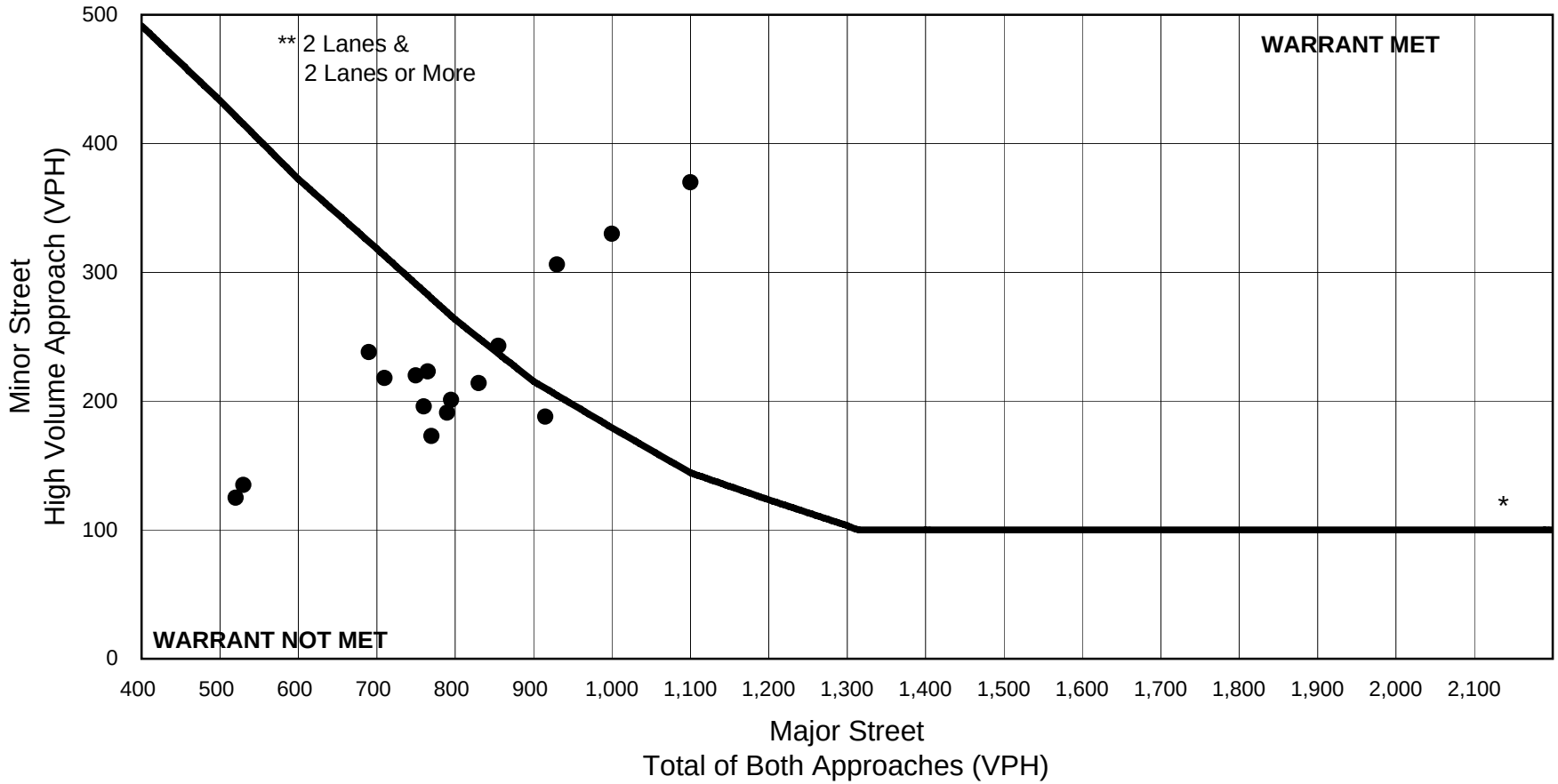
* NOTE: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2010 Weekday Volume

TABLE C-8
WARRANT 2
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD



Warrant Met for 4 Hours

* NOTE: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2010 Weekday Volume

TABLE C-9
WARRANT 3
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

TABLE C-10
SIGNAL WARRANT ANALYSIS - 2030 FORECAST WITHOUT EXTENSION
WARRANT 1
LOCATION: **CSAH 9 at CSAH 60**

Count Date: **2030 Forecast - Without Extension**
Source: See Footnote
Factor: 1.00
Population < 10,000? NO
Speed over 40 mph? YES

APPROACH	DESCRIPTION	NUMBER OF LANES	SPEED (MPH)
Major Approach 1	CSAH 9, South Approach, NB	3	55
Major Approach 3	CSAH 9, North Approach, SB	3	55
Minor Approach 2	CSAH 60, West Approach, EB	2	45
Minor Approach 4	--		

If population is less than 10,000; or the major street speed is over 40 mph, seventy percent factor can be applied. Apply seventy percent factor? YES

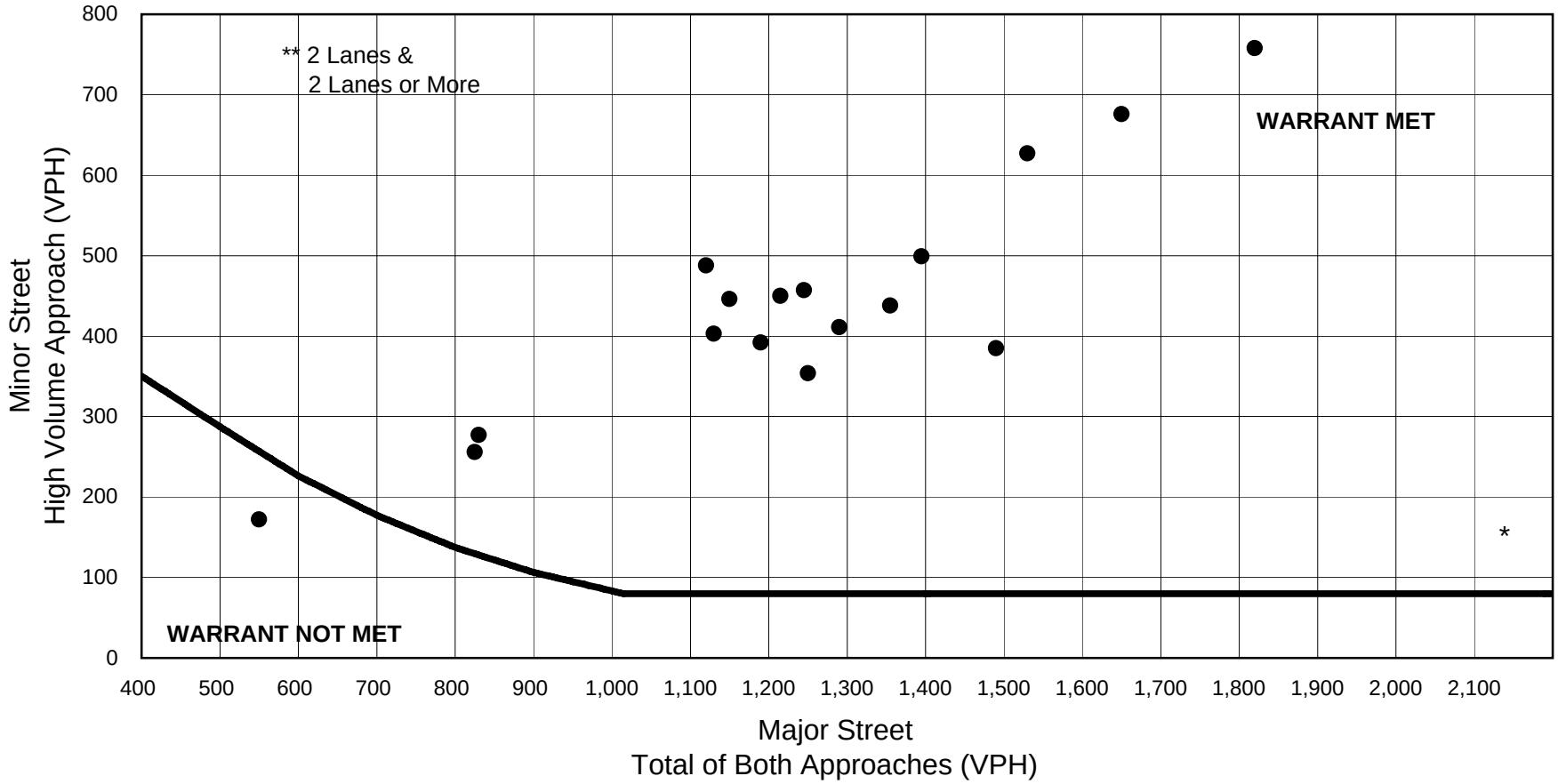
	MAJOR STREET							MINOR STREET									WARRANT MET SAME HOURS ON MAJOR AND MINOR STREETS			
	APPROACH VOLUME			WARRANT MET *				APPROACH VOLUME		WARRANT MET APPROACH 2 *				WARRANT MET APPROACH 4 *						
				Cond. A	Cond. B	7 & (A&B) Comb.				Cond. A	Cond. B	7 & (A&B) Comb.		Cond. A	Cond. B	7 & (A&B) Comb.				7 & (A&B) Comb.
			TOTAL			80% of A	80% of B					80% of A	80% of B			80% of A	80% of B			
HOUR	1	3	1 + 3	420	630	336	504	2	4	140	70	112	56	105	53	84	42.4	Cond. A	Cond. B	80% of A	80% of B
12 - 1 AM	39	85	124					40	0												
1 - 2 AM	16	25	41					12	0												
2 - 3 AM	29	34	64					33	0												
3 - 4 AM	14	20	34					7	0												
4 - 5 AM	35	24	59					26	0												
5 - 6 AM	137	112	250					142	0	X	X	X	X								
6 - 7 AM	289	434	723	X	X	X	X	256	0	X	X	X	X					X	X	X	X
7 - 8 AM	436	695	1,130	X	X	X	X	403	0	X	X	X	X					X	X	X	X
8 - 9 AM	451	597	1,048	X	X	X	X	446	0	X	X	X	X					X	X	X	X
9 - 10 AM	485	537	1,022	X	X	X	X	488	0	X	X	X	X					X	X	X	X
10 - 11 AM	453	698	1,152	X	X	X	X	354	0	X	X	X	X					X	X	X	X
11 - Noon	438	709	1,147	X	X	X	X	457	0	X	X	X	X					X	X	X	X
12 - 1 PM	485	772	1,257	X	X	X	X	438	0	X	X	X	X					X	X	X	X
1 - 2 PM	426	763	1,189	X	X	X	X	392	0	X	X	X	X					X	X	X	X
2 - 3 PM	393	722	1,114	X	X	X	X	450	0	X	X	X	X					X	X	X	X
3 - 4 PM	471	823	1,294	X	X	X	X	499	0	X	X	X	X					X	X	X	X
4 - 5 PM	546	883	1,428	X	X	X	X	627	0	X	X	X	X					X	X	X	X
5 - 6 PM	658	1,060	1,717	X	X	X	X	758	0	X	X	X	X					X	X	X	X
6 - 7 PM	595	955	1,550	X	X	X	X	676	0	X	X	X	X					X	X	X	X
7 - 8 PM	416	776	1,192	X	X	X	X	411	0	X	X	X	X					X	X	X	X
8 - 9 PM	451	940	1,392	X	X	X	X	385	0	X	X	X	X					X	X	X	X
9 - 10 PM	232	499	731	X	X	X	X	277	0	X	X	X	X					X	X	X	X
10 - 11 PM	147	304	451	X		X		172	0	X	X	X	X					X		X	
11 - Midnight	75	190	264					77	0		X		X								

SUMMARY OF RESULTS:

Warrant 1 - Cond. A was	met:	17	hours satisfied requirements
Warrant 1 - Cond. B was	met:	16	hours satisfied requirements
Warrant 1 - Combine A & B was	met:	16	hours satisfied requirements

Note:
* Warrant volume requirements are from the 2005 Minnesota Manual on Uniform Traffic Control Devices.

Source: Alliant Engineering, Inc. and using background growth rates provided by Dakota County.



Warrant Met for 16 Hours

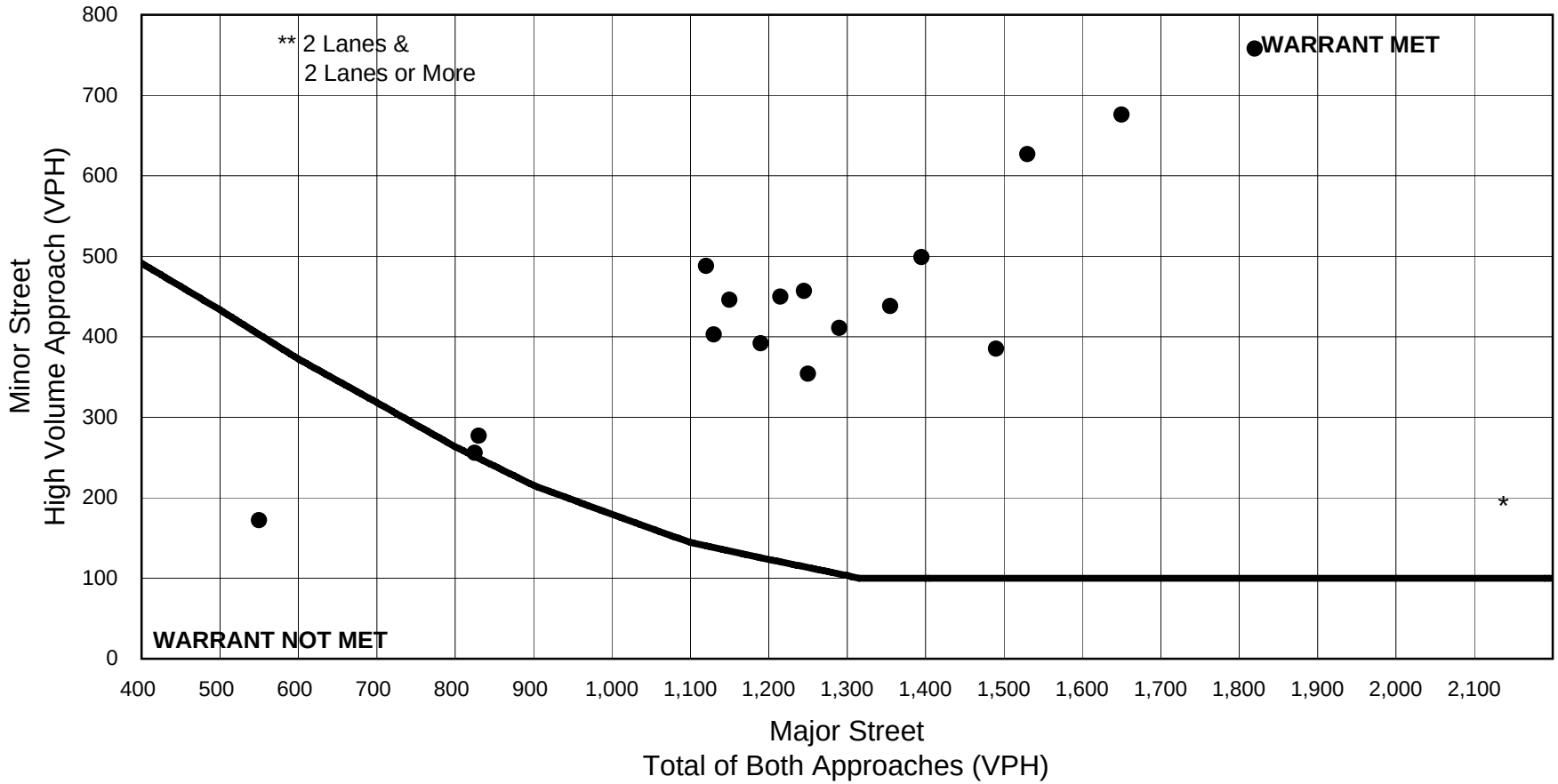
* NOTE: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-11
WARRANT 2
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD



Warrant Met for 16 Hours

* NOTE: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-12
WARRANT 3
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

2030 Warrant Analysis_9 at 60 WO EXT.xls(PkHr70%), 2/25/2009

TABLE C-13
SIGNAL WARRANT ANALYSIS - 2030 FORECAST WITH EXTENSION
WARRANT 1
LOCATION: **CSAH 9 at CSAH 60**

Count Date: **2030 Forecast - With Extension**
Source: See Footnote
Factor: 1.00
Population < 10,000? NO
Speed over 40 mph? YES

APPROACH	DESCRIPTION	NUMBER OF LANES	SPEED (MPH)
Major Approach 1	CSAH 60, West Approach, EB	4	55
Major Approach 3	CSAH 60, East Approach, WB	4	55
Minor Approach 2	CSAH 9, South Approach, NB	4	45
Minor Approach 4	CSAH 9, North Approach, SB	4	45

If population is less than 10,000; or the major street speed is over 40 mph, seventy percent factor can be applied. Apply seventy percent factor? YES

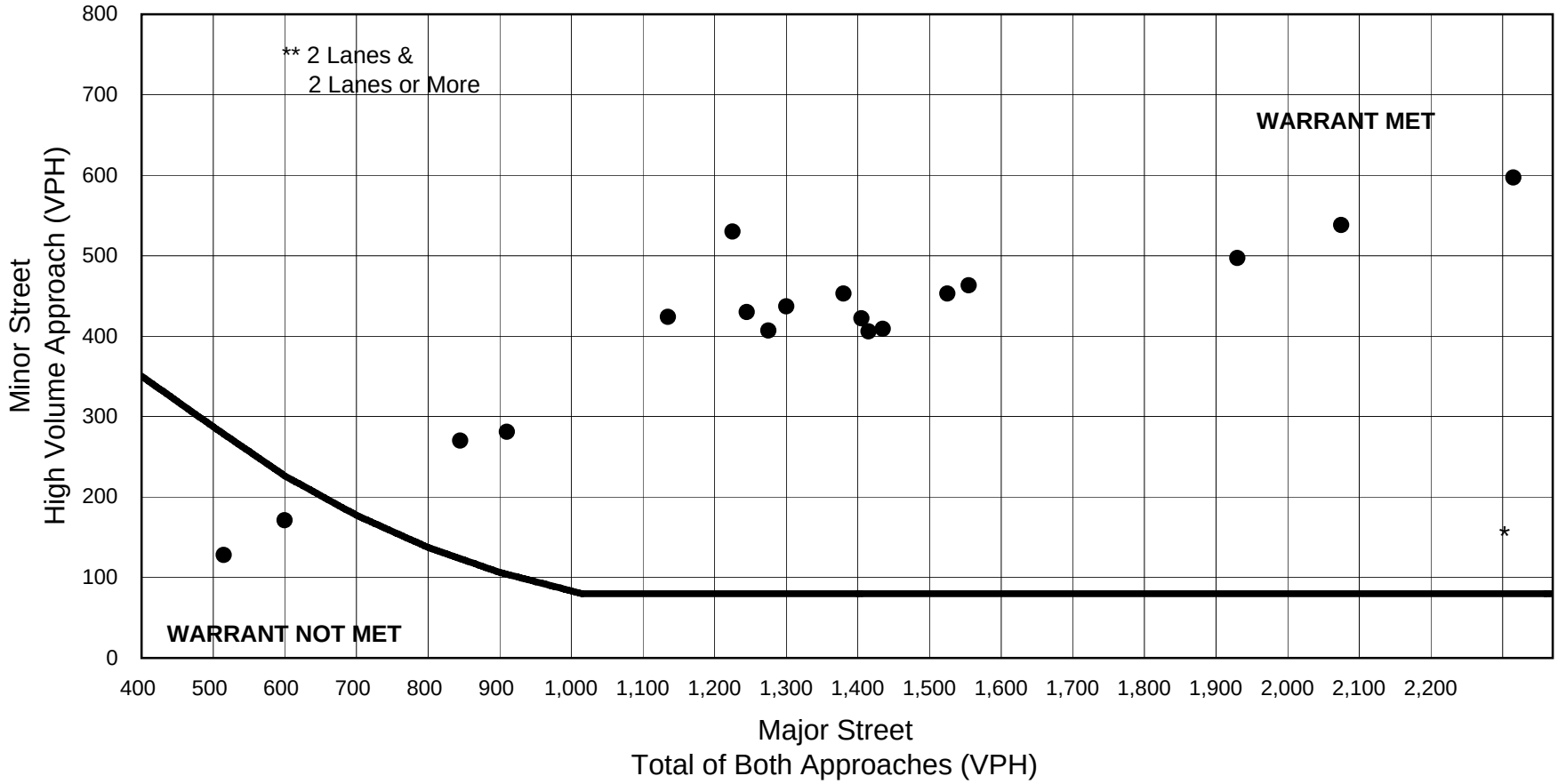
	MAJOR STREET							MINOR STREET									WARRANT MET SAME HOURS ON MAJOR AND MINOR STREETS			
	APPROACH VOLUME			WARRANT MET *				APPROACH VOLUME		WARRANT MET APPROACH 2 *				WARRANT MET APPROACH 4 *						
				Cond. A	Cond. B	7 & (A&B) Comb.				Cond. A	Cond. B	7 & (A&B) Comb.		Cond. A	Cond. B	7 & (A&B) Comb.				7 & (A&B) Comb.
			TOTAL			80% of A	80% of B					80% of A	80% of B			80% of A	80% of B			
HOUR	1	3	1 + 3	420	630	336	504	2	4	140	70	112	56	140	70	112	56	Cond. A	Cond. B	80% of A	80% of B
12 - 1 AM	71	47	118					37	48												
1 - 2 AM	22	14	36					15	14												
2 - 3 AM	58	39	97					28	19												
3 - 4 AM	12	8	20					13	11												
4 - 5 AM	46	31	77					33	13												
5 - 6 AM	249	165	414			X		128	63		X	X	X				X			X	
6 - 7 AM	449	297	746	X	X	X	X	270	244	X	X	X	X	X	X	X	X	X	X	X	X
7 - 8 AM	707	468	1,176	X	X	X	X	407	391	X	X	X	X	X	X	X	X	X	X	X	X
8 - 9 AM	784	519	1,304	X	X	X	X	422	336	X	X	X	X	X	X	X	X	X	X	X	X
9 - 10 AM	858	568	1,426	X	X	X	X	453	303	X	X	X	X	X	X	X	X	X	X	X	X
10 - 11 AM	621	411	1,033	X	X	X	X	424	393	X	X	X	X	X	X	X	X	X	X	X	X
11 - Noon	803	531	1,334	X	X	X	X	409	399	X	X	X	X	X	X	X	X	X	X	X	X
12 - 1 PM	769	509	1,278	X	X	X	X	453	435	X	X	X	X	X	X	X	X	X	X	X	X
1 - 2 PM	689	456	1,145	X	X	X	X	398	430	X	X	X	X	X	X	X	X	X	X	X	X
2 - 3 PM	791	523	1,314	X	X	X	X	367	406	X	X	X	X	X	X	X	X	X	X	X	X
3 - 4 PM	877	580	1,457	X	X	X	X	440	463	X	X	X	X	X	X	X	X	X	X	X	X
4 - 5 PM	1,101	729	1,830	X	X	X	X	510	497	X	X	X	X	X	X	X	X	X	X	X	X
5 - 6 PM	1,332	882	2,213	X	X	X	X	614	597	X	X	X	X	X	X	X	X	X	X	X	X
6 - 7 PM	1,187	786	1,973	X	X	X	X	556	538	X	X	X	X	X	X	X	X	X	X	X	X
7 - 8 PM	723	478	1,201	X	X	X	X	389	437	X	X	X	X	X	X	X	X	X	X	X	X
8 - 9 PM	677	448	1,125	X	X	X	X	422	530	X	X	X	X	X	X	X	X	X	X	X	X
9 - 10 PM	486	322	808	X	X	X	X	216	281	X	X	X	X	X	X	X	X	X	X	X	X
10 - 11 PM	301	200	501	X		X		138	171		X	X	X	X	X	X	X	X		X	
11 - Midnight	135	90	225					70	107				X		X		X				

SUMMARY OF RESULTS:

Warrant 1 - Cond. A was	met:	17	hours satisfied requirements
Warrant 1 - Cond. B was	met:	16	hours satisfied requirements
Warrant 1 - Combine A & B was	met:	16	hours satisfied requirements

Note:
* Warrant volume requirements are from the 2005 Minnesota Manual on Uniform Traffic Control Devices.

Source: Alliant Engineering, Inc. and using 2030 forecast ADT values provided by Dakota County.



Warrant Met for 16 Hours

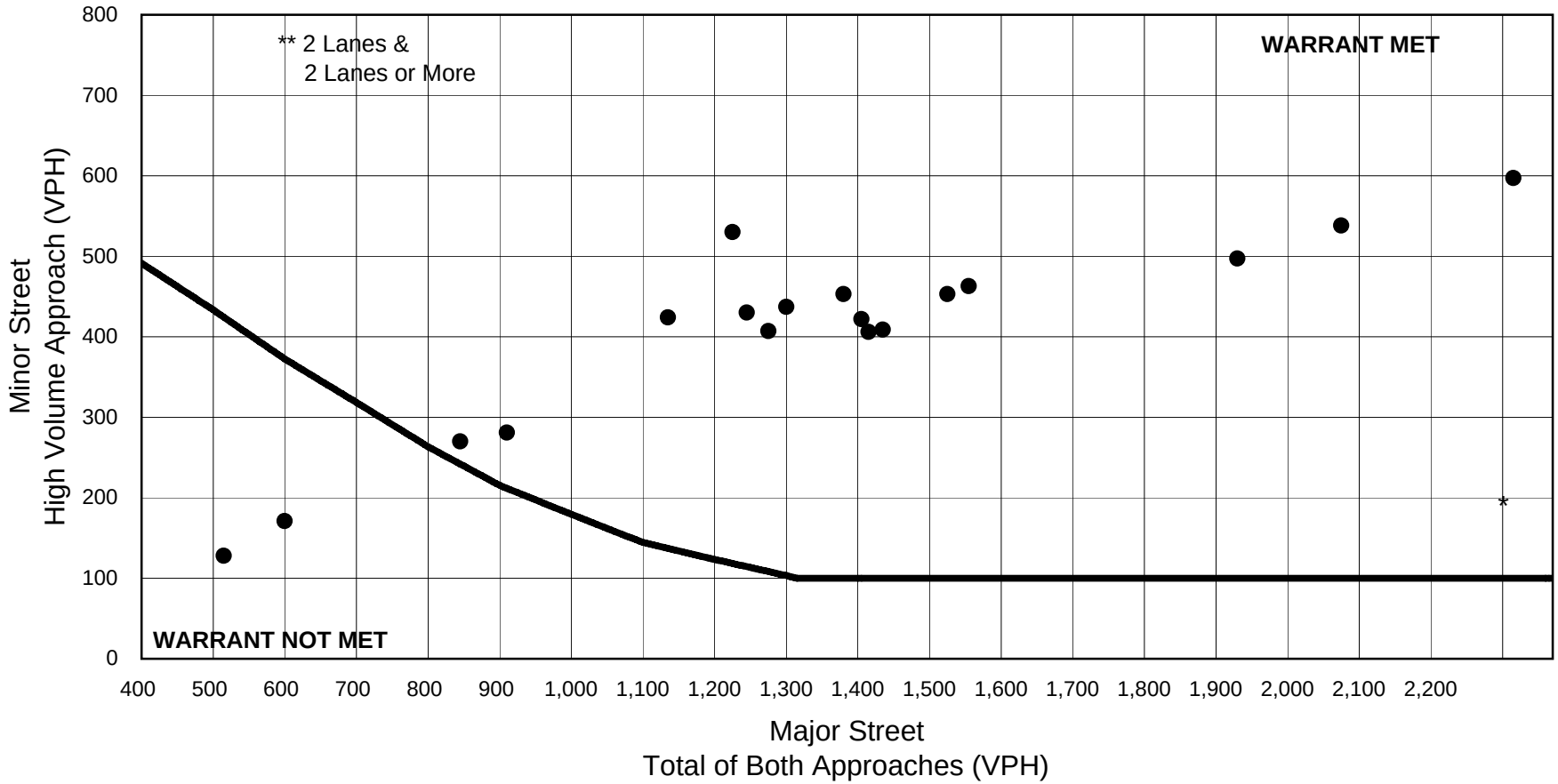
* NOTE: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-14
WARRANT 2
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD



Warrant Met for 16 Hours

* NOTE: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes.

** The first number refers to the number of lanes of approach on the major street and the second number refers to the number of lanes of approach on the minor street.

CSAH 9 at CSAH 60
SIGNAL WARRANT ANALYSIS
Forecast 2030 Weekday Volume

TABLE C-15
WARRANT 3
(Speed Above 40 MPH on Major Street)

Source: Alliant Engineering, Inc. using the MMUTCD

2030 Warrant Analysis_9 at 60 W EXT.xls(PkHr70%), 2/25/2009

Appendix D:
RODEL Output Files

Table D-1. Scenario 6 - 2030 Roundabout AM Peak (CSAH 9 at Highview Avenue)

31:3:09 2030 RAB OPT HI AM 56

E (m)	5.50	7.30	5.50	7.30	
L' (m)	27.30	0.00	27.40	0.00	
V (m)	3.70	7.30	3.70	7.30	
RAD (m)	57.90	24.38	57.90	24.38	
PHI (d)	11.20	20.70	10.60	20.60	
DIA (m)	48.77	48.77	48.77	48.77	
GRAD SEP	0	0	0	0	

TIME PERIOD min	90
TIME SLICE min	15
RESULTS PERIOD min	15 75
TIME COST $/hr	15.00
FLOW PERIOD min	15 75
FLOW TYPE pcu/veh	VEH
FLOW PEAK am/op/pm	PM

LEG NAME	PCU	VEH	TURNS (1st exit, 2nd..U)			FLOF	CL	FLOW RATIO			FLOW TIME
HI SB	1.02	100	83	40	0	1.00	90	0.65	1.143	0.65	15 45 75
HI EB	1.02	19	440	63	0	1.00	90	0.87	1.257	0.87	15 45 75
HI NB	1.02	182	114	32	0	1.00	90	0.82	1.235	0.82	15 45 75
HI WB	1.02	8	451	98	0	1.00	90	0.84	1.075	0.84	15 45 75

FLOW	veh	223	522	328	557	AVEDEL s	3.3
CAPACITY	veh	1064	1843	1091	1853	LOS SIG	A
AVE DELAY	mins	0.07	0.04	0.08	0.05	LOS UNSIG	A
MAX DELAY	mins	0.10	0.06	0.11	0.05		
AVE QUEUE	veh	0	0	0	0	VEHIC HRS	1.5
MAX QUEUE	veh	0	0	1	0	COST $	22

Table D-2. Scenario 6 - 2030 Roundabout PM Peak (CSAH 9 at Highview Avenue)

```
*******************************************************************************
*                                                                             *
*  31:3:09                    2030 RAB OPT HI PM                          47  *
*                                                                             *
*******************************************************************************
*                                          *                                  *
* E    (m)    5.50   7.30   5.50   7.30     * TIME PERIOD     min    90      *
* L'   (m)   27.30   0.00  27.40   0.00     * TIME SLICE      min    15      *
* V    (m)    3.70   7.30   3.70   7.30     * RESULTS PERIOD  min 15 75      *
* RAD  (m)   57.90  24.38  57.90  24.38     * TIME COST      $/hr 15.00      *
* PHI  (d)   11.20  20.70  10.60  20.60     * FLOW PERIOD     min 15 75      *
* DIA  (m)   48.77  48.77  48.77  48.77     * FLOW TYPE   pcu/veh   VEH      *
* GRAD SEP       0      0      0      0     * FLOW PEAK  am/op/pm    PM      *
*                                          *                                  *
*******************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                          *    *  *                *         *
* HI SB    *1.02*  281  217   88  0         *1.00*90*0.90 1.240 0.90*15 45 75 *
* HI EB    *1.02*   10  554  185  0         *1.00*90*0.92 1.082 0.92*15 45 75 *
* HI NB    *1.02*  146  187   10  0         *1.00*90*0.68 1.261 0.68*15 45 75 *
* HI WB    *1.02*   34  701   77  0         *1.00*90*0.91 1.060 0.91*15 45 75 *
*          *    *                          *    *  *                *         *
*          *    *                          *    *  *                *         *
*          *    *                          *    *  *                *         *
*******************************************************************************
*                                                    *                        *
* FLOW        veh     586    749    343    812      * AVEDEL  s    5.7       *
* CAPACITY    veh     930   1724    907   1724      * LOS   SIG      A       *
* AVE DELAY  mins    0.17   0.06   0.11   0.06      * LOS UNSIG      A       *
* MAX DELAY  mins    0.25   0.07   0.17   0.08      *                        *
* AVE QUEUE   veh       2      1      1      1      * VEHIC HRS    3.9       *
* MAX QUEUE   veh       2      1      1      1      * COST    $     59       *
*                                                    *                        *
*******************************************************************************
```

Table D-3. Scenario 8 - 2010 Roundabout AM Peak (CSAH 9 at Highview Avenue)

```
*******************************************************************************
*                                                                             *
*  31:3:09                      2010 RAB OPT HI AM                        38  *
*                                                                             *
*******************************************************************************
*                                                *                            *
* E    (m)    5.50   7.30   5.50   7.30          * TIME PERIOD     min    90  *
* L'   (m)   27.30   0.00  27.40   0.00          * TIME SLICE      min    15  *
* V    (m)    3.70   7.30   3.70   7.30          * RESULTS PERIOD  min 15 75  *
* RAD  (m)   57.90  24.38  57.90  24.38          * TIME COST      $/hr 15.00  *
* PHI  (d)   11.20  20.70  10.60  20.60          * FLOW PERIOD     min 15 75  *
* DIA  (m)   48.77  48.77  48.77  48.77          * FLOW TYPE   pcu/veh   VEH  *
* GRAD SEP       0      0      0      0          * FLOW PEAK  am/op/pm    PM  *
*                                                *                            *
*******************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* HI SB    *1.02*   64   53   25  0          *1.00*90*0.65 1.143 0.65*15 45 75 *
* HI EB    *1.02*   11  279   40  0          *1.00*90*0.87 1.257 0.87*15 45 75 *
* HI NB    *1.02*  116   72   19  0          *1.00*90*0.82 1.235 0.82*15 45 75 *
* HI WB    *1.02*    5  287   61  0          *1.00*90*0.84 1.075 0.84*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                          *                  *
* FLOW        veh     142    330    207    353            * AVEDEL  s   2.6 *
* CAPACITY    veh    1202   1904   1220   1910            * LOS   SIG     A *
* AVE DELAY  mins    0.05   0.04   0.06   0.04            * LOS UNSIG     A *
* MAX DELAY  mins    0.08   0.05   0.08   0.04            *                  *
* AVE QUEUE   veh       0      0      0      0            * VEHIC HRS   0.8 *
* MAX QUEUE   veh       0      0      0      0            * COST    $    11 *
*                                                          *                  *
*******************************************************************************
```

Table D-4. Scenario 8 - 2010 Roundabout PM Peak (CSAH 9 at Highview Avenue)

31:3:09 2010 RAB OPT HI PM 36

E (m)	5.50	7.30	5.50	7.30	
L' (m)	27.30	0.00	27.40	0.00	
V (m)	3.70	7.30	3.70	7.30	
RAD (m)	57.90	24.38	57.90	24.38	
PHI (d)	11.20	20.70	10.60	20.60	
DIA (m)	48.77	48.77	48.77	48.77	
GRAD SEP	0	0	0	0	

TIME PERIOD	min 90
TIME SLICE	min 15
RESULTS PERIOD	min 15 75
TIME COST	$/hr 15.00
FLOW PERIOD	min 15 75
FLOW TYPE	pcu/veh VEH
FLOW PEAK	am/op/pm PM

LEG NAME	PCU	VEH	TURNS (1st exit, 2nd..U)			FLOF	CL	FLOW RATIO		FLOW TIME
HI SB	1.02	179	138	56	0	1.00	90	0.90	1.240 0.90	15 45 75
HI EB	1.02	6	352	117	0	1.00	90	0.92	1.082 0.92	15 45 75
HI NB	1.02	93	118	6	0	1.00	90	0.68	1.261 0.68	15 45 75
HI WB	1.02	22	444	50	0	1.00	90	0.91	1.060 0.91	15 45 75

FLOW	veh	373	475	217	516	AVEDEL s	3.3
CAPACITY	veh	1116	1826	1103	1829	LOS SIG	A
AVE DELAY	mins	0.08	0.04	0.07	0.05	LOS UNSIG	A
MAX DELAY	mins	0.10	0.05	0.10	0.05		
AVE QUEUE	veh	1	0	0	0	VEHIC HRS	1.5
MAX QUEUE	veh	1	0	0	0	COST $	22

Table D-5. Scenario 10 - 2010 Roundabout AM Peak (CSAH 9 at Highview Avenue)

31:3:09 2010 SL RAB HI AM 39

E	(m)	4.90	4.90	4.90	4.90
L'	(m)	6.00	6.00	6.00	6.00
V	(m)	4.30	4.30	4.30	4.30
RAD	(m)	25.00	25.00	25.00	25.00
PHI	(d)	20.00	20.00	20.00	20.00
DIA	(m)	50.00	50.00	50.00	50.00
GRAD SEP		0	0	0	0

TIME PERIOD	min 90
TIME SLICE	min 15
RESULTS PERIOD	min 15 75
TIME COST	$/hr 15.00
FLOW PERIOD	min 15 75
FLOW TYPE	pcu/veh VEH
FLOW PEAK	am/op/pm PM

LEG NAME	PCU	VEH	TURNS (1st exit, 2nd..U)				FLOF	CL		FLOW RATIO			FLOW TIME		
HI SB	1.02	64	53	25	0		1.00	90	0.65	1.143	0.65	15	45	75
HI EB	1.02	11	279	40	0		1.00	90	0.87	1.257	0.87	15	45	75
HI NB	1.02	116	72	19	0		1.00	90	0.82	1.235	0.82	15	45	75
HI WB	1.02	5	287	61	0		1.00	90	0.84	1.075	0.84	15	45	75

FLOW	veh	142	330	207	353	AVEDEL	s	4.3
CAPACITY	veh	1010	1143	1023	1148	LOS SIG		A
AVE DELAY	mins	0.07	0.07	0.07	0.07	LOS UNSIG		A
MAX DELAY	mins	0.09	0.09	0.09	0.09			
AVE QUEUE	veh	0	0	0	0	VEHIC HRS		1.2
MAX QUEUE	veh	0	0	0	0	COST	$	19

Table D-6. Scenario 10 - 2010 Roundabout PM Peak (CSAH 9 at Highview Avenue)

31:3:09 2010 SL RAB HI PM 37

E	(m)	4.90	4.90	4.90	4.90
L'	(m)	6.00	6.00	6.00	6.00
V	(m)	4.30	4.30	4.30	4.30
RAD	(m)	25.00	25.00	25.00	25.00
PHI	(d)	20.00	20.00	20.00	20.00
DIA	(m)	50.00	50.00	50.00	50.00
GRAD SEP		0	0	0	0

TIME PERIOD	min 90
TIME SLICE	min 15
RESULTS PERIOD	min 15 75
TIME COST	$/hr 15.00
FLOW PERIOD	min 15 75
FLOW TYPE	pcu/veh VEH
FLOW PEAK	am/op/pm PM

LEG NAME	PCU	VEH TURNS (1st exit, 2nd..U)				FLOF	CL	FLOW RATIO		FLOW TIME
HI SB	1.02	179	138	56	0	1.00	90	0.90	1.240 0.90	15 45 75
HI EB	1.02	6	352	117	0	1.00	90	0.92	1.082 0.92	15 45 75
HI NB	1.02	93	118	6	0	1.00	90	0.68	1.261 0.68	15 45 75
HI WB	1.02	22	444	50	0	1.00	90	0.91	1.060 0.91	15 45 75

FLOW	veh	373	475	217	516	AVEDEL s	6.0
CAPACITY	veh	932	1082	918	1083	LOS SIG	A
AVE DELAY	mins	0.11	0.10	0.08	0.10	LOS UNSIG	A
MAX DELAY	mins	0.13	0.11	0.12	0.12		
AVE QUEUE	veh	1	1	0	1	VEHIC HRS	2.6
MAX QUEUE	veh	1	1	0	1	COST $	39

Table D-7. Scenario 4 - 2030 Roundabout AM Peak (CSAH 9 at CSAH 60)

```
*******************************************************************************
*                                                                             *
*  31:3:09                     2030 RAB OPT 60 AM                         56  *
*                                                                             *
*******************************************************************************
*                                          *                                  *
* E    (m)    8.53   8.53   8.53   8.53     * TIME PERIOD     min    90  *
* L'   (m)    0.00   0.00   0.00   0.00     * TIME SLICE      min    15  *
* V    (m)    8.53   8.53   8.53   8.53     * RESULTS PERIOD  min 15 75  *
* RAD  (m)   24.38  24.38  24.38  24.38     * TIME COST      $/hr 15.00  *
* PHI  (d)   16.50  30.50  24.50  23.50     * FLOW PERIOD     min 15 75  *
* DIA  (m)   48.77  48.77  48.77  48.77     * FLOW TYPE   pcu/veh   VEH  *
* GRAD SEP       0      0      0      0     * FLOW PEAK  am/op/pm    PM  *
*                                          *                                  *
*******************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                          *    *  *                *         *
* 60 SB    *1.02*  262  269   28  0         *1.00*90*0.55 1.418 0.55*15 45 75 *
* 60 EB    *1.02*  150  273  320  0         *1.00*90*0.85 1.174 0.85*15 45 75 *
* 60 NB    *1.02*   88  154   90  0         *1.00*90*0.63 1.279 0.63*15 45 75 *
* 60 WB    *1.02*   26  302  206  0         *1.00*90*0.85 1.174 0.85*15 45 75 *
*          *    *                          *    *  *                *         *
*          *    *                          *    *  *                *         *
*          *    *                          *    *  *                *         *
*******************************************************************************
*                                                    *                        *
* FLOW        veh     559    743    332    534      * AVEDEL  s   2.7 *
* CAPACITY    veh    1930   1904   1854   1907      * LOS   SIG     A *
* AVE DELAY  mins    0.04   0.05   0.04   0.04      * LOS UNSIG     A *
* MAX DELAY  mins    0.08   0.07   0.06   0.06      *                   *
* AVE QUEUE   veh       0      1      0      0      * VEHIC HRS   1.6 *
* MAX QUEUE   veh       1      1      0      0      * COST    $    25 *
*                                                    *                        *
*******************************************************************************
```

Table D-8.Scenario 4 - 2030 Roundabout PM Peak (CSAH 9 at CSAH 60)

31:3:09 2030 RAB OPT 60 PM 51

E	(m)	8.53	8.53	8.53	8.53
L'	(m)	0.00	0.00	0.00	0.00
V	(m)	8.53	8.53	8.53	8.53
RAD	(m)	24.38	24.38	24.38	24.38
PHI	(d)	16.50	30.50	24.50	23.50
DIA	(m)	48.77	48.77	48.77	48.77
GRAD SEP		0	0	0	0

TIME PERIOD	min 90
TIME SLICE	min 15
RESULTS PERIOD	min 15 75
TIME COST	$/hr 15.00
FLOW PERIOD	min 15 75
FLOW TYPE	pcu/veh VEH
FLOW PEAK	am/op/pm PM

LEG NAME	PCU	VEH	TURNS (1st exit, 2nd..U)			FLOF	CL	FLOW RATIO			FLOW TIME		
60 SB	1.02	501	370	45	0	1.00	90	0.89	1.077	0.89	15	45	75
60 EB	1.02	219	832	460	0	1.00	90	0.92	1.080	0.92	15	45	75
60 NB	1.02	198	272	187	0	1.00	90	0.79	1.333	0.79	15	45	75
60 WB	1.02	31	465	192	0	1.00	90	0.92	1.080	0.92	15	45	75

FLOW	veh	916	1511	657	688	AVEDEL s	7.4
CAPACITY	veh	1727	1822	1279	1621	LOS SIG	A
AVE DELAY	mins	0.07	0.19	0.10	0.06	LOS UNSIG	A
MAX DELAY	mins	0.09	0.26	0.16	0.08		
AVE QUEUE	veh	1	5	1	1	VEHIC HRS	7.7
MAX QUEUE	veh	1	6	1	1	COST $	116