County Highway 50
Kenwood Trail
Corridor Study

DRAFT

September 2013

Contents

Background

This study was developed to provide Dakota County and the City of Lakeville a better understanding of the existing and future traffic operations along the County Highway (CH) 50 (Kenwood Trail) corridor. The main questions to be answered by this study include:

- What changes in traffic operations can be expected from the implementation of a roundabout at the CH 50/60 intersection?
- What other corridor improvements may be necessary along the corridor to provide acceptable traffic operations both near-term and long-term?

Dakota County is currently developing a project to replace the existing traffic signal at the intersection of CH 50 and CH 60 (185th Street) with a multi-lane roundabout to address operational and safety deficiencies at the intersection. The project also includes expanding the existing three-lane CH 50 to a four-lane divided facility from south of CH 60 to the current transition at Jurel Way.

During public outreach for the project, a number of comments were provided by area residents and the Lakeville City Council requesting additional information about how a roundabout at the intersection of CH 50/60 would affect the availability of gaps in traffic along CH 50, which in turn affects driver's ability to turn on and off the highway.

This study provides information on how CH 50 is expected to operate with a roundabout at CH 60, including the influence it would have on gaps downstream of the roundabout that allow side street traffic to enter the highway.

In addition, the goal of this study was to develop short-term and long-term vision for the corridor, including potential improvement needs such as changes to intersection traffic control, access, and potential new local street connections. The study included the CH 50 corridor from CH 60 to Dodd Boulevard (see Figure 1).

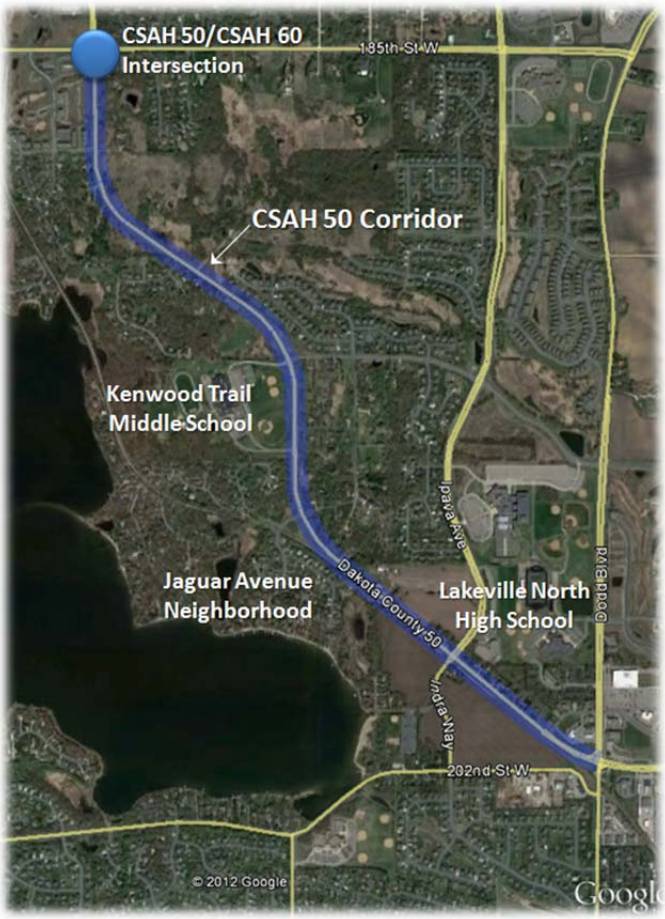


Figure 1
CH 50 Corridor Study Area

Roundabout at County Highway 60

The decision to implement a roundabout at the CH 50/60 intersection was based on the analysis completed in July, 2011 and documented in the *CSAH 50/Kenwood Trail and CSAH 60/185th Street Intersection Study*. This analysis included a comparison of multiple intersection control alternatives including cost, operations, right-of-way impacts, and safety considerations. The final recommendation was the implementation of a roundabout based on these factors:

- Less delay is expected at the CH 50/60 intersection with the implementation of a roundabout instead of a signal
- Roundabouts have lower expected crash rates and less severe crashes
- There would be an expected decrease in pedestrian conflicts with less exposure to traffic and lower vehicle speeds in a roundabout
- The roundabout alternative was expected to cost less than a signalized intersection
- There were less right-of-way impacts in the area of the intersection with a roundabout alternative

Corridor Characteristics

As part of understanding the current operations of CH 50 and to assist in the development of potential corridor improvements, existing characteristics of the corridor were documented including roadway geometry, access locations, traffic control, current and forecasted traffic volumes and crash history.

Figure 2
CH 50 Roadway Geometry – Three-Lane Cross-Section

Roadway Access

The CH 50 corridor, between CH 60 and CH 9 (Dodd Road), is a three-lane roadway with one lane of travel in each direction and a continuous center two way turn lane (see Figure 2). It is classified as an A Minor Arterial in the Dakota County Transportation Plan, based on its important connections between Interstate 35 and locations further east in Lakeville and connections to Farmington.

Along with the continuous left-turn lane there are also right-turn lanes at all major intersections including:

- 188th Street
- Jordan Circle
- 192nd Street
- 194th Street
- Jaguar Avenue
- Ipava Avenue
- Icenic Trail
- Dodd Road (CH 9)

In addition to local street access, the corridor also provides access to the Kenwood Trail Middle School, located near the 192nd Street intersection, and various commercial and private properties adjacent to the corridor. A summary of local street, private residences and commercial/school access is included in Table 1.

Table 1
CH 50 Number and Type of Access Summary

Segment	Segment Length	Local Street (not including segment end)	Private Residence	Commercial/ School
CH 60/185th to 188th St	0.25 miles	2	4	0
188th St to Jordan Ct	0.4 miles	3	2	0
Jordan Ct to 192nd St	0.4 miles	3	1	0
192nd St to Jaguar Ave	0.4 miles	3	0	1
Jaguar Ave to Ipava Ave	0.5 miles	3	6	0
Ipava Ave to Dodd Rd/CH 9	0.5 miles	3	5	6

There are currently three traffic signals along the corridor (CH 60, Ipava Avenue and Dodd Road). All other local street accesses are thru-STOP controlled, with STOP signs on the local street approaches as shown in Figure 4.

Current and Future Traffic Volumes

The CH 50 corridor within the study area currently carries on average between 13,500- 15,000 vehicles per day. The volumes vary between the northern part of the corridor, from CH 60 to 192nd Street and the southern part, from 192nd Street to Dodd Road (CH 9), as shown in Table 2. Traffic counts, counting all vehicles entering an intersection and the direction they travel, were also collected in December 2012 at all major intersections. The counts went from 6 AM to 8 PM to document the hours during the day when the highest volume of vehicles were using each intersection. These "Peak Hours" were then used to analyze the entire corridor during both the morning (7:00 to 8:00 AM) and evening peak (4:30 to 5:30 PM) hours.

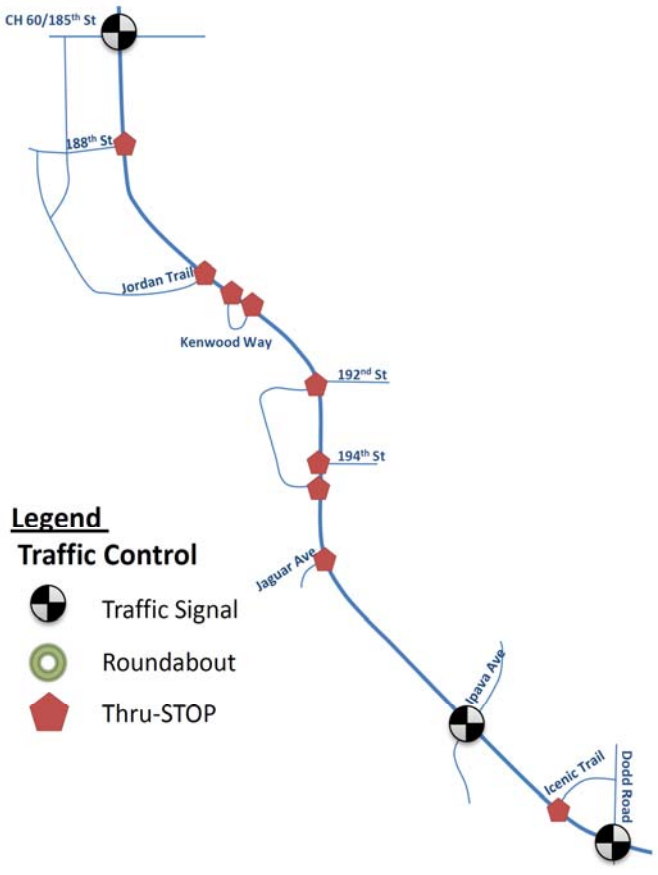


Figure 4
Existing Local Street Access and Traffic Control Type

The AM peak hour for the corridor includes the peak traffic leaving Kenwood Trail Middle School in the morning. The school's afternoon peak occurs when CH 50 traffic is not at its peak in the afternoon. The counts are included in Appendix A and were input into the traffic model used to analyze potential alternatives.

Future Traffic Volumes

The Dakota County 2030 Transportation Plan includes forecasts for all County highways based on the Dakota County Travel Demand Model. This model takes into account future land use, local travel patterns based on the future roadway system and regional traffic demand. Based on this model, the forecast volumes for the corridor are between 19,000 and 27,000 vehicles per day in the year 2030.

Table 2
County Highway 50 Average Daily Traffic Volumes

Location	2011 ADT	2012 ADT	2030 Projection
CH 60 to 192nd St	15,000	17,800	27,000
192nd St to CH 9	13,500	N/A	19,000

The typical capacity of a three-lane roadway is around 18,000 vehicles per day. With future traffic volumes of 27,000 vehicles per day, capacity improvements will be required on the corridor to accommodate this traffic growth.

Kenwood Trail Middle School

Kenwood Trail Middle School (KTMS), part of the Lakeville School District (ISD 194), is located along the west side of the corridor, between Lake Marion and CH 50. The school houses grades 6-8.

One of the main transportation challenges with the KTMS site is that the only public street available to serve the school is CH 50. It currently has 2 accesses that serve the site: one lining up with 192nd Street, and the other approximately 250' south of 194th Street. The 2 accesses are approximately 1150' apart. Buses use only the south access to dropoff and pickup students on the west side of the building. Staff and parents use both accesses to park in the east lot and for student dropoff/pickup.

192nd Street to the east of CH 50 is a collector street. The access spacing between the south access and 194th Street (250') and the spacing between the south access and Jaguar Avenue (850') are both less than the County's access spacing guideline of ¼ mile.

The school currently provides busing for all students east of CH 50 because CH 50 is considered a barrier for kids walking to school.

Corridor Crash History

A review of crashes from 2012 showed a total of 21 reported crashes on CH 50 with a majority of these crashes (14 crashes) occurring at the CH 60 intersection (see Table 3). In addition to the single year of data, five-years of injury and fatal crashes were reviewed (2007-2011) and are shown in Table 4. Within these five years, there was one fatal crash and eight injury crashes, with most of the crashes intersection-related. The fatal crash was a head-on where a vehicle crossed the centerline of CH 50 between Jaguar Avenue and Ipava Avenue. Four out of the eight injury crashes were southbound rear end crashes at intersections. Three of the injury crashes involved vehicles turning left out of 188th, 192nd and Jaguar Avenue and being hit by a southbound vehicle on CH 50.

Table 3
2012 County Highway 50
All Reported Crashes

Location	Crashes
CH 60	14 crashes
188th Street	1 crash
192nd Street	None
194th Street	1 crash
Jaguar Ave	2 crashes
Ipava Avenue	3 crashes
Icenic Trail	None
TOTAL	**21 crashes**

Table 4
2007-2011 Fatal and Injury Crash Summary

Location	Crashes	Crash Types
188th Street and CH 50 intersection	2 crashes	1 Left turn out, 1 rear end
192nd Street and CH 50 intersection	1 crash	Left turn out
Jaguar Ave and CH 50 intersection	1 crash	Left turn out with bicycle
Ipava Avenue and CH 50 intersection	3 crashes	2 rear end, 1 Right angle
Icenic Trail and CH 50 intersection	1 crashes	Rear End
Non-Intersection	1 crash	Fatal head-on crash

Public Outreach

There were various meetings with local residents and business owners throughout the study process in order to share study progress, analysis results and to obtain public input into the process and final recommendations.

Neighborhood Meetings, November 2012

Meetings were held in November to allow residents along the corridor to learn about the planned scope of the study, provide input on their individual concerns and give suggestions for the direction of the study. There were four separate meetings for different neighborhoods within the study area. The separate meeting provided for each neighborhood to focus on their unique situations and experiences within the CH 50 corridor. Kenwood Trail Middle School officials were also invited to attend all meetings. The neighborhoods were separated as follows:

- North Neighborhood – Between CH 60 and 192nd Street
- Jaguar Neighborhood – All residents that have access to CH 50 from Jaguar Avenue
- East Neighborhood – All residents located on the east side of CH 50 across from Kenwood Trail Middle between CH 50 and Ipava Avenue.
- Corridor Businesses – Local businesses along CH 50, mainly around Ipava Avenue and Dodd Road/CH 9

At these meetings, residents expressed concerns about the impact of the roundabout on the ability to access CH 50 at access locations further south. With these concerns, they also suggested potential improvements, such as:

- Lower the speed limit of CH 50
- Provide another access for the Jaguar Avenue neighborhood
- Install traffic signals at additional locations along the corridor to improve gaps

These suggestions and comments were used by the study team to develop potential alternative scenarios to model and review to be sure the analysis addressed concerns and questions posed by meeting participants.

Business Owners Meetings – February 2013

County and City staff met directly with representatives of businesses that border CH 50 along the northeast side of the roadway between Ipava Avenue and Icenic Trail. One-on-one meetings were held with representatives from Lakeville Dental, White Funeral Homes, McDonald Eye Care, Farmshow Publishing, and Kindernook Preschool.

The goal of the meetings was to ensure the businesses understood the study intent and process, and to ensure County and City staff understood any pertinent issues the businesses may have that should be addressed by the study. The main issue discussed was the proximity of the existing roadway to the commercial buildings and the potential implications of expanding the roadway, and building a divided roadway. Because a divided roadway would convert all existing driveway access to right-in/right-out access, the potential for alternative access locations was also discussed.

Public Open House – March 2013

On March 21, 2013 a public open house was held at the Kenwood Trail Middle School. At this meeting, results of the alternative analysis were shared along with proposed next steps. Participants were encouraged to provide comments. The information shared at the open house was posted on the County's website prior to the meeting to allow time for interested citizens to review the information before attending the meeting, and to make it available for those who were not able to attend the meeting. Appendix B includes the information shared with the residents on the website and at the meeting and comments received. Many of the comments expressed continued concerns about operations and safety at Jaguar Avenue.

Alternative Development

Alternative corridor and intersection improvement scenarios were developed based on the need to answer key questions about the operations of the CH 50 corridor, with a total of six alternatives analyzed. Table 5 provides a summary of the alternatives analyzed along with the purpose or question to be answered by the alternative. More information on the development of alternatives, such as the assumed traffic control, local street connections and roadway geometry are discussed further in the following sections.

Table 5
Corridor Alternatives Analyzed

Questions to Answer	Alternatives Developed
What are traffic operations like today? Does the model simulate these conditions?	**Alternative 1 - Existing Conditions** – this scenario used the existing roadway and current traffic volume. The results were compared with actual video of the corridor to calibrate the model.
What if the signal at CH 50/CH 60 is improved instead of installing a roundabout?	**Alternative 2 - Existing with an Improved Signal at CH 60** – existing roadway but additional capacity at the signal at CH 60 and current traffic volumes
What happens when the signal is replaced with a roundabout?	**Alternative 3 - Existing with Roundabout at CH 60** – existing roadway but with a roundabout at CH 60 and current traffic volumes
When the roundabout is installed, what if there are other traffic signals along the corridor – does that improve gaps and travel times?	**Alternative 4 - Existing with Roundabout at CH 60 & Signal at 192nd Street** – this scenario used existing roadway with a roundabout at CH 60 and a signal at 192nd Street and current traffic volumes
When the roundabout is installed, what if the geometry of CH 50 is a four-lane roadway – does that improve gaps and travel times?	**Alternative 5 - Existing with Four-Lane & Roundabout at CH 60**– current traffic volumes are used in this scenario with a four-lane divided roadway. This scenario does not include any changes in access except the roundabout at CH 60.
How does the corridor work in the future (with expected growth), with a roundabout at CH 50, four-lane roadway and other traffic control changes?	**Alternative 6 –Future (2030)** – the future scenario included a four-lane divided roadway, the roundabout at CH 60, signals at Jordan Trail/190th Street, 192nd Street, Ipava Avenue and Dodd Road and other access changes with future traffic volumes.

Intersection Control Alternatives

The traffic control assumed for each alternative is shown in Figure 5. For Alternatives 1 through 5, the traffic control was changed in order to answer specific questions about operations on the existing system. For these alternatives there were one or two changes to traffic control types (i.e, change a signal to a roundabout).

The access types and traffic control for Alternative 6 was based on providing full access only at signalized intersections along the corridor, with all other access restricted to either ¾ access (left turns allowed from CH 50, but no left turns or through movements from the cross street) or right-in/right-out. The assumption in the model was that all vehicles at the partial access intersections wanting to make a restricted movement (such as turning left and going south on CH 50 at a right-in/right-out intersection) would have to divert (turn right, head north to the next signal and complete a U-turn in order to head south). This created a "worst case" scenario in terms of traffic volumes at the signals and an understanding of the overall operations of the corridor with the most restrictions on access. In order for such a scenario to work, local street connections, such as a connections for the Jaguar neighborhood to Ipava Avenue and a connection of 198th Way to Ipava Avenue, shown in Figure 6 (see also the Roadway Connection Alternatives section for more information on these new roadway connections).

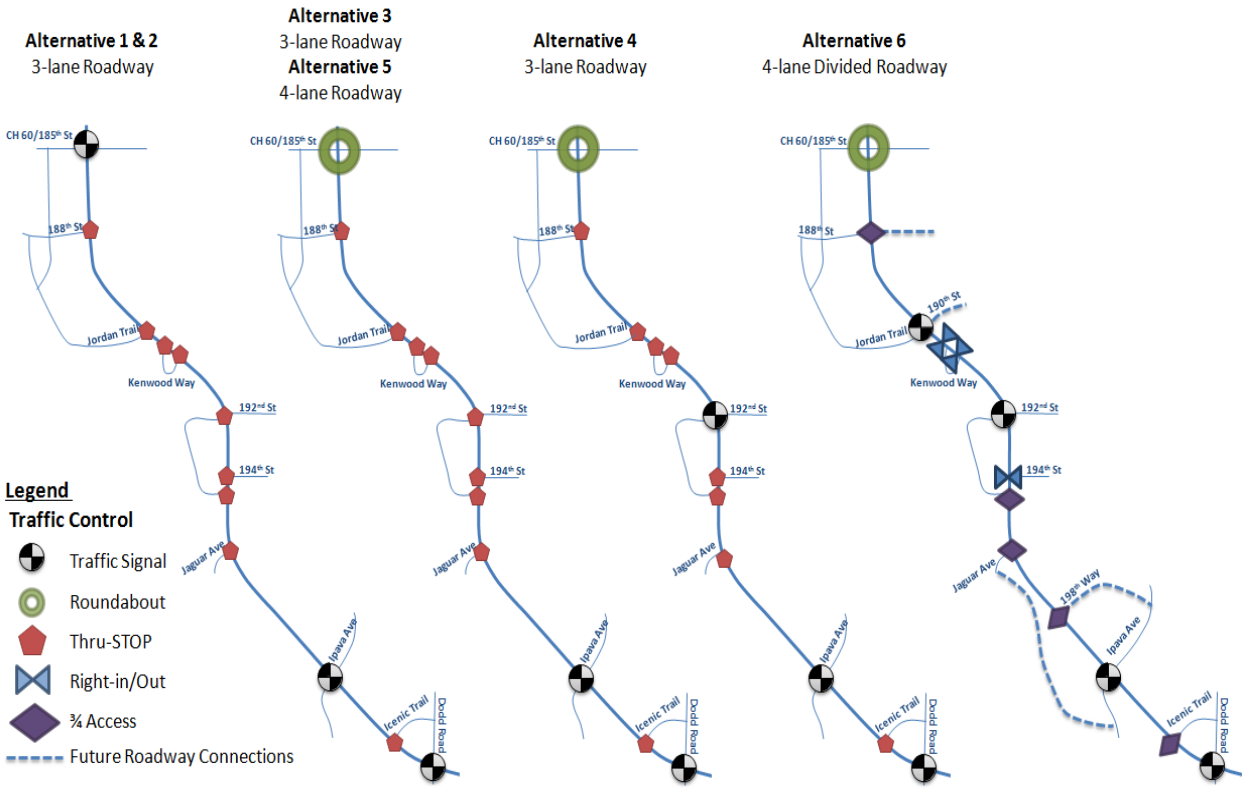


Figure 5
Access and Traffic Control for Alternatives Modeled in VISSIM

While the decision was made to model Alternative 6 with the most restrictions in access along the corridor, this access and traffic control scenarios did not provide a balance between the access needs of the corridor and traffic operations of CH 50. Based on discussions between the County and City staff and the future plans for roadway connections (see next section), a Future Access and Traffic Control Plan was developed (see Figure 6).

Future Access and Traffic Control

The Future Access and Traffic Control Plan presented in Figure 6 should be used as a blue print for access along the corridor as new access is required to support future development, as improvements are made to CH 50, or as safety/operational issues are experienced.

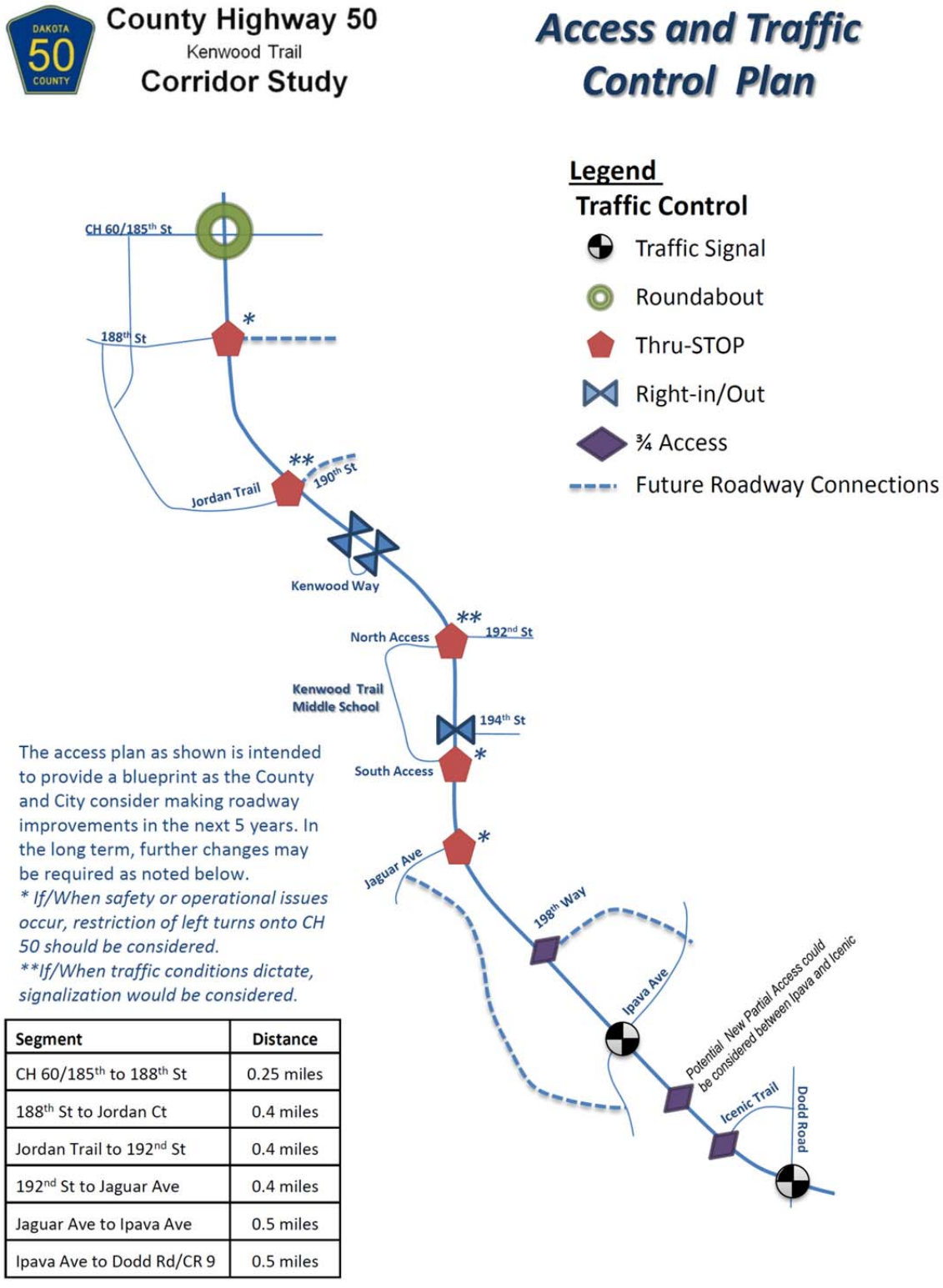
The Future Access and Traffic Control Plan was developed closely with the Kenwood Trail Middle School representatives since the school's two access points and internal circulation of school vehicles would be impacted. The school uses their two access points to help separate bus traffic (using the south access) and student drop-off/pick-up traffic (using the 192nd Street access). The proposed access and traffic control plan would maintain the existing full access with STOP control. However, if safety or operational issues occur, the 192nd Street access would be considered for a traffic signal and the south access may change to a ¾ access.

The Future Access and Traffic Control Plan includes the following elements:

- 188th Street should be left as a side-street stop. If safety or operational issues are experienced in the future, conversion to a ¾ access intersection should be considered.
- 190th Street/Jordan Trail should be left as a side-street stop. If safety or operational issues are experienced in the future, conversion to a signalized intersection should be considered due to 190th Street's future functionality as a City east-west collector street.
- Both accesses of Kenwood Way should be converted to right-in/right-out intersections at the time CH 50 is improved to a divided roadway.
- 192nd Street/North KTMS access should be left as a side-street stop. There are some delays currently experienced in the morning peak hour for traffic exiting the school, but they are short-lived, and the intersection has minimal reported crashes. Expanding CH 50 to 4-lanes is the most effective way to reduce delays at this intersection. If safety or operational issues arise in the future at the intersection, the implications of the horizontal and vertical curvature of CH 50 should be taken into account before installing a signal.
- 194th Street should be converted to a right-in/right-out intersection at the time CH 50 is improved to a divided roadway.
- The south KTMS access should be left as a side-street stop. Although the Dakota County Access Spacing guidelines recommend 1320' between full-movement intersections along divided roadways, this is not a typical intersection. This is a "T" intersection serving only the school (with low volumes), and restricting movements here would require more traffic to use the north entrance when exiting KTMS. With the two

accesses operating well today, there is no tangible benefit to making such a change. If safety or operational issues are experienced in the future, movement restrictions should be considered at that time.

- Jaguar Avenue should be left as a side-street stop. An alternative connection from the neighborhood to Ipava Avenue is recommended. If safety or operational issues are experienced in the future, conversion to a ¾ access intersection should be considered.
- 198th Way should be constructed as a ¾ intersection with a future CH 50 improvement project.
- Ipava Avenue should continue as a signalized intersection.
- A potential new access to future developable area northeast of CH 50 should be considered between Ipava Avenue and Icenic Trail with a future CH 50 improvement project. Allowing for more efficient connection to existing parcels via this access should be provided if the access can be constructed safety and feasibly.
- Icenic Trail should be constructed as a ¾ intersection with a future CH 50 improvement project due to its close proximity to Dodd Road and its connectivity to Dodd Road north of CH 50.



Segment	Distance
CH 60/185th to 188th St	0.25 miles
188th St to Jordan Ct	0.4 miles
Jordan Trail to 192nd St	0.4 miles
192nd St to Jaguar Ave	0.4 miles
Jaguar Ave to Ipava Ave	0.5 miles
Ipava Ave to Dodd Rd/CR 9	0.5 miles

Figure 6
Future Access and Traffic Control Plan

Roadway Connection Alternatives

The City of Lakeville has plans for future roadway connections throughout the study area. These roadway connections are planned to be implemented in conjunction with future development where possible. Two local street connections are already part of the City of Lakeville's Transportation Plan in the northern half of the study (188th Street and 190th Street); these will be implemented as the large undeveloped parcels on the east side of CH 50 are developed. These new roadways include extending both 188th Street and 190th Street from their current termini just west of Ipava Avenue to new access locations on CH 50.

The Jaguar Avenue access to CH 50 is the only connection into the Jaguar neighborhood of over 180 homes. The neighborhood's location on the west side of CH 50, between Lake Marion and the railroad, limit the ability to provide additional access. Based on review of the current roadway network and potential future development in the northwest quadrant of CH 50 and Ipava Avenue intersection, a new connection that provides access to Ipava Avenue via Itasca Lane and 201st Street should be incorporated into future development of this area. Figure 7 provides the currently proposed area for this connection.

Figure 7

Potential New Connection to Ipava Avenue from Jaguar Neighborhood

Roadway Geometry Alternatives

As discussed in the Current and Future Traffic Volumes section of this report, the current traffic volumes are approaching the capacity of a three-lane roadway configuration. With CH 50 just to the north and south of the corridor currently four-lane divided roadway configuration, and with the additional expected capacity of this configuration (up to 40,000 vehicles per day) the conversion, from three-lane to four-lane divided, makes sense. The four-lane geometry was assumed for Alternatives 5 and 6.

However, there are real constraints, especially between Ipava Avenue and Dodd Road/CH 9, in implementing the four-lane divided roadway. At this location, CH 50 is between the railroad on the west side and a number of local businesses on the east side. As designs for the roadway continue to be developed, this constraint will need to be addressed in greater detail to determine the actual impacts to adjacent parcels.

Corridor Speeds

A suggestion provided by a Neighborhood Meeting participant was to lower the speed on CH 50 from its current 50 mph. Minnesota has laws regarding the establishment of speed limits and speed zones. By statute, the speed limit is 30 miles per hour (mph) on urban roads and streets, and 55 mph on 2-lane rural roads. Where state and local authorities think that the statutory limits would not be effective, the statute goes on to say that a speed zone may be established, but only after a study has been conducted and the Commissioner of the Department of Transportation has approved the change. CH 50's speed of 50 mph was authorized by the Commissioner of Transportation through this process.

This process of setting speeds based on speed studies is consistent with what is considered to be a best practice approach that basically says that the majority of drivers along a section of road will select a travel speed that is both reasonable and proper given the actual roadway conditions and traffic characteristics of that road. The result has been a high level of consistency in the establishment of speed limits among roads that have similar characteristics and in most cases a very high level of compliance by road users, because the speed limit matches their expectations. This best practice approach to setting speed limits has been demonstrated to result in the most uniform vehicle operating speeds, and the uniform operating speeds have resulted in the overall safest conditions with fewer crashes.

When CH 50 is reconstructed to a 4-lane facility, Dakota County should request the Commissioner of the Department of Transportation to conduct a new speed study to ensure the posted speed is appropriate for the new roadway.

Results of Alternative Analysis

Model Characteristics

The VISSIM model simulates operations on the roadway by accounting for each individual vehicle. Each vehicle is unique and has various driver-behavior characteristics such as how aggressive the driver is, how fast they drive, or how closely the driver will follow the next vehicle. Individual vehicles also have unique vehicle characteristics. For example, the model accounts for slower acceleration and deceleration of larger vehicles.

A model "run" estimates traffic conditions for an hour and records the results of both individual vehicles and the system as a whole. The model was run 10 times for each alternative and the average of the results is what is reported.

The model was calibrated by comparing real-world information collected through the traffic counts and gap analysis completed in December 2012 and included:

- Volume at Intersections - the amount of volume served during the peak hour in the model was 90% or more compared to the actual count for all intersections. This confirmed that the same amount of traffic was being modeled as was on the corridor during both peak hours.
- Delay at Intersections – the average delay of vehicles was also collected during the traffic counts and compared to the delays modeled. The delays were usually within a few seconds of the actual measured delay confirming that the amount of congestion and delay was comparable to actual roadway conditions.
- Gaps Available at Intersections- the final calibration comparison was in the number of gaps at the key intersections. This comparison allowed the driver behavior's in the model to be adjusted to better represent actual driver decisions on the actual roadway, specifically when and how they chose their gaps to make turning maneuvers.

More information on the calibration factors and results of the Existing Alternative VISSIM model runs can be found in Appendix C.

Traffic Volumes

The traffic volumes used in the VISSIM model are based on the actual traffic counts collected in December 2012 (see Appendix A). These same volumes were applicable to Alternatives 1 through 5 for all of the intersections modeled.

The future scenario (Alternative 6) required growing the turning counts to match expected 2030 traffic volumes. This included using the forecasted volumes assumed in the *CSAH 50/Kenwood Trail and CSAH 60/185th Street Intersection Study* for the roundabout at CH 50/60 intersection, information provided by the Dakota County Travel Demand Model and balancing the entire corridor using the method outlined in NCHRP-365. The Alternative 6 volumes also include changes in travel patterns due to the assumed changes in access. Some of the access changes, shown in Figure 5, require diverting vehicles along the corridor to other signalized intersections in order to complete their maneuvers. These diversions are included in the volumes and are summarized in Appendix D.

Gap Analysis

A gap is the amount of time available for a vehicle on a side street to make a left turn onto CH 50. In the case of a left-turn maneuver, gaps in traffic for both southbound and northbound traffic need to be considered and there needs to be enough overlap of these two gaps to provide time to complete the left turn (see Figure 8).

The number and length of gaps on the roadway can be affected by the following:

- **Volume** – the more vehicles, the less gaps that will be available on the main roadway. This changes along a corridor because traffic is random in speed and constantly turning on to and off of the corridor.
- **Lanes** – the more lanes (includes through lanes and turn lanes), the more gaps that will be available.
- **Traffic control device and type** – signals and roundabouts can create gaps, however, the further from the traffic control device, the less effect it has. All-way stops can also have a metering effect.
- **Driver behavior** – variability in speed can change the number and duration of gaps.

For this analysis, a gap of 8 seconds or more was considered an acceptable length to complete the left-turn maneuver. The length of a gap also defines how many vehicles can make a left onto CH 50. For example, a 12 second gap allows for 2 vehicles to turn left onto CH 50. The number of vehicles reported that can access CH 50 is conservative since the minimum acceptable gap works for left-turning vehicles. Vehicles turning right only need a gap in one direction.

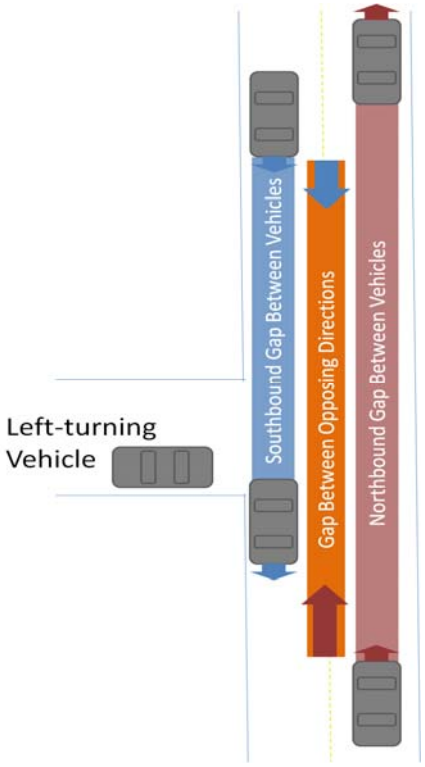


Figure 8
Gap for Left-Turning Vehicles

The gap analysis provided the following output for each alternative analyzed (summarized in Table 6 with details of the analysis in Appendix E):

- **Vehicle Demand** - the number of vehicles needing gaps to access CH 50. This number is based on the current traffic counts for existing alternatives, and the forecast traffic volumes in the future alternative.
- **Average Number of Gaps** - the average number of gaps that were 8 seconds or longer. The number of gaps from the ten model runs was averaged for each location.
- **Vehicles Served** – the average number of vehicles that were allowed to turn onto CH 50 in ten model runs.

The result of the analysis show minor differences between all of the existing alternatives (Alternatives 1 through 5) for both the average number of gaps and vehicles served. As expected, the roundabout has the most influence at the 188th Street access, which is also the closest intersection to the roundabout. All intersections still have enough gaps to serve the demand of vehicles wanting to access CH 50 during the peak hours in all scenarios. Also, adding traffic signals at 192nd Street (Alternative 4) did not significantly change the number of gaps for Jaguar Avenue.

Table 6

Summary of Gap Analysis Results

		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
AM Peak Hour	Criteria	Existing	With Improved Signal at CH 60	With Roundabout at CH 60	With Roundabout at 60 & Signal at 192nd Street	4-Lane Roadway & Roundabout at CH 60	Future
188th Street	Vehicle Demand	45	45	45	45	45	55*
	Average Number of Gaps	83	86	73	85	118	53*
	Vehicles Served	174	181	140	199	262	102*
192nd Street	Vehicle Demand	140	140	140	140	140	300
	Average Number of Gaps	93	98	92	Signal	98	Signal
	Vehicles Served	225	242	199	NA	215	NA
Jaguar Avenue	Vehicle Demand	120	120	120	120	120	75*
	Average Number of Gaps	115	116	117	116	152	114*
	Vehicles Served	320	311	303	324	418	334*
PM PEAK HOUR							
188th Street	Vehicle Demand	20	20	20	20	20	25*
	Average Number of Gaps	59	70	44	50	72	36*
	Vehicles Served	147	161	78	99	134	63*
192nd Street	Vehicle Demand	110	110	110	110	110	215
	Average Number of Gaps	67	71	59	Signal	62	Signal
	Vehicles Served	162	173	107	NA	114	NA
Jaguar Avenue	Vehicle Demand	70	70	70	70	70	50*
	Average Number of Gaps	75	71	68	77	92	89*
	Vehicles Served	192	177	135	199	187	254*

*Intersection geometry was assumed ¾ Access in the future scenario

Some questions that were addressed during the public open houses include:

- **Why are the delays in the AM peak hour so different between 192nd and Jaguar when they have similar volumes?** 192nd Street is a 4-leg intersection while Jaguar Ave is a T-intersection. So when turning (especially when turning left) at 192nd Street from one of the side streets, the vehicles may have to not only wait for an appropriate gap, but yield to an opposing vehicle turning left or going straight. For example, there are 90 southbound vehicles turning left at 192nd Street in the peak hour, and vehicles turning left from the school driveway have to yield to these vehicles.

- **Why are the delays at Jaguar generally the same with and without a signal at 192nd when the gapping data shows differences?** There are two measures associated with gaps. First, how many are there. Second, how many vehicles can be served. While the number of gaps changes as well as the number of vehicles that can be served, the vehicles that can be served is well above the demand volume. The videos of the model runs illustrate that there is a difference in delay for some vehicles. However, some vehicles wait less, others have to wait more. So by the time these differences are averaged over 10 model runs, the intersections operate about the same for the two scenarios.

Based on the modeling, the roundabout at CH 60 should have little effect on the current number of gaps and the delays experienced at local roads throughout the corridor. The modeling also indicates that forecast increases in traffic along the CH 50 corridor will likely have a greater effect on accessing the highway than converting the CH 50/CH 60 intersection to a roundabout.

Intersection Delay Analysis

Roadway operations are estimated using a Level of Service (LOS) measure based on the amount of delay experienced by motorists. Delay is rated from A to F, with LOS A representing little to no delay and LOS F representing high levels of congestion with very long delays. Traffic volumes, intersection control (signalized or STOP sign controlled), and roadway geometry (number of turn or through lanes at each approach) were used to develop an average delay at each intersection within the VISSIM model. The results of the side street delay analysis is included in Table 7.

Table 7
Side Street Delay and Level of Service Summary

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
AM Peak Hour	Existing	With Improved Signal at CH 60	With Roundabout at CH 60	With Roundabout at 60 & Signal at 192nd Street	4-Lane Roadway & Roundabout at CH 60	Future
188th Street	LOS C (16 sec)	LOS C (15 sec)	LOS C (16 sec)	LOS C (17 sec)	LOS B (13 sec)	LOS B (10 sec)
192nd Street	LOS D (28 sec)	LOS C (24 sec)	LOS D (31 sec)	LOS C * (18 sec)	LOS C (18 sec)	LOS B * (21 sec)
Jaguar Avenue	LOS C (16 sec)	LOS B (15 sec)	LOS B (14 sec)	LOS C (16 sec)	LOS B (11 sec)	LOS A (7 sec)
PM Peak Hour						
188th Street	LOS D (29 sec)	LOS B (13 sec)	LOS C (22 sec)	LOS C (24 sec)	LOS C (17 sec)	LOS B (10 sec)
192nd Street	LOS D (29 sec)	LOS C (24 sec)	LOS D (28 sec)	LOS C * (20 sec)	LOS C (22 sec)	LOS B * (20 sec)
Jaguar Avenue	LOS C (25 sec)	LOS C (25 sec)	LOS C (22 sec)	LOS C (22 sec)	LOS B (15 sec)	LOS A (9 sec)

*Signalized intersection. Delay and Level of Service reported is for side-street approaches only. Delays for traffic along CH 50 are reported here.

The delay results illustrate that the only way to substantially reduce delay at all of the intersections along the corridor is to convert CH 50 to a 4-lane facility. It should be noted that adding a signal at 192nd Street (Alternative 4) does result in side-street delays very similar to improving CH 50 to a 4-lane facility (Alternative 5), but it results in additional impacts not listed in Table 7. These include:

1. Safety: Crash rates are generally higher at signalized intersections than at non-signalized intersections. The crash history for the corridor reported on Page 6 reflects this. In addition, adding a signal at the current 192nd Street intersection would involve additional risk factors for

crashes, including the horizontal and vertical curves on CH 50 that reduce sight lines to the intersection.

2. CH 50 Delays: Under Alternative 5, no signal is added at 192nd Street, so delay for CH 50 traffic is minimal. Under Alternative 4, where a signal is added at 192nd Street, average delays for CH 50 northbound and southbound approaches are summarized in Table 8 and Table 9. This would be a substantial impact to CH 50 that does not occur with Alternative 5.

Table 8

Average Delay and Level of Service Summary – **CSAH 50 NORTH & SOUTH APPROACHES**

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
AM Peak Hour	Existing	With Improved Signal at CH 60	With Roundabout at CH 60	With Roundabout at 60 & Signal at 192nd Street	4-Lane Roadway & Roundabout at CH 60	Future
192nd Street	LOS A (1 sec)			LOS B (11 sec)*		LOS B (13 sec)*
PM Peak Hour						
192nd Street	LOS A (1 sec)			LOS A (9 sec)*		LOS A (9 sec)*

*Signalized intersection.

Table 9

Average Delay and Level of Service Summary – **CSAH 50 LEFT TURNS ONLY**

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
AM Peak Hour	Existing	With Improved Signal at CH 60	With Roundabout at CH 60	With Roundabout at 60 & Signal at 192nd Street	4-Lane Roadway & Roundabout at CH 60	Future
192nd Street	LOS A (5 sec)			LOS C (26 sec)*		LOS C (35 sec)*
PM Peak Hour						
192nd Street	LOS A (4 sec)			LOS C (26 sec)*		LOS C (35 sec)*

*Signalized intersection.

Analysis Results

All the alternatives were summarized with the following evaluation criteria to compare the operations and driver experience between each alternative: (1) Average Corridor Speed, (2) Average Travel Time, (3) Safety Performance vs. Existing, and (4) Cost. These factors along with the gap and delay analyses summarized in the previous section provide an overall comparison of the alternatives.

Table 8 provides the summary of each alternative. For all existing scenarios (Alternatives 2 through 5), the average corridor speeds are higher than existing and varied between 41 mph and 45 mph. The

future alternative (Alternative 6) does have lower speeds, even with a 4-lane cross section, however it also has a large increase in traffic volumes and adds another signal at 190th Street that together increases congestion and slows speeds. The speeds directly correlate with the average travel times that decrease in the existing scenarios.

The safety performance is based on the change in traffic control and roadway geometry. The roundabout configuration has a lower crash rate than a signalized intersection, so an improvement in safety is expected with any alternative that replaces the signal with a roundabout. The conversion of the roadway to a four-lane divided roadway would also be considered a safety improvement since it provides the opportunity to minimize certain crash types (head-on crashes) and implement access restrictions (3/4 or right-in/out access).

The final evaluation criteria was the overall cost of construction of the alternatives ranging from $3.5 million for the construction of just the roundabout at CH 60, to a concept level estimate of $12 million for the conversion of CH 50 to a 4-lane divided roadway.

Table 10
Alternative Analysis Results

Performance Measures	Alternative 1 **EXISTING**	Alternative 2 **EXISTING** (improved signal at CH 60)	Alternative 3 **EXISTING** (roundabout at CH 60)	Alternative 4 **EXISTING** (roundabout at CH 60 & signal at 192nd)	Alternative 5 **EXISTING** (roundabout at CH 60 & four-lanes)	Alternative 6 **FUTURE**
Average Corridor Speed	41 mph (NB AM Peak) 35 mph (SB PM Peak)	43 mph (NB AM Peak) 40 mph (SB PM Peak)	44 mph (NB AM Peak) 41 mph (SB PM Peak)	42 mph (NB AM Peak) 40 mph (SB PM Peak)	45 mph (NB AM Peak) 43 mph (SB PM Peak)	37 mph (NB AM Peak) 32 mph (SB PM Peak)
Average Travel Time	4.0 min (NB AM Peak) 4.7 min (SB PM Peak)	3.8 min (NB AM Peak) 4.1 min (SB PM Peak)	3.7 min (NB AM Peak) 4.0 min (SB PM Peak)	3.9 min (NB AM Peak) 4.1 min (SB PM Peak)	3.6 min (NB AM Peak) 3.8 min (SB PM Peak)	4.4 min (NB AM Peak) 5.2 min (SB PM Peak)
Safety Performance vs. Existing	2012 Crash Rate = 1.4 crashes per million vehicle miles Lower than the expected rate of 2.5 crashes per million vehicle miles	Same safety performance as existing– no reduction in crashes expected	Reduction in severity of crashes with roundabout at CH 60	Reduction in severity of crashes with roundabout at CH 60 Increase in crashes expected with signal at 192nd Street	Reduction in severity of crashes with roundabout at CH 60 Reduction in head-on crashes with 4-lane roadway Reduction in right-angle crashes with reduced-access intersections	Reduction in severity of crashes with roundabout at CH 60 Reduction in head-on crashes with 4-lane roadway Reduction in right-angle crashes with reduced-access intersections
Cost	NA	$8.3 million*	$3.5 million*	Additional $250,000 for signal installation	$12 million (based on $4.5 million/mile reconstruction costs)	$12 million (based on $4.5 million/mile reconstruction costs)

Conclusions

The key objectives of this study included documenting the likely effects on access to the corridor associated with converting the signalized intersection of CH 50/60 to a roundabout and conducting a comprehensive review of access based on consistency with Dakota County guidelines and best safety practices.

- **Modeling Results** - Based on the modeling, the roundabout at CH 60 should have little effect on the current number of gaps and the delays experienced at local roads throughout the corridor.
    - Modeling indicates there will be a change in the nature of the gaps during the peak hours with a roundabout at CH 60, but the change in gaps does not affect the delays that will be experienced along the CH 50 corridor.
    - Modeling also indicates that forecast increases in traffic along the CH 50 corridor will likely have a greater effect on accessing the highway than converting the CH 50/CH 60 intersection to a roundabout.
    - Modeling also indicates that adding a traffic signal to intersections with major collectors (190th Street/Jordan Trail and 192nd Street) will not significantly improve the number of gaps on CH 50 from the minor street and the addition of traffic signals would adversely affect overall operations and safety along the corridor.
- **Corridor Safety** - Most of the reported crashes (66%) occurred at the intersection of CH 50/CH 60. Each of the unsignalized intersections between CH 60 and Ipava Avenue averaged about one reported crash per year.
- **Access** – The Future Access and Traffic Control Plan presented in Figure 6 should be used as a blue print for access along the corridor as new access is required to support future development, as improvements are made to CH 50, or as safety/operational issues are experienced. The Future Access and Traffic Control Plan includes the following elements:
    - 188th Street should be left as a side-street stop. If safety or operational issues are experienced in the future, conversion to a ¾ access intersection should be considered.
    - 190th Street/Jordan Trail should be left as a side-street stop. If safety or operational issues are experienced in the future, conversion to a signalized intersection should be considered due to 190th Street's future functionality as a City east-west collector street.
    - Both accesses of Kenwood Way should be converted to right-in/right-out intersections at the time CH 50 is improved to a divided roadway.
    - 192nd Street/North KTMS access should be left as a side-street stop. There are some delays currently experienced in the morning peak hour for traffic exiting the school, but they are short-lived, and the intersection has minimal reported crashes. Expanding CH 50 to 4-lanes is the most effective way to reduce delays at this intersection. If safety or operational issues arise in the future at the intersection, the implications of the horizontal and vertical curvature of CH 50 should be taken into account before installing a signal.
    - 194th Street should be converted to a right-in/right-out intersection at the time CH 50 is improved to a divided roadway.

- The south KTMS access should be left as a side-street stop. Although the Dakota County Access Spacing guidelines recommend 1320' between full-movement intersections along divided roadways, this is not a typical intersection. This is a "T" intersection serving only the school (with low volumes), and restricting movements here would require more traffic to use the north entrance when exiting KTMS. With the two accesses operating well today, there is no tangible benefit to making such a change. If safety or operational issues are experienced in the future, movement restrictions should be considered at that time.
- Jaguar Avenue should be left as a side-street stop. If safety or operational issues are experienced in the future, conversion to a ¾ access intersection should be considered together with an alternative connection from the neighborhood to Ipava Avenue.
- 198th Way should be constructed as a ¾ intersection with a future CH 50 improvement project.
- Ipava Avenue should continue as a signalized intersection.
- A potential new access to future developable area northeast of CH 50 should be considered between Ipava Avenue and Icenic Trail with a future CH 50 improvement project. Allowing for more efficient connection to existing parcels via this access should be provided if the access can be constructed safety and feasibly.
- Icenic Trail should be constructed as a ¾ intersection with a future CH 50 improvement project due to its close proximity to Dodd Road and its connectivity to Dodd Road north of CH 50.

- **Jaguar Avenue** – The intersection currently has more than one acceptable gap per minute during the peak hours suggesting adequate access to CH 50. Modeling indicates that a roundabout at CH 50/CH 60 would reduce the number of acceptable gaps by 10% in the PM peak hour, but there would still be more than one per minute during the peak traffic periods, so average delays are not significantly affected. However, for fire/life/safety concerns, an additional access to the neighborhood would also provide a connection to a signal controlled intersection for access to CH 50. The suggested location would be between Itasca Lane and 201st Street. A second approach lane for Jaguar Avenue will also help to reduce delays at the CH 50 intersection by allowing right turns to enter onto CH 50 without having to wait for left-turning vehicles.

Recommendations

The following are recommended next steps based on the analysis completed as part of this study:

- Planning and construction should continue for the roundabout at CH 60. The modeling did not suggest that there would be significant impact to operations along the CH 50 corridor due to the change from a signalized intersection to a roundabout. The modeling did indicate that the nature of the gaps during the peak hours would change, but it would not significantly affect the delay experienced by traffic entering CH 50 from the sidestreets.
- A follow-up Gap Analysis Study should be performed after construction of the roundabout to verify the results of the modeling.
- Dakota County and City of Lakeville should consider improving CH 50 to a four-lane roadway to reduce delays along the corridor and to address the challenges related to growth and development in the area. As the design moves forward, the potential right-of-way impacts and access control options should be examined in more detail.
- Jaguar Avenue's approach to CH 50 should be widened to provide separate left and right turn lanes.
- The Future Access and Traffic Control Plan developed as part of this project should be used to guide future decisions on the CH 50 corridor.