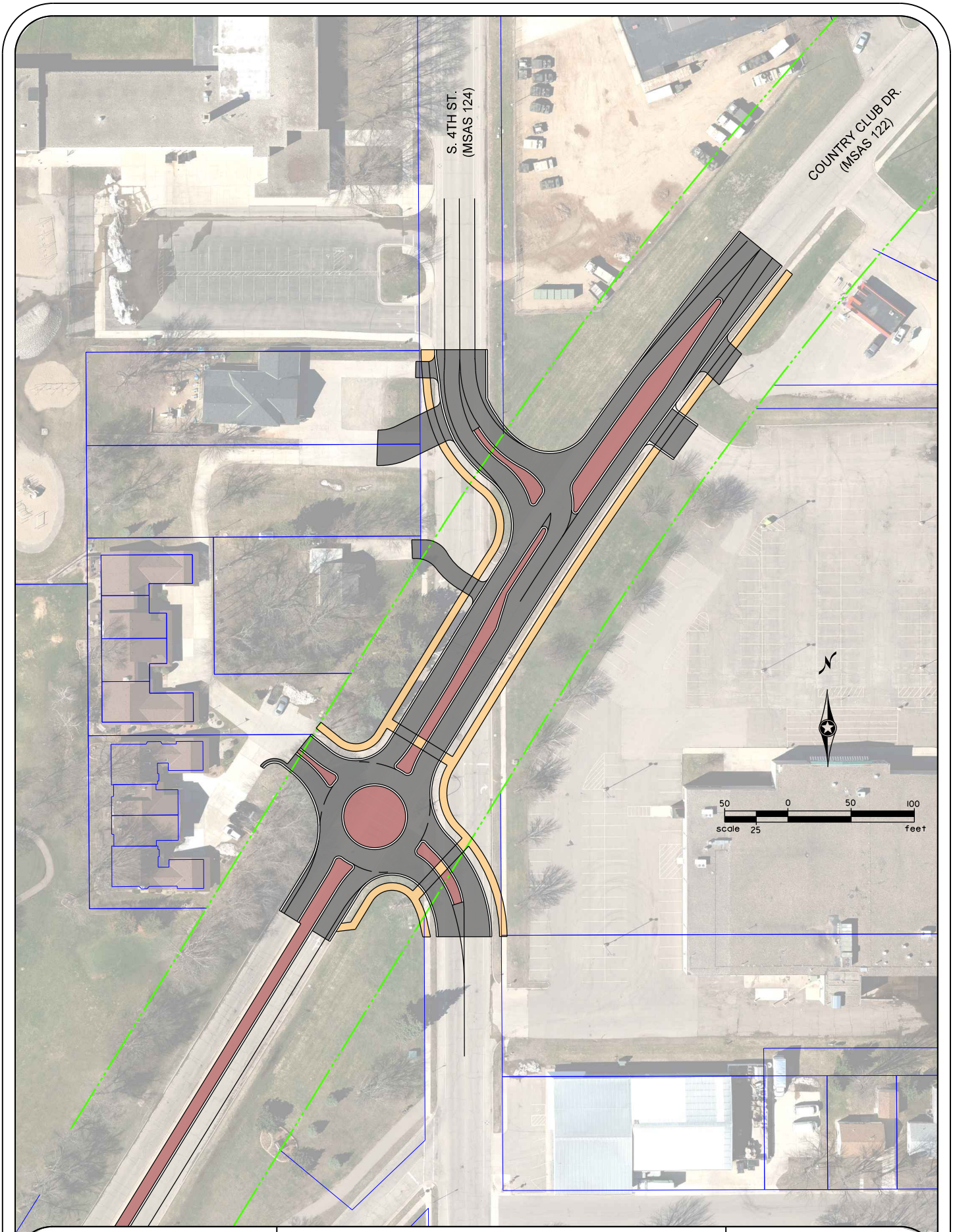

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Split T - Mini Roundabout and ¾ Intersection

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 5

Intersection Control Evaluation

Country Club Drive and 4th Street

Marshall, MN

S.A.P. 139-124-XXX
S.A.P. 139-122-XXX
MARSH 160121 | June 25, 2021

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Intersection Control Evaluation

Country Club Drive and 4th Street
Marshall, MN

S.A.P. 139-124-XXX
S.A.P. 139-122-XXX
SEH No. MARSH 160121

June 25, 2021

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

Graham Johnson, PE (MN, SD, IA), PTOE

Date: June 25, 2021 License No.: 45429

Approved By:

Date:

MnDOT District 8 State Aid Engineer

Date: 6/29/2021

City of Marshall Engineer

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Intersection Control Evaluation

Country Club Drive and 4th Street

Prepared for the City of Marshall, Minnesota, in cooperation with MnDOT District 8 State Aid.

1 Background and Purpose

The existing intersection of Country Club Drive and South 4th Street operates under traffic signal control. It is currently the only traffic signal that is owned, operated, and maintained by the City of Marshall.

Country Club Drive was previously Minnesota Trunk Highway 23 (TH 23) prior to the Minnesota Department of Transportation (MnDOT) constructing the TH 23 Bypass along the east and south sides of the City of Marshall. Country Club Drive was turned back to the City and is currently a part of the City's Municipal State Aid system (MSA 122); this roadway intersects S 4th Street which is also part of Marshall's MSA system (MSA 124).

There are two redevelopment sites adjacent to the study intersection that will change traffic patterns surrounding the intersection. In the southeast corner of the intersection, the County Fair grocery store, now closed, is anticipated to be redeveloped into a potential apartment building. In the northwest quadrant, the West Side Elementary school is moving locations in the fall of 2021; it is anticipated to be redeveloped into single family residential.

The City of Marshall is finishing reconstruction of S. 4th Street up to the study intersection in 2020/2021. MnDOT has plans to reconstruct College Drive (TH 19) in 2025, including a roundabout at the intersection of College Drive, Country Club Drive, and S. 2nd Street which is less than 1,000 feet away.

The evaluation of this study intersection is intended to determine the long-term intersection traffic control and geometrics at the intersection. The recommendations will consider improving intersection safety, for both vehicle and non-motorized users, as well as improving the overall efficiency of the intersection operations. In addition, maintaining access for the existing driveways on both roadways, minimizing construction impacts, and construction costs will also be a consideration in the recommendation of the intersection control.

1.1 Overview

The Minnesota Department of Transportation (MnDOT) Intersection Control Evaluation (ICE) is an objective process used to investigate and determine the optimal type of traffic control that should be provided at an intersection to serve the existing conditions and future needs. The investigation includes analyzing traffic operations during the AM and PM peak hours for the existing year (2021) and forecast year (2042) traffic conditions. The evaluations include assessing traffic control volume warrants, intersection and roadway safety, and traffic operations.

The range of traffic control options includes a No Build scenario, with no change to the existing control conditions, and viable traffic control options for the intersection, including all-way stop

control, traffic signal control, roundabout control, minor street stop control, or potential access reduction such as right-in/right out (RI/RO) or 3/4 access intersection control.

Figure 1 depicts the study intersection in a location map.

Figure 1 – Project Location

2 Existing Conditions

Country Club Drive is a 2-lane roadway, functionally classified as a Major Collector. The roadway provides a connection between TH 23 and TH 19. At the intersection, a northeast bound left turn lane is provided, while there are no southwest bound turn lanes provided, there is enough room that traffic will bypass a left turning vehicle. The speed limit on Country Club Drive is posted at 30 mph to the east, and 40 mph to the west of the intersection.

S. 4th Street is a 2-lane roadway, functionally classified as a Major Collector. The roadway provides a connection between TH 23 and TH 19; it also provides a connection to the downtown Marshall central business district. At the intersection, both the northbound and southbound approaches have shared left-through lanes and separate right turn lanes; an on-street bike lane is provided through the study intersection. The speed limit on S 4th Street is posted at 30 mph.

2.1 Crash History

Crash data from January 1st, 2016 through December 31st, 2020 was provided from the MnDOT Crash Mapping Analysis Tool (MnCMAT2). The type and severity of the crashes were reviewed, and crash rates and critical rates were calculated for the study intersection.

The crash rate at each intersection is expressed as the number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be reviewed.

Crash severity is separated into five categories based on injuries sustained during the crash.

- Fatal – Crash that results in a death
- Severity A – Crash that results in an incapacitating injury or serious injury
- Severity B – Crash that results in a non-incapacitating injury or minor injury
- Severity C – Crash that results in possible injury
- Property Damage – Crash that results in property damage only, with no injuries

The intersection of Country Club Drive and S 4th Street has only experienced 3 reported crashes during the 5-year analysis period and has an existing crash rate below the calculated critical rate.

There was a single rear-end collision, which are typical for signalized intersections. There was a single right-angle crash involving a northeast bound left turn not yielding to a southwest bound through vehicle. A southwest bound driver collided with a bicyclist crossing the west leg of the intersection, the bicyclist did not observe the “Don’t Walk” signal.

The crash information is summarized in **Table 1**.

Table 1 – Crash History 2016-2020

Intersection:	Crash Severity						Crash Rates	
	Fatal	Sev A	Sev B	Sev C	Property Damage	Total	Int. Rate	Critical
Country Club Drive at S 4th Street	0	0	1	0	2	3	0.30	1.15

2.2 Intersection Volumes

As part of the study, an intersection turning movement count was collected in March 2021, when the adjacent elementary school was in session. A 13-hour count was conducted from 6am to 7pm to capture the majority of traffic throughout the day. The AM peak hour was determined to be 7:15 to 8:15 am and the PM peak was 4:30 to 5:30 pm.

Passenger vehicles, trucks, buses, pedestrians, and bicyclists were all counted; the intersection daily trucks range from approximately 2% to 4% trucks. A total of 47 pedestrians and bicyclist used the intersection in the 13-hour count, a majority of users crossed the west leg which had 36 crossings.

Due to the presence of the elementary school, the driveway and drop-off/pick-up area were counted in each peak hour. The school is currently planned to vacate the existing site after the current 2020-2021 school year; therefore, the school traffic was separated out to be able to remove the drop-off and pick-up trips during the school start and dismissal times.

The following **Figure 2** represents the existing intersection data.

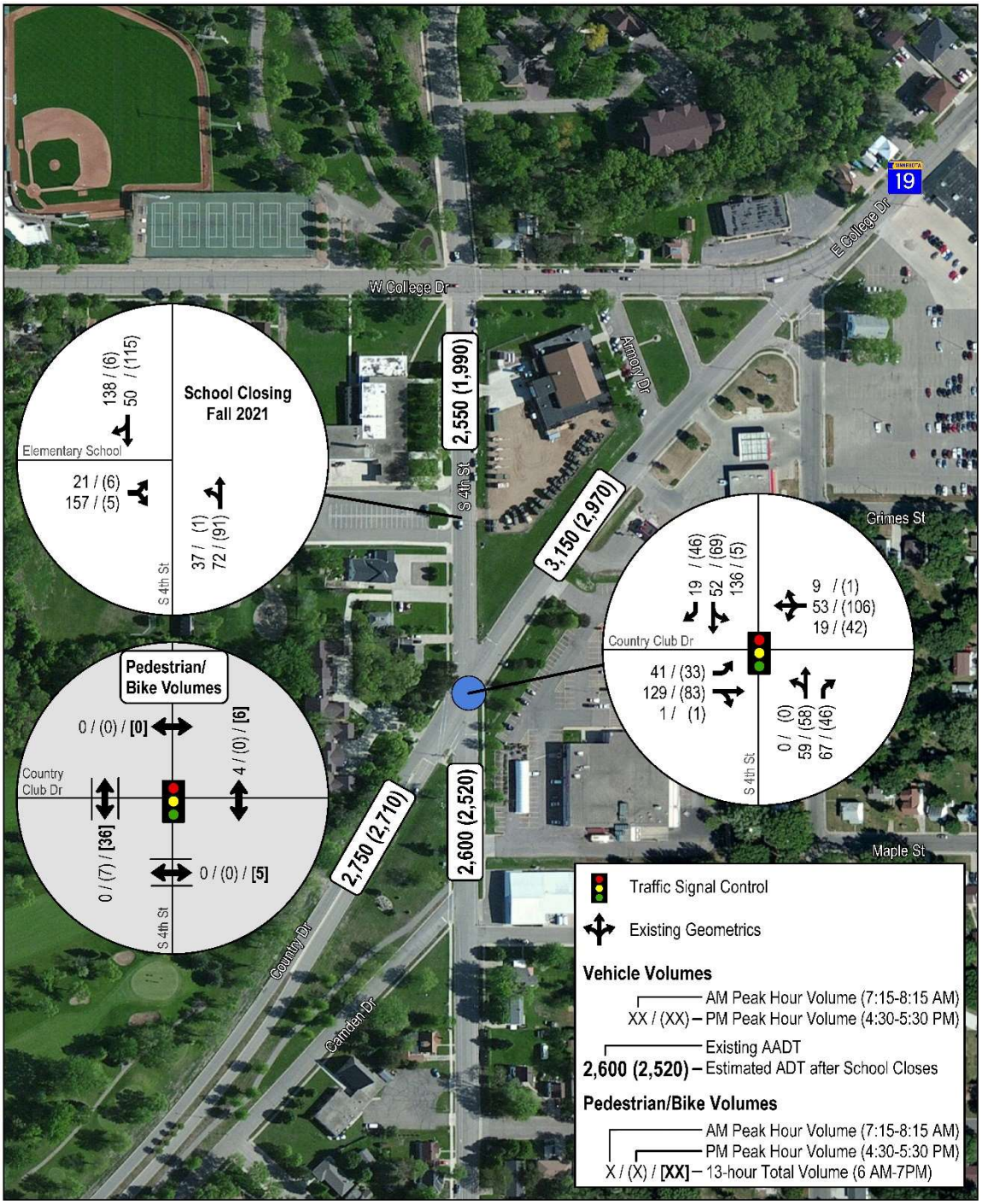
Due to the current health pandemic, a comparison of the 2021 count to historical daily traffic volumes and adjacent intersection data was completed to ensure the volumes are within reason. To estimate the daily volumes for the 2021 traffic count, the 13-hour traffic data was extrapolated to a 24-hour daily number based on MnDOT's 24-hour distribution, which suggests that approximately 81% of all trips occur within the 13-hour turning movement data collected as part of this project.

The daily volume comparison is summarized in **Table 2**. The east and west legs along County Club Drive are slightly higher than the previous 2018 daily volume. The north and south legs of S. 4th Street are lower than the previous counts; however, when the peak hour data was compared to historical traffic data from the MnDOT TH 19 Corridor Study, the volumes are within 15 to 30 vehicles. Therefore, the 2021 traffic volumes appear to not be significantly impacted.

Table 2 – Existing Daily Traffic Volumes

Intersection:	Leg	2021*	2018
Country Club Drive at S 4th Street	North Leg	2,310	2,550
	South Leg	2,070	2,600
	East Leg	3,270	3,150
	West Leg	2,880	2,750
*2021 daily volume estimated from 13-hour count information; assumes 81% captures in 13-hour data.			

Figure 2 – Existing (2021) Traffic Data



2.3 Intersection Information

The existing intersection has a severe skew as the two roadways do not cross each other perpendicularly. Severe intersection skews can have an adverse impact on safety and operations of the intersection as vehicles have more exposure time within the intersection and driver sight lines can become difficult.

Country Club Drive crosses S. 4th Street at an angle of approximately 35 degrees at the study intersection. Typically, MnDOT guidance suggests that the roadways should not cross at less than 75 degrees at an intersection to maintain sight lines, safety and operations.

- It should be noted that typically "Intersection Skew Angle" is defined as the difference between perpendicular (90 degrees) and the actual intersection angle. In this case, the actual intersection skew angle is approximately 55 degrees, which is significantly higher than the MnDOT guidance of a 15-degree skew angle.

The existing intersection is controlled by a traffic signal. The signal operates under a simple two-phase operation, with phase 2 and phase 6 running concurrently for County Club Drive, and phase 4 running separately for S. 4th Street. The signal is not coordinated with any adjacent intersection and runs in a "Free" mode as traffic is detected on any approach leg.

As previously mentioned, County Club Drive has a separate eastbound left turn lane while westbound traffic has enough room to bypass a left turning vehicles; S. 4th Street has a separate right turn lane on both approaches.

Two crosswalks are currently provided on the west and south legs of the intersection. Due to the intersection skew, the west leg crosswalk is offset from the intersection and runs perpendicular to County Club Drive; the south leg crosswalk has increased distance due to the skew. The provided "Flash Don't Walk" (FDW) is not sufficient for a crossing of the south leg of the intersection; the west leg does have sufficient FDW time. The south leg has a total crossing distance of approximately 95 feet due to the intersection skew. Using the standard 3.5 feet per second (fps) for a pedestrian to cross the leg would require 27 seconds of FDW time for a pedestrian to clear the intersection if they entered at the end of the Walk phase. However, only 20 seconds is provided for the crossing under the existing timings.

In addition, the existing Yellow and All Red timings are not up to present standards based on MnDOT Traffic Signal Timing Manual; the signal is currently timed with 3.5 seconds of yellow and 1.5 seconds of All Red time for both roadways.

- Yellow times are based on roadway speeds, for S. 4th Street, the 3.5 seconds is appropriate for a 30-mph roadway; however, the speeds along Country Club Drive are higher with the west leg posted at 40-mph, this phase should include a yellow time of 4.0 seconds.
- All Red times are based on both the roadway speeds and the intersection width; the existing skew significantly increases the overall crossing distance. Based on provided guidance, the intersection width should be from the stop bar to the farthest conflicting lane, this would be approximately 105 feet for S. 4th Street and approximately 150 feet for County Club Drive. However, southbound and westbound traffic should also clear the downstream crosswalk in order to ensure the Walk phase not to come up when a vehicle is still within the intersection.

The total distance for these two approaches is 130 feet for southbound on S. 4th Street and 230 feet for westbound on Country Club Drive. The additional distance due to the intersection skew should be accounted for with All Red times of 3.4 seconds for S. 4th Street and 5.7 seconds for Country Club Drive.

The intersection does currently have lighting provided by two overhead "cobra" style fixtures in the southwest and northwest quadrants.

2.4 Delay Study

As part of this intersection study, an approach delay study for eastbound and southbound vehicles at the intersection was conducted from the intersection count video. This was conducted for the purposes of ensuring the existing traffic model is replicating actual field conditions.

Delay data was collected for each vehicle during a 15-minute peak during both the AM (7:30 to 7:45 am) and PM (4:45 to 5:00 pm) peak hours. **Table 3** represents the delay for each approach under the existing conditions.

Table 3 – Existing Intersection Delay Study

Peak Hour	Eastbound Approach (Delay / LOS)	Southbound Approach (Delay / LOS)
AM	14.3 / B	24.3 / C
PM	8.0 / A	11.9 / B

The southbound approach is heavily impacted by the existing school traffic at the intersection. Drop-off traffic for the school typically enters the school from the north and exits to the south. It was observed that many vehicles do not get through the signal in one cycle; however, due to the intersection operating free and its short timings, the overall delay is not significant.

The delay information will be compared to the existing operational models to ensure the proper evaluation tool is used for the analysis.

2.5 Right of Way – Utilities

Currently, the City has right-of-way along Country Club Drive that is approximately 150 feet wide and along S. 4th Street that is approximately 66 feet wide. The northwest quadrant currently has residential land uses that include a single-family home and 2 Four-plex townhomes. The southeast quadrant is a vacant commercial site with potential for redevelopment. The northeast quadrant is currently owned by the Minnesota State Armory with the Minnesota National Guard occupying the site; the desire is to limit impact to this site. The southwest quadrant is currently owned by the City of Marshall.

The City recently reconstruction S. 4th Street up to Country Club Drive; impacts to the south leg of S. 4th Street should be kept to a minimum. Completed in 2020, the project included utility and pavement improvements along the roadway.

In the immediate intersection area, stormwater is captured in the northwest quadrant of the intersection along County Club Drive and on the south leg of S. 4th Street. Along the north and east legs, the catch basins are further downstream from the intersection.

2.6 Current and Proposed Developments

Two existing land uses surrounding the study intersection are planned to be redeveloped soon.

The existing West Side Elementary school is moving to a new location southeast of the current location. The new school is anticipated to be open in the Fall of 2021, so the current site adjacent to the study intersection will be vacated after the 2020-2021 school year. While no current development plans are in place, it is assumed to potentially be redeveloped into single family residential homes. With the current land area, it is anticipated to develop up to 40 homes.

An empty grocery store in the southeast quadrant, formerly County Fair Food Store, is also anticipated to be redeveloped. While no current redevelopment plans are in place, it is assumed to potentially be redeveloped into an apartment complex with up to 100 units.

3 Future Conditions

Historical daily traffic volumes along each roadway leg surrounding the intersection were reviewed as well as historical population growth in the area. A linear regression analysis of daily volumes results in very limited growth on many of the roadways, including some negative values. This indicates that traffic demands have been fairly steady in recent history.

MnDOT's Office of State Aid maintains current 20-year growth factors for all counties in Minnesota. The current growth factor for Lyon County is 1.3, which equates to a linear growth rate of 1.5% per year over a 20-year projection. However, it should be noted this is for the entire county area, which has extensive undeveloped land area outside of the City of Marshall.

Based on the previous 50 years of census data, Lyon County has had a relatively flat growth rate and the City of Marshall has had a growth rate of just over 0.6% per year.

Based on the linear regression analysis, historical population growth, and input from City staff, a linear growth rate of 0.5% per year was selected and utilized to develop the 2042 forecast traffic volumes. Due to the low expected growth, a year of opening forecast and analysis was not performed for this study.

3.1 Trip Removal and Trip Generation

To account for the redevelopment of land uses in the area, trip generation was conducted to estimate the number of trips that may be generated by the new land uses.

The first step is to remove the existing land use trips from the intersection data. As the southeast quadrant has been vacant for many years, there are no existing trips to remove from the intersection. The traffic that was collected at the existing school dop-off/pick-up site was removed from the study intersection; this included:

- AM Peak Hour – 157 southbound trips and 37 northbound trips.
- School Dismissal Peak Hour – 78 southbound trips and 16 northbound trips.
- PM Peak Hour – 5 southbound trips and 1 northbound trip.
- It should be noted that addition trips would be reduced at S. 4th Street and TH 19.

The Institute of Transportation Engineers (ITE) Trip Generation Manual 10th Edition was used to estimate new development trips for the various land uses. The following **Table 4** represent the new trips generated by the two redevelopment sites.

Table 4 – Trip Generation

Development	Development		Daily Total	AM Peak			PM Peak		
	Size	Units		Enter	Exit	Total	Enter	Exit	Total
Single Family Homes (210)	40	Units	378	8	22	30	26	14	40
Apartments (221)	100	Units	544	9	23	32	25	16	41
Total Trip Generation			**922**	**17**	**45**	**62**	**51**	**30**	**81**

Trip distribution to the roadway network followed the existing traffic patterns surrounding the project area; the following distribution was utilized:

- TH 19 to the East 40%
- TH 19 to the West 25%
- N. 4th Street into Downtown 10%
- S. 4th Street to the South 15%
- Country Club Drive to the West 5%
- S 2nd Street to the South 5%

Based on this distribution, many of the newly generated trips won't use the study intersection, rather they would head north on S. 4th Street or County Club Drive to access TH 19.

The 2042 forecasted turning movement volumes can be found in **Figure 3**. Due to the existing intersection skew, it is anticipated to include analysis of a "split T" design; therefore, **Figure 4** represents the 2042 turning movements at the two T-intersections.

Figure 3 – Future (2042) Traffic Data

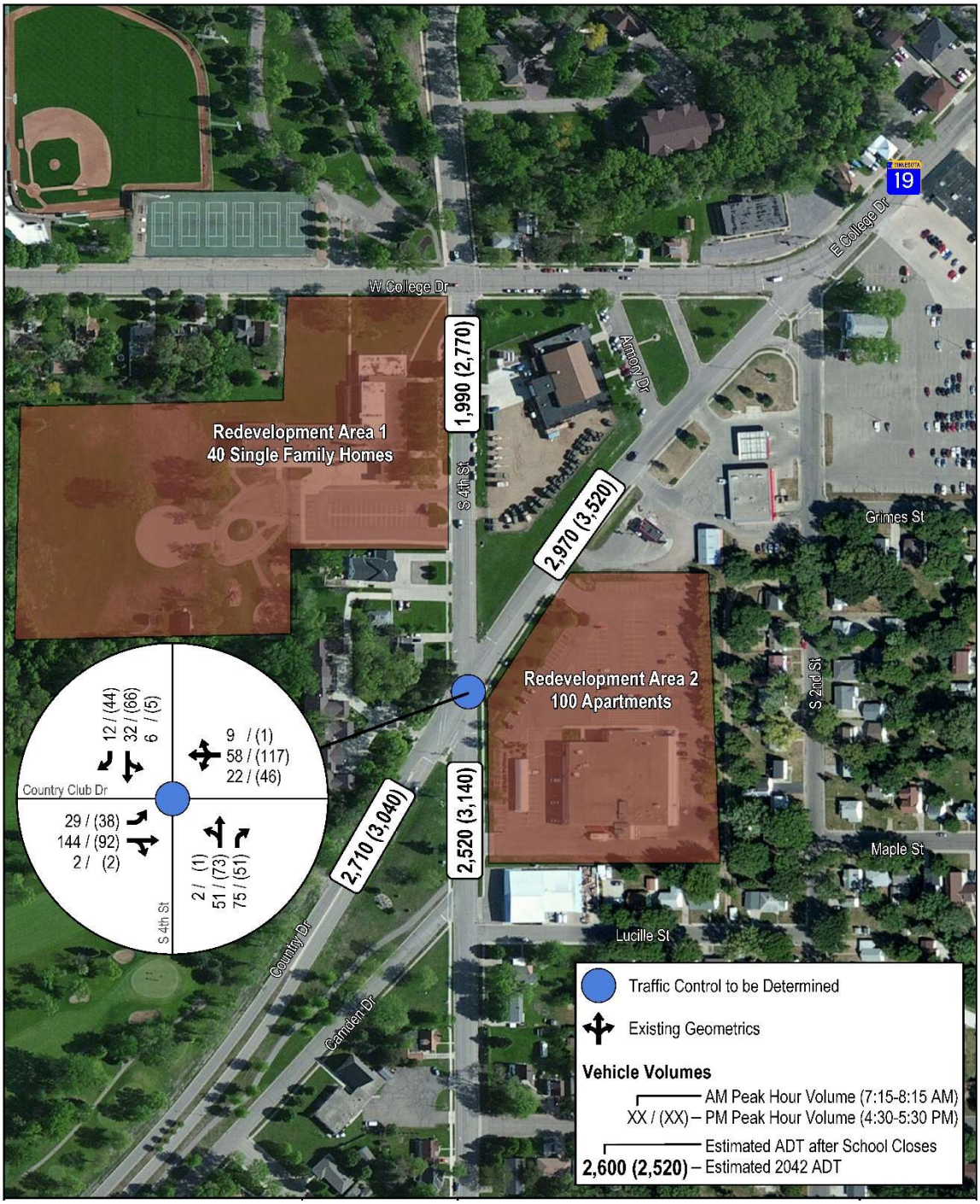
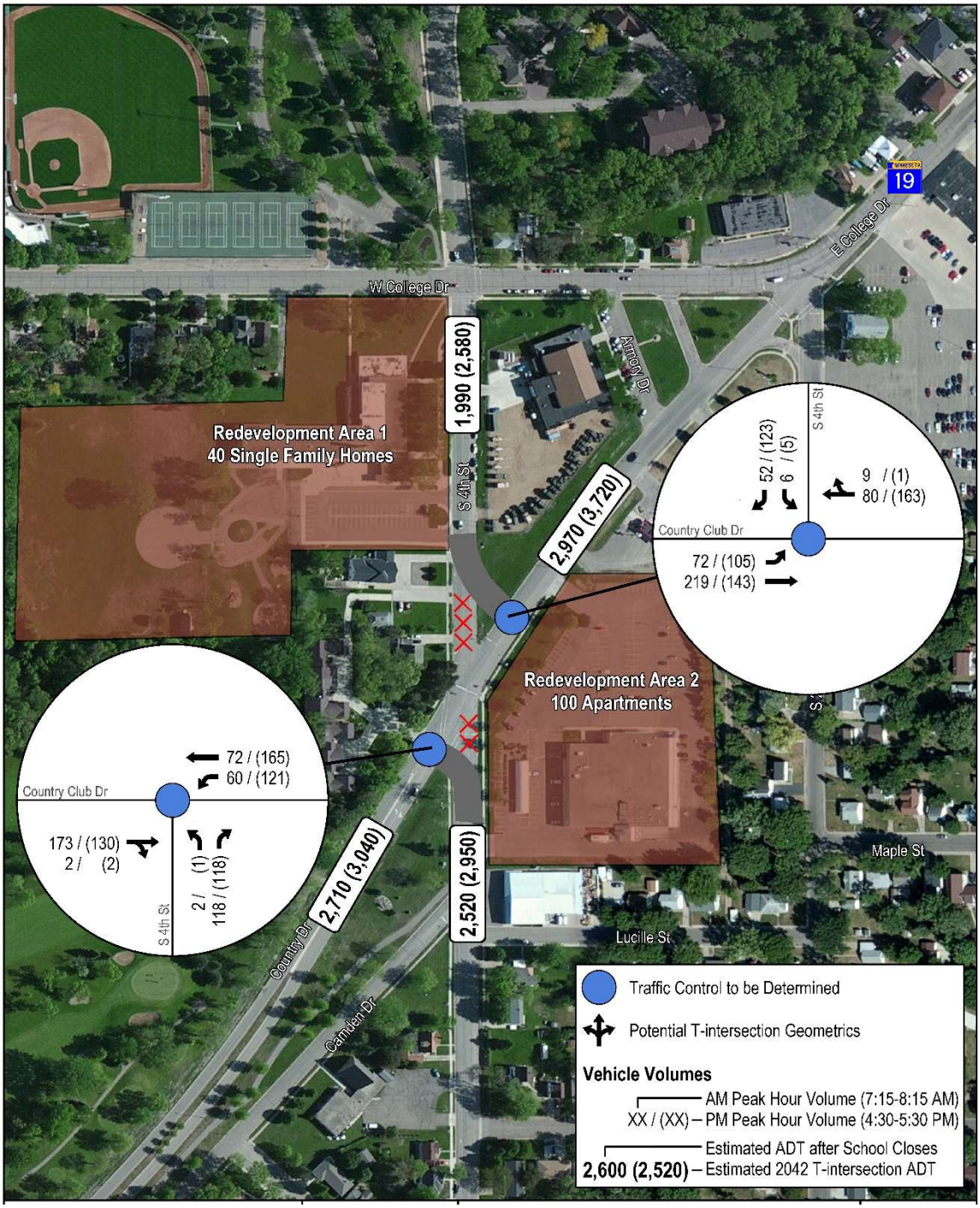


Figure 4 – Future T-Intersection (2042) Traffic Data



4 Analysis of Alternatives

Intersection control evaluations rely on traffic control warrants to assess the different options available at any intersection. To determine the control options, warrants are evaluated to assess where control changes can be made based on volumes. The results are used to aid in the evaluation of traffic safety and traffic operations at the study intersections

4.1 Warrant Analysis

The Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) provides guidance on when it may be appropriate to use all-way stop or signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors to determine when all-way stop or signal control may be justified. All-way stop or signal control should not be installed at an intersection unless a MnMUTCD warrant is met. Meeting a warrant at an intersection does not in itself require the installation of a particular control type. The particular control type also requires an engineering analysis of the intersection's design in order for it to be justified.

Under the MnDOT ICE process, roundabouts are considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control.

4.1.1 Requirements for Installation of a Traffic Signal

For traffic signal installation, MnDOT typically requires volume thresholds for Warrant 1 to be satisfied, which requires 8-hours of combined major approach volumes and the highest minor street approach volume to meet MnMUTCD thresholds. These thresholds vary with the number of approach lanes on the major and minor street. Other warrants may be used as indicators of a need to consider traffic control change; an engineering study that considers factors, including warrants, should be performed to determine the optimum type of control at an intersection.

4.1.2 Requirements for Removal of an Existing Traffic Signal

The MnDOT Traffic Engineering Manual (TEM) provides guidance on volume requirements to remove an existing traffic signal. Based on Chapter 9, section 9-5.02.05 of the TEM, an intersection that meets 80 percent of the volume requirements of Warrant 1 should be considered justified and should not be removed. A signalized intersection that does not meet 60 percent of the volume requirements of Warrant 1, and meets no other Warrant, is an unjustified traffic signal and should be removed.

A signalized intersection that does not meet 80 percent of the volume requirements but does meet 60 percent of the volume requirements of Warrant 1 is in a "gray area" and may be considered for traffic signal removal. Additional studies, findings, engineering judgment and documentation beyond the volume requirements are needed to justify retaining the signal.

4.1.3 Warrant Analysis Assumptions

MnDOT guidelines suggest that for the purpose of warrant analysis, 100% of right turning traffic from the minor leg should be removed because right turning vehicles are typically able to enter the traffic stream with minimal delay or conflict; the right turning traffic would not require a traffic signal to reduce delay or improve safety. In certain circumstances (i.e. high right turn volume, minimum mainline gaps, etc.), MnDOT procedures allow for the inclusion of 50% of the minor

street right turning traffic in the analysis. The MnDOT guidance states "if right turning volume exceeds 70% of its potential capacity for any hour for each approach, 50% of the right turning volume for all hours should be added back in."

- Based upon MnDOT guidance, the analysis of the study intersection includes removal of 100% of the right turning traffic on the minor approaches.

MnDOT guidelines suggest that the warrant thresholds may also be reduced based on the roadway speeds and population of the city the intersection is within. If either major approach to the intersection has a posted speed, or 85th percentile speed, that exceeds 40 mph, then a reduction to 70% threshold volumes is allowed. If the population of the city is less than 10,000 people, a reduction to 70% threshold volumes is allowed.

- Based upon MnDOT guidance, the analysis of the study intersection includes the reduction based on speeds as the west leg has speeds higher than 40 mph (posted at 40 mph).

Traffic warrants were completed for the existing and forecasted 2042 traffic demands; the existing volumes were evaluated with and without the elementary school traffic.

Based on the existing and future traffic volumes, the intersection does not meet the All-Way stop warrants or any traffic signal warrant. As the intersection does not meet the 60% thresholds of Warrant 1, the existing traffic signal control should be evaluated for removal.

The attached **Appendix A** includes all traffic control warrant worksheets.

Table 5 – Warrant Analysis Results

Volume Year	Scenario	All-way Stop Warrant	Traffic Signal Warrants				
			Warrant 1 (8 Hour)	Warrant 1 (8 Hour)	Warrant 1 (8 Hour)	Warrant 1 80% (8 Hour)	Warrant 1 60% (8 Hour)
2021	Existing	Not Met	Not Met	Not Met	Not Met	Not Met	Not Met[1]
		5 of 8 hours	0 of 8 hours	0 of 4 hours	0 of 1 hour	0 of 8 hours	0 of 8 hours
	Existing[2]	Not Met	Not Met	Not Met	Not Met	Not Met	Not Met[1]
		3 of 8 hours	0 of 8 hours	0 of 4 hours	0 of 1 hour	0 of 8 hours	0 of 8 hours
2042	Future[2]	Not Met	Not Met	Not Met	Not Met	Not Met	Not Met[1]
		6 of 8 hours	0 of 8 hours	0 of 4 hours	0 of 1 hour	0 of 8 hours	2 of 8 hours

Notes:

1. Existing signal that does not meet the 60 percent volume threshold for Warrant 1.
2. West Side Elementary School traffic volume was removed.

4.2 Safety Analysis

Future vehicular crash estimates were determined by applying the MnDOT Statewide average crash rates to the forecast 2042 average entering traffic for the study intersection.

- The No Build estimates are based on the existing crash rates as described in Section 2; the existing crash rate is 0.30 crashes per million entering vehicles (MEV).

- Signalized intersections are based on the MnDOT Statewide average crash rates for a signalized intersection with less than 15,000 Average Daily Traffic for the highest volume leg of the intersection and a speed limit below 45 mph; the statewide average crash rate is 0.52 crashes per MEV.
- The MnDOT statewide average crash rate for urban minor street stop-controlled intersections is 0.18 crashes per million vehicles entering the intersection.
- The MnDOT statewide average crash rate for all-way stop controlled intersections is 0.35 crashes per million vehicles entering the intersection.
- Roundabout crash estimation was done using MnDOT's *A Study of Traffic Safety at Roundabouts in Minnesota*. This study concluded that single lane roundabouts in Minnesota have an average crash rate of 0.32 crashes per MEV.
  - MnDOT's study did not include separating 4-leg roundabouts from 3-lane roundabouts; however, NCHRP 672 provides formulas for varying legs and results in a 3-leg have approximately ½ the crashes as a 4-leg roundabout when comparing single lane roundabouts.
- The MnDOT statewide average crash rate for "other" controlled intersections includes both right-in/right-out (RI/RO) and ¾ access intersection, the crash rate is 0.16 crashes per million vehicles entering the intersection.

Table 6 shows the projected numbers of total annual crashes at the study intersection for each traffic control type analyzed for the existing 2021 and future forecast 2042 traffic conditions.

Table 6 – Future Annual Crash Estimates

Analysis Year	Annual Crash Estimate[1]	Total Annual Crash Estimates by Control Type[2]				
	No Build	Minor Stop	All-Way Stop	Traffic Signal	Single Lane Roundabout[3]	¾ Access or RI/RO
2021	0.6	0.4	0.7	1.0	0.6	0.3
2042	0.7	0.4	0.8	1.2	0.7	0.4

1: Existing Intersection Crash Rate (2016 to 2020 5-year data)

2: MnDOT Statewide Average Crash Rates (2015 5-year data; latest published)

3: NCHRP 672 suggests that a 3-leg single lane roundabout is estimated to have ½ the crashes as a 4-leg roundabout.

The minor stop control and reduced access control (3/4 Access or RI/RO) are estimated to have the lowest overall crash number prediction; however, the existing intersection would likely have a crash rate higher than the statewide average under minor street stop control due to the existing intersection skew.

The existing signal operates safer than the MnDOT average for similar signalized intersections, with almost half as many crashes; though it should be noted that the MnDOT average signalized intersection has the highest estimated crashes.

A single lane roundabout controlled intersection would incur a similar estimate to the existing conditions. Crashes at roundabouts are typically less severe than the other control types due to the reduced speeds approaching and departing the intersection. Roundabouts require a low

travel speed through the intersection and eliminate left turn and crossing crashes. This greatly reduces the potential for the most severe types of crashes that result in personal injury or fatality. The previously mentioned MnDOT roundabout study demonstrated roundabouts had a reduction in fatal crashes of 86% and a reduction of 83% of serious injury crashes. For these reasons, the roundabout control was evaluated to provide a safer intersection for all users.

Table 6 represents the estimated crashes based on existing intersection configuration. A "Split T" design would create two 3-legged intersections. The volume at each intersection will be less than the single intersection; however, since most traffic is through along Country Club Drive, the two intersections would still have a lot of traffic passing through; the T-intersections have approximately 70% to 75% of the total volume at each intersection.

The split T crash estimates were calculated for the 2042 future year to compare to **Table 6**. One thing to note, most intersections have 4-legs and the average crash rates MnDOT provides is skewed to that configuration; due to the reduced movements and conflicts it is assumed these estimates would be on the high side.

- **Minor Street Stop T-Intersection**: 0.3 crashes at each, 0.6 crashes total.
- **¾ Access T-Intersection**: 0.3 crashes at each, 0.6 crashes total.
- **Single Lane Roundabout T-Intersection**: 0.25 crashes at each, 0.5 crashes total.
  - This included a 50% reduction based on NCHRP 672 as previously mentioned.

4.2.1 Conflict Point Analysis

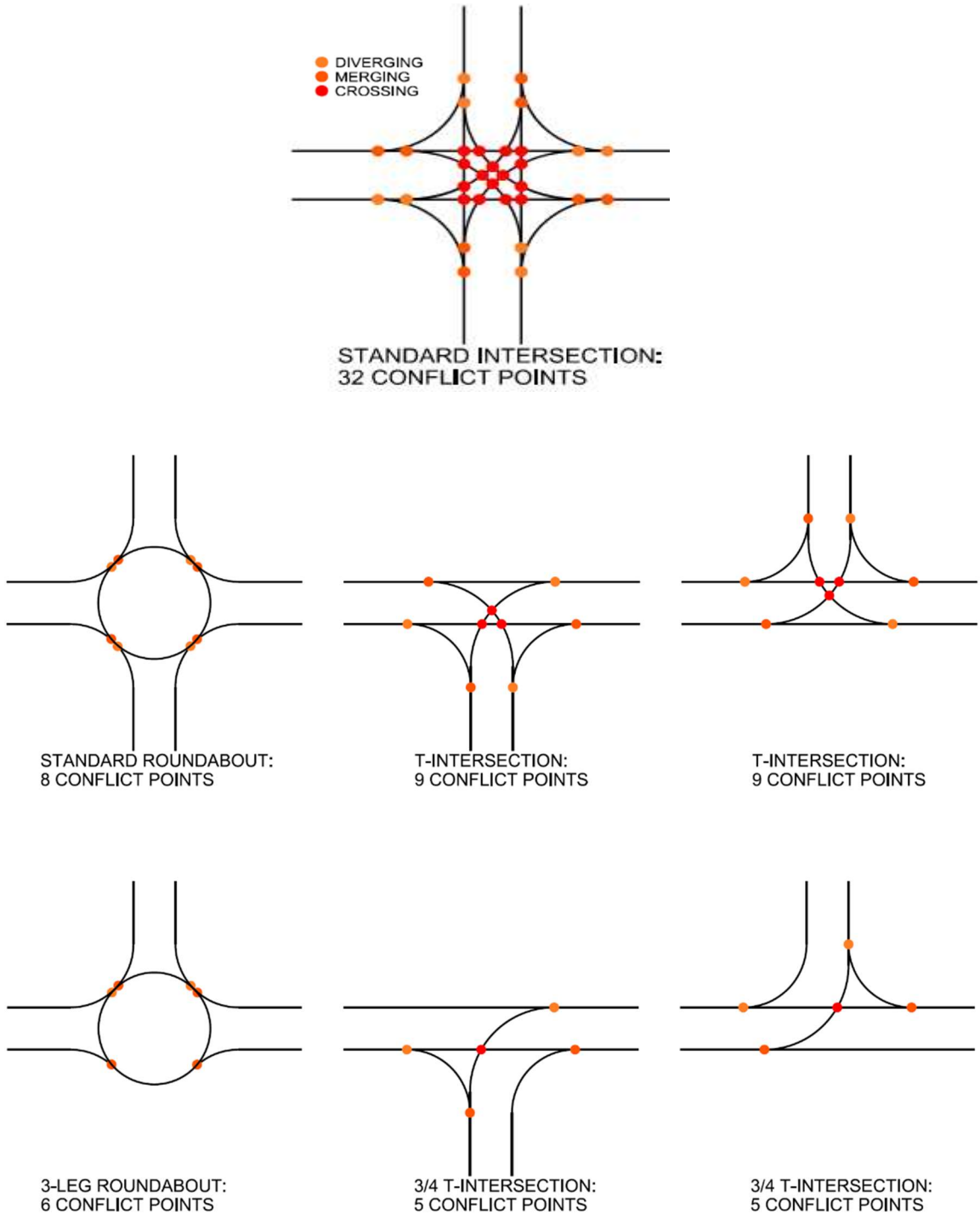
Another predictor of safety at an intersection is the number of conflict points. A conflict point is any point where vehicles cross, merge, or diverge at an intersection and are the points at which a crash is most likely to occur. Reducing the number of conflict points at an intersection by reducing access can improve vehicle safety.

The existing 4-leg intersection has a total of 32 conflict points. As a single intersection, the only feasible way to reduce conflict points would be to install a roundabout control which reduces the number of conflict points to 8; a ¾ access at the single intersection would create major traffic pattern shifting due to the high number of minor stop approach through movements.

Modifying the intersection to a "Split T" design is a common improvement at severely skewed intersections. The two intersections have a significant reduction in conflict points with a total of 18 conflicts at the two intersections. These conflicts can be further reduced with roundabout control or ¾ access.

Figure 5 shows various conflict point diagrams for a 4-leg intersection, T-intersection, ¾ access T-intersection, and roundabout options.

Figure 5 – Safety – Conflict Point Diagrams



4.3 Traffic Operations

Traffic operations analyses were conducted to determine the level of service (LOS), delay, and queueing information for the AM and PM peak hour conditions of each control type scenario.

LOS is a qualitative rating system used to describe the efficiency of traffic operations at an intersection. Six LOS are defined, designated by letters A through F. LOS A represents the best operating conditions (no congestion), and LOS F represents the worst operating conditions (severe congestion). For the study intersection it was assumed that a LOS D or better, for all approaches and the overall intersection, represents acceptable operating conditions.

LOS for intersections is determined by the average control delay per vehicle. The range of control delay for each LOS is different for signalized and unsignalized intersections. The expectation is that a signalized intersection is designed to carry higher traffic volumes and will experience greater delays than an unsignalized intersection; driver tolerance for delay is greater at a signal than at a stop sign. Therefore, the LOS thresholds for each LOS category are lower for unsignalized intersections than for signalized intersections

All traffic operations analyses were performed using the Highway Capacity Software (HCS 7); which is a faithful implementation of the Highway Capacity Manual calculations.

- Other traffic models for operations analysis were investigated, including Synchro/SimTraffic; however, HCS was found to most accurately represent the existing traffic conditions seen when compared to the delay study conducted at the intersection.

The attached **Appendix B** includes all relevant operational tables and results for the existing and future 2042 scenarios that follow.

4.3.1 Existing 2021 Conditions

During both the AM and PM peak hours, the existing signalized intersection operates acceptably with all approaches at a LOS C or better. The existing traffic signal operates in free mode and is vehicle actuated, this keeps the cycle length short, and any queued vehicles are served relatively quickly in most instances.

Under the current traffic conditions, the southbound approach in the AM peak hour incurs the worst delay. This approach can typically see higher delays in a shorter window of time due to the drop-off operations of the elementary school. The existing delay study did show queues of up to 7-9 vehicles at the signal during the peak drop off times, with some vehicles not being served within one cycle.

Table 7 shows the existing approach and intersection delays/LOS for both peak hours.

Table 7 – Existing 2021 MOE's

Peak Hour	Delay (sec/veh) / LOS				
	EB Approach Country Club	WB Approach Country Club	NB Approach S. 4th Street	SB Approach S. 4th Street	Intersection
AM	6.8 / A	6.2 / A	18.3 / B	23.3 / C	15.0 / B
PM	4.7 / A	4.7 / A	15.6 / B	15.7 / B	9.7 / A

4.3.2 Future No Build 2042 Conditions

While the traffic control warrant analysis did show that signal control is not warranted due to low volumes not meeting 60% of Warrant 1 volume thresholds, this scenario was carried forward for comparative purposes; this option is currently not considered viable.

For this scenario, no geometric changes were made to the intersection. The existing signal timings were modified based on discussion in Section 2.3 of this report; this pertains to increasing the Flash Don't Walk, Yellow, and All Red times at the signal.

With these changes, all approaches still operate acceptably. The AM peak hour shows an improvement over the existing conditions, this is due to the reduction in volumes at the intersection from the school redevelopment. The PM peak hour results in slightly increased delay times due to the increase in All Red times at the signal.

Table 8 shows the 2042 No Build approach and intersection delays/LOS for both peak hours.

Table 8 – Future No Build 2042 MOE's

Peak Hour	Delay (sec/veh) / LOS				
	EB Approach Country Club	WB Approach Country Club	NB Approach S. 4th Street	SB Approach S. 4th Street	Intersection
AM	7.3 / A	6.8 / A	19.4 / B	18.3 / B	12.1 / B
PM	7.3 / A	7.3 / A	18.8 / B	18.9 / B	12.7 / B

4.3.3 Traffic Control Alternatives Future 2042

Based on the warrant analysis, the study intersection does not meet either the all-way stop control or traffic signal control warrants. The existing intersection skew provides significant issues concerning sight distance to simply remove the existing traffic signal and install stop signs.

Without a traffic signal to provide assignment of right-of-way for vehicles, the existing intersection skew would not operate safely as a minor stop-controlled intersection. Reducing access would significantly impede traffic patterns along S. 4th Street, as the through traffic across Country Club Drive is approximately 25% of the total intersection volumes. Therefore, the only viable option at the existing intersection, without signal control, would be to install a single lane roundabout.

To improve the intersection skew, a "Split T" design was considered. This design would develop two T-intersections that can be squared up to Country Club Drive to remove the skew issues. This design can provide a reduction in crashes as described in the safety section of this report. Under the Split T design, the intersection control could consider minor stop control, ¾ Access, and single lane or mini roundabouts.

This section will evaluate the following scenarios:

- Single Lane Roundabout (single intersection design)
- Split T – Minor Stop Control
- Split T – Reduced ¾ Access
- Split T – Mini roundabouts

4.3.3.1 Roundabout Control

This scenario includes the reconstruction of the intersection to accommodate a single lane roundabout. Due to the intersection skew, the roundabout was designed as an elongated oval shape with additional curves to ensure vehicles remain at low speeds as they traverse the intersection. The skew also requires right turn bypass lanes along both directions of Country Club Drive for vehicles to make the movement, especially larger vehicles including trucks and buses.

Additional discussion of design considerations and impacts beyond the traffic operations will be discussed in Section 5 of this report.

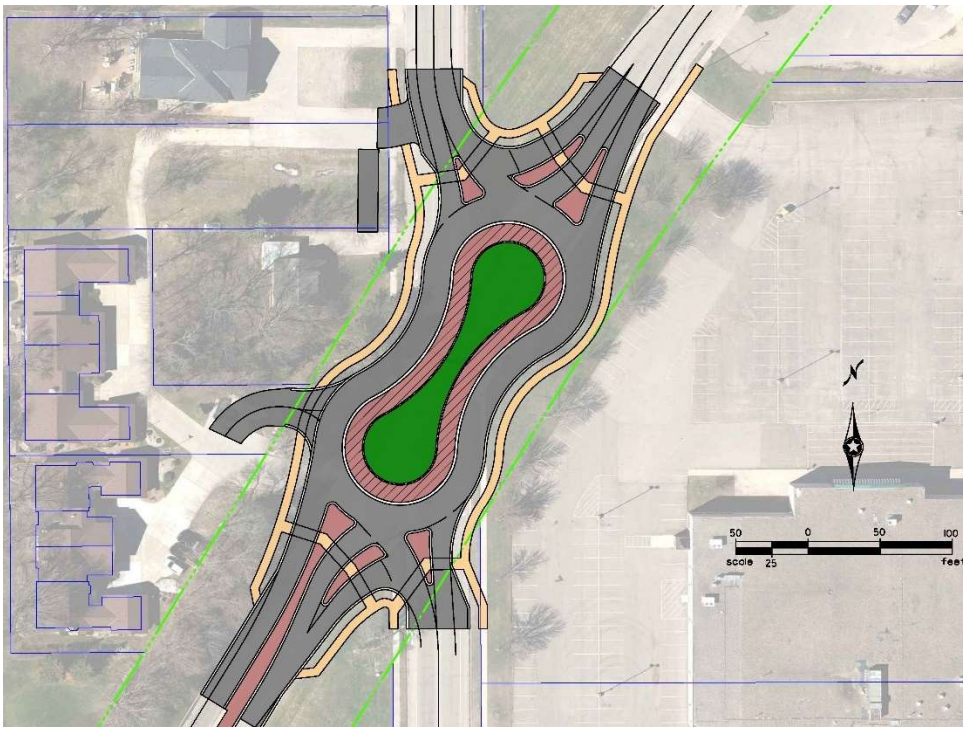
The single lane roundabout would operate with minimal delay and all approaches would operate at LOS A under the 2042 traffic forecast volumes.

Table 9 shows the 2042 single lane roundabout approach and intersection delays/LOS for both peak hours. **Figure 6** represents the preliminary design of the intersection.

Table 9 – Future 2042 Roundabout MOE's

Peak Hour	Delay (sec/veh) / LOS				
	EB Approach Country Club	WB Approach Country Club	NB Approach S. 4th Street	SB Approach S. 4th Street	Intersection
AM	4.4 / A	3.7 / A	4.7 / A	3.5 / A	4.3 / A
PM	4.2 / A	4.4 / A	4.2 / A	4.4 / A	4.3 / A

Figure 6 – Roundabout Control



4.3.3.2 Split T-Intersection – Minor Stop Control

This scenario includes the reconstruction of the intersection to provide two separate T-intersections. Each leg of S. 4th Street is squared up to remove any skew at each intersection. S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street; left turn lanes will be provided between the T-intersections.

Additional discussion of design considerations and impacts beyond the traffic operations will be discussed in Section 5 of this report.

The full access minor stop T-intersections would operate with minimal delay and all approaches would operate at LOS A under the 2042 traffic forecast volumes.

Table 10 shows the 2042 Split T-intersection design with minor street stop control approach and intersection delays/LOS for both peak hours. **Figure 7**, on the following page, represents the preliminary design of the split T-intersection.

Table 10 – Future 2042 Split T-Intersection Minor Stop MOE's

Intersection	Peak Hour	Delay (sec/veh) / LOS				
		EB Left Turn Country Club	WB Left Turn Country Club	NB Approach S. 4th Street	SB Approach S. 4th Street	Intersection
West Intersection	AM		7.8 / A	10.4 / B		n/a
East Intersection		7.6 / A			9.5 / A	n/a
West Intersection	PM		7.8 / A	9.7 / A		n/a
East Intersection		7.8 / A			10.1 / B	n/a

Notes: Minor Street Stop Control intersection LOS is typically defined as the worst approach LOS on the minor street; mainline through traffic would have no delay and only the mainline left turns would yield.

4.3.3.3 Split T-Intersection – ¾ Access Control

This scenario includes the reconstruction of the intersection to provide two separate ¾ access T-intersections. Each leg of S. 4th Street is squared up to remove any skew at each intersection. S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street; left turn lanes are provided between the T-intersections.

With the reduction to ¾ Access for this design, only the S. 4th Street left turning traffic would be impacted; the volume for these two movements is low without the school traffic. The southbound left turn is expected to be less than 75 vehicles per day and the northbound left turn is expected to be 10 vehicles per day or less. Additional discussion of design considerations and impacts beyond the traffic operations will be discussed in Section 5 of this report.

This scenario was not analyzed operationally as it would operate better than the previous full access scenario, therefore it is expected it would operate with minimal delay and all approaches would operate at LOS A under the 2042 traffic forecast volumes.

Figure 8, on the following page, represents the preliminary design of the split T-intersection with ¾ Access control.

Figure 7 – Split T-Intersection – Minor Stop Control

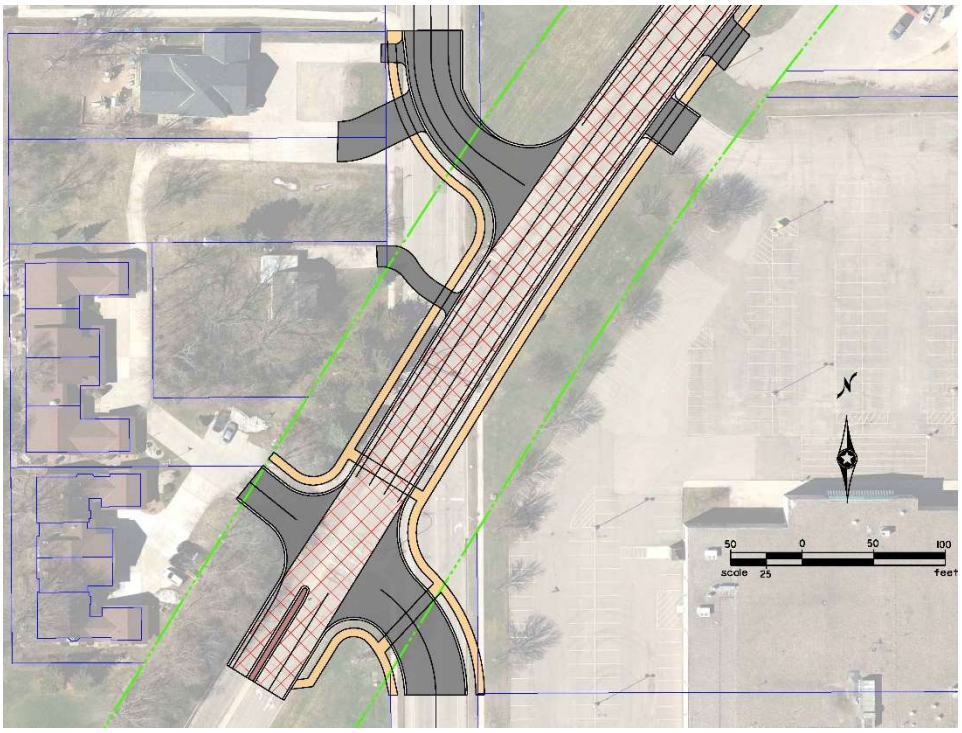
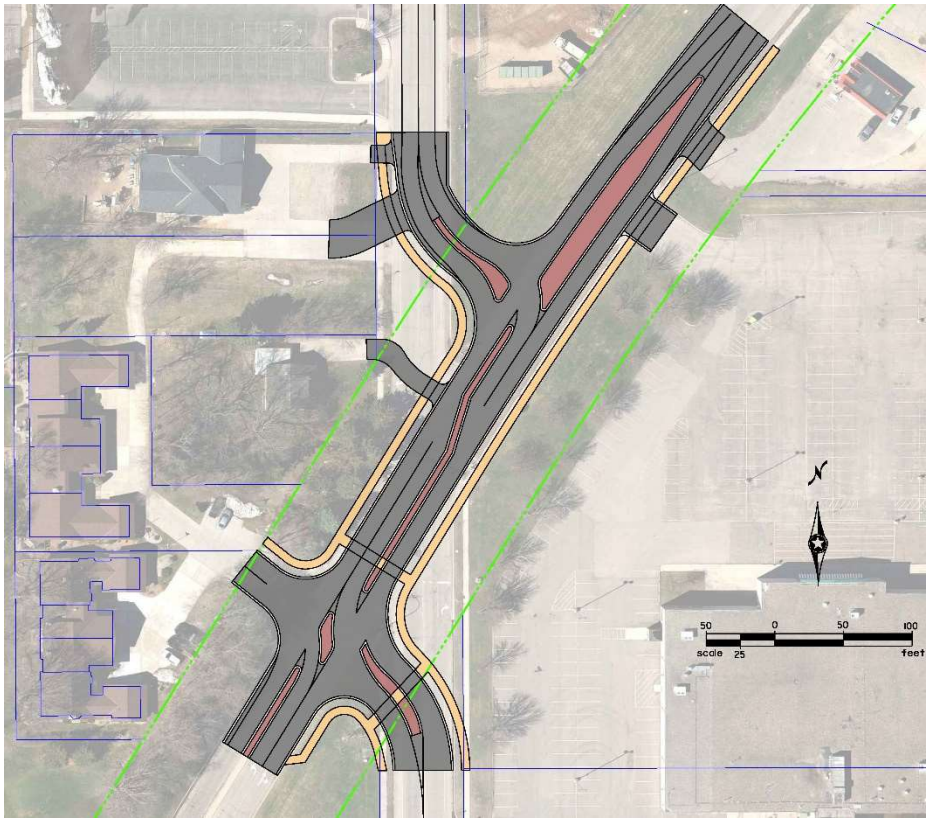


Figure 8 – Split T-Intersection – ¾ Access Control



4.3.3.4 Split T-Intersection – Mini roundabout Control

This scenario includes the reconstruction of the intersection to provide two separate mini roundabout T-intersections. Each leg of S. 4th Street is squared up to remove any skew at each intersection. S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street.

Additional discussion of design considerations and impacts beyond the traffic operations will be discussed in Section 5 of this report.

Currently, there is not a standard traffic operations analysis tool to evaluate a mini roundabout; there are only guidelines for the expected operational capacity of the intersection. It should be noted that a mini roundabout would have slightly less capacity than single-lane roundabout examined in this section.

Current FHWA guidance suggests a total entering demand for a mini roundabout to be less than 1,600 vehicles per hour on all approaches. The two study T-intersections have significantly less than this capacity limit, the highest volume in 2042 at either T-intersection is 550 vehicles in the PM peak hour; this is less than 1/3 of the capacity of a mini roundabout.

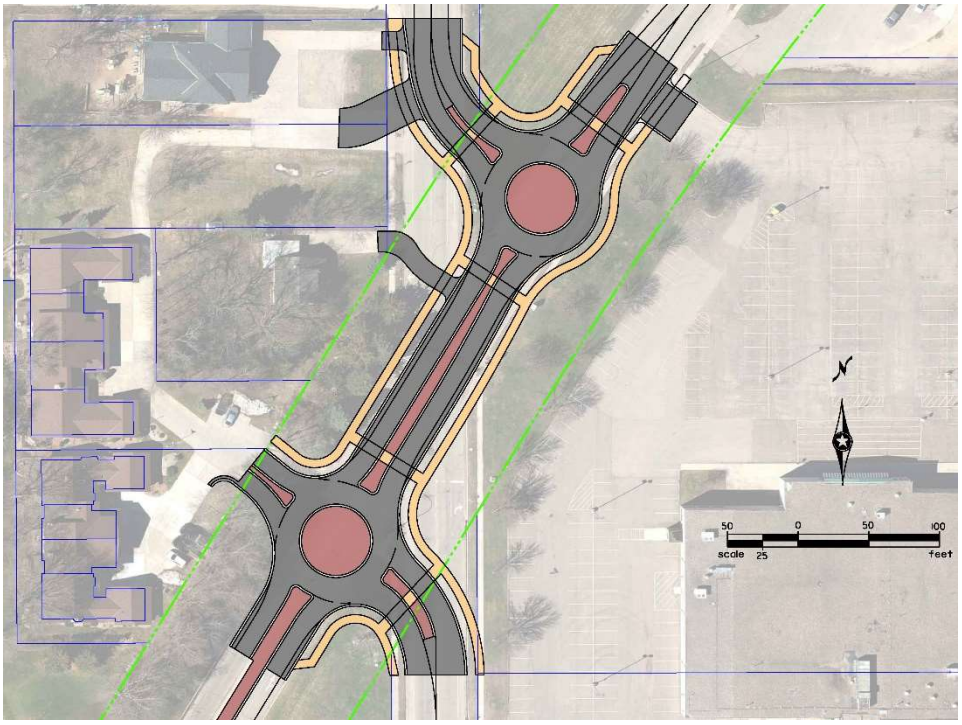
The full access mini roundabout intersections would operate with minimal delay and all approaches would operate at LOS A under the 2042 traffic forecast volumes; this is based on a single lane roundabout analysis within the HCS software.

Table 11 shows the 2042 Split T-intersection design with minor street stop control approach and intersection delays/LOS for both peak hours. **Figure 9** represents the preliminary design of mini roundabouts at the study intersections.

Table 11 – Future 2042 Split T-Intersection Mini roundabout MOE's

Intersection	Peak Hour	Delay (sec/veh) / LOS				
		EB Approach Country Club	WB Approach Country Club	NB Approach S. 4th Street	SB Approach S. 4th Street	Intersection
West Intersection	AM	4.4 / A	3.7 / A	4.6 / A		4.2 / A
East Intersection		5.1 / A	3.7 / A		3.5 / A	4.6 / A
West Intersection	PM	4.1 / A	4.7 / A	4.1 / A		4.4 / A
East Intersection		4.4 / A	4.3 / A		4.3 / A	4.3 / A

Figure 9 – Split T-Intersection – Mini roundabout Control



4.4 Control Comparisons

All traffic control options can have advantages and disadvantages. This section will provide a brief description of each control evaluated.

While traffic signal control provides orderly flow for all traffic with reasonable delays, they can increase crashes, add delay to the major roadway, and have continuous maintenance costs. For this study intersection, the volumes do not warrant the current traffic signal control and it should be removed.

Roundabout control also provides orderly flow for all traffic but at much lower speeds; this results in reduced crashes and less severe crashes. The biggest disadvantage of roundabouts is typically the cost to construct and potential right-of-way impacts.

Minor stop control provides no delay for the mainline through traffic; this typically results in added delays for the minor stop approaches. The main concern with this type of intersection is safety with vehicles trying to find gaps to cross the major roadway; these crashes can typically be more severe as they result in right-angle collisions.

A ¾ access intersection removes the through and left turning traffic from the minor approach and significantly improves the safety of the intersection, all while mainline through traffic incurs no delays. The restricted access can increase travel times for some movements and the addition of medians can add to the overall cost and construction impacts.

5 Other Considerations

In addition to providing safe and efficient intersection control, a desired outcome of the study is to also provide safe pedestrian crossings, minimize driveway access impacts, minimize right-of-way impacts, and construction costs.

5.1 Pedestrian Crossing

The 2021 count was conducted in March with good weather; while this may not represent the peak pedestrian times throughout the year, the intersection did see pedestrians crossing.

As previously mentioned, there are only marked crossings on the west and south legs of the intersection. The west leg had the most activity with 36 crossing throughout the day, the south leg had a total of 5 crossings. These 41 crossings occurred mostly after the noon hour and did not seem to be generated by the nearby school.

The north and east legs do not have any markings as there is no sidewalk provided on either roadway in the northeast quadrant of the intersection. While the north leg did not have any crossings, the east leg did have 6 total crossings. In the AM peak period, prior to the school start time, 4 of these crossings did occur and appeared to be students and staff.

The existing traffic signal currently provides a controlled pedestrian crossing at the intersection; however, with the potential signal removal, the pedestrian crossing would change.

In most alternatives, a median was included in the design in order to provide a pedestrian refuge. The refuge island allows pedestrians to cross one direction of traffic at a time, making finding available gaps significantly easier and can improve pedestrian visibility.

Based on the MnDOT guidance, additional crossing treatments are typically only installed for crossing that have 20 pedestrians per hour; therefore, no additional enhancements were considered at this time other than providing marked crosswalks.

5.2 Design Alternatives

Each design alternative was preliminarily laid out to assess the various impacts of each design. This section will review each design scenario, the impacts, and provide preliminary cost estimates.

Discussion with City staff resulted in some design considerations for each of the alternatives. The design considerations are as follows:

- Limit impacts to the northeast quadrant of the intersection. The property is currently occupied by the Minnesota National Guard.
  - No plans to construct sidewalks in this quadrant.
- The southwest quadrant is a city owned property that can be utilized as needed.
- Show existing driveway connections.

As previously mentioned, the existing traffic signal is not warranted and should be removed. Due to the existing intersection skew, stop control is not a viable option as the intersection sight lines become problematic and safety a big concern.

Full intersection layouts and cost estimate information can be found in **Appendix C**. It should be noted that the cost estimates do not include right-of-way or the cost to remove the existing signal.

5.2.1 Single Roundabout

The only viable option to keep a single intersection without skew issues is to provide a single lane roundabout. Due to the intersection skew, the roundabout was designed as an elongated oval shape with additional curves to ensure vehicles remain at low speeds as they traverse the intersection. The skew also requires right turn bypass lanes along both directions of Country Club Drive for vehicles to make the movement, especially larger vehicles including trucks and buses.

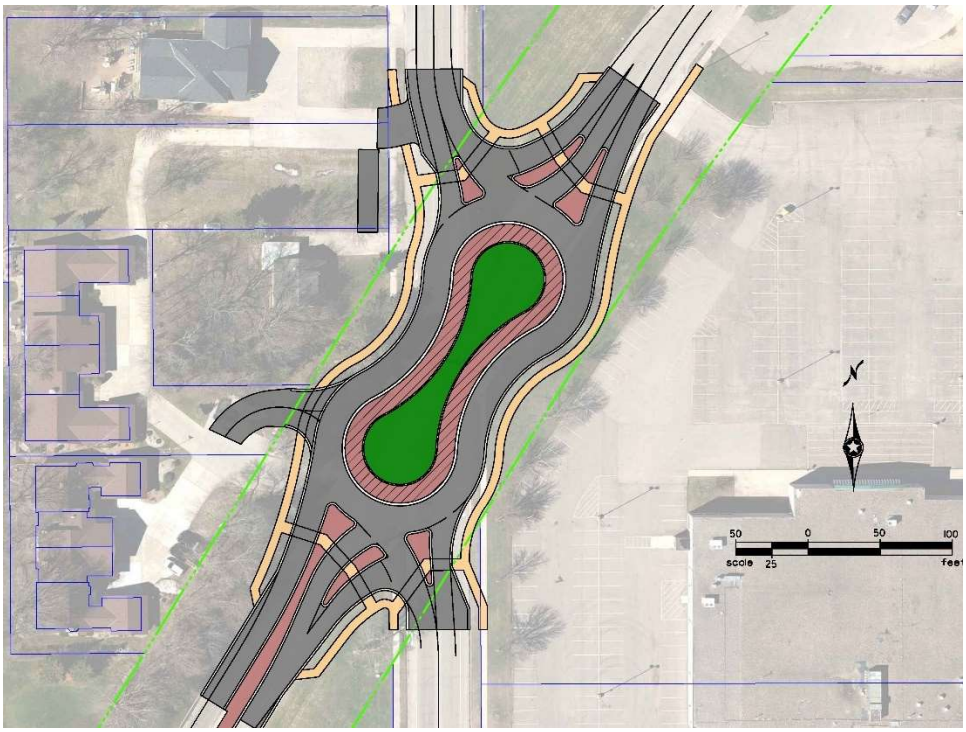
This design currently shows sidewalks surrounding the intersection, considerations for final placement of sidewalks and crosswalks can be done during the design phase.

Driveways were connected in varying ways for this alternative. The multi-family complex driveway was connected as an additional leg of the roundabout to allow for full movement to and from the driveway. The two driveways on S. 4th Street would be combined to provide access out to S. 4th Street.

The estimated construction cost for this design alternative is approximately **$1,369,500**.

Figure 10 represents the preliminary design of the single lane roundabout.

Figure 10 – Roundabout Control



5.2.2 Split T – Minor Stop

To address the existing intersection skew, this scenario includes the reconstruction of the intersection to provide two separate T-intersections. Each leg of S. 4th Street is squared up to remove any skew at each intersection. The north leg of S. 4th Street was tightened to limit impacts to the northeast quadrant, the south leg was aligned across from the driveway in the northwest quadrant.

Vehicle traffic patterns along S. 4th Street would be impacted with the split T design. Through traffic on S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street; left turn lanes will be provided between the T-intersections. All other movements are not impacted by the design change.

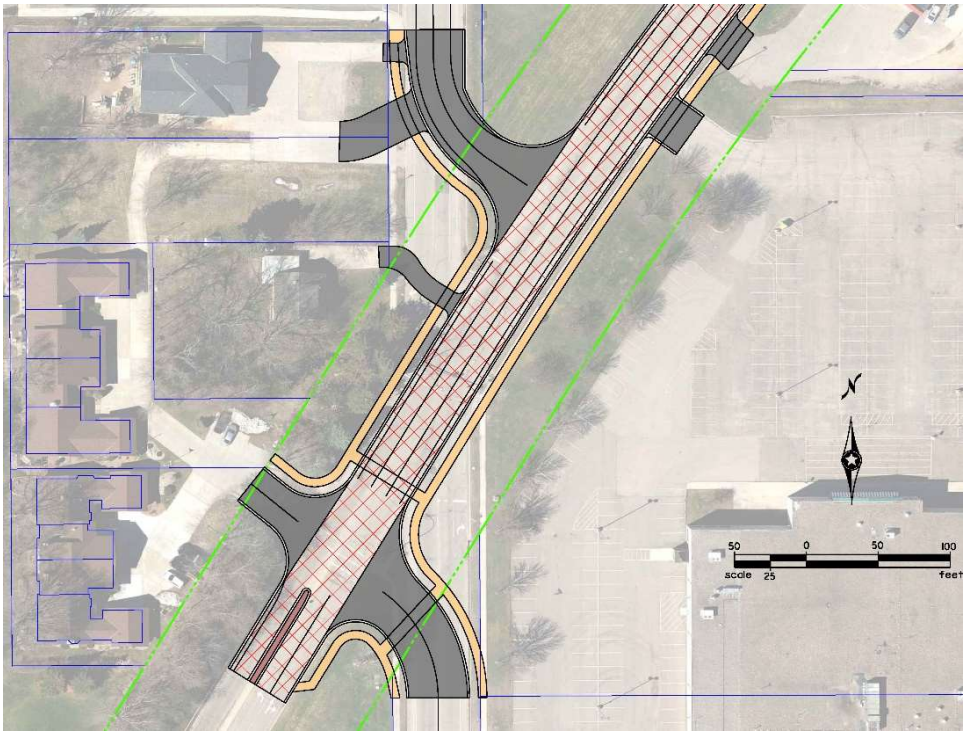
Driveways were connected in varying ways for this alternative. The multi-family complex driveway was connected as an additional leg of the west intersection to allow for full movement to and from the driveway. The two driveways on S. 4th Street would be split with one connecting to S. 4th Street and one connecting to Country Club Drive.

Without medians, this design is considered the minimal option to incorporate the split T-intersection design. Without medians, the pedestrian crossing would cross 3 full lanes of traffic on Country Club Drive.

The estimated construction cost for this design alternative is approximately **$732,300**; if medians are provided between the intersections, the cost increases to approximately **$873,000**.

Figure 11 represents the preliminary design of the split T minor stop intersections.

Figure 11 – Split T-Intersection – Minor Stop Control



5.2.3 Split T – ¾ Access

To improve safety of the intersection, the ¾ access scenario provides medians and reduced conflict points. The design is a continuation of the prior Split T design information.

Vehicle traffic patterns along S. 4th Street would be impacted with the split T design. Through traffic on S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street; left turn lanes will be provided between the T-intersections. The biggest impact with this design is the removal of the minor street, S. 4th Street, left turns onto County Club Drive. The volume for these two movements is low without the existing school traffic.

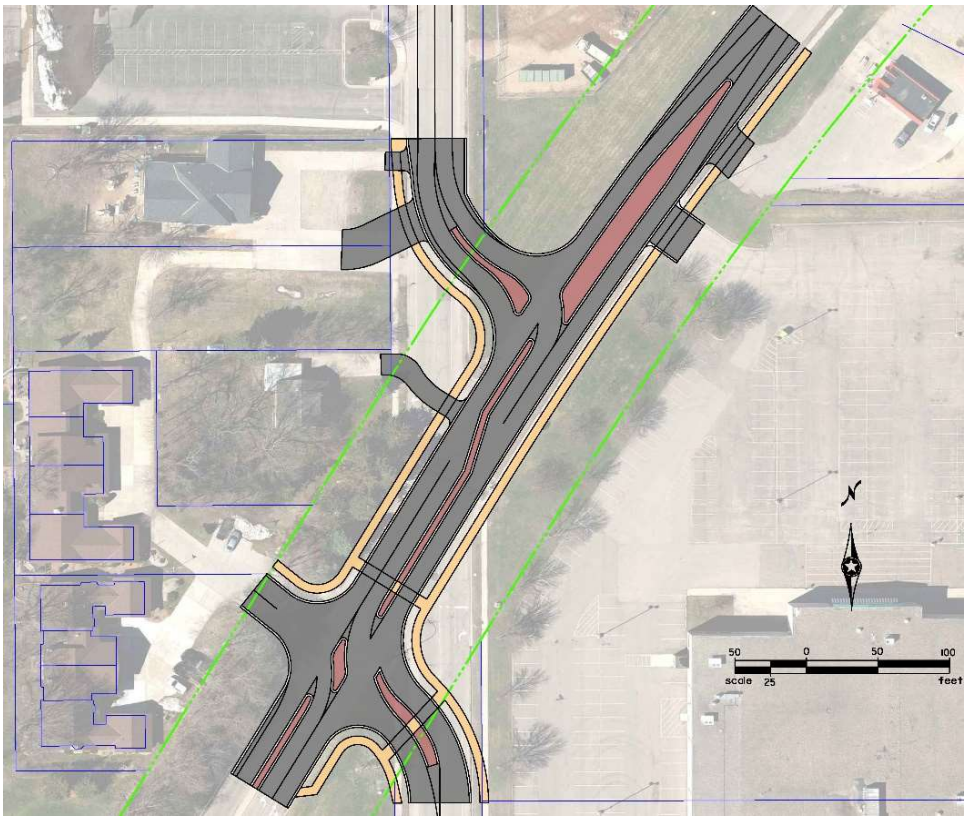
- The southbound left turn is expected to be less than 75 vehicles per day. There is no direct u-turn movement is provided; however, southbound traffic can easily reroute to the new roundabout at TH 19/Country Club Drive.
- The northbound left turn is expected to be 10 vehicles per day or less; this traffic can travel east to the new roundabout at TH 19/Country Club Drive to make a u-turn.

Driveways were connected in the same fashion as the previous split T-intersection design; however, the reduced access design would require some trips to reroute or complete a U-turn. With medians, this design provides a pedestrian refuge crossing of Country Club Drive.

The estimated construction cost for this design alternative is approximately **$952,100**.

Figure 12 represents the preliminary design of the split T ¾ access intersections.

Figure 12 – Split T-Intersection – ¾ Access Control



5.2.4 Split T – Mini Roundabouts

To improve safety of the intersection, this mini roundabout scenario provides reduced speeds, reduced conflict points, and reduced injury crashes. The design is a continuation of the prior split T design information.

The mini roundabout design will lower vehicle speeds as they travel through the intersections. Typical travel speeds are reduced to approximately 15 mph with mini roundabouts. The lower speeds not only significantly reduce the severity of crashes but provide pedestrians a more comfortable crossing experience.

Mini roundabouts have an inscribed circle diameter ranging from 50 to 95 feet. Accommodation of large vehicles through a mini roundabout is feasible with the traversable center median and MnDOT has constructed several mini roundabouts throughout the State on similar roadways.

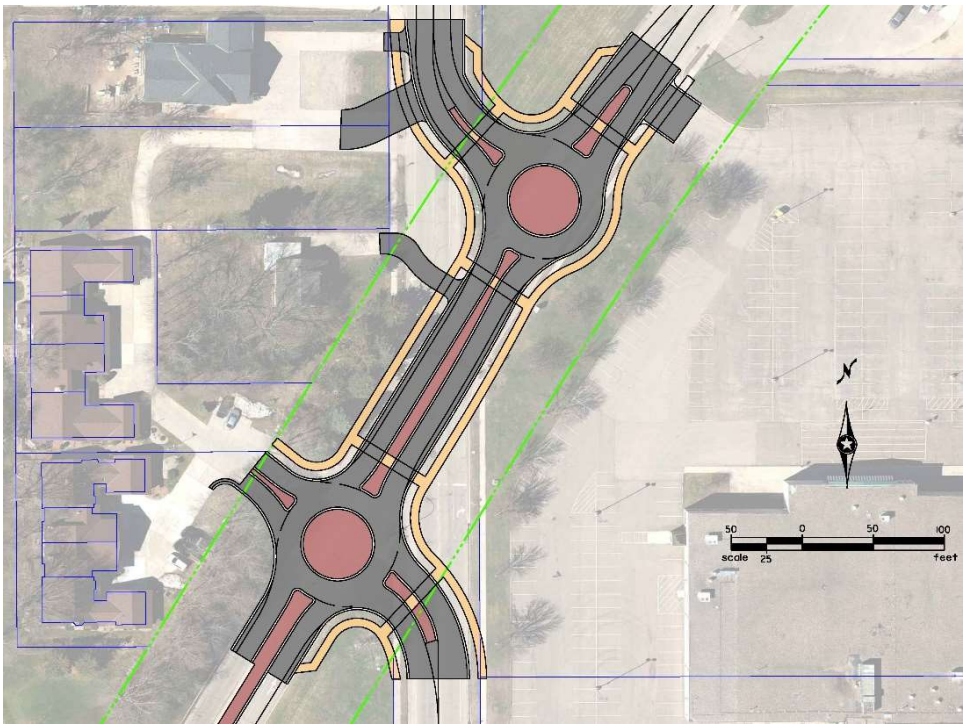
Vehicle traffic patterns along S. 4th Street would be impacted with the split T design. Through traffic on S. 4th Street vehicles can still make a right turn onto Country Club Drive and make a left turn to continue along S. 4th Street. All other movements are not impacted by the design change.

Driveways were connected in the same fashion as the previous split T-intersection designs. With medians, this design provides a pedestrian refuge crossing of Country Club Drive. This design currently shows sidewalks surrounding the intersection, considerations for final placement of sidewalks and crosswalks can be done during the design phase.

The estimated construction cost for this design alternative is approximately **$1,162,900**.

Figure 13 represents the preliminary design of the split T mini roundabout intersections.

Figure 13 – Split T-Intersection – Mini roundabout Control



5.2.5 Split T – Combination of Control

Any of the split T-intersection control options operate very well and would provide a safe and efficient travel. With the reduced access, ¾ access, only impacting a small number of vehicles per day, each of these T-intersection options could essentially be interchangeable and combined

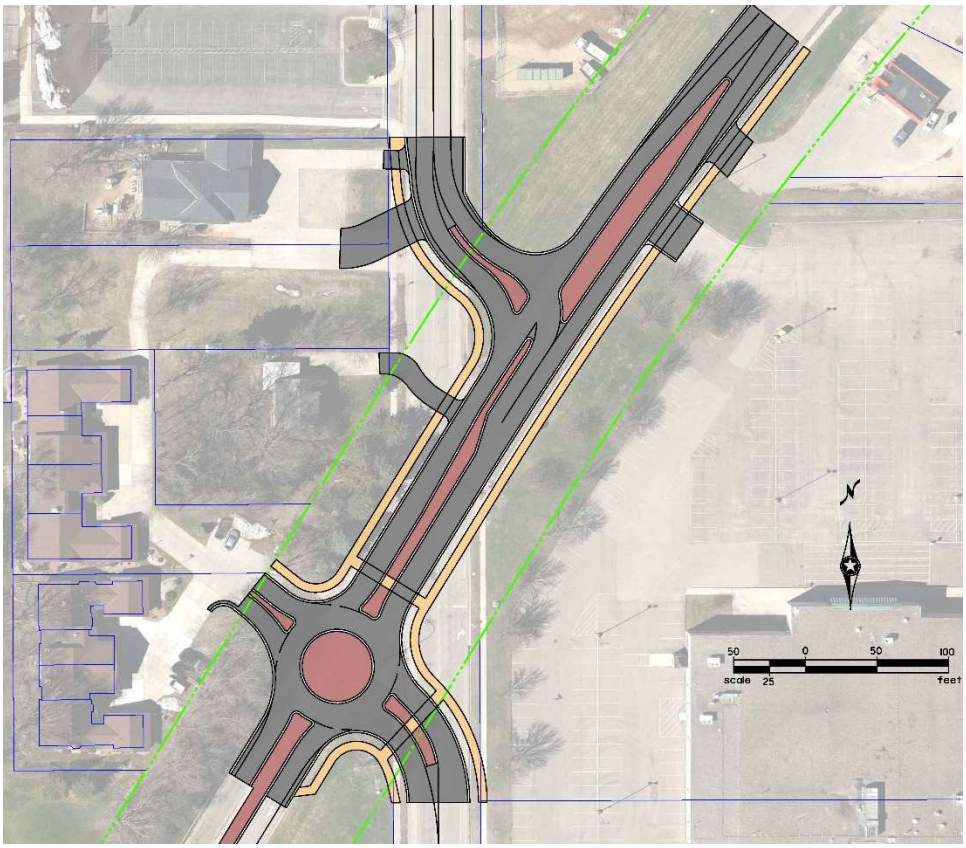
Based on input from the City, the western intersection would have a positive impact on vehicles speeds with a mini roundabout option. Currently, this leg of the intersection is posted at a higher speed than the adjacent roadway; the roundabout design would geometrically control vehicles speeds approaching from the west. The mini roundabout provides full access for the multi-family driveway and a u-turn opportunity for the RI/RO driveway on Country Club Drive.

The eastern intersection as a ¾ access would provide a safety benefit with the reduction in vehicle conflicts. Paired with the mini roundabout, any southbound left turning vehicle would have the ability to make a u-turn movement at the mini roundabout.

The estimated construction cost for this design alternative is approximately **$1,137,200**.

Figure 14 represents the preliminary design of the split T with mini roundabout and ¾ access intersections.

Figure 14 – Split T-Intersection – Combination Control



6 Conclusion

The existing traffic signal control currently operates acceptably and does not have a safety concern based on the existing crash history; traffic operations are expected to remain acceptable through the forecast year of 2042 even with redevelopment in the area.

However, the intersection does not currently meet volume warrant criteria for keeping a traffic signal; based on not meeting the 60% of the Warrant 1 volume thresholds from the MnMUTCD. Due to the intersection skew, the current signal timings do not provide enough Yellow and All Red times for vehicles to clear the downstream crosswalks safely. The traffic signal also provides additional maintenance costs as it is currently the only signal operated by the City of Marshall.

If the existing, unwarranted traffic signal remained in-place, there are negative impacts for the intersection and its users. The traffic signal, on average, has the highest crash rate of any intersection control option. While the intersection is currently performing safely, the MnDOT average for this intersection signal type suggests that crashes could increase. The traffic signal also creates unnecessary delays for all roadway users. When a minor street vehicle approaches the intersection, the vehicle waits for the signal phase change, creating delays for the mainline traffic when the phase switches. With volumes much lower than the warrant thresholds, the mainline vehicles would not be required to stop, and the minor street vehicle can easily find gaps in traffic to pass through the intersection.

Due to the intersection skew, vehicles sight lines can be severely impacted. Therefore, minor street stop control and all-way stop control at the current intersection were not evaluated. Roundabout control was evaluated based on the safety and operational benefits.

The only viable option to keep the existing intersection operating is a single lane roundabout configuration. Due to the skew, the roundabout is elongated and requires right turn bypass lanes along Country Club Drive. The addition of the multi-family driveway would also make this a 5-legged roundabout with an elongated circle. While this alternative provides LOS A operations, reduced conflict points, lower speeds, and an overall safe intersection design, it also has the highest estimated construction costs **($1,369,500**) and potential for driver confusion with the non-standard design. Therefore, this alternative is not being carried forward for consideration.

To improve the intersection skew and vehicle sight lines, a split T-intersection design was evaluated; this design creates two separate T-intersections and squares up the S. 4th Street approaches to County Club Drive, providing a smaller intersection footprint. Under this design configuration, 3 intersection control options were evaluated at each T-intersection.

- **Minor Street Stop Control (Split T)**: this option provides LOS B or better for the minor street approaches at each intersection; it should be noted that Country Club Drive through traffic would no longer incur delays. The average crash rate for an urban minor stop controlled intersection is 0.18 crashes per MEV; the MnDOT traffic signal average is 0.52 crashes per MEV. The two T-intersection design would reduce the vehicle conflict points down to 9 points at each intersection: a 44% reduction. The base cost for this alternative is **$732,300**; if medians were added the cost increases to **$873,000**.
- ¾ **Access Control (Split T)**: this option was not operationally analyzed; the minor stop approaches should be improved over the minor stop control scenario as all traffic must now make a right turn maneuver. Therefore, it is expected to provide LOS A for all traffic. As S. 4th Street through traffic can still make a right to left maneuver, only the minor

street left turns are impacted by this reduced access design. The volume currently making this maneuver, after the school has moved, is relatively low with less than 100 vehicles per day. This control option was considered for the safety benefits of the design. The two T-intersection design would reduce the vehicle conflict points down to 5 points at each intersection, a 69% reduction; the MnDOT average crash rate for this type of intersection is 0.16 crashes per MEV. The base cost for this alternative is **$952,100.**

- **Mini Roundabout Control (Split T)**: this option provides LOS A for all traffic entering the intersection area. This control option was considered for the safety benefits of the designs. The design of the intersections geometrically reduces vehicle speeds to pass through the intersection, this is one reason roundabouts have a significant reduction in severe crashes; approximately 85% reduction in fatal and severe injury crashes. The two T-intersection design would reduce the vehicle conflict points down to 6 points at each intersection, a 63% reduction. MnDOT does not provide a mini roundabout crash rate, though a single lane roundabout crash rate is 0.32 crashes per MEV. The base cost for this alternative is **$1,162,900.**

The following matrix compares the various control options evaluated:

Table 12 – Evaluation Matrix

Scenario/Control Option	Operations (worst LOS)	Expected Crashes (2042 year)	Estimated Construction Cost	Comment
Traffic Signal (existing Intersection)	LOS B	0.7 (1.2)[3]	n/a	✗ Signal not warranted; not viable.
Minor Stop (existing intersection)	n/a	0.4	n/a	✗ Intersection Skew, not viable.
All-Way Stop (existing intersection)	n/a	0.8	n/a	✗ Intersection Skew, not viable.
Roundabout (existing intersection)	LOS A	0.7	$1,369,500	✗ Driver confusion, highest cost.
Minor Stop (Split T)	LOS B	0.6[4]	$732,300 ($873,000)[5]	✓ Viable at both intersections.
¾ Access (Split T)	LOS A	0.6[4]	$952,100	✓ Viable at both intersections.
Mini Roundabout (Split T)	LOS A	0.5[4]	$1,162,900	✓ Viable at both intersections.

Notes:

1: “Existing Intersection” leave existing skew; “Split T” develops two T-intersections.

2: ”n/a” alternative considered not viable and no information exists.

3: 0.7 crashes based on existing intersection rate; 1.2 crashes based on MnDOT average crash rate.

4: MnDOT average crash rates at both T-intersections; reduced conflict points at T-intersections would improve estimate.

5: Higher costs includes medians along County Club Drive.

6.1 Recommendation

All evaluated options would provide safe and efficient operations. With the existing signal control not meeting warrants, it should be removed to improve the overall user experience. Based on the analysis the split T-intersection design provides the best solution through the 2042 forecast year. The split T-intersection design allows for mixing the control options as previously discussed.

The following recommendation is based on the intended purpose of the project to improve the intersection safety for both vehicle and non-motorized users, improve the operational efficiency of the intersection, maintain driveway access, and minimize construction impacts and costs. Input from City of Marshall staff and the analysis documented in this report resulted in the recommendation of the **Split T-Intersection design** with the following control:

- Mini Roundabout at the western intersection
- ¾ Access at the eastern intersection.

This recommended control option provides the intended purpose to improve intersection safety for all users, improve the operational efficiency, maintain driveway access, while limiting construction impacts and costs. This scenario improves the safety of the intersections by significantly reducing vehicle conflict points and lower travel speeds, it also provides the lowest overall delay with LOS A operations for all vehicles.

The mini roundabout would geometrically control vehicle speeds at the intersection, as well the approaching higher speed Country Club Drive traffic from the west, the reduced speeds improve the safety of the intersection, as does the ¾ access at the eastern intersection. The total vehicle conflict points are significantly reduced from 32 at the standard intersection down to 13 with this configuration: a 60% reduction. Fatal and severe injury crashes are reduced by approximately 85% at a single lane roundabout controlled intersection. The proposed design is expected to reduce the overall crashes by just over 20% compared to the existing traffic signal.

The mini roundabout also provides the ability for U-turns to easily be maneuvered. With the reduction in access at the eastern T-intersection, as well as the single-family driveways adjacent to the intersection, this minimizes the access impacts; the multi-family residential driveway is provided full access at the mini roundabout. This results in very minimal traffic pattern impacts for the minor street approaches or the driveways within the design area.

The design has minimal construction impacts as most of the work is within the existing right of way. The overall construction cost for this recommendation is approximately **$1,137,200** (see Appendix C for layout and full cost estimate); while this not the lowest alternative cost estimate, it provides additional benefits that meet the intended purpose of the project.

A typical concern with a mini roundabout is larger vehicles turning at the intersection. The current design shown in the layout includes an outside diameter of 85 feet; therefore, this design on the larger scale for a mini roundabout. The larger diameter allows for a typical school bus to make a right or left turn at the intersection within the travel lanes. Larger vehicles, including semi-trucks, would have to use the traversable center median to pass through the intersection.

The following **Figure 15** represents the recommended intersection control options with the mini roundabout and ¾ access intersection control. **Figure 16** represents a typical school bus vehicle path through the mini roundabout intersection for both turns from Country Club Drive.

Figure 15 – Recommended Intersection Control

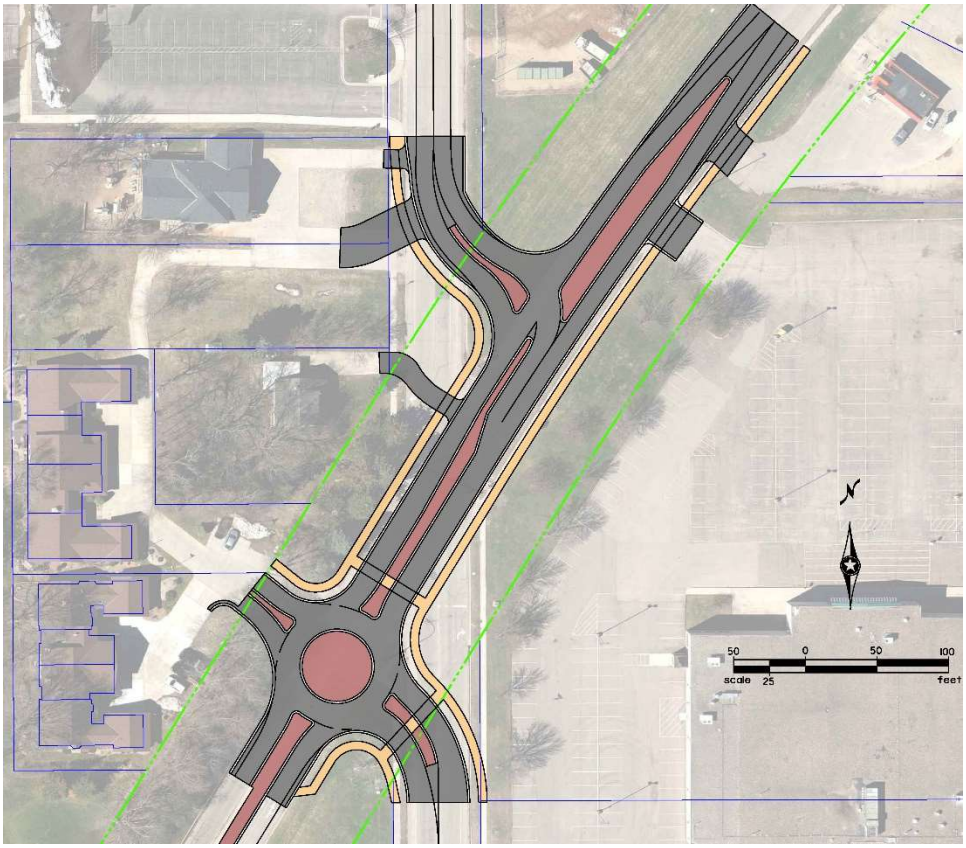
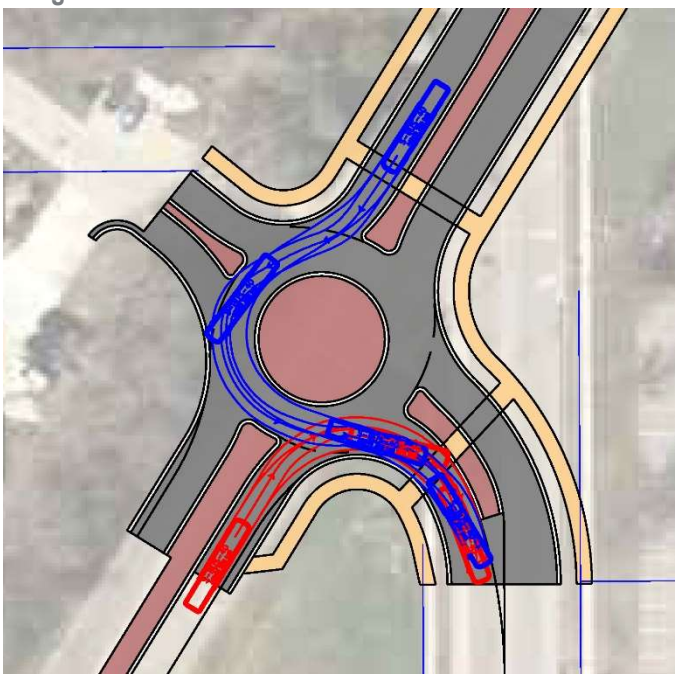


Figure 16 – Mini Roundabout School Bus Vehicle Path



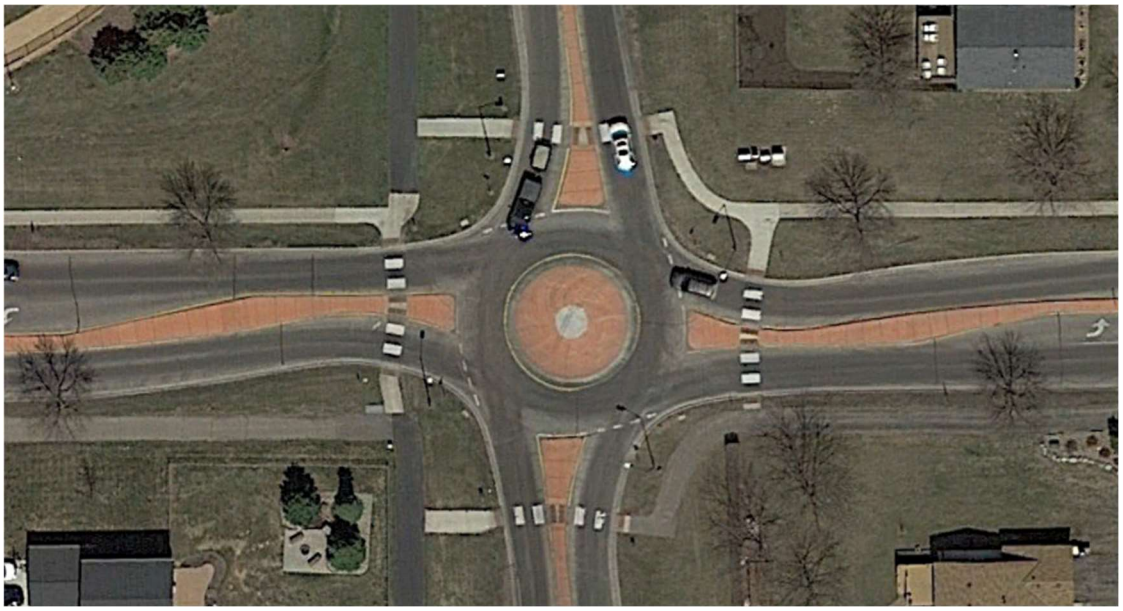
6.1.1 Example Intersections

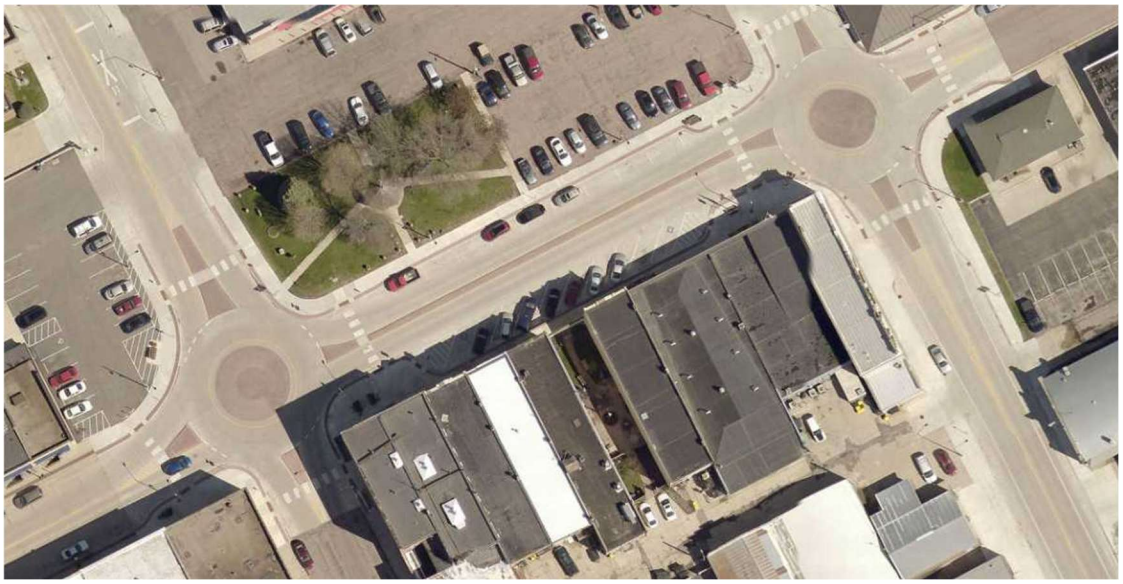
Both the mini roundabout and the ¾ access intersection may not be familiar to many drivers. The following are some examples of both intersection types throughout the state.

The 1st image is a mini roundabout in Shakopee at Vierling Drive and Spencer Street (CR 79). Average daily traffic on all four legs ranges from 2,950 to 7,300 vehicles per day: approximate 80' outside diameter.

The 2nd image is a pair of mini roundabouts in St James at 1st Avenue (TH 4) and both 7th Street and Armstrong Boulevard. Average daily traffic on all legs of each ranges from 2,250 to 5,400 vehicles per day: approximate 85' outside diameter.

Figure 17 – Example Mini Roundabout – Shakopee and St James, MN

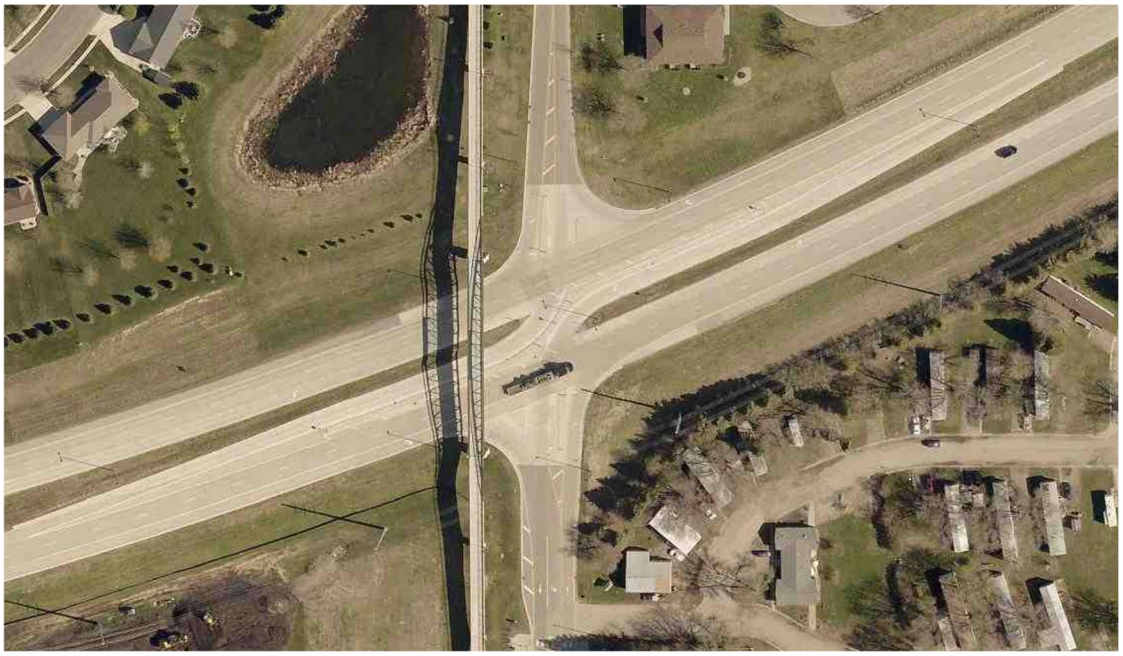




The 1st image is a reduced conflict intersection (RCI) in Marshall at TH 23 and Saratoga Street includes a ¾ access at the main intersection. U-turn movements at this intersection are provided downstream along TH 23, the mini roundabout provides the U-turn ability for the proposed ¾ access.

The 2nd image is a ¾ access T-intersection in Maple Plain at US 12 and Howard Avenue.

Figure 18 – Example ¾ Access – Marshall and Maple Plain, MN



Appendix A

Traffic Control Warrants

Table 1
Country Club Drive at 4th Street
Warrant Analysis Summary

Year	Scenario	All-way Stop Warrant	Signal Warrant				
			Warrant 1 8-hour	Warrant 2 4-hour	Warrant 3 Peak Hour	Warrant 1 (80%) 8-hour	Warrant 1 (60%) 8-hour
2021	Existing	Not Met 5 of 8 hours	Not Met 0 of 8 hours	Not Met 0 of 4 hours	Not Met 0 of 1 hours	Not Met 0 of 8 hours	Not Met 0 of 8 hours
	School Volumes Removed	Not Met 3 of 8 hours	Not Met 0 of 8 hours	Not Met 0 of 4 hours	Not Met 0 of 1 hours	Not Met 0 of 8 hours	Not Met 0 of 8 hours
2042	School Volumes Removed	Not Met 6 of 8 hours	Not Met 0 of 8 hours	Not Met 0 of 4 hours	Not Met 0 of 1 hours	Not Met 0 of 8 hours	Not Met 2 of 8 hours

Based on existing and future warrant analysis, the existing traffic signal at this intersection should be removed because it does not meet 60% of the warrant volume thresholds. None of the volume on Country Club Drive (major approach) are within 35% of the volume thresholds to meet even 1 hour of Warrant 1.

SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1a

2021 Existing - Country Club Dr at 4th St
ALL WAY STOP
WARRANT ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021

OPERATOR: 1/0/1900

85th% Speed	Approach Description		Lanes	Approach Total
41	Major App1:	Country Club Dr EB	2	1161
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	2	899
30	Minor App4:	4th St SB	2	1088

0.70 SPEED FACTOR USED? **Yes**

Minimum Volume Requirement
210 **140**

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MINOR APPROACH TOTAL Σ (APP.2 + APP. 4)	WARRANT MET MAJOR / MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO
6:00 - 7:00	58	30	40	13	88	53	NO / NO
7:00 - 8:00	156	59	122	192	215	314	**YES / YES**
8:00 - 9:00	90	58	55	53	148	108	NO / NO
9:00 - 10:00	69	33	47	34	102	81	NO / NO
10:00 - 11:00	87	59	62	49	146	111	NO / NO
11:00 - 12:00	62	66	51	77	128	128	NO / NO
12:00 - 13:00	92	102	81	113	194	194	NO / YES
13:00 - 14:00	69	96	60	65	165	125	NO / NO
14:00 - 15:00	107	104	87	123	211	210	**YES / YES**
15:00 - 16:00	89	146	75	89	235	164	**YES / YES**
16:00 - 17:00	110	121	85	116	231	201	**YES / YES**
17:00 - 18:00	100	148	76	109	248	185	**YES / YES**
18:00 - 19:00	72	93	58	55	165	113	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO
Daily	**1161**	**1115**	**899**	**1088**			

	Met (Hr)	Required (Hr)
Hours met for warrant:	**5**	**8**

All-way Stop Warrant: **Not satisfied**

REMARKS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A1b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2021 Existing - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1161
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	447
30	Minor App4:	4th St SB	1	700

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	156	59	57	174	215	174	NO / YES	NO / YES	NO / YES
8:00 - 9:00	90	58	31	47	148	47	NO / NO	NO / NO	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / NO	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / NO	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / NO	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / NO	NO / NO
14:00 - 15:00	107	104	38	100	211	100	NO / NO	NO / YES	NO / YES
15:00 - 16:00	89	146	35	62	235	62	NO / NO	NO / YES	NO / NO
16:00 - 17:00	110	121	40	65	231	65	NO / NO	NO / YES	NO / NO
17:00 - 18:00	100	148	39	65	248	65	NO / NO	NO / YES	NO / NO
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1161**	**1115**	**447**	**700**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1c

2021 Existing - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021

OPERATOR: 0

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1161
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	447
30	Minor App4:	4th St SB	1	700

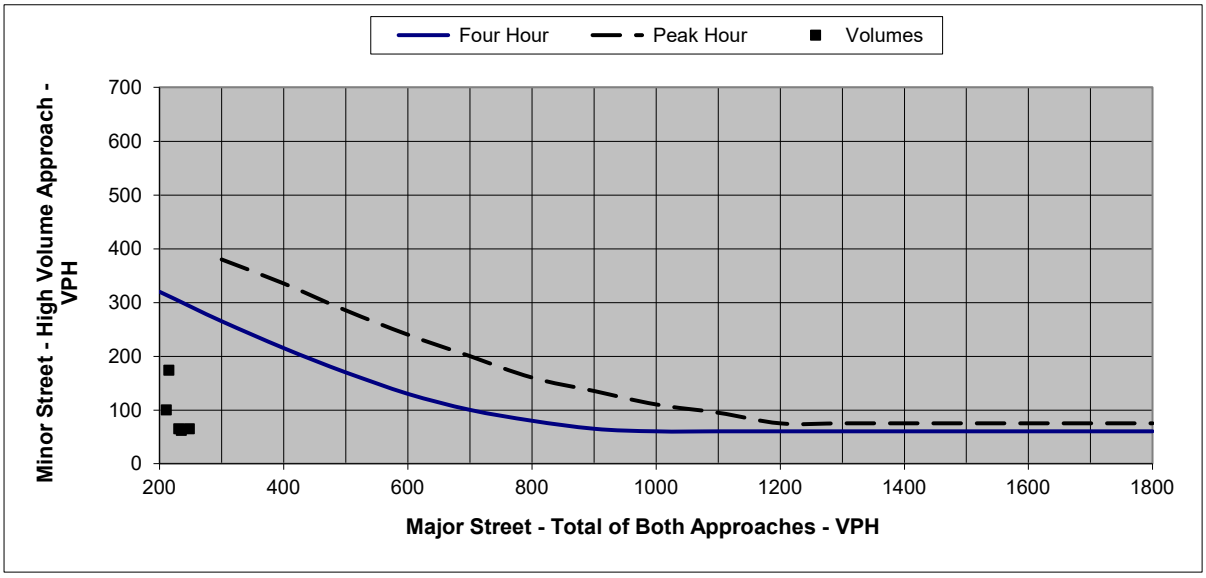


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	320	
300	265	380
400	215	335
500	170	285
600	130	240
700	100	200
800	80	160
900	65	135
1000	60	110
1100	60	95
1200	60	75
1300	60	75
1400	60	75
1500	60	75
1600	60	75
1700	60	75
1800	60	75

Actual Hourly Count			Warrants Met:	
			Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	88	30	NO	NO
7:00 - 8:00	215	174	NO	NO
8:00 - 9:00	148	47	NO	NO
9:00 - 10:00	102	26	NO	NO
10:00 - 11:00	146	33	NO	NO
11:00 - 12:00	128	37	NO	NO
12:00 - 13:00	194	46	NO	NO
13:00 - 14:00	165	34	NO	NO
14:00 - 15:00	211	100	NO	NO
15:00 - 16:00	235	62	NO	NO
16:00 - 17:00	231	65	NO	NO
17:00 - 18:00	248	65	NO	NO
18:00 - 19:00	165	26	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A1d

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2021 Existing - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1161
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	447
30	Minor App4:	4th St SB	1	700

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	336	504	403.2
Minor Approach	84	42.4	67.2

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	156	59	57	174	215	174	NO / YES	NO / YES	NO / YES
8:00 - 9:00	90	58	31	47	148	47	NO / NO	NO / YES	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / NO	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / NO	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / YES	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / NO	NO / NO
14:00 - 15:00	107	104	38	100	211	100	NO / YES	NO / YES	NO / YES
15:00 - 16:00	89	146	35	62	235	62	NO / NO	NO / YES	NO / NO
16:00 - 17:00	110	121	40	65	231	65	NO / NO	NO / YES	NO / NO
17:00 - 18:00	100	148	39	65	248	65	NO / NO	NO / YES	NO / NO
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1161**	**1115**	**447**	**700**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A1e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2021 Existing - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1161
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	447
30	Minor App4:	4th St SB	1	700

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

60%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	252	378	302.4
Minor Approach	63	31.8	50.4

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	156	59	57	174	215	174	NO / YES	NO / YES	NO / YES
8:00 - 9:00	90	58	31	47	148	47	NO / NO	NO / YES	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / YES	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / YES	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / YES	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / YES	NO / NO
14:00 - 15:00	107	104	38	100	211	100	NO / YES	NO / YES	NO / YES
15:00 - 16:00	89	146	35	62	235	62	NO / NO	NO / YES	NO / YES
16:00 - 17:00	110	121	40	65	231	65	NO / YES	NO / YES	NO / YES
17:00 - 18:00	100	148	39	65	248	65	NO / YES	NO / YES	NO / YES
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1161**	**1115**	**447**	**700**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2a

2021 School Traffic Removed - Country Club Dr at 4th St
ALL WAY STOP
WARRANT ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021

OPERATOR: 1/0/1900

85th% Speed	Approach Description	Lanes	Approach Total
41	Major App1: Country Club Dr EB	2	1139
30	Major App3: Country Club Dr WB	2	1115
30	Minor App2: 4th St NB	2	867
30	Minor App4: 4th St SB	2	848

0.70 SPEED FACTOR USED? **Yes**

Minimum Volume Requirement
210 **140**

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MINOR APPROACH TOTAL Σ (APP.2 + APP. 4)	WARRANT MET MAJOR / MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO
6:00 - 7:00	58	30	40	13	88	53	NO / NO
7:00 - 8:00	144	59	104	49	203	153	NO / YES
8:00 - 9:00	87	58	51	39	145	90	NO / NO
9:00 - 10:00	69	33	47	34	102	81	NO / NO
10:00 - 11:00	87	59	62	49	146	111	NO / NO
11:00 - 12:00	62	66	51	77	128	128	NO / NO
12:00 - 13:00	92	102	81	113	194	194	NO / YES
13:00 - 14:00	69	96	60	65	165	125	NO / NO
14:00 - 15:00	104	104	82	62	208	144	NO / YES
15:00 - 16:00	85	146	71	72	231	143	**YES / YES**
16:00 - 17:00	110	121	85	112	231	197	**YES / YES**
17:00 - 18:00	100	148	75	108	248	183	**YES / YES**
18:00 - 19:00	72	93	58	55	165	113	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO
Daily	**1139**	**1115**	**867**	**848**			

	Met (Hr)	Required (Hr)
Hours met for warrant:	**3**	**8**

All-way Stop Warrant: **Not satisfied**

REMARKS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2021 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1139
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	415
30	Minor App4:	4th St SB	1	479

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	144	59	39	37	203	39	NO / NO	NO / NO	NO / NO
8:00 - 9:00	87	58	27	34	145	34	NO / NO	NO / NO	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / NO	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / NO	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / NO	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / NO	NO / NO
14:00 - 15:00	104	104	33	44	208	44	NO / NO	NO / NO	NO / NO
15:00 - 16:00	85	146	31	50	231	50	NO / NO	NO / NO	NO / NO
16:00 - 17:00	110	121	40	63	231	63	NO / NO	NO / YES	NO / NO
17:00 - 18:00	100	148	38	64	248	64	NO / NO	NO / YES	NO / NO
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1139**	**1115**	**415**	**479**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2c

2021 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 0

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1139
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	415
30	Minor App4:	4th St SB	1	479

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

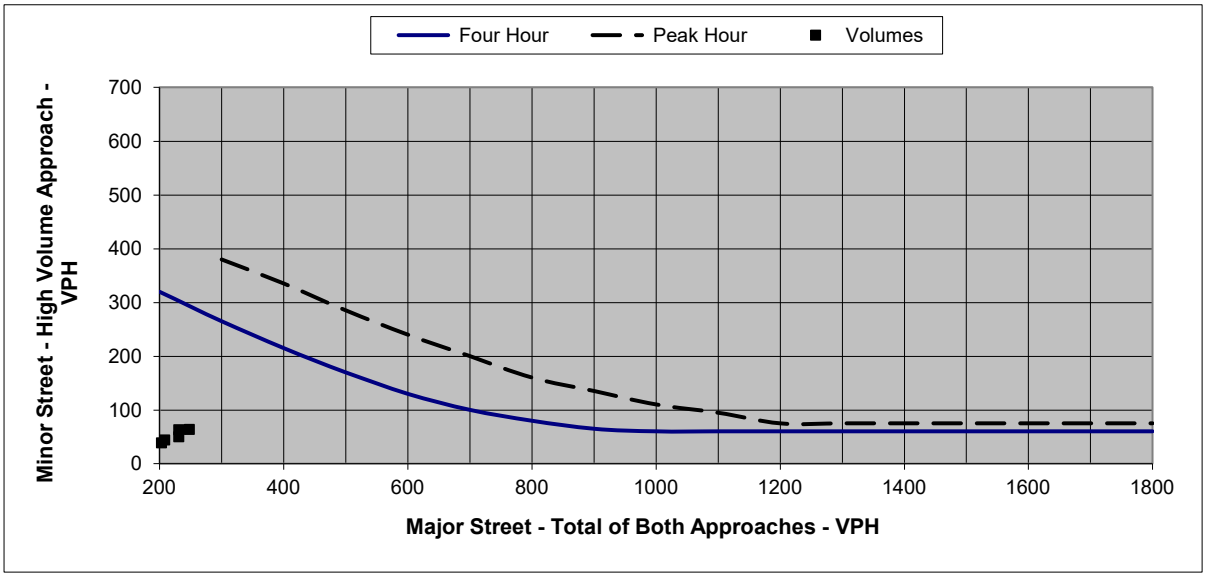


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	320	
300	265	380
400	215	335
500	170	285
600	130	240
700	100	200
800	80	160
900	65	135
1000	60	110
1100	60	95
1200	60	75
1300	60	75
1400	60	75
1500	60	75
1600	60	75
1700	60	75
1800	60	75

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	88	30	NO	NO
7:00 - 8:00	203	39	NO	NO
8:00 - 9:00	145	34	NO	NO
9:00 - 10:00	102	26	NO	NO
10:00 - 11:00	146	33	NO	NO
11:00 - 12:00	128	37	NO	NO
12:00 - 13:00	194	46	NO	NO
13:00 - 14:00	165	34	NO	NO
14:00 - 15:00	208	44	NO	NO
15:00 - 16:00	231	50	NO	NO
16:00 - 17:00	231	63	NO	NO
17:00 - 18:00	248	64	NO	NO
18:00 - 19:00	165	26	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

SHORT ELLIOTT HENDRICKSON INC.
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2d

2021 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1139
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	415
30	Minor App4:	4th St SB	1	479

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	336	504	403.2
Minor Approach	84	42.4	67.2

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	144	59	39	37	203	39	NO / NO	NO / NO	NO / NO
8:00 - 9:00	87	58	27	34	145	34	NO / NO	NO / NO	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / NO	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / NO	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / YES	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / NO	NO / NO
14:00 - 15:00	104	104	33	44	208	44	NO / NO	NO / YES	NO / NO
15:00 - 16:00	85	146	31	50	231	50	NO / NO	NO / YES	NO / NO
16:00 - 17:00	110	121	40	63	231	63	NO / NO	NO / YES	NO / NO
17:00 - 18:00	100	148	38	64	248	64	NO / NO	NO / YES	NO / NO
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1139**	**1115**	**415**	**479**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2021 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1139
30	Major App3:	Country Club Dr WB	2	1115
30	Minor App2:	4th St NB	1	415
30	Minor App4:	4th St SB	1	479

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

60%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	252	378	302.4
Minor Approach	63	31.8	50.4

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	58	30	30	9	88	30	NO / NO	NO / NO	NO / NO
7:00 - 8:00	144	59	39	37	203	39	NO / NO	NO / YES	NO / NO
8:00 - 9:00	87	58	27	34	145	34	NO / NO	NO / YES	NO / NO
9:00 - 10:00	69	33	26	16	102	26	NO / NO	NO / NO	NO / NO
10:00 - 11:00	87	59	26	33	146	33	NO / NO	NO / YES	NO / NO
11:00 - 12:00	62	66	20	37	128	37	NO / NO	NO / YES	NO / NO
12:00 - 13:00	92	102	46	33	194	46	NO / NO	NO / YES	NO / NO
13:00 - 14:00	69	96	33	34	165	34	NO / NO	NO / YES	NO / NO
14:00 - 15:00	104	104	33	44	208	44	NO / NO	NO / YES	NO / NO
15:00 - 16:00	85	146	31	50	231	50	NO / NO	NO / YES	NO / NO
16:00 - 17:00	110	121	40	63	231	63	NO / YES	NO / YES	NO / YES
17:00 - 18:00	100	148	38	64	248	64	NO / YES	NO / YES	NO / YES
18:00 - 19:00	72	93	26	25	165	26	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1139**	**1115**	**415**	**479**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3a

2042 School Traffic Removed - Country Club Dr at 4th St
ALL WAY STOP
WARRANT ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021

OPERATOR: 1/0/1900

85th% Speed	Approach Description		Lanes	Approach Total
41	Major App1:	Country Club Dr EB	2	1259
30	Major App3:	Country Club Dr WB	2	1233
30	Minor App2:	4th St NB	2	958
30	Minor App4:	4th St SB	2	938

0.70 SPEED FACTOR USED? **Yes**

Minimum Volume Requirement	
210	**140**

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MINOR APPROACH TOTAL Σ (APP.2 + APP. 4)	WARRANT MET MAJOR / MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO
6:00 - 7:00	64	33	44	14	97	58	NO / NO
7:00 - 8:00	160	65	114	54	225	168	**YES / YES**
8:00 - 9:00	96	65	56	44	161	100	NO / NO
9:00 - 10:00	77	37	52	38	114	90	NO / NO
10:00 - 11:00	96	65	68	54	161	122	NO / NO
11:00 - 12:00	68	73	56	85	141	141	NO / YES
12:00 - 13:00	102	112	90	126	214	216	**YES / YES**
13:00 - 14:00	76	106	67	71	182	138	NO / NO
14:00 - 15:00	115	114	91	69	229	160	**YES / YES**
15:00 - 16:00	94	162	79	79	256	158	**YES / YES**
16:00 - 17:00	122	134	94	124	256	218	**YES / YES**
17:00 - 18:00	110	164	82	119	274	201	**YES / YES**
18:00 - 19:00	79	103	65	61	182	126	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO
Daily	**1259**	**1233**	**958**	**938**			

	Met (Hr)	**Required (Hr)**
Hours met for warrant:	**6**	**8**

All-way Stop Warrant: **Not satisfied**

REMARKS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A3b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2042 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1259
30	Major App3:	Country Club Dr WB	2	1233
30	Minor App2:	4th St NB	1	462
30	Minor App4:	4th St SB	1	528

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	64	33	33	9	97	33	NO / NO	NO / NO	NO / NO
7:00 - 8:00	160	65	44	40	225	44	NO / NO	NO / NO	NO / NO
8:00 - 9:00	96	65	30	38	161	38	NO / NO	NO / NO	NO / NO
9:00 - 10:00	77	37	30	17	114	30	NO / NO	NO / NO	NO / NO
10:00 - 11:00	96	65	29	36	161	36	NO / NO	NO / NO	NO / NO
11:00 - 12:00	68	73	21	41	141	41	NO / NO	NO / NO	NO / NO
12:00 - 13:00	102	112	50	37	214	50	NO / NO	NO / NO	NO / NO
13:00 - 14:00	76	106	37	38	182	38	NO / NO	NO / NO	NO / NO
14:00 - 15:00	115	114	37	49	229	49	NO / NO	NO / NO	NO / NO
15:00 - 16:00	94	162	35	56	256	56	NO / NO	NO / YES	NO / NO
16:00 - 17:00	122	134	45	69	256	69	NO / NO	NO / YES	NO / NO
17:00 - 18:00	110	164	42	70	274	70	NO / NO	NO / YES	NO / NO
18:00 - 19:00	79	103	29	28	182	29	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1259**	**1233**	**462**	**528**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3c

2042 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 0

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1259
30	Major App3:	Country Club Dr WB	2	1233
30	Minor App2:	4th St NB	1	462
30	Minor App4:	4th St SB	1	528

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

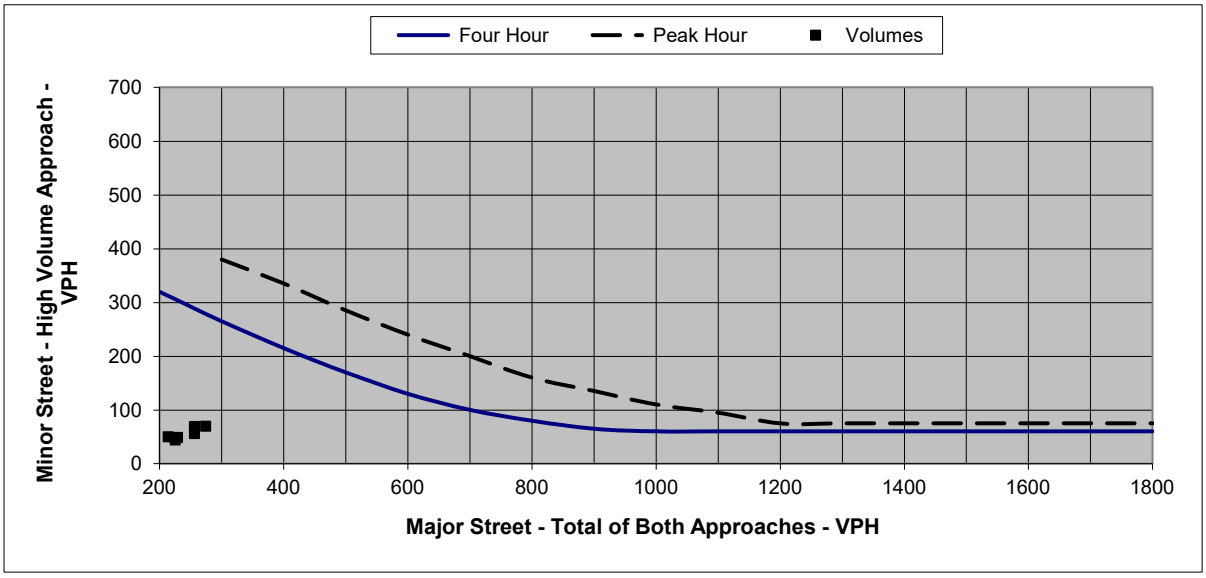


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major	Minor App.	Minor App.
Approach	Four Hour	Peak Hour
200	320	
300	265	380
400	215	335
500	170	285
600	130	240
700	100	200
800	80	160
900	65	135
1000	60	110
1100	60	95
1200	60	75
1300	60	75
1400	60	75
1500	60	75
1600	60	75
1700	60	75
1800	60	75

Actual Hourly Count			Warrants Met:	
			Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	97	33	NO	NO
7:00 - 8:00	225	44	NO	NO
8:00 - 9:00	161	38	NO	NO
9:00 - 10:00	114	30	NO	NO
10:00 - 11:00	161	36	NO	NO
11:00 - 12:00	141	41	NO	NO
12:00 - 13:00	214	50	NO	NO
13:00 - 14:00	182	38	NO	NO
14:00 - 15:00	229	49	NO	NO
15:00 - 16:00	256	56	NO	NO
16:00 - 17:00	256	69	NO	NO
17:00 - 18:00	274	70	NO	NO
18:00 - 19:00	182	29	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

SHORT ELLIOTT HENDRICKSON INC.
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3d

2042 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1259
30	Major App3:	Country Club Dr WB	2	1233
30	Minor App2:	4th St NB	1	462
30	Minor App4:	4th St SB	1	528

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	336	504	403.2
Minor Approach	84	42.4	67.2

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	64	33	33	9	97	33	NO / NO	NO / NO	NO / NO
7:00 - 8:00	160	65	44	40	225	44	NO / NO	NO / YES	NO / NO
8:00 - 9:00	96	65	30	38	161	38	NO / NO	NO / NO	NO / NO
9:00 - 10:00	77	37	30	17	114	30	NO / NO	NO / NO	NO / NO
10:00 - 11:00	96	65	29	36	161	36	NO / NO	NO / NO	NO / NO
11:00 - 12:00	68	73	21	41	141	41	NO / NO	NO / NO	NO / NO
12:00 - 13:00	102	112	50	37	214	50	NO / NO	NO / YES	NO / NO
13:00 - 14:00	76	106	37	38	182	38	NO / NO	NO / NO	NO / NO
14:00 - 15:00	115	114	37	49	229	49	NO / NO	NO / YES	NO / NO
15:00 - 16:00	94	162	35	56	256	56	NO / NO	NO / YES	NO / NO
16:00 - 17:00	122	134	45	69	256	69	NO / NO	NO / YES	NO / YES
17:00 - 18:00	110	164	42	70	274	70	NO / NO	NO / YES	NO / YES
18:00 - 19:00	79	103	29	28	182	29	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1259**	**1233**	**462**	**528**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

SHORT ELLIOTT HENDRICKSON INC.

Exhibit A3e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2042 School Traffic Removed - Country Club Dr at 4th St
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: Country Club Dr at 4th St
COUNTY: Lyon
REF. POINT: 0
DATE: 4/8/2021
OPERATOR: 1/0/1900

85th% Speed	Approach	Description	Lanes	Approach
41	Major App1:	Country Club Dr EB	2	1259
30	Major App3:	Country Club Dr WB	2	1233
30	Minor App2:	4th St NB	1	462
30	Minor App4:	4th St SB	1	528

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

60%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	252	378	302.4
Minor Approach	63	31.8	50.4

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	64	33	33	9	97	33	NO / NO	NO / YES	NO / NO
7:00 - 8:00	160	65	44	40	225	44	NO / NO	NO / YES	NO / NO
8:00 - 9:00	96	65	30	38	161	38	NO / NO	NO / YES	NO / NO
9:00 - 10:00	77	37	30	17	114	30	NO / NO	NO / NO	NO / NO
10:00 - 11:00	96	65	29	36	161	36	NO / NO	NO / YES	NO / NO
11:00 - 12:00	68	73	21	41	141	41	NO / NO	NO / YES	NO / NO
12:00 - 13:00	102	112	50	37	214	50	NO / NO	NO / YES	NO / NO
13:00 - 14:00	76	106	37	38	182	38	NO / NO	NO / YES	NO / NO
14:00 - 15:00	115	114	37	49	229	49	NO / NO	NO / YES	NO / NO
15:00 - 16:00	94	162	35	56	256	56	YES / NO	NO / YES	NO / YES
16:00 - 17:00	122	134	45	69	256	69	**YES / YES**	NO / YES	NO / YES
17:00 - 18:00	110	164	42	70	274	70	**YES / YES**	NO / YES	NO / YES
18:00 - 19:00	79	103	29	28	182	29	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**1259**	**1233**	**462**	**528**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	2	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	2	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

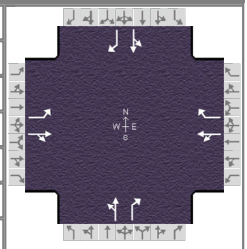
COMMENTS:

Appendix B

HCS Results

HCS7 Signalized Intersection Results Summary

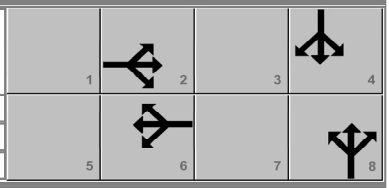
General Information				Intersection Information	
Agency	SEH Inc.			Duration, h	0.250
Analyst	Graham Johnson, PE	Analysis Date	4/19/2021	Area Type	CBD
Jurisdiction	City of Marshall	Time Period	AM Peak	PHF	0.75
Urban Street	Country Club Drive	Analysis Year	2021	Analysis Period	1> 7:15
Intersection	Country Club Dr at S 4th…	File Name	Existing AM - Signal.xus		
Project Description	Existing AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	41	129	1	19	53	9	0	59	67	136	52	19

Signal Information			
Cycle, s	51.6	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	27.0	14.6	0.0	0.0	0.0	0.0
Yellow	3.5	3.5	0.0	0.0	0.0	0.0
Red	1.5	1.5	0.0	0.0	0.0	0.0



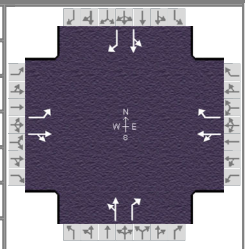
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		7.0		7.0		7.0
Phase Duration, s		32.0		32.0		19.6		19.6
Change Period, ($Y+R_c$), s		5.0		5.0		5.0		5.0
Max Allow Headway (*MAH*), s		4.1		4.1		4.3		4.3
Queue Clearance Time (g_s), s		5.0		3.6		5.2		13.6
Green Extension Time (g_e), s		1.2		1.2		1.5		1.0
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.00		0.01		0.42

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	55	173			96	12		0	89		251	25
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1197	1593			1457	1351		0	1351		1128	1351
Queue Service Time (g_s), s	1.3	3.0			0.0	0.2		0.0	3.2		9.3	0.9
Cycle Queue Clearance Time (g_c), s	2.8	3.0			1.6	0.2		0.0	3.2		11.6	0.9
Green Ratio (*g/C*)	0.52	0.52			0.52	0.52			0.28		0.28	0.28
Capacity (*c*), veh/h	591	834			851	708			382		439	382
Volume-to-Capacity Ratio (*X*)	0.093	0.208			0.113	0.017		0.000	0.234		0.571	0.066
Back of Queue (*Q*), ft/ln (50 th percentile)	6	17.9			10.6	1.3		0	24		85.6	6.4
Back of Queue (*Q*), veh/ln (50 th percentile)	0.2	0.7			0.4	0.0		0.0	0.9		3.4	0.3
Queue Storage Ratio (*RQ*) (50 th percentile)	0.03	0.00			0.00	0.03		0.00	0.48		0.00	0.13
Uniform Delay (d_1), s/veh	6.9	6.6			6.2	5.9			18.2		22.7	17.2
Incremental Delay (d_2), s/veh	0.1	0.1			0.1	0.0		0.0	0.3		1.2	0.1
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0		0.0	0.0		0.0	0.0
Control Delay (*d*), s/veh	7.0	6.7			6.3	5.9			18.5		23.9	17.2
Level of Service (LOS)	A	A			A	A			B		C	B
Approach Delay, s/veh / LOS	6.8	A		6.2	A		18.3	B		23.3	C	
Intersection Delay, s/veh / LOS	15.0						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.87	B	1.87	B	1.90	B	1.90	B
Bicycle LOS Score / LOS	0.86	A	0.67	A	0.76	A	0.94	A

HCS7 Signalized Intersection Results Summary

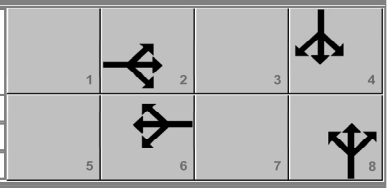
General Information				Intersection Information	
Agency	SEH Inc.			Duration, h	0.250
Analyst	Graham Johnson, PE	Analysis Date	4/19/2021	Area Type	CBD
Jurisdiction	City of Marshall	Time Period	PM Peak	PHF	0.88
Urban Street	Country Club Drive	Analysis Year	2021	Analysis Period	1> 16:30
Intersection	Country Club Dr at S 4th…	File Name	Existing PM - Signal.xus		
Project Description	Existing PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	33	83	1	42	106	1	0	58	46	5	69	46

Signal Information			
Cycle, s	46.6	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	27.0	9.6	0.0	0.0	0.0	0.0
Yellow	3.5	3.5	0.0	0.0	0.0	0.0
Red	1.5	1.5	0.0	0.0	0.0	0.0



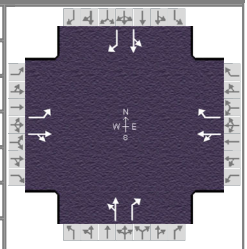
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		7.0		7.0		7.0
Phase Duration, s		32.0		32.0		14.6		14.6
Change Period, ($Y+R_c$), s		5.0		5.0		5.0		5.0
Max Allow Headway (*MAH*), s		4.2		4.2		4.2		4.2
Queue Clearance Time (g_s), s		5.1		4.3		3.6		4.1
Green Extension Time (g_e), s		1.1		1.1		0.8		0.8
Phase Call Probability		1.00		1.00		0.96		0.96
Max Out Probability		0.00		0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	38	95			168	1		0	52		84	52
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1144	1591			1473	1351		0	1351		1583	1351
Queue Service Time (g_s), s	0.7	1.3			0.0	0.0		0.0	1.5		0.0	1.5
Cycle Queue Clearance Time (g_c), s	3.1	1.3			2.3	0.0		0.0	1.5		2.1	1.5
Green Ratio (*g/C*)	0.58	0.58			0.58	0.58			0.21		0.21	0.21
Capacity (*c*), veh/h	606	921			952	783			279		409	279
Volume-to-Capacity Ratio (*X*)	0.062	0.104			0.177	0.001		0.000	0.187		0.205	0.187
Back of Queue (*Q*), ft/ln (50 th percentile)	2.9	5.7			12.8	0.1		0	10.8		17.4	10.8
Back of Queue (*Q*), veh/ln (50 th percentile)	0.1	0.2			0.5	0.0		0.0	0.4		0.7	0.4
Queue Storage Ratio (*RQ*) (50 th percentile)	0.01	0.00			0.00	0.00		0.00	0.22		0.00	0.22
Uniform Delay (d_1), s/veh	5.3	4.4			4.6	4.1			15.3		15.5	15.3
Incremental Delay (d_2), s/veh	0.0	0.0			0.1	0.0		0.0	0.3		0.2	0.3
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0		0.0	0.0		0.0	0.0
Control Delay (*d*), s/veh	5.4	4.4			4.7	4.1			15.6		15.7	15.6
Level of Service (LOS)	A	A			A	A			B		B	B
Approach Delay, s/veh / LOS	4.7	A		4.7	A		15.6	B		15.7	B	
Intersection Delay, s/veh / LOS	9.7						A					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.85	B	1.85	B	1.91	B	1.91	B
Bicycle LOS Score / LOS	0.71	A	0.77	A	0.68	A	0.71	A

HCS7 Signalized Intersection Results Summary

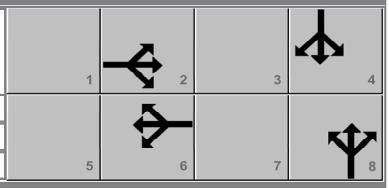
General Information				Intersection Information	
Agency	SEH Inc.			Duration, h	0.250
Analyst	Graham Johnson, PE	Analysis Date	4/19/2021	Area Type	CBD
Jurisdiction	City of Marshall	Time Period	AM Peak	PHF	0.75
Urban Street	Country Club Drive	Analysis Year	2042	Analysis Period	1> 7:15
Intersection	Country Club Dr at S 4th…	File Name	2042 No Build AM - Signal.xus		
Project Description	No Build 2042 AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	29	144	2	22	58	9	2	51	75	6	41	14

Signal Information			
Cycle, s	52.8	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	27.0	9.8	0.0	0.0	0.0	0.0
Yellow	3.5	3.5	0.0	0.0	0.0	0.0
Red	5.5	3.5	0.0	0.0	0.0	0.0



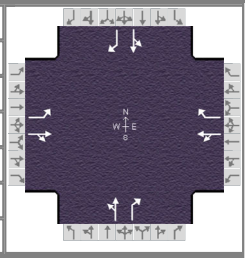
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		7.0		7.0		7.0
Phase Duration, s		36.0		36.0		16.8		16.8
Change Period, ($Y+R_c$), s		9.0		9.0		7.0		7.0
Max Allow Headway (*MAH*), s		4.1		4.1		4.3		4.3
Queue Clearance Time (g_s), s		5.6		3.8		5.4		3.8
Green Extension Time (g_e), s		1.3		1.3		0.8		0.8
Phase Call Probability		1.00		1.00		0.98		0.98
Max Out Probability		0.00		0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	39	195			107	12		71	100		63	19
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1190	1591			1441	1351		1589	1351		1570	1351
Queue Service Time (g_s), s	0.9	3.6			0.0	0.2		0.0	3.4		0.0	0.6
Cycle Queue Clearance Time (g_c), s	2.8	3.6			1.8	0.2		2.0	3.4		1.8	0.6
Green Ratio (*g/C*)	0.51	0.51			0.51	0.51		0.18	0.18		0.18	0.18
Capacity (*c*), veh/h	567	814			825	692		365	250		367	250
Volume-to-Capacity Ratio (*X*)	0.068	0.239			0.129	0.017		0.194	0.400		0.171	0.075
Back of Queue (*Q*), ft/ln (50 th percentile)	4.6	22.3			12.8	1.4		17.7	26.7		15.6	4.6
Back of Queue (*Q*), veh/ln (50 th percentile)	0.2	0.9			0.5	0.1		0.7	1.1		0.6	0.2
Queue Storage Ratio (*RQ*) (50 th percentile)	0.02	0.00			0.00	0.03		0.00	0.53		0.00	0.09
Uniform Delay (d_1), s/veh	7.5	7.2			6.7	6.3		18.3	18.9		18.2	17.8
Incremental Delay (d_2), s/veh	0.1	0.1			0.1	0.0		0.3	1.0		0.2	0.1
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0		0.0	0.0		0.0	0.0
Control Delay (*d*), s/veh	7.5	7.3			6.8	6.4		18.6	20.0		18.5	17.9
Level of Service (LOS)	A	A			A	A		B	B		B	B
Approach Delay, s/veh / LOS	7.3	A		6.8	A		19.4	B		18.3	B	
Intersection Delay, s/veh / LOS	12.1						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.87	B	1.87	B	1.91	B	1.91	B
Bicycle LOS Score / LOS	0.87	A	0.68	A	0.77	A	0.62	A

HCS7 Signalized Intersection Results Summary

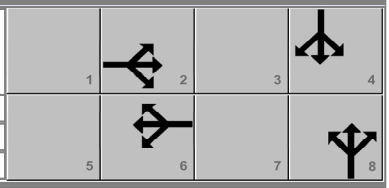
General Information				Intersection Information	
Agency	SEH Inc.			Duration, h	0.250
Analyst	Graham Johnson, PE	Analysis Date	4/19/2021	Area Type	CBD
Jurisdiction	City of Marshall	Time Period	PM Peak	PHF	0.88
Urban Street	Country Club Drive	Analysis Year	2042	Analysis Period	1> 16:30
Intersection	Country Club Dr at S 4th…	File Name	2042 No Build PM - Signal.xus		
Project Description	No Build 2042 PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	38	92	2	46	117	1	1	73	51	5	84	48

Signal Information			
Cycle, s	52.9	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	27.0	9.9	0.0	0.0	0.0	0.0
Yellow	3.5	3.5	0.0	0.0	0.0	0.0
Red	5.5	3.5	0.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		7.0		7.0		7.0
Phase Duration, s		36.0		36.0		16.9		16.9
Change Period, ($Y+R_c$), s		9.0		9.0		7.0		7.0
Max Allow Headway (*MAH*), s		4.2		4.2		4.2		4.2
Queue Clearance Time (g_s), s		6.6		5.4		4.4		4.9
Green Extension Time (g_e), s		1.2		1.2		0.9		0.9
Phase Call Probability		1.00		1.00		0.99		0.99
Max Out Probability		0.00		0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	43	107			185	1		84	58		101	55
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1131	1589			1470	1351		1593	1351		1584	1351
Queue Service Time (g_s), s	1.2	1.9			0.0	0.0		0.0	1.9		0.0	1.8
Cycle Queue Clearance Time (g_c), s	4.6	1.9			3.4	0.0		2.4	1.9		2.9	1.8
Green Ratio (*g/C*)	0.51	0.51			0.51	0.51		0.19	0.19		0.19	0.19
Capacity (*c*), veh/h	505	811			838	690		366	252		368	252
Volume-to-Capacity Ratio (*X*)	0.086	0.132			0.221	0.002		0.229	0.230		0.275	0.216
Back of Queue (*Q*), ft/ln (50 th percentile)	5.7	11.6			23.6	0.1		21.3	14.8		25.9	13.8
Back of Queue (*Q*), veh/ln (50 th percentile)	0.2	0.5			0.9	0.0		0.8	0.6		1.0	0.5
Queue Storage Ratio (*RQ*) (50 th percentile)	0.03	0.00			0.00	0.00		0.00	0.30		0.00	0.28
Uniform Delay (d_1), s/veh	8.4	6.8			7.2	6.3		18.5	18.3		18.7	18.2
Incremental Delay (d_2), s/veh	0.1	0.1			0.1	0.0		0.3	0.5		0.4	0.4
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0		0.0	0.0		0.0	0.0
Control Delay (*d*), s/veh	8.5	6.9			7.3	6.3		18.8	18.7		19.1	18.6
Level of Service (LOS)	A	A			A	A		B	B		B	B
Approach Delay, s/veh / LOS	7.3	A		7.3	A		18.8	B		18.9	B	
Intersection Delay, s/veh / LOS	12.7						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.87	B	1.87	B	1.91	B	1.91	B
Bicycle LOS Score / LOS	0.74	A	0.80	A	0.72	A	0.74	A

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	AM Peak Hour
Project Description	2042 Future (1-intersection)

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.79
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	29	144	2	0	22	58	9	0	2	51	75	0	6	41	14
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	37	186	3	0	28	75	12	0	3	66	97	0	8	53	18
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		226			115			166			79	
Entry Volume, veh/h		222			113			163			77	
Circulating Flow (v_c), pc/h	89			106			231			106		
Exiting Flow (v_{ex}), pc/h	291			96			115			84		
Capacity (c_{pce}), pc/h		1260			1239			1090			1239	
Capacity (c), veh/h		1236			1214			1069			1214	
v/c Ratio (x)		0.18			0.09			0.15			0.06	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.4			3.7			4.7			3.5	
Lane LOS		A			A			A			A	
95% Queue, veh		0.7			0.3			0.5			0.2	
Approach Delay, s/veh	4.4			3.7			4.7			3.5		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	4.3						A					

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	PM Peak Hour
Project Description	2042 Future (1-intersection)

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.89
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	38	92	2	0	46	117	1	0	1	73	51	0	5	84	48
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	44	105	2	0	53	134	1	0	1	84	58	0	6	96	55
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		151			188			143			157	
Entry Volume, veh/h		148			184			140			154	
Circulating Flow (v_c), pc/h	155			129			155			188		
Exiting Flow (v_{ex}), pc/h	169			190			129			151		
Capacity (c_{pce}), pc/h		1178			1210			1178			1139	
Capacity (c), veh/h		1155			1186			1155			1117	
v/c Ratio (x)		0.13			0.16			0.12			0.14	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.2			4.4			4.2			4.4	
Lane LOS		A			A			A			A	
95% Queue, veh		0.4			0.5			0.4			0.5	
Approach Delay, s/veh	4.2			4.4			4.2			4.4		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	4.3						A					

HCS7 Two-Way Stop-Control Report

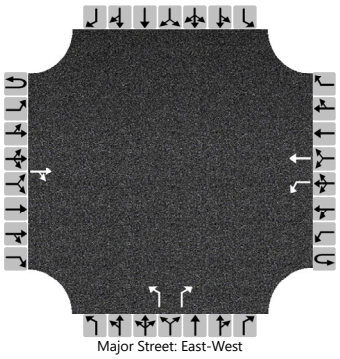
General Information

Analyst	Graham Johnson, PE
Agency/Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	AM Peak Hour
Intersection Orientation	East-West
Project Description	2042 Future (West Intersection)

Site Information

Intersection	Country Club at S 4th St
Jurisdiction	City of Marshall
East/West Street	Country Club Drive
North/South Street	S 4th Street
Peak Hour Factor	0.78
Analysis Time Period (hrs)	0.25

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	1	1	0		1	0	1		0	0	0
Configuration				TR		L	T			L		R				
Volume (veh/h)			173	2		60	72			2		118				
Percent Heavy Vehicles (%)						2				2		2				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized										No						
Median Type | Storage						Undivided										

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.12				6.42		6.22				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.22				3.52		3.32				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						77				3		151				
Capacity, c (veh/h)						1344				521		816				
v/c Ratio						0.06				0.00		0.19				
95% Queue Length, Q_{95} (veh)						0.2				0.0		0.7				
Control Delay (s/veh)						7.8				11.9		10.4				
Level of Service (LOS)						A				B		B				
Approach Delay (s/veh)						3.6				10.4						
Approach LOS										B						

HCS7 Two-Way Stop-Control Report

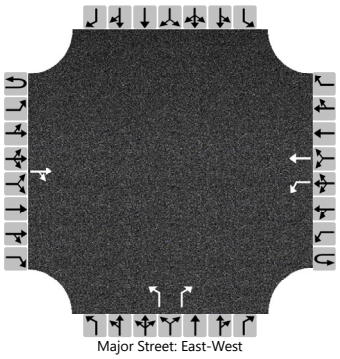
General Information

Analyst	Graham Johnson, PE
Agency/Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	PM Peak Hour
Intersection Orientation	East-West
Project Description	2042 Future (West Intersection)

Site Information

Intersection	Country Club at S 4th St
Jurisdiction	City of Marshall
East/West Street	Country Club Drive
North/South Street	S 4th Street
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	1	1	0		1	0	1		0	0	0
Configuration				TR		L	T			L		R				
Volume (veh/h)			130	2		121	165			1		118				
Percent Heavy Vehicles (%)						2				2		2				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized										No						
Median Type | Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.12				6.42		6.22				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.22				3.52		3.32				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						134				1		131				
Capacity, c (veh/h)						1435				422		902				
v/c Ratio						0.09				0.00		0.15				
95% Queue Length, Q_{95} (veh)						0.3				0.0		0.5				
Control Delay (s/veh)						7.8				13.6		9.7				
Level of Service (LOS)						A				B		A				
Approach Delay (s/veh)					3.3				9.7							
Approach LOS									A							

HCS7 Two-Way Stop-Control Report

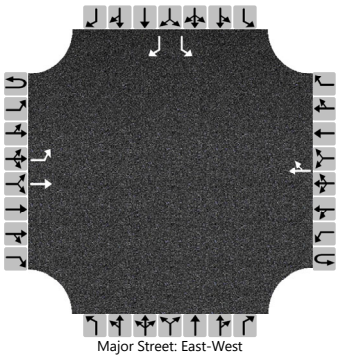
General Information

Analyst	Graham Johnson, PE
Agency/Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	AM Peak Hour
Intersection Orientation	East-West
Project Description	2042 Future (East Intersection)

Site Information

Intersection	Country Club at S 4th St
Jurisdiction	City of Marshall
East/West Street	Country Club Drive
North/South Street	S 4th Street
Peak Hour Factor	0.78
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	0		0	0	0		1	0	1
Configuration		L	T					TR						L		R
Volume (veh/h)		72	219				80	9						6		52
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized														No		
Median Type | Storage																
					Undivided											

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		92												8		67
Capacity, c (veh/h)		1475												450		945
v/c Ratio		0.06												0.02		0.07
95% Queue Length, Q_{95} (veh)		0.2												0.1		0.2
Control Delay (s/veh)		7.6												13.1		9.1
Level of Service (LOS)		A												B		A
Approach Delay (s/veh)		1.9												9.5		
Approach LOS														A		

HCS7 Two-Way Stop-Control Report

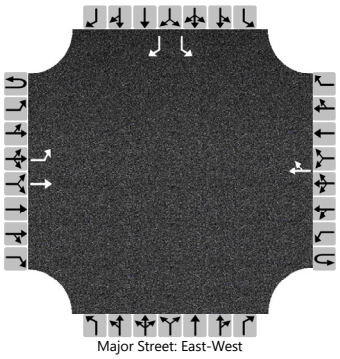
General Information

Analyst	Graham Johnson, PE
Agency/Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	PM Peak Hour
Intersection Orientation	East-West
Project Description	2042 Future (East Intersection)

Site Information

Intersection	Country Club at S 4th St
Jurisdiction	City of Marshall
East/West Street	Country Club Drive
North/South Street	S 4th Street
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes


Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	0		0	0	0		1	0	1
Configuration		L	T					TR						L		R
Volume (veh/h)		105	143				163	1						5		123
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized														No		
Median Type | Storage																
					Undivided											

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		117												6		137
Capacity, c (veh/h)		1393												440		861
v/c Ratio		0.08												0.01		0.16
95% Queue Length, Q_{95} (veh)		0.3												0.0		0.6
Control Delay (s/veh)		7.8												13.3		10.0
Level of Service (LOS)		A												B		A
Approach Delay (s/veh)		3.3												10.1		
Approach LOS														B		

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	AM Peak Hour
Project Description	2042 Future (West Intersecti...

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.78
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment			TR				LT				LR					
Volume (V), veh/h	0		173	2	0	60	72		0	2		118				
Percent Heavy Vehicles, %	2		2	2	2	2	2		2	2		2				
Flow Rate (v_{PCE}), pc/h	0		226	3	0	78	94		0	3		154				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		229			172			157				
Entry Volume, veh/h		225			169			154				
Circulating Flow (v_c), pc/h	78			3			226			175		
Exiting Flow (v_{ex}), pc/h	380			97			0			81		
Capacity (c_{pce}), pc/h		1274			1376			1096				
Capacity (c), veh/h		1249			1349			1074				
v/c Ratio (x)		0.18			0.13			0.14				

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.4			3.7			4.6				
Lane LOS		A			A			A				
95% Queue, veh		0.7			0.4			0.5				
Approach Delay, s/veh	4.4			3.7			4.6					
Approach LOS	A			A			A					
Intersection Delay, s/veh | LOS	4.2						A					

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	PM Peak Hour
Project Description	2042 Future (West Intersecti...

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.90
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment			TR				LT				LR					
Volume (V), veh/h	0		130	2	0	121	165		0	1		118				
Percent Heavy Vehicles, %	2		2	2	2	2	2		2	2		2				
Flow Rate (v_{PCE}), pc/h	0		147	2	0	137	187		0	1		134				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		149			324			135				
Entry Volume, veh/h		146			318			132				
Circulating Flow (v_c), pc/h	137			1			147			325		
Exiting Flow (v_{ex}), pc/h	281			188			0			139		
Capacity (c_{pce}), pc/h		1200			1379			1188				
Capacity (c), veh/h		1176			1352			1165				
v/c Ratio (x)		0.12			0.24			0.11				

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.1			4.7			4.1				
Lane LOS		A			A			A				
95% Queue, veh		0.4			0.9			0.4				
Approach Delay, s/veh	4.1			4.7			4.1					
Approach LOS	A			A			A					
Intersection Delay, s/veh | LOS	4.4						A					

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	PM Peak Hour
Project Description	2042 Future (East Intersection)

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.90
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0
Lane Assignment			LT				TR								LR	
Volume (V), veh/h	0	105	143		0		163	1					0	5		123
Percent Heavy Vehicles, %	2	2	2		2		2	2					2	2		2
Flow Rate (v_{PCE}), pc/h	0	119	162		0		185	1					0	6		139
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1								1			
Pedestrians Crossing, p/h	0				0								0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763						4.9763	
Follow-Up Headway (s)		2.6087			2.6087						2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		281			186						145	
Entry Volume, veh/h		275			182						142	
Circulating Flow (v_c), pc/h	6			119			287			185		
Exiting Flow (v_{ex}), pc/h	168			324			120			0		
Capacity (c_{pce}), pc/h		1372			1222						1143	
Capacity (c), veh/h		1345			1198						1120	
v/c Ratio (x)		0.20			0.15						0.13	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.4			4.3						4.3	
Lane LOS		A			A						A	
95% Queue, veh		0.8			0.5						0.4	
Approach Delay, s/veh	4.4			4.3						4.3		
Approach LOS	A			A						A		
Intersection Delay, s/veh | LOS	4.3						A					

HCS7 Roundabouts Report

General Information

Analyst	Graham Johnson, PE
Agency or Co.	SEH Inc.
Date Performed	4/19/2021
Analysis Year	2042
Time Analyzed	AM Peak Hour
Project Description	2042 Future (East Intersection)

Site Information

Intersection	Country Club at S 4th St
E/W Street Name	Country Club Drive
N/S Street Name	S 4th Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.78
Jurisdiction	City of Marshall

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0
Lane Assignment			LT				TR								LR	
Volume (V), veh/h	0	72	219		0		80	9					0	6		52
Percent Heavy Vehicles, %	2	2	2		2		2	2					2	2		2
Flow Rate (v_{PCE}), pc/h	0	94	286		0		105	12					0	8		68
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1								1			
Pedestrians Crossing, p/h	0				0								0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763						4.9763	
Follow-Up Headway (s)		2.6087			2.6087						2.6087	

Flow Computations, Capacity and v/c Ratios

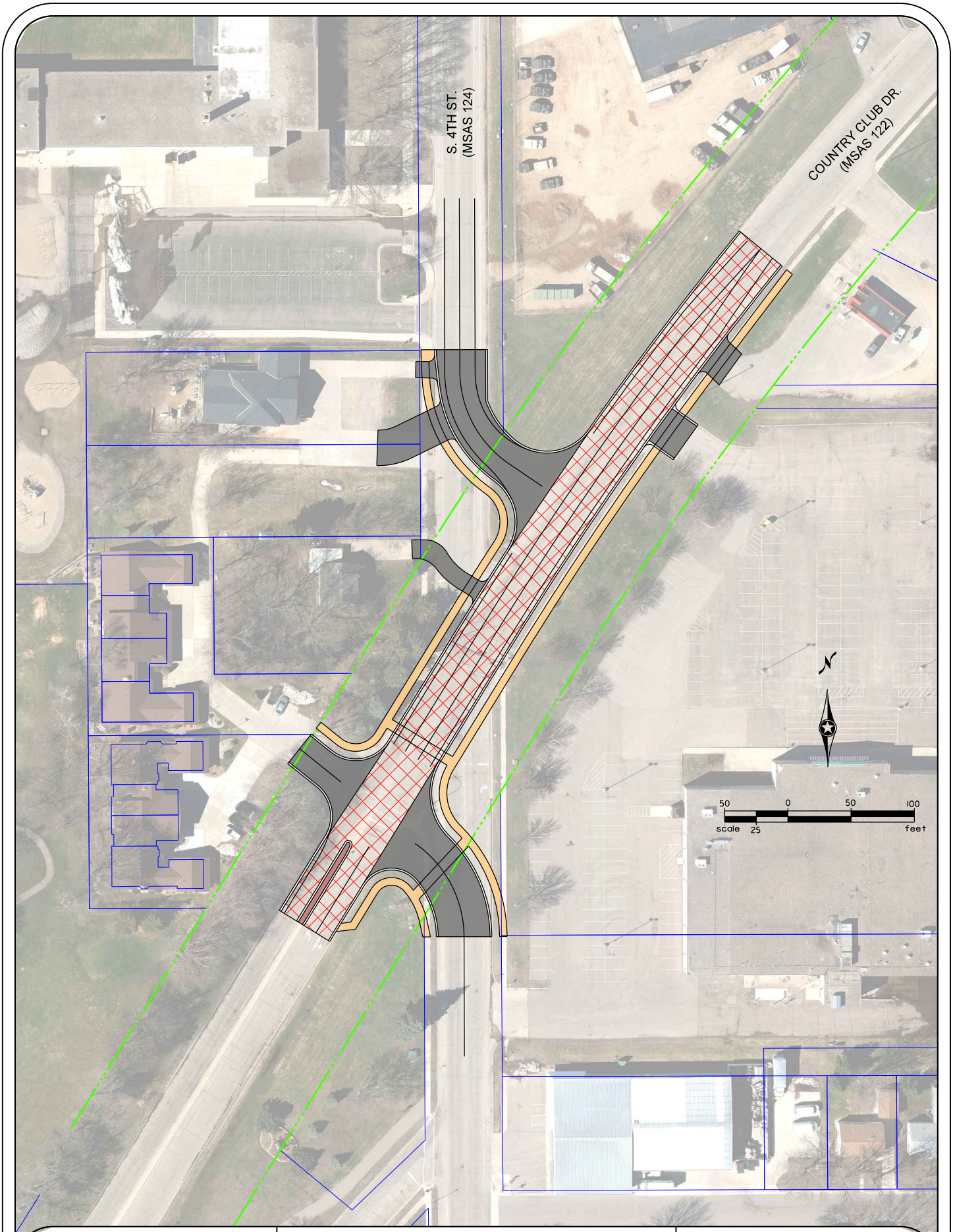
Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		380			117						76	
Entry Volume, veh/h		373			115						75	
Circulating Flow (v_c), pc/h	8			94			388			105		
Exiting Flow (v_{ex}), pc/h	294			173			106			0		
Capacity (c_{pce}), pc/h		1369			1254						1240	
Capacity (c), veh/h		1342			1229						1216	
v/c Ratio (x)		0.28			0.09						0.06	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.1			3.7						3.5	
Lane LOS		A			A						A	
95% Queue, veh		1.1			0.3						0.2	
Approach Delay, s/veh	5.1			3.7						3.5		
Approach LOS	A			A						A		
Intersection Delay, s/veh | LOS	4.6						A					

Appendix C

Layouts and Cost Estimates

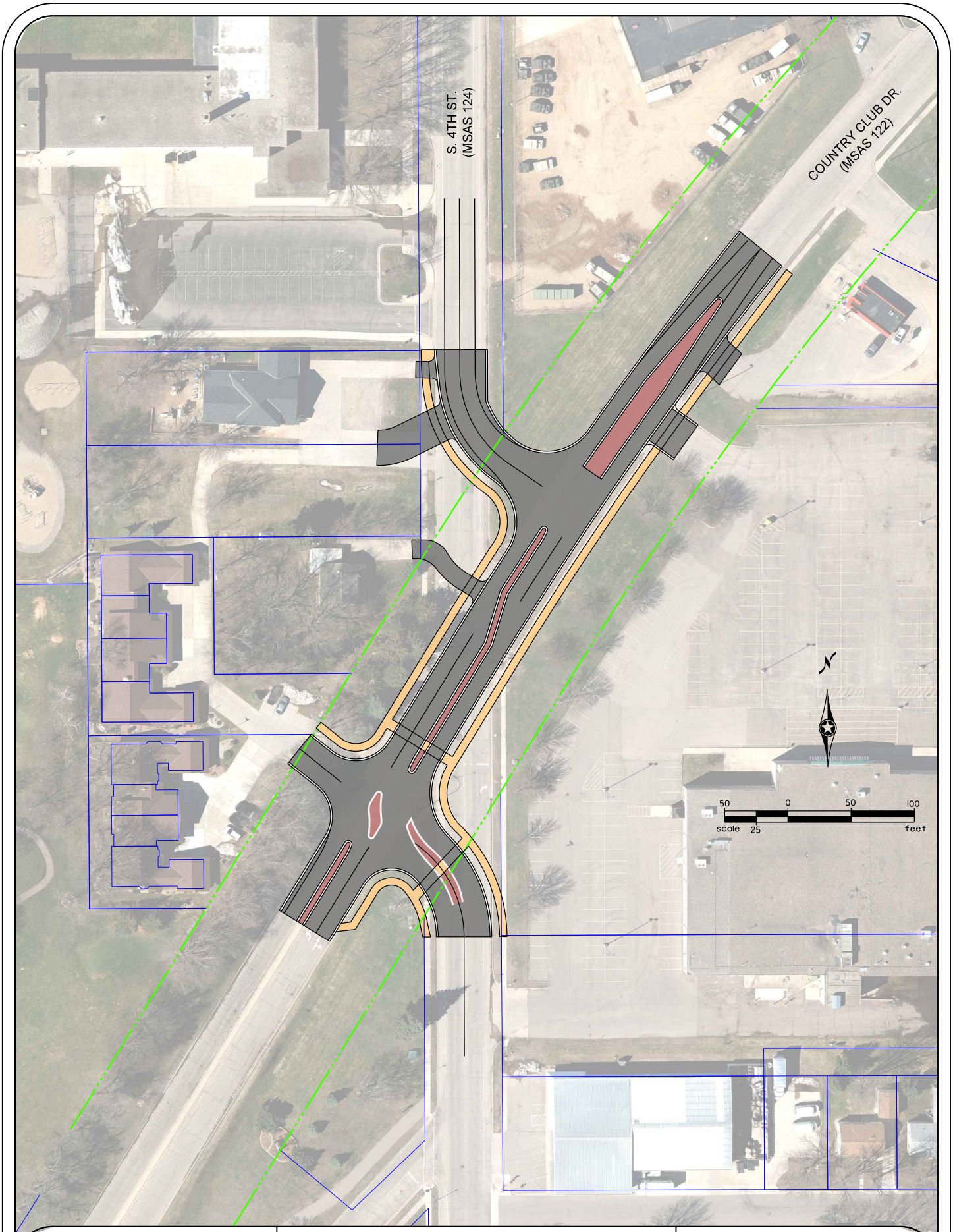


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - No Median

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 1

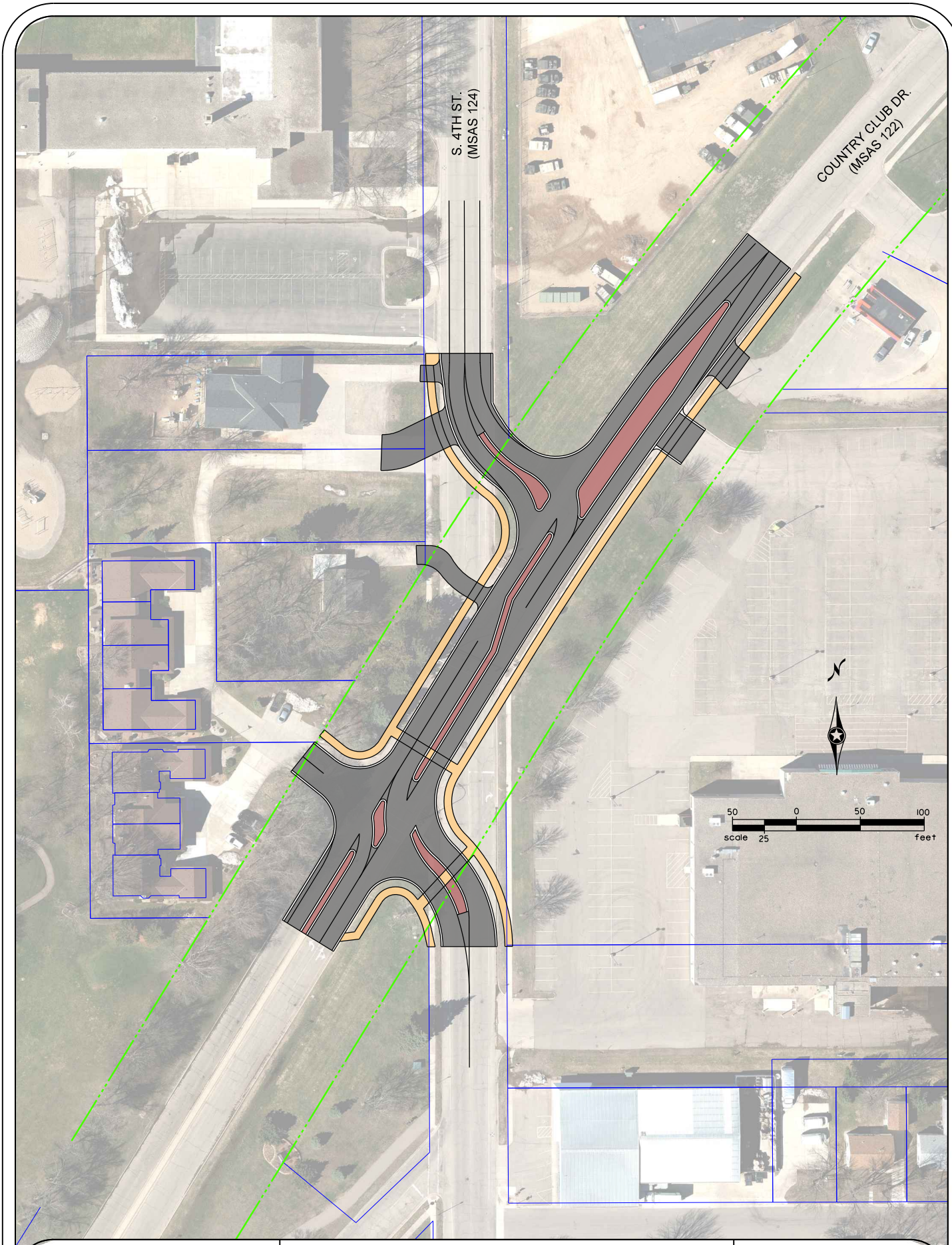


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - With Median

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 2

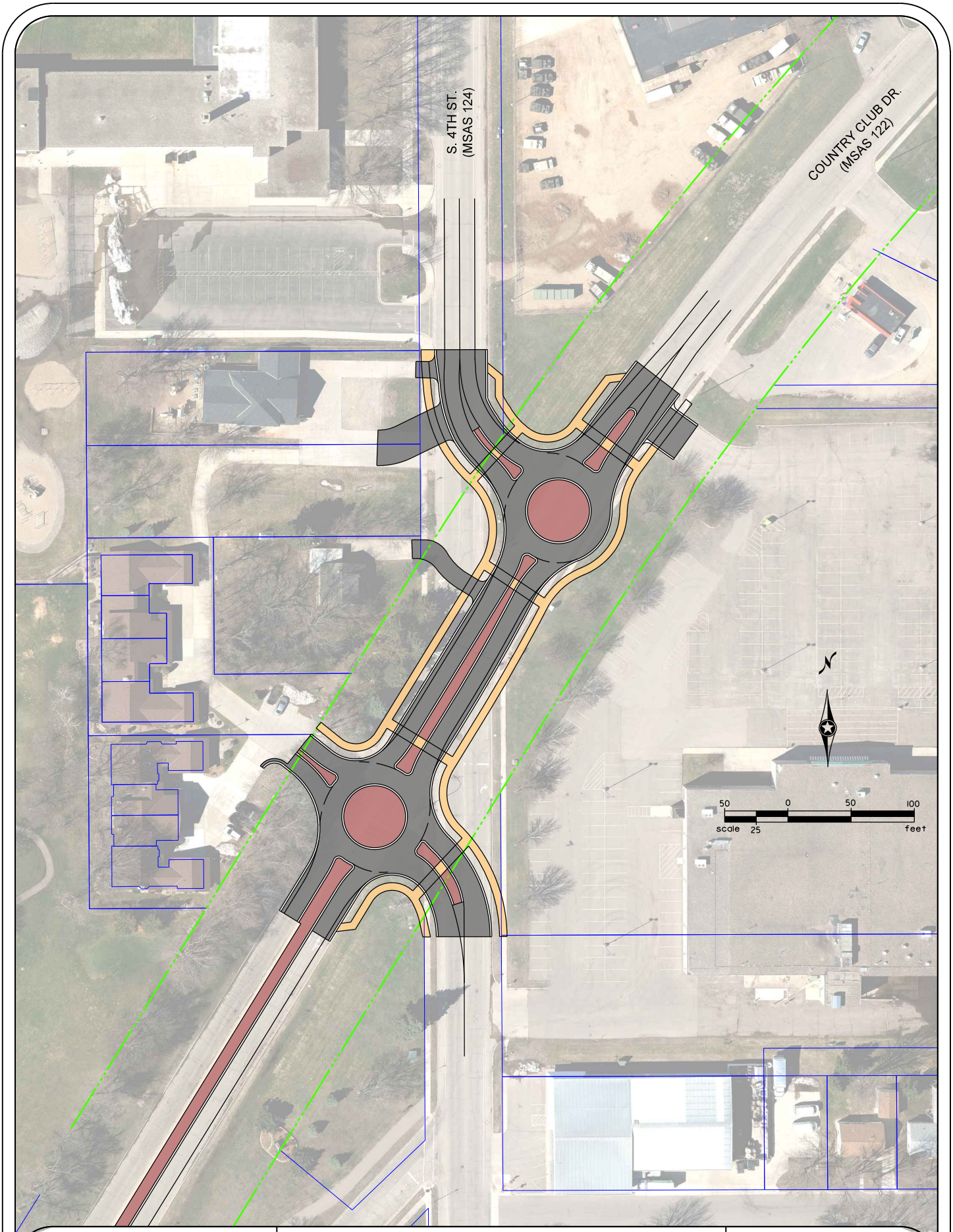


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - 3/4 Intersections

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 3

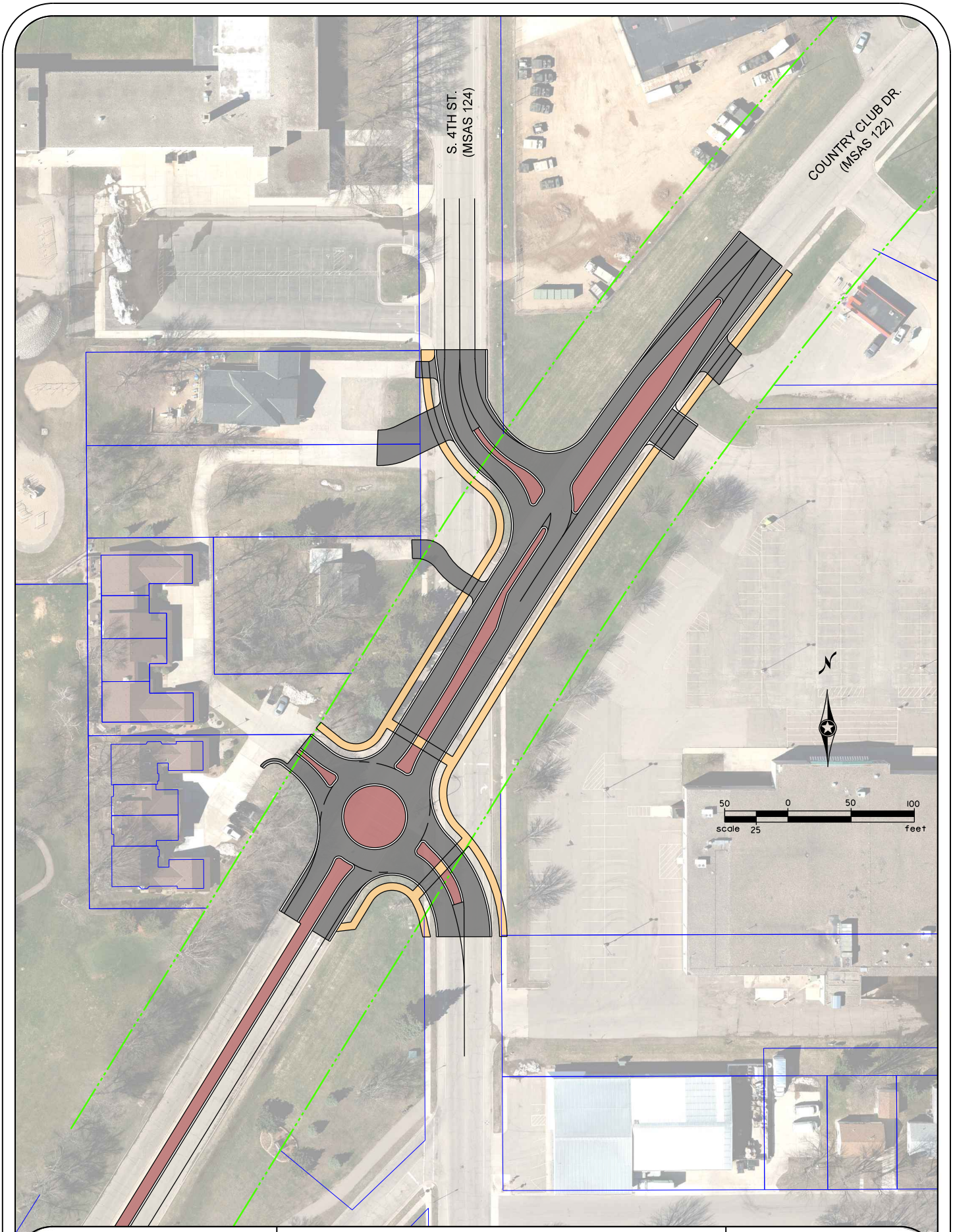


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - Mini Roundabouts

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 4

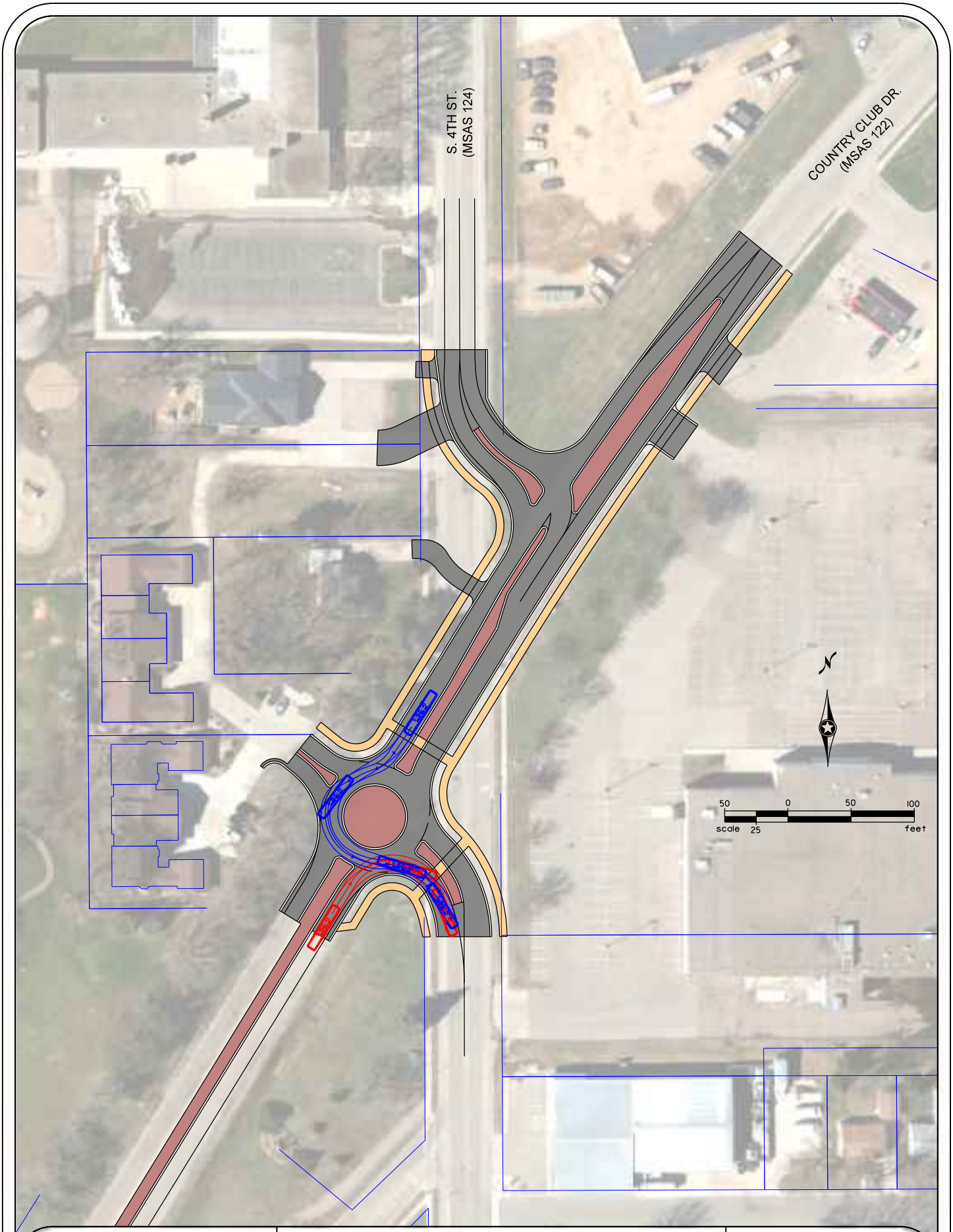


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - Mini Roundabout and ¾ Intersection

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 5

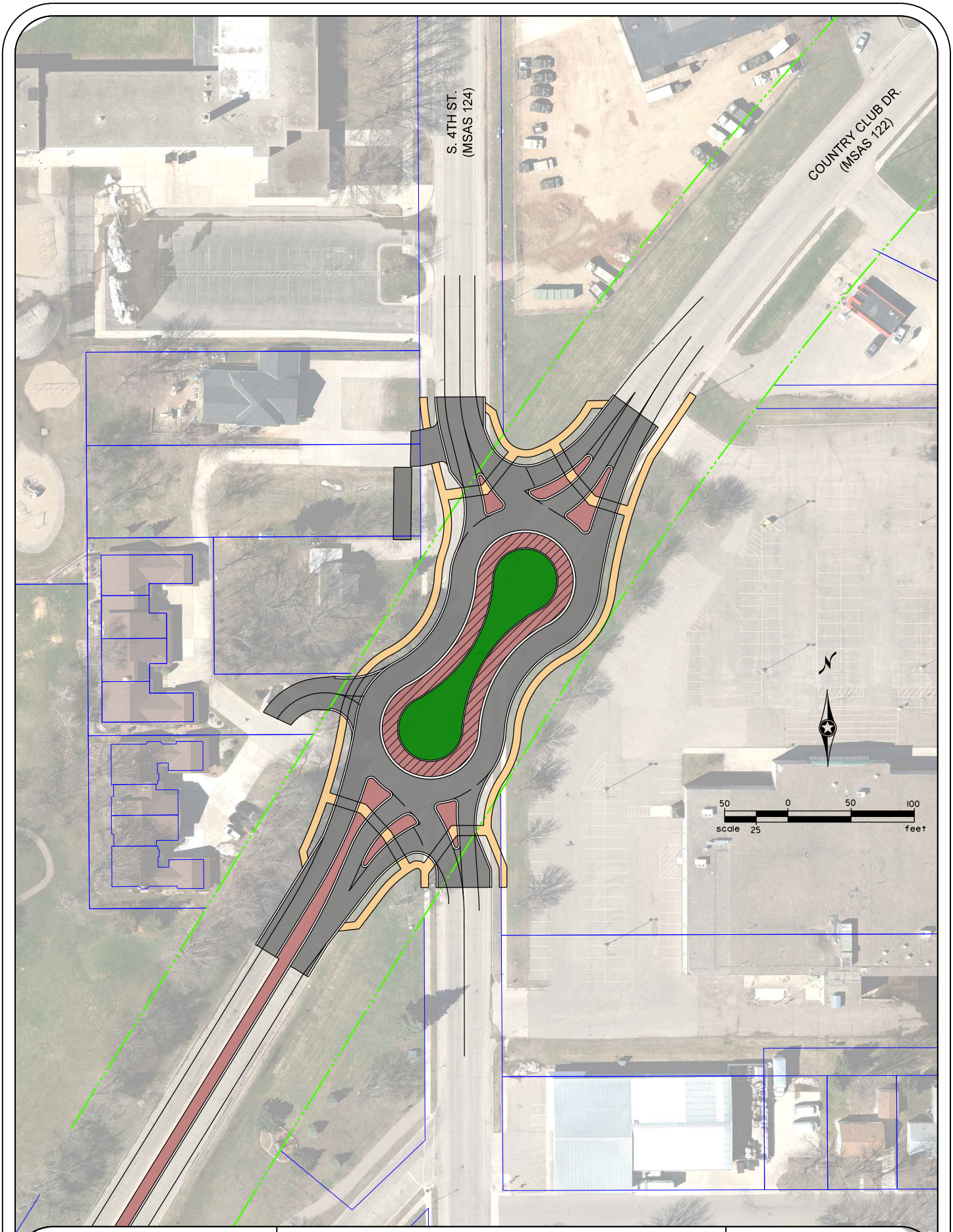


SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Split T - Mini Roundabout and ¾ Intersection

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 5



SEH
PHONE: (651) 490-2000
3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110

Single Peanut Roundabout

Country Club Dr. / 4th St.
Marshall, MN

DRAWING NO. 6

Construction Cost Estimate

Split T - Full access with no median

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	852	$ 68,154
4" Concrete Walk	sq ft	$6.20	6,699	$ 41,534
8" Concrete pavement	sq yd	$72.00	0	$ -
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	919	$ 32,158
Subgrade Excavation (1)	cu yd	$10.00	1,600	$ 16,003
Common Excavation	cu yd	$10.00	1,665	$ 16,647
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,497	$ 24,970
Select Granular Borrow	cu yd	$17.00	1,600	$ 27,206
Mill	sq yd	$2.00	2,921	$ 5,843
Curb and Gutter Design B624	lin ft	$26.00	1,900	$ 49,400
(a) Subtotal Paving and Grading				**$ 281,914**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 14,096
Minor City Utilities		5.0%		$ 14,096
Signing, Striping, Traffic Control		5.0%		$ 14,096
Erosion Control and Turf Establishment		5.0%		$ 14,096
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 56,383**
DRAINAGE				
Storm Sewer		20.0%		$ 56,383
(c) Subtotal Drainage				**$ 56,383**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000		$ -
Interchange Lighting		$480,000		$ -
Roundabout Landscaping		$20,000		$ -
Intersection ADA	each	$ 6,000.00	6	$ 36,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 36,000**
(a+b+c+d) Subtotal Construction				**$ 430,680**
Risk & Contingency		20.0%		$ 86,136
TMP		5.0%		$ 21,534
Mobilization		5.0%		$ 21,534
(e) Subtotal Miscellaneous				**$ 129,204**
(a+b+c+d+e) Total Construction				**$ 559,884**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 610,273**
Design & Construction Engineering		20.0%		$ 122,055
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**

Total Estimated Cost	**$ 732,328**

Construction Cost Estimate

Split T - Full access with median

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	1,217	$ 97,358
4" Concrete Walk	sq ft	$6.20	9,651	$ 59,836
8" Concrete pavement	sq yd	$72.00	0	$ -
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	897	$ 31,385
Subgrade Excavation (1)	cu yd	$10.00	1,556	$ 15,561
Common Excavation	cu yd	$10.00	1,624	$ 16,242
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,436	$ 24,363
Select Granular Borrow	cu yd	$17.00	1,556	$ 26,455
Mill	sq yd	$2.00	0	$ -
Curb and Gutter Design B624	lin ft	$26.00	2,685	$ 69,810
(a) Subtotal Paving and Grading				**$ 341,010**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 17,050
Minor City Utilities		5.0%		$ 17,050
Signing, Striping, Traffic Control		5.0%		$ 17,050
Erosion Control and Turf Establishment		5.0%		$ 17,050
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 68,202**
DRAINAGE				
Storm Sewer		20.0%		$ 68,202
(c) Subtotal Drainage				**$ 68,202**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000		$ -
Interchange Lighting		$480,000		$ -
Roundabout Landscaping		$20,000		$ -
Intersection ADA	each	$ 6,000.00	6	$ 36,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 36,000**
(a+b+c+d) Subtotal Construction				**$ 513,414**
Risk & Contingency		20.0%		$ 102,683
TMP		5.0%		$ 25,671
Mobilization		5.0%		$ 25,671
(e) Subtotal Miscellaneous				**$ 154,024**
(a+b+c+d+e) Total Construction				**$ 667,438**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 727,507**
Design & Construction Engineering		20.0%		$ 145,501
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**
Total Estimated Cost				**$ 873,009**

Construction Cost Estimate

Split T - 3/4 Access

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	1,155	$ 92,386
4" Concrete Walk	sq ft	$6.20	11,259	$ 69,806
8" Concrete pavement	sq yd	$72.00	0	$ -
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	890	$ 31,144
Subgrade Excavation (1)	cu yd	$10.00	1,542	$ 15,424
Common Excavation	cu yd	$10.00	1,612	$ 16,116
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,417	$ 24,173
Select Granular Borrow	cu yd	$17.00	1,542	$ 26,220
Mill	sq yd	$2.00	0	$ -
Curb and Gutter Design B624	lin ft	$26.00	3,147	$ 81,822
(a) Subtotal Paving and Grading				**$ 357,090**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 17,855
Minor City Utilities		5.0%		$ 17,855
Signing, Striping, Traffic Control		5.0%		$ 17,855
Erosion Control and Turf Establishment		5.0%		$ 17,855
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 71,418**
DRAINAGE				
Storm Sewer		20.0%		$ 71,418
(c) Subtotal Drainage				**$ 71,418**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000		$ -
Interchange Lighting		$480,000		$ -
Roundabout Landscaping		$20,000		$ -
Intersection ADA	each	$ 6,000.00	10	$ 60,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 60,000**
(a+b+c+d) Subtotal Construction				**$ 559,927**
Risk & Contingency		20.0%		$ 111,985
TMP		5.0%		$ 27,996
Mobilization		5.0%		$ 27,996
(e) Subtotal Miscellaneous				**$ 167,978**
(a+b+c+d+e) Total Construction				**$ 727,905**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 793,416**
Design & Construction Engineering		20.0%		$ 158,683
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**

Total Estimated Cost	**$ 952,099**

Construction Cost Estimate

Split T - Mini Roundabouts

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	953	$ 76,227
4" Concrete Walk	sq ft	$6.20	14,894	$ 92,343
8" Concrete pavement	sq yd	$72.00	419	$ 30,176
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	908	$ 31,774
Subgrade Excavation (1)	cu yd	$10.00	1,539	$ 15,390
Common Excavation	cu yd	$10.00	1,641	$ 16,413
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,462	$ 24,619
Select Granular Borrow	cu yd	$17.00	1,539	$ 26,162
Mill	sq yd	$2.00	0	$ -
Curb and Gutter Design B624	lin ft	$26.00	3,246	$ 84,396
(a) Subtotal Paving and Grading				**$ 397,499**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 19,875
Minor City Utilities		5.0%		$ 19,875
Signing, Striping, Traffic Control		5.0%		$ 19,875
Erosion Control and Turf Establishment		5.0%		$ 19,875
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 79,500**
DRAINAGE				
Storm Sewer		20.0%		$ 79,500
(c) Subtotal Drainage				**$ 79,500**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000	8	$ 56,000
Interchange Lighting		$480,000		$ -
Roundabout Landscaping		$20,000		$ -
Intersection ADA	each	$ 6,000.00	12	$ 72,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 128,000**
(a+b+c+d) Subtotal Construction				**$ 684,499**
Risk & Contingency		20.0%		$ 136,900
TMP		5.0%		$ 34,225
Mobilization		5.0%		$ 34,225
(e) Subtotal Miscellaneous				**$ 205,350**
(a+b+c+d+e) Total Construction				**$ 889,849**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 969,935**
Design & Construction Engineering		20.0%		$ 193,987
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**
Total Estimated Cost				**$ 1,163,922**

Construction Cost Estimate

Split T - Mini and 3/4

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	1,082	$ 86,535
4" Concrete Walk	sq ft	$6.20	16,185	$ 100,347
8" Concrete pavement	sq yd	$72.00	210	$ 15,088
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	973	$ 34,049
Subgrade Excavation (1)	cu yd	$10.00	1,710	$ 17,101
Common Excavation	cu yd	$10.00	1,764	$ 17,639
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,646	$ 26,458
Select Granular Borrow	cu yd	$17.00	1,710	$ 29,072
Mill	sq yd	$2.00	0	$ -
Curb and Gutter Design B624	lin ft	$26.00	3,736	$ 97,136
(a) Subtotal Paving and Grading				**$ 423,425**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 21,171
Minor City Utilities		5.0%		$ 21,171
Signing, Striping, Traffic Control		5.0%		$ 21,171
Erosion Control and Turf Establishment		5.0%		$ 21,171
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 84,685**
DRAINAGE				
Storm Sewer		20.0%		$ 84,685
(c) Subtotal Drainage				**$ 84,685**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000	4	$ 28,000
Interchange Lighting		$480,000		$ -
Roundabout Landscaping		$20,000		$ -
Intersection ADA	each	$ 6,000.00	8	$ 48,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 76,000**
(a+b+c+d) Subtotal Construction				**$ 668,794**
Risk & Contingency		20.0%		$ 133,759
TMP		5.0%		$ 33,440
Mobilization		5.0%		$ 33,440
(e) Subtotal Miscellaneous				**$ 200,638**
(a+b+c+d+e) Total Construction				**$ 869,433**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 947,682**
Design & Construction Engineering		20.0%		$ 189,536
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**

Total Estimated Cost	**$ 1,137,218**

Construction Cost Estimate

Single Roundabout

Item Description	Units	Unit Cost	Quantity	Total
PAVING AND GRADING (P & G) COSTS				
Bituminous Pavement (1)	ton	$80.00	1,052	$ 84,135
4" Concrete Walk	sq ft	$6.20	13,669	$ 84,748
8" Concrete pavement	sq yd	$72.00	657	$ 47,280
Concrete pavement	sq yd	$72.00	0	$ -
Class 2 Aggregate Shoulder (1)	cu yd	$45.00	0	$ -
Class 6 Aggregate Base (1)	cu yd	$35.00	983	$ 34,406
Subgrade Excavation (1)	cu yd	$10.00	1,725	$ 17,252
Common Excavation	cu yd	$10.00	1,782	$ 17,822
Muck Excavation	cu yd	$10.00	0	$ -
Common Borrow	cu yd	$10.00	2,673	$ 26,732
Select Granular Borrow	cu yd	$17.00	1,725	$ 29,328
Mill	sq yd	$2.00	0	$ -
Curb and Gutter Design B624	lin ft	$26.00	3,600	$ 93,600
(a) Subtotal Paving and Grading				**$ 435,303**
UTILITIES, REMOVALS, DRAINAGE, ETC.				
Removals/Clear and Grub		5.0%		$ 21,765
Minor City Utilities		5.0%		$ 21,765
Signing, Striping, Traffic Control		5.0%		$ 21,765
Erosion Control and Turf Establishment		5.0%		$ 21,765
(b) Subtotal Utilities, Removals, Drainage, Etc.				**$ 87,061**
DRAINAGE				
Storm Sewer		20.0%		$ 87,061
(c) Subtotal Drainage				**$ 87,061**
STRUCTURES/SIGNALS/MISC. COST				
Bridge removal	sqft	$15		$ -
Retaining Wall	sqft	$100		$ -
Retaining Block Wall	sqft	$60		$ -
Lighting		$7,000	8	$ 56,000
Interchange Lighting		$480,000		$ -
Roundabout Landscaping	each	$20,000	1	$ 20,000
Intersection ADA	each	$ 6,000.00	20	$ 120,000
Signal System	each	$ 250,000.00		$ -
Wetland Impact	acre	$ 80,000.00		$ -
				$ -
(d) Subtotal Structural				**$ 196,000**
(a+b+c+d) Subtotal Construction				**$ 805,424**
Risk & Contingency		20.0%		$ 161,085
TMP		5.0%		$ 40,271
Mobilization		5.0%		$ 40,271
(e) Subtotal Miscellaneous				**$ 241,627**
(a+b+c+d+e) Total Construction				**$ 1,047,051**
Inflation Adjusted Construction Cost for 2021 (1.09 factor)				**$ 1,141,286**
Design & Construction Engineering		20.0%		$ 228,257
RW Cost				
	acre	$15,000		$ -
Total RW				**$ -**

Total Estimated Cost	**$ 1,369,543**

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