cityofnovi.org

CITY of NOVI CITY COUNCIL

Agenda Item G
November 8, 2010

SUBJECT: Approval of Traffic Control Orders 10-49, 10-50, and 10-51 to establish a permanent three-way stop control at the intersection of South Lake Drive, Old Novi Road, and 13 Mile Road as part of the intersection improvement project, which includes removal of the existing traffic signal.

SUBMITTING DEPARTMENT: Department of Public Services, Engineering Division

CITY MANAGER APPROVAL:

BACKGROUND INFORMATION:

The existing traffic signals at the intersection of South Lake Drive, Old Novi Road and 13 Mile Road are slated for removal as part of a project that includes:

- Removal of the existing but now unwarranted traffic signal (to be replaced with the three-way stop that is currently in place).
- Reconfiguration of the South Lake Drive approach to better accommodate large vehicles (e.g., school buses and fire trucks).
- Installation of a sidewalk to fill in a gap along the south side of 13 Mile between the intersection and Martin Ave.

The existing signals were placed in flash mode in late August 2010 as required by the Michigan Manual of Uniform Traffic Control Devices (MMUTCD) as one of the steps toward decommissioning a signal (see attached August 24, 2010 memo). At that time, stop signs were installed at all three legs of the intersection and a temporary traffic control order for the stop signs was signed by the traffic engineer. Staff is requesting approval of the permanent traffic control order at this time, as the temporary traffic control order is only valid for 90 days and will expire on November 24, 2010.

A public information meeting was held on October 27, 2010 and was attended by four people representing three properties (see attached October 28, 2010 memo). Staff received valuable feedback that will be used to finalize the design of the project. While there was opposition from the four people to the removal of the signal (based on the perception that it would lead to increased traffic on South Lake Drive), staff explained that the traffic signal is no longer warranted and is not intended or recognized as a method of traffic calming, and therefore should be removed. Feedback was also solicited in August when signs were posted (as required by MMUTCD) informing the public that the signal was under review. At that time we received 15 calls, of which 11 callers wanted the signal removed.

The final design of the project is in progress and will be posted on the project webpage (www.cityofnovi.org/southlake) when complete. Construction is anticipated to begin in spring 2011 with complete in summer 2011.

RECOMMENDED ACTION: Approval of Traffic Control Orders 10-49, 10-50, and 10-51 to establish a permanent three-way stop control at the intersection of South Lake Drive, Old Novi Road, and 13 Mile Road as part of the intersection improvement project, which includes removal of the existing traffic signal.

	1	2	Y	N
Mayor Landry				
Mayor Pro Tem Gatt				
Council Member Crawford				
Council Member Fischer				

	1	2	Y	N
Council Member Margolis				
Council Member Mutch				
Council Member Staudt				

CITY OF NOVI
TRAFFIC CONTROL ORDER

_____ SPEED
_____ PARKING
_X_ OTHER

DATE OF ORDER: August 26, 2010

CONTROL NUMBER: 10-49

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

SOUTH LAKE DRIVE

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE STOP SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

WESTBOUND SOUTH LAKE DRIVE TO STOP AT OLD NOVI RD/13 MILE ROAD

Brian Coburn, P.E. - Traffic Engineer

Dated: August 26, 2010

APPROVED BY CITY COUNCIL
TRAFFIC CONTROL ORDER NUMBER 10-49 HAVING BEEN PRESENTED TO THE COUNCIL OF THE CITY OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDERED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COPY THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

WESTBOUND SOUTH LAKE DRIVE TO STOP AT OLD NOVI RD/13 MILE ROAD

ADOPTED AT THE REGULAR MEETING OF CITY COUNCIL ON _____.

By: _____
David Landry, Mayor

By: _____
Maryanne Cornelius, Clerk

CITY OF NOVI
TRAFFIC CONTROL ORDER

_____ SPEED
_____ PARKING
_X_ OTHER

DATE OF ORDER: August 26, 2010

CONTROL NUMBER: 10-50

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

OLD NOVI ROAD

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE STOP SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

NORTHBOUND OLD NOVI ROAD TO STOP AT 13 MILE RD/SOUTH LAKE DRIVE

Brian Coburn, P.E. - Traffic Engineer

Dated: August 26, 2010

APPROVED BY CITY COUNCIL
TRAFFIC CONTROL ORDER NUMBER 10-50 HAVING BEEN PRESENTED TO THE COUNCIL OF THE CITY OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDERED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COPY THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

NORTHBOUND OLD NOVI ROAD TO STOP AT 13 MILE RD/SOUTH LAKE DRIVE

ADOPTED AT THE REGULAR MEETING OF CITY COUNCIL ON _____.

By: _____
David Landry, Mayor

By: _____
Maryanne Cornelius, Clerk

CITY OF NOVI
TRAFFIC CONTROL ORDER

_____ SPEED
_____ PARKING
_X_ OTHER

DATE OF ORDER: August 26, 2010

CONTROL NUMBER: 10-51

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

13 MILE ROAD

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE STOP SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

EASTBOUND 13 MILE TO STOP AT OLD NOVI ROAD/SOUTH LAKE DRIVE

Brian Coburn, P.E. - Traffic Engineer

Dated: August 26, 2010

APPROVED BY CITY COUNCIL
TRAFFIC CONTROL ORDER NUMBER 10-51 HAVING BEEN PRESENTED TO THE COUNCIL OF THE CITY OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDERED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COPY THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

EASTBOUND 13 MILE TO STOP AT OLD NOVI ROAD/SOUTH LAKE DRIVE

ADOPTED AT THE REGULAR MEETING OF CITY COUNCIL ON _____.

By: _____
David Landry, Mayor

By: _____
Maryanne Cornelius, Clerk

MEMORANDUM

cityofnovi.org

TO: ROB HAYES, P.E.; DIRECTOR OF PUBLIC SERVICES

FROM: BRIAN COBURN, P.E.; ENGINEERING MANAGER BC

SUBJECT: S LAKE/OLD NOVI/13 MILE INTERSECTION PUBLIC MEETING

DATE: OCTOBER 28, 2010

The Engineering Division hosted a Public Information Meeting last evening for the proposed improvements at the intersection of South Lake Drive, Old Novi Road and 13 Mile Road. The scope of the project includes:

- Removal of the existing but now unwarranted traffic signal (to be replaced with the three-way stop that is currently in place).
- Reconfiguration of the South Lake Drive approach to better accommodate large vehicles (e.g., school buses and fire trucks).
- Installation of a sidewalk to fill in a gap along the south side of 13 Mile between the intersection and Martin Ave.

Postcard invitations were mailed to 350 homes in the vicinity of the project. The meeting was attended by four people representing three properties. The chief concern is the perception that changes to the intersection would make it easier for traffic to use South Lake Drive leading to an increase in traffic. There is fear that the removal of the traffic island at the intersection would make it feel less residential and lead to increased traffic. There was also fear that the installed stop signs would decrease the delay vehicles currently experience with the unwarranted traffic signal and would lead to increased traffic. Concern was expressed for pedestrian travel across the intersection under stop control and for the lack of compliance with the new stop signs. There no were major concerns about the proposed sidewalk or the repaving of the intersection.

Staff explained that while there some minor traffic calming measures installed with the reconstruction of South Lake Drive in 2003, such as the median islands and narrower lanes, the reduction in traffic was most likely caused by the realignment of Novi Road, the construction of West Park Drive and the opening of an on ramp to eastbound I-96 at Beck Road. These improvements have helped to decrease the traffic on South Lake Drive from 7,400 vehicles per day in 1986 to 2,600 vehicles per day now. Further, we explained that the traffic signal is no longer warranted, is not intended or recognized as a method of traffic calming, and should be removed. The all way stop control that is proposed for the intersection will provide better protection for pedestrians since all directions are required to stop (as opposed to the open green phase under a traffic signal). We will work with the Police Department to increase enforcement of the stop signs.

Based on the comments received at the meeting, we intend to continue with final design of the project, but will leave the median island in place on South Lake Drive while widening the approach to South Lake Drive to accommodate fire trucks and busses. Additionally, we will review the feasibility of adding some trees near the intersection to promote traffic calming. We will continue to include the removal of the signal, rehabilitation of the pavement, and construction of the sidewalk gap as originally proposed. Once the final design is complete,

we will post on the project webpage www.cityofnovi.org/southlake to share with these interested residents.

The traffic signal is currently flashing red in all directions and temporary stop signs have been installed to establish a three-way stop at the intersection under a temporary traffic control order. A permanent control order will be presented for consideration on a future City Council agenda. Construction is anticipated to begin in spring 2011 with completion in summer 2011.

MEMORANDUM

8/25/10
To: Mayor & City Council Members
FYI

TO: ROB HAYES, P.E.; DIRECTOR OF PUBLIC SERVICES
FROM: BRIAN COBURN, P.E.; SENIOR CIVIL ENGINEER BC
SUBJECT: SOUTH LAKE DRIVE/OLD NOVI/ 13 MILE SIGNAL
DATE: AUGUST 24, 2010

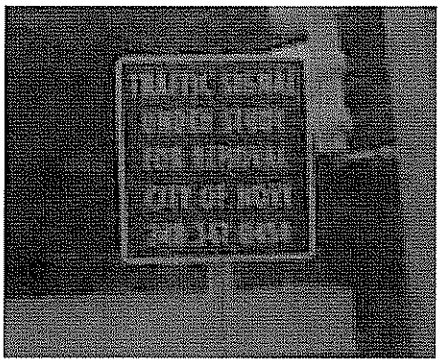
cityofnovi.org

The decommissioning of the existing traffic signal at the intersection of South Lake Drive, Old Novi Road, and 13 Mile Road is part of the project to improve this intersection. The existing traffic signal at the intersection was installed in 1986 at a time when traffic counts on South Lake Drive were as high as 7,400 vehicles per day. The City has constructed two new roads in the northern part of the City since that time that have diverted traffic away from this intersection, including the "new" Novi Road alignment between 12-1/2 Mile Road and 13 Mile in the late 1990s and the construction of West Park Drive in early 2000s. The traffic volumes on South Lake Drive have since decreased to 2,600 vehicles per day.

A traffic study was completed for this intersection in 2009 by the City's traffic consultant, Birchler Arroyo. The study (attached) found the existing traffic signal to be unwarranted based on existing and future anticipated traffic volumes, as well as other traffic design parameters. The study recommended that the intersection be improved to increase the level of service (an indicator of the time delay to proceed through the intersection), and to allow for improved turning movements through the intersection. Based on this study, improvements proposed to this intersection include the removal of the existing unwarranted traffic signal, replacing the signal with all-way stop sign control, partial reconstruction of the South Lake Drive approach to better accommodate large vehicles (e.g. school buses and fire trucks), and other minor improvements that may be required following further study of the intersection during preliminary design.

The operation of a traffic signal is governed by the Michigan Manual of Uniform Traffic Devices (MMUTCD). The MMUTCD requires the following steps be followed before a signal can be removed:

A. Determine the appropriate traffic control to be used after removal of the signal.
B. Remove any sight-distance restrictions as necessary.
C. Inform the public of the removal study, for example by installing an informational sign (or signs) with the legend TRAFFIC SIGNAL UNDER STUDY FOR REMOVAL at the signalized location in a position where it is visible to all road users.
D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.
E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed. Instead of total removal of the traffic control signal, the poles and cables may remain in place after removal of the signal heads for continued analysis.



Items A and B were addressed in the Birchler Arroyo study, which identified that an all way stop control would be appropriate traffic control for the intersection if the signal were removed. The sight distance at the intersection is appropriate for an all-way stop. To meet Item C, staff installed appropriate signs (see photo left) at all three legs of the intersection in late July. In the past month, we have received 15 calls from motorists of which 11 callers wanted the signal removed and only four wanted the signal to remain. Most of the callers that were against removal were concerned about pedestrian use of the intersection. A few, when informed of the proposed all way stop at the intersection, acknowledged that it would facilitate the pedestrians.

The next step toward removal of the signal is to place the signal in flash mode for 90 days per Item D. The signal will begin to flash red in all directions on August 26, 2010 for a period of 90 days. Stop signs will be installed to supplement the flashing signals under a temporary traffic control order that will expire at the end of November 2010. The improvements to this intersection will be coordinated with planned improvements to the City's Landings Property and the general alignment of the intersection will remain unchanged. As with other construction projects of this nature, a public information meeting will be held to solicit public input as part of the design development process, especially from neighboring homeowners associations and businesses. We anticipate that by the time a permanent traffic control order is presented to City Council for consideration in early November that a design incorporating public input would be near completion.

The final step in the signal removal process would occur with the construction project. Once the design is finalized this fall, the project would be bid for spring 2011 construction.

CHAPTER 4B. TRAFFIC CONTROL SIGNALS—GENERAL

Section 4B.01 General

Standard:

A traffic control signal (traffic signal) shall be defined as any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed.

Traffic shall be defined as pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using any highway for purposes of travel.

Support:

Words such as pedestrians and bicyclists are used redundantly in selected sections of Part 4 to encourage sensitivity to these elements of "traffic."

Standards for traffic control signals are important because traffic control signals need to attract the attention of a variety of road users, including those who are older, those with impaired vision, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location.

Section 4B.02 Basis of Installation or Removal of Traffic Control Signals

Guidance:

The selection and use of traffic control signals should be based on an engineering study of roadway, traffic, and other conditions.

Support:

A careful analysis of traffic operations, pedestrian and bicyclist needs, and other factors at a large number of signalized and unsignalized locations, coupled with engineering judgment, has provided a series of signal warrants, described in Chapter 4C, that define the minimum conditions under which installing traffic control signals might be justified.

Guidance:

Engineering judgment should be applied in the review of operating traffic control signals to determine whether the type of installation and the timing program meet the current requirements of all forms of traffic.

If changes in traffic patterns eliminate the need for a traffic control signal, consideration should be given to removing it and replacing it with appropriate alternative traffic control devices, if any are needed.

Option:

If the engineering study indicates that the traffic control signal is no longer justified, removal may be accomplished using the following steps:

A. Determine the appropriate traffic control to be used after removal of the signal.
B. Remove any sight-distance restrictions as necessary.
C. Inform the public of the removal study, for example by installing an informational sign (or signs) with the legend TRAFFIC SIGNAL UNDER STUDY FOR REMOVAL at the signalized location in a position where it is visible to all road users.
D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.
E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed. Instead of total removal of the traffic control signal, the poles and cables may remain in place after removal of the signal heads for continued analysis.

Section 4B.03 Advantages and Disadvantages of Traffic Control Signals

Support:

When properly used, traffic control signals are valuable devices for the control of vehicular and pedestrian traffic. They assign the right-of-way to the various traffic movements and thereby profoundly influence traffic flow.

Traffic control signals that are properly designed, located, operated, and maintained will have one or more of the following advantages:

A. They provide for the orderly movement of traffic.
B. They increase the traffic-handling capacity of the intersection if:
   1. Proper physical layouts and control measures are used, and
   2. The signal operational parameters are reviewed and updated (if needed) on a regular basis (as engineering judgment determines that significant traffic flow and/or land use changes have occurred)

January 9, 2009

Brian T. Coburn, P.E.
Engineering Department
City of Novi
45175 W. Ten Mile Road
Novi, MI 48375
bcoburn@cityofnovi.org

BIRCHLER ARROYO ASSOCIATES, INC.

Subject: Traffic Study Report for Intersection of Old Novi, 13 Mile, and South Lake

Dear Mr. Coburn:

We have completed our study of the above intersection (see Figures 1-2, below), conducted per our City-approved proposal of December 2, 2008. This report summarizes our recommendations, data collection, analytical findings, and field observations.

Recommendations

1. The existing unwarranted traffic signal should either be removed or operated in flashing mode (red in all three directions) at all times. The cycling operation of the signal should replaced by all-way STOP signs, and the stop bar on the northeast-bound Old Novi Road approach moved somewhat closer to the intersection (by an amount to be determined under #3, below).

2. South Lake Drive near Old Novi / 13 Mile should be redesigned and partially reconstructed to better accommodate large vehicles having a legitimate need to turn onto South Lake Dr. from both the east and south (e.g., school buses). This might involve flaring out the northern curb and removing the off-tracking apron, and/or tapering the south end of the boulevard island.

3. To properly design for larger vehicles, a survey should be done of the road edges and existing lane striping within 150 ft of the intersection in all directions. We would then be in a better position to sketch our recommended design changes. (The 2003 reconstruction plan for South Lake Drive, prepared by others, shows only the South Lake Drive leg of the intersection.)

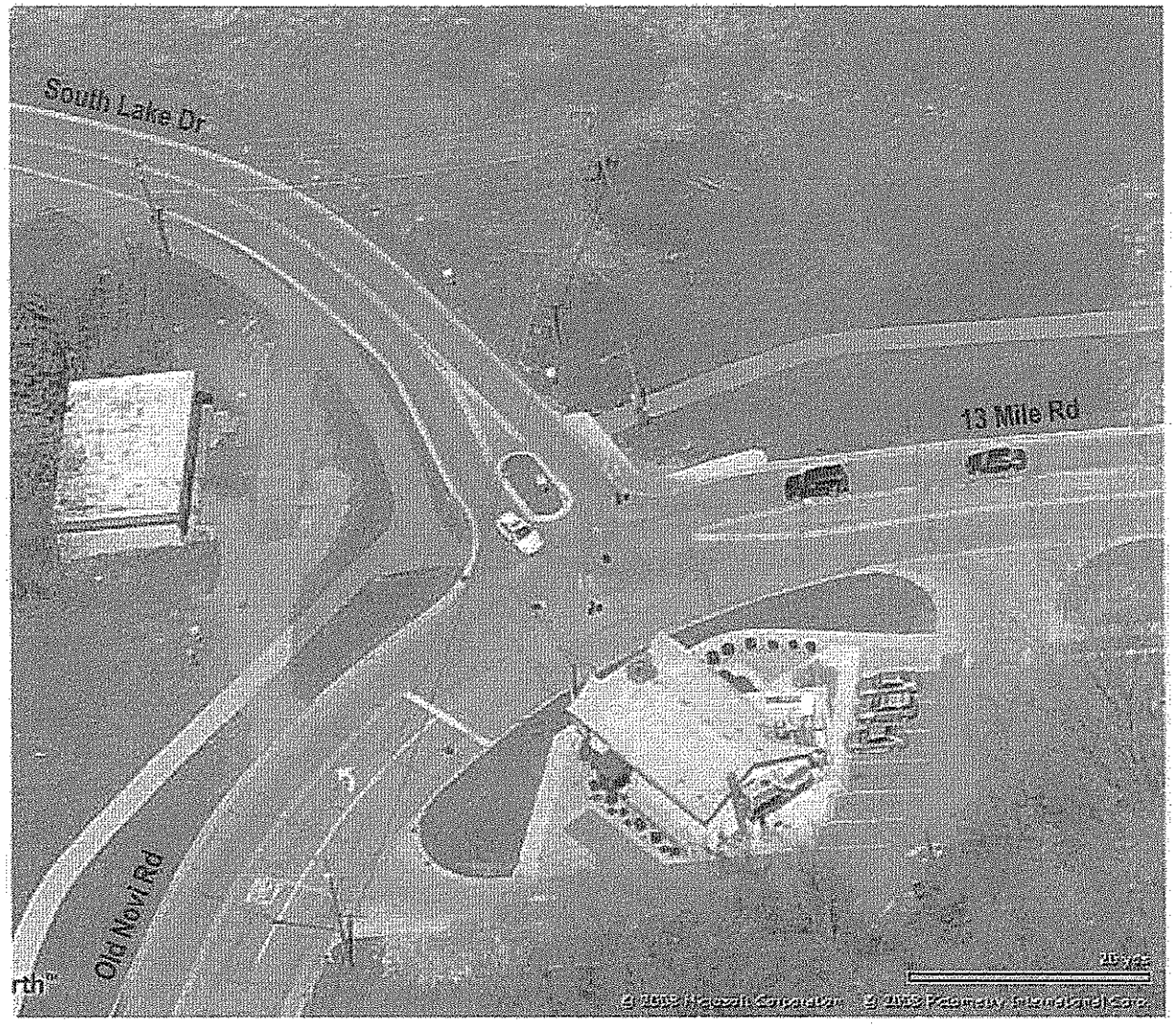
Data Collection

Both traffic volume and crash data were obtained. Volume data include the results of manual counts done by Birchler Arroyo Associates during the 7:00-9:00 a.m. and 4:00-6:00 p.m. peak periods on Wednesday, December 10, 2008 (detailed in Appendix A). Also, to check on recent traffic volume trends, hourly two-way counts for Old Novi Road were retrieved from the SEMCOG data base (see appendix Figure A-1).

Crash data were provided by the Traffic Improvement Association (TIA) for the latest available three calendar years, 2005-2007. These detailed data appear in Appendix B, along with our summary of the 19 reported crashes (Table B-1).

BIRCHLER ARROYO ASSOCIATES, INC.

Figure 1. Vertical Aerial



BIRCHLER ARROYO ASSOCIATES, INC.

Figure 2. Birdseye Aerial

Current and Future Peak-Hour Traffic Volumes

Figure 3 shows the intersection's current movement volumes during the AM and PM peak hours, which were found to be 7:30-8:30 a.m. and 4:45-5:45 p.m. These counts yield two-way volumes on Old Novi Road just south of the intersection of 105 vehicles and 217 vehicles, respectively.

Table 1 compares, for selected hours, the current two-way volumes on Old Novi Road to the May 2004 volumes reported by SEMCOG. Note that *the volumes observed in 2004 have decreased some 20-25%.* This may reflect a reduction in cut-through traffic using Old Novi Road leaving and returning to South Lake Drive, likely due to such factors as the completion of the full-service I-96 / Beck Road interchange as well as the traffic-calming reconstruction of South Lake Drive.

Table 1. Two-Way Volumes on Old Novi Road

Hour Starting	Dec 08	May 04[2]	Dec 08 : May 04
7:00 am	99	147	0.67
7:30 am[1]	105	-	0.75 (avg.)
8:00 am	96	115	0.83
4:00 pm	182	227	0.80
4:45 pm[1]	217	-	0.80 (avg.)
5:00 pm	221	278	0.79

[1] Peak hour in Dec 08
[2] From SEMCOG website

With respect to the design year of 2028, we believe that it is reasonable to assume that a modest rate of positive traffic growth will replace the recent decline noted above. For this study, we are assuming an average annual growth of 1%. Compounded annually over 20 years, this means that 2028 volumes could exceed current volumes by 22%. Figure 4 reflects such an adjustment.

Traffic Signal Warrants

Of the eight signal installation warrants appearing in the 2005 *Michigan Manual of Uniform Traffic Control Devices*, the one we have generally found to be most easily met is the peak-hour volume warrant, officially Part B of "Warrant 3, Peak Hour" (excerpted in Appendix C). Warrant 3 has two parts, with Part B dealing only with peak-hour volumes and Part A dealing with both cumulative peak-hour delay and the associated volumes. Only one of the two parts of Warrant 3 must be met for the warrant to be met, and only one warrant of the total of eight must be met to permit (but not require) a cycling signal.

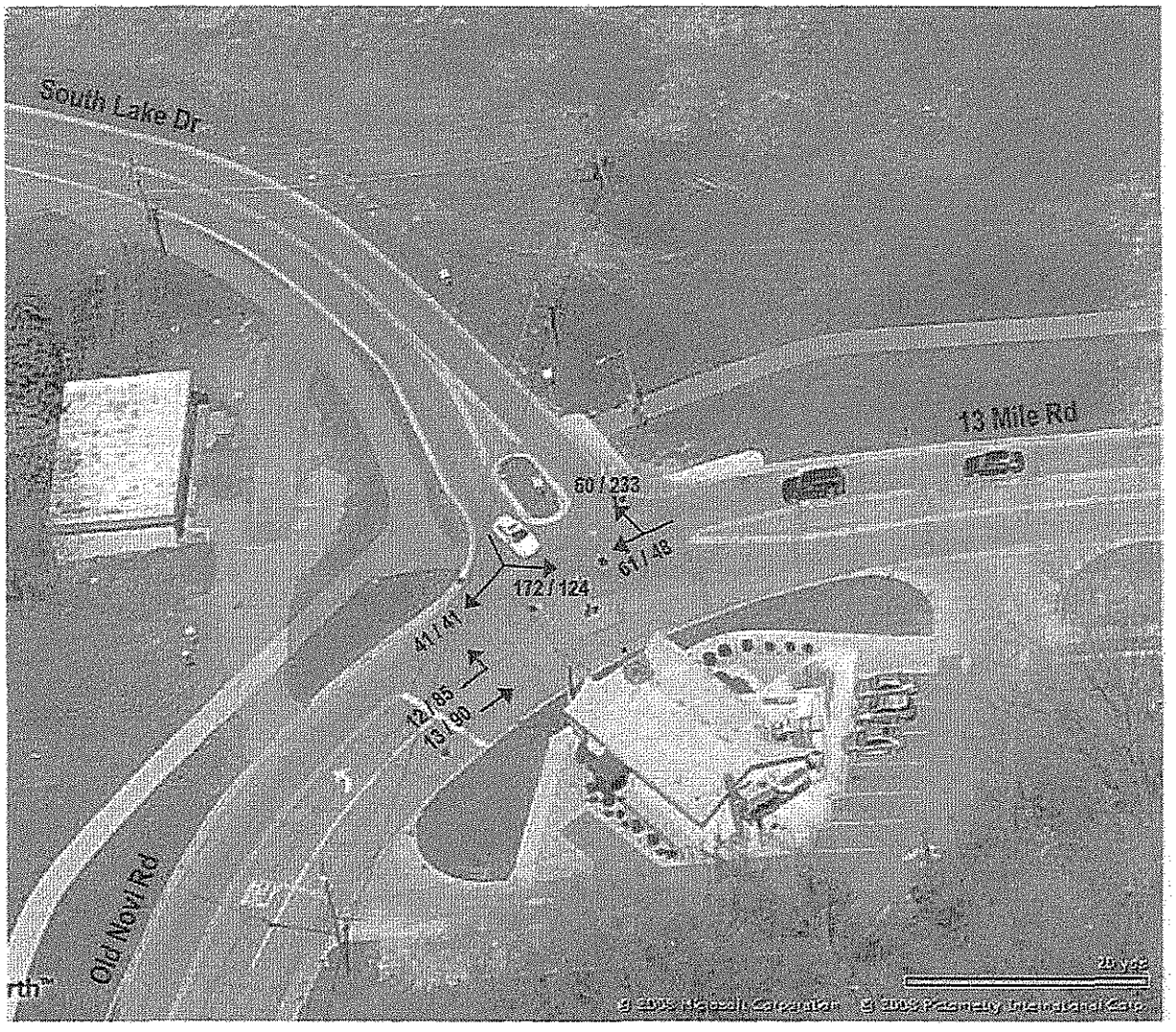
Figure 3 indicates that the highest two-way peak-hour volume on the "major" road at this intersection is now 374 vehicles in the PM peak hour (total of the NEB and SWB approaches). *Since the applicable warrant chart in Appendix C begins at 400 vehicles, the signal is clearly unwarranted.*

BIRCHLER ARROYO ASSOCIATES, INC.

Legend

X / Y, where:
X = 7:30-8:30 AM
Y = 4:45-5:45 PM

Figure 3. Current Peak-Hour Traffic Volumes



SINCLAIR ARROYO ASSOCIATES, INC.

Legend

X / Y, where:
X = 7:30-8:30 AM
Y = 4:45-5:45 PM

[1] Current (Dec 08) volumes increased 1% / year, compounded annually (or multiplied by a factor of 1.22).

Figure 4. Forecasted 2028 Peak-Hour Volumes[1]

Current and Future Levels of Service

Synchro 7 capacity analysis software was used to predict average vehicular delays, associated levels of service, and queue lengths. As briefly explained at the beginning of Appendix D, the level of service (LOS) for a traffic movement, approach, or intersection is a letter grade between A and F, assigned by the analysis software based on the average delay per vehicle predicted in a computer simulation. An overall level of service of D or better is typically sought in an urban or suburban area.

Table 2 summarizes the LOS results obtained from our analysis of the intersection. The first block of the table presents the current operation, which overall is LOS C in the AM peak hour and LOS D in the PM peak hour. While these levels are normally considered acceptable, the D in the PM is largely due to LOS F for northeast-bound left turns onto South Lake Drive, which must yield to the higher volume of southwest-bound right turns from 13 Mile (there is no left-turn signal phase).

Table 2. Levels of Service at Old Novi / 13 Mile / South Lake: Existing Signal v. Alternative All-Way Stop Control[1]

Approach[2]	Movement[3]	AM Peak Hour			PM Peak Hour		
		Volume (veh)	Avg. Delay (sec/veh)	LOS	Volume (veh)	Avg. Delay (sec/veh)	LOS
Current (2008) Traffic – With Signal							
Overall Intersection		295	26.4	C	510	38.6	D
SEB	L + R	175	26.3	C	136	35.8	D
NEB	L	10	30.7	C	70	106.1	F
	T	11	25.0	C	74	24.3	C
SWB	T + R	99	26.4	C	230	25.4	C
Current (2008) Traffic – With All-Way Stop in Lieu of Signal							
Overall Intersection		295	8.6	A	510	8.7	A
SEB*	L + R	175	9.1	A	136	9.3	A
NEB*	L	10	7.2	A	70	7.7	A
	T	11	6.1	A	74	6.9	A
SWB*	T + R	99	8.0	A	230	9.1	A
Future (2028) Traffic – With All-Way Stop							
Overall Intersection		359	9.1	A	621	9.5	A
EB*	L + R	213	9.8	A	165	10.2	B
NEB*	L	12	7.3	A	85	8.2	A
	T	13	6.2	A	90	7.3	A
SWB*	T + R	121	8.3	A	281	10.2	B

[1] Level of service (LOS) based on average delay per vehicle, the latter computed with *Synchro 7.0* software based on the *Highway Capacity Manual*, Special Report 209, Transportation Research Board, 2000. See Appendix D for details.

[2] SEB = southeast-bound (S. Lake), NEB = northeast-bound (Old Novi), and SWB = southwest-bound (13 Mile). * denotes STOP sign control.

[3] L = left turn, T = through movement, and R = right turn.

The second block of Table 2 shows that *the replacement of the existing cycling traffic signal by all-way* STOP *sign control would improve current peak-hour LOS rather dramatically, to an A in both peak hours.* The third block of the table shows that all-way stop control would continue to provide LOS A under the traffic volumes projected to year 2028.

Recent Crash History

As indicated in appendix Table C-1, the annual intersection crash frequency in 2005, 2006, and 2007 was 11, 7, and 1, respectively. While crash frequencies typically vary significantly from year to year at lower-volume intersections such as this one, the downward trend in this case is rather remarkable. Clearly, decreasing traffic volumes would be one contributing factor, but it remains unclear what other factors may be at play.

The average annual crash frequency in 2005-2007 was 6.33 crashes per year. Assuming that the total PM peak-hour traffic volume now entering the intersection is 10.2% of the daily volume as it was in 2004 (per Figure A-1), the average daily volume now entering the intersection is 5,000 vehicles. Further assuming that the current entering volume is the best available estimate of the average entering volume in 2005-2007, the resulting average crash rate in those years was 3.5 crashes per million vehicles. Applying procedures and test values found in the 2nd edition of the *SEMCOG Traffic Safety Manual, we find that this is not a "high-crash" intersection* (the average observed crash rate of 3.5 was less than the critical crash rate for this type of intersection of 4.0).

Furthermore, we are of the opinion that neither our crash summary (Table C-1) nor the TIA summary tables (also in Appendix C) show any significant crash patterns that may indicate the need for a particular form of safety mitigation. There was only one crash resulting in incapacitating injury (level A), and it involved a single vehicle operated after dark by an alcohol-affected driver. In addition, there were only three other crashes involving "possible" injury (level C).

Field Observations

Under the current two-phase signal operation, all left turns from northeast-bound Old Novi Road must yield to traffic on southwest-bound 13 Mile Road. This means that 70 left turns in the PM peak hour must yield to 230 oncoming vehicles on 13 Mile, most of the latter (83%) turning right. As shown above, Synchro predicts that this results in relatively long delays for the left turns.

Observations by our traffic count supervisor suggest that the desire of those left-turn drivers to minimize their delays sometimes results in left turns starting before oncoming traffic fully clears the intersection, apparently reflecting the assumption that oncoming traffic will invariably turn right. Cases were noted where southwest-bound through drivers used their left-turn signals, either due to the curve (Figures 5-6) or to show that they were *not* turning right.

Figures 7 and 8 confirm that larger vehicles turning right into South Lake Drive are unable to do so without encroaching on areas behind the curb-and-gutter. An off-tracking apron, not shown in the original reconstruction plan, was later added to accommodate these turns (also note the gray traffic

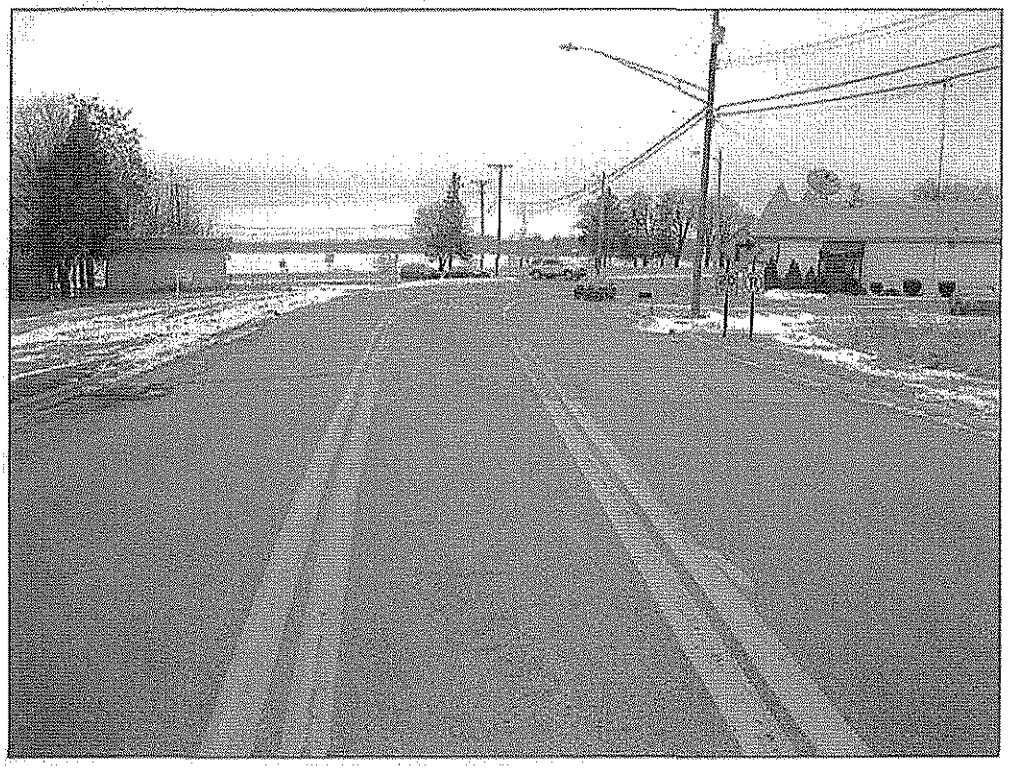


Figure 5. Northeast-bound Old Novi Road

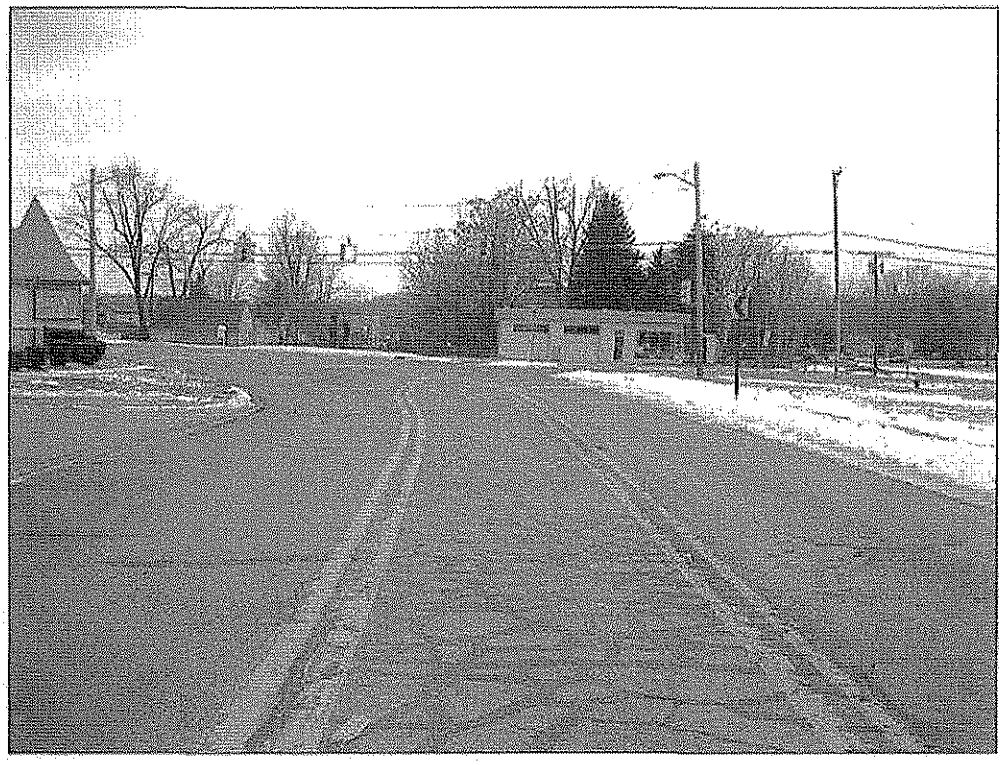


Figure 6. Southwest-bound 13 Mile Road

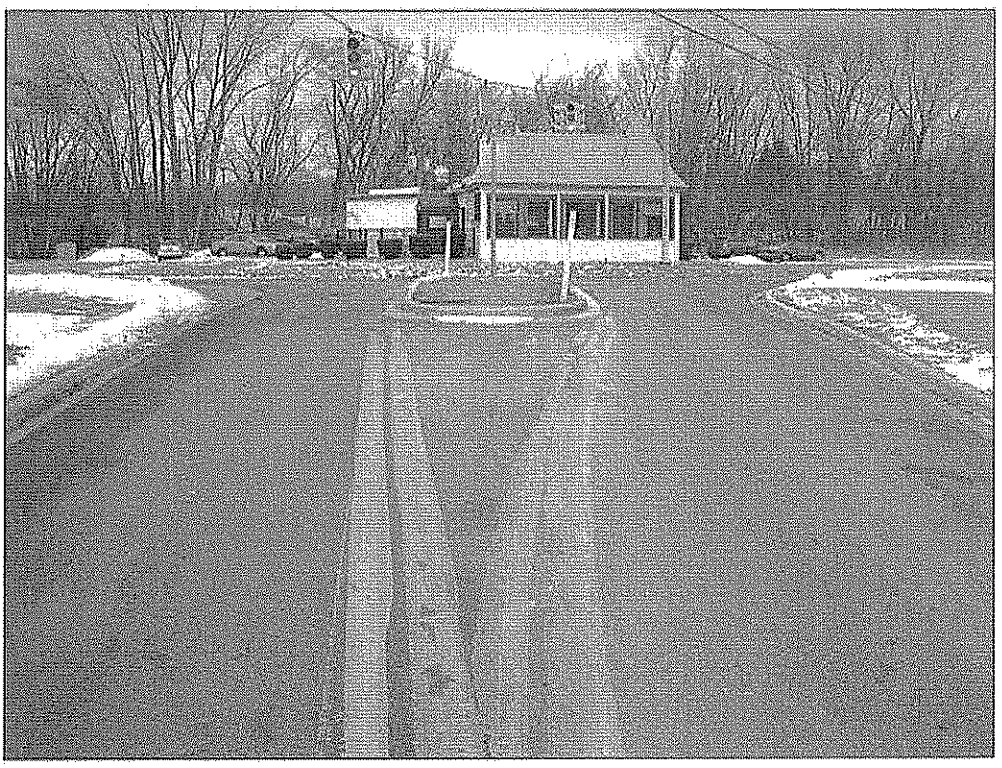


Figure 7. Southeast-bound South Lake Drive

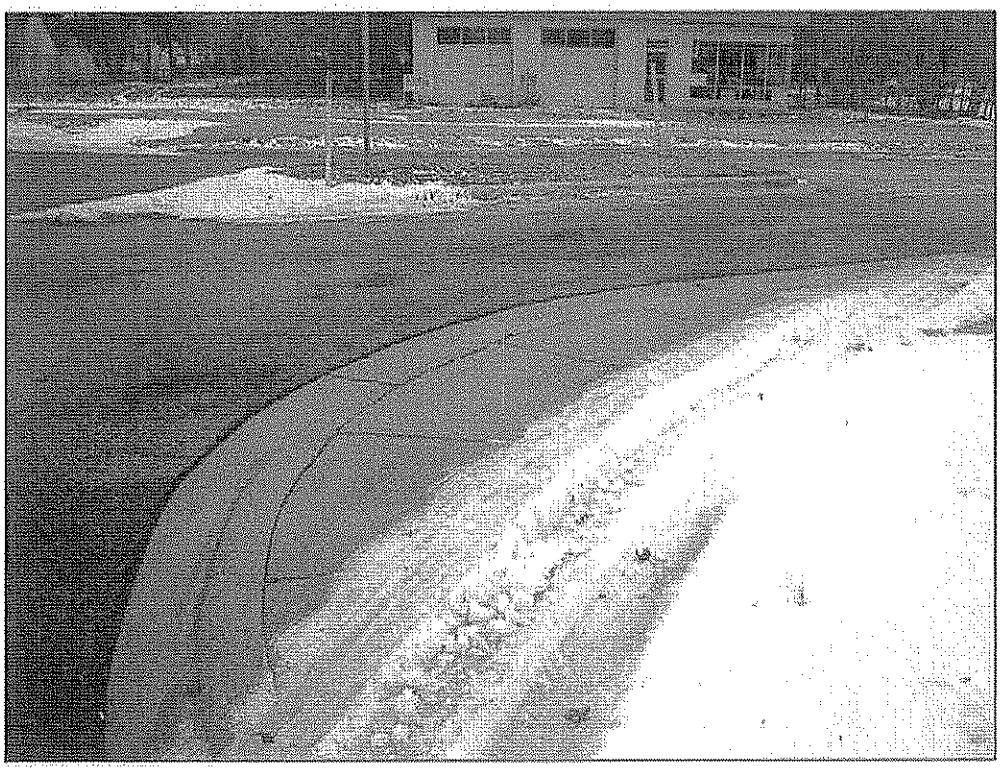


Figure 8. Off-Tracking Apron at Entrance to South Lake Drive

wear on, and even north of, the apron shown in Figure 2). Even with the apron, we noted numerous marks and gouges in the north curb of the island (look closely at Figure 8).

We suspect that larger vehicles turning left onto South Lake Drive also have to use the apron and/or "swing wide" and encroach on the northeast-bound lane as they begin their turn. *Our preliminary use of design-vehicle turning templates on an approximately scaled aerial photo indicates likely problems for larger vehicles entering South Lake from both the east and south.*

Conclusions

From the above, it is clear that a cycling traffic signal at this location is no longer warranted. Since the reduced traffic volumes do not warrant a signal, we also believe that they do not warrant a large capital investment (such as the possible installation of a roundabout). The intersection should be controlled by all-way STOP signs. At the City's option, the existing signal hardware could be retained indefinitely, with the signals placed in full-time flashing-red mode as a way of alerting drivers to the stop requirement.

It also appears to appropriate to refine the intersection's design to better accommodate legitimate design vehicles (e.g., school buses). In the next construction season, we believe that the City should strive to widen the entering throat of South Lake Drive, by flaring the north curb and/or tapering the end of the boulevard island. Accompanied by all-way STOP signs, the wider entering throat for South Lake should not increase the road's appeal as a potential cut-through route.

Please let us know if you have any questions or comments regarding this report. As indicated in Recommendation #3 (above), we would be glad to further assist you with the preparation of a conceptual redesign of the South Lake Drive side of the intersection.

Sincerely,
BIRCHLER ARROYO ASSOCIATES, INC.

Rodney L. Arroyo, AICP
Vice President

William A. Stimpson, P.E.
Director of Traffic Engineering

APPENDIX A:

TRAFFIC COUNTS

TRAFFIC STUDY OF OLD NOVI RD / 13 MILE RD / SOUTH LAKE DR
AM Turning-Movement Count - All Traffic
Wednesday, December 10, 2008

Cumulative Turning-Movement Counts

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:15	26	10	4	9	1	2	52
7:30	45	23	11	13	2	9	103
7:45	83	34	24	25	4	12	182
8:00	126	45	35	40	5	14	265
8:15	162	53	46	52	7	18	338
8:30	186	57	61	62	12	20	398
8:45	215	63	74	69	16	22	459
9:00	248	68	85	83	16	26	526

Turning-Movement Counts by 15-Minute Interval

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:15	26	10	4	9	1	2	52
7:30	19	13	7	4	1	7	51
7:45	38	11	13	12	2	3	79
8:00	43	11	11	15	1	2	83
8:15	36	8	11	12	2	4	73
8:30	24	4	15	10	5	2	60
8:45	29	6	13	7	4	2	61
9:00	33	5	11	14	0	4	67
TOTAL	248	68	85	83	16	26	526

Hourly Total

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:00	126	45	35	40	5	14	265
7:15	136	43	42	43	6	16	286
7:30	141	34	50	49	10	11	295
7:45	132	29	50	44	12	10	277
8:00	122	23	50	43	11	12	261

AM Peak Hour

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:30	**141**	**34**	**50**	**49**	**10**	**11**	**295**
PHF (Peak-Hour Factor)	0.82	0.77	0.83	0.82	0.50	0.69	0.89
	0.81		0.95		0.75		
Percent Large Vehicles	2.1%	0.0%	6.0%	6.1%	20.0%	0.0%	3.7%

TRAFFIC STUDY OF OLD NOVI RD / 13 MILE RD / SOUTH LAKE DR
PM Turning-Movement Count - All Traffic
Wednesday, December 10, 2008

Cumulative Turning-Movement Counts

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:15	11	2	9	34	17	11	84
4:30	32	9	24	66	40	30	201
4:45	47	13	31	93	49	42	275
5:00	83	17	42	141	66	57	406
5:15	109	28	48	201	85	77	548
5:30	127	39	59	235	102	97	659
5:45	149	47	70	284	119	116	785
6:00	158	53	82	322	140	128	883

Turning-Movement Counts by 15-Minute Interval

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:15	11	2	9	34	17	11	84
4:30	21	7	15	32	23	19	117
4:45	15	4	7	27	9	12	74
5:00	36	4	11	48	17	15	131
5:15	26	11	6	60	19	20	142
5:30	18	11	11	34	17	20	111
5:45	22	8	11	49	17	19	126
6:00	9	6	12	38	21	12	98
TOTAL	158	53	82	322	140	128	883

Hourly Total

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:00	83	17	42	141	66	57	406
4:15	98	26	39	167	68	66	464
4:30	95	30	35	169	62	67	458
4:45	102	34	39	191	70	74	510
5:00	75	36	40	181	74	71	477

PM Peak Hour

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:45	**102**	**34**	**39**	**191**	**70**	**74**	**510**
PHF (Peak-Hour Factor)	0.71	0.77	0.89	0.80	0.92	0.93	0.90
	0.85		0.87		0.92		
Percent Large Vehicles	0.0%	0.0%	0.0%	0.5%	0.0%	1.4%	0.4%

TRAFFIC STUDY OF OLD NOVI RD / 13 MILE RD / SOUTH LAKE DR
AM Turning-Movement Count - Large Vehicles Only
Wednesday, December 10, 2008

Cumulative Turning-Movement Counts

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:15	0	0	0	0	0	0	0
7:30	1	0	0	0	0	0	1
7:45	3	0	1	0	0	0	4
8:00	3	0	2	3	0	0	8
8:15	4	0	3	3	1	0	11
8:30	4	0	3	3	2	0	12
8:45	5	1	3	4	3	0	16
9:00	7	1	4	7	3	2	24

Turning-Movement Counts by 15-Minute Interval

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:15	0	0	0	0	0	0	0
7:30	1	0	0	0	0	0	1
7:45	2	0	1	0	0	0	3
8:00	0	0	1	3	0	0	4
8:15	1	0	1	0	1	0	3
8:30	0	0	0	0	1	0	1
8:45	1	1	0	1	1	0	4
9:00	2	0	1	3	0	2	8
TOTAL	7	1	4	7	3	2	24

Hourly Total

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
7:00	3	0	2	3	0	0	8
7:15	4	0	3	3	1	0	11
7:30*	3	0	3	3	2	0	11
7:45	2	1	2	4	3	0	12
8:00	4	1	2	4	3	2	16

* Peak hour for overall traffic:
3 school buses SEB LT, 3 school buses SWB RT, & 2 SU trucks NEB LT.

AM Peak Hour

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
8:00	**4**	**1**	**2**	**4**	**3**	**2**	**16**
PHF (Peak-Hour Factor)	0.50	0.25	0.50	0.33	0.75	0.25	0.50
	0.63		0.38		0.63		

TRAFFIC STUDY OF OLD NOVI RD / 13 MILE RD / SOUTH LAKE DR
PM Turning-Movement Count - Large Vehicles Only
Wednesday, December 10, 2008

Cumulative Turning-Movement Counts

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:15	0	0	0	3	0	0	3
4:30	1	0	0	3	1	0	5
4:45	1	0	0	4	1	0	6
5:00	1	0	0	4	1	0	6
5:15	1	0	0	4	1	0	6
5:30	1	0	0	5	1	1	8
5:45	1	0	0	5	1	1	8
6:00	1	0	0	5	1	1	8

Turning-Movement Counts by 15-Minute Interval

15 MINUTES ENDING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:15	0	0	0	3	0	0	3
4:30	1	0	0	0	1	0	2
4:45	0	0	0	1	0	0	1
5:00	0	0	0	0	0	0	0
5:15	0	0	0	0	0	0	0
5:30	0	0	0	1	0	1	2
5:45	0	0	0	0	0	0	0
6:00	0	0	0	0	0	0	0
TOTAL	1	0	0	5	1	1	8

Hourly Total

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:00	1	0	0	4	1	0	6
4:15	1	0	0	1	1	0	3
4:30	0	0	0	2	0	1	3
4:45*	0	0	0	1	0	1	2
5:00	0	0	0	1	0	1	2

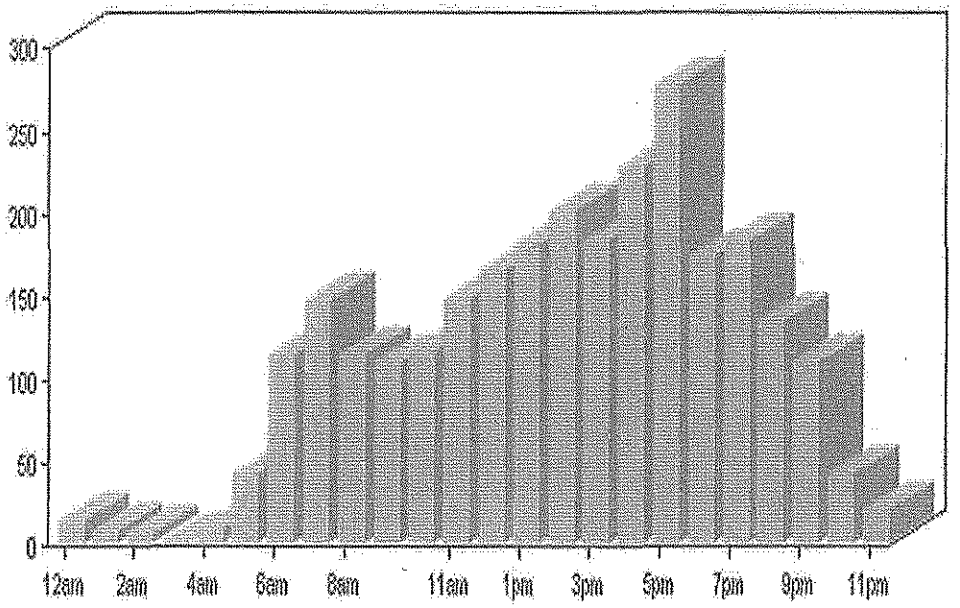
@ 4:00: 1 bus SEB LT, 3 buses & UPS trk SWB RT, & 1 bus NEB LT.

* Peak hour for overall traffic: 1 UPS truck SWB RT.

PM Peak Hour

HOUR BEGINNING	SEB South Lake		SWB 13 Mile		NEB Old Novi		TOTAL
	LT	RT	TH	RT	LT	TH	
4:00	**1**	**0**	**0**	**4**	**1**	**0**	**6**
PHF (Peak-Hour Factor)	0.25	#DIV/0!	#DIV/0!	0.33	0.25	#DIV/0!	0.50
	0.25		0.33		0.25		

Date of Count:	5/17/2004 to 5/18/2004
Day of Week:	Monday
County:	Oakland
Community:	Novi
PR Number:	621910
From Mile Point:	0.000
To Mile Point:	0.445
24 Hour Count:	2,736



Hour	Count	Hour	Count	Hour	Count
12 am - 1 am	14	8 am - 9 am	115	4 pm - 5 pm	227
1 am - 2 am	8	9 am - 10 am	110	5 pm - 6 pm	278
2 am - 3 am	7	10 am - 11 am	116	6 pm - 7 pm	174
3 am - 4 am	3	11 am - 12 pm	149	7 pm - 8 pm	183
4 am - 5 am	10	12 pm - 1 pm	166	8 pm - 9 pm	134
5 am - 6 am	42	1 pm - 2 pm	181	9 pm - 10 pm	109
6 am - 7 am	115	2 pm - 3 pm	202	10 pm - 11 pm	43
7 am - 8 am	147	3 pm - 4 pm	182	11 pm - 12 am	21

$K = \frac{278}{2,736} = 0.102$

Figure A-1. Two-Way Traffic Volumes in 2004 on Old Novi Road (SEMCOG)

APPENDIX B:

CRASH DATA

Table B-1. Summary of 2005-2007 Crashes at Old Novi / 13 Mile / South Lake

#	Date	Location	Crash Type								Condition		Severity (# of Persons)				
			Angle		Head-On		Side Swipe		Rear	Other	Light	Weather	K	A	B	C	O
			Dir 1	Dir 2	Straight	LT	Dir 1	Dir 2									
1	1-18-05	Driveway 30' S of 13 Mile					SB	SB			Day	Dry					3
2	2-05-05	Driveway 15' W of Old Novi							Backed into WB		Dark	Dry					4
3	3-29-05	Center of intersection							Hit rear of WB		Day	Dry					2
4	6-06-05	SLD 15' NW of Old Novi								<< NB H-O LT?	Day	Dry					3
5	6-25-05	13 Mile 60' E of Old Novi								Non-collison	Dark	Dry		1			2
6	7-03-05	Old Novi 25' S of 13 Mile							Hit rear of NB		Day	Dry					5
7	7-18-05	13 Mile 10' E of Old Novi							Hit rear of WB		Day	Wet					2
8	8-05-05	Old Novi 10' N of 13 Mile	EBL	NBT							Day	Dry				1	1
9	9-08-05	13 Mile 10' W of Old Novi	WB	SB							Day	Dry					2
10	10-11-05	Old Novi 1' S of SLD							Hit rear of EB		Day	Dry				1	2
11	12-31-05	13 Mile 75' NE of Old Novi	EB	WB							Dark	Snowy					4
12	1-22-06	Old Novi 10' N of 13 Mile							Hit rear of SB		Dark	Dry					4
13	1-27-06	Center of intersection				EB					Day	Dry					1
14	2-03-06	Old Novi 50' N of 13 Mile							Hit rear of SB		Dawn	Wet					3
15	4-28-06	13 Mile 100' E of Old Novi							3 WB vehicles		Day	Dry				2	3
16	5-03-06	13 Mile 3' E of Old Novi				EB					Dark	Dry					2
17	9-25-06	Old Novi 10' NE of 13 Mile	SB	NB							Day	Dry					2
18	10-03-06	Center of intersection								< 4 veh all 3 dir.	Day	Dry					5
19	10-04-07	SLD 12' NW of 13 Mile								Backed into NB	Dark	Dry					2
												Total # of Persons	0	1	0	4	52

Intersection Crash Report
William Stimpson (Old Novi, 13 Mile Rd, South Lake Dr)
Dates: 01/01/2005 - 12/31/2007
Roads: Old Novi Rd / S (0 - 0.04)
13 Mile Rd / W (1.98 - 2.06)
Criteria:
TIA Traffic Crash Analysis Tool

Report Printed On 12/17/2008

#1 Location: NOVI (0.01) 30 feet S of 13 MILE **Crash ID:** 5887920

Crash Date: 01/18/2005 **Day:** Tue **Hour:** 1pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 3 **How:** ss-same
CVT: NOVI **Area:** drivwy at inter **HBD:** N **Drugs:** N **Complaint No:** 05003583

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	S	change lanes	veh in transpt	none	none	none	fail to yield	car	lftside
2	S	go straight	veh in transpt	none	none	none	none	car	rtside

---

#2 Location: 13MILE (2.03) 15 feet W of NOVI **Crash ID:** 5928917

Crash Date: 02/05/2005 **Day:** Sat **Hour:** 7pm **Weather:** clear **Roadway:** dry **Light:** dark/unltd
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 4 **How:** rr-end
CVT: NOVI **Area:** drivwy at inter **HBD:** N **Druge:** N **Complaint No:** 057090

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	backing	veh in transpt	none	none	none	improp backing	car	ctrrear
2	W	stop on road	veh in transpt	none	none	none	none	car	ctrfrnt

---

#3 Location: W 13 MILE RD (2.03) 0 feet X of NOVI RD **Crash ID:** 6008782

Crash Date: 03/29/2005 **Day:** Tue **Hour:** 4pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** rr-end
CVT: NOVI **Area:** inter other **HBD:** N **Drugs:** N **Complaint No:** 0516236

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	loss of control	veh in transpt	none	none	unable to stop	car	ctrfrnt
2	W	stop on road	veh in transpt	none	none	none	none	pickup	ctrrear

---

#4 Location: S LAKE DR (1.36) 15 feet NW of NOVI RD **Crash ID:** 6074294

Crash Date: 06/06/2005 **Day:** Mon **Hour:** 3pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 3 **How:** other
CVT: NOVI **Area:** unkn **HBD:** N **Drugs:** N **Complaint No:** 0529362

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	N	left turn	veh in transpt	none	none	none	unknown	car	ctrfrnt
2	S	go straight	veh in transpt	none	none	none	unknown	car	lftside

---

#5 Location: E 13 MILE RD (2.02) 60 feet E of NOVI RD **Crash ID:** 6062228

Crash Date: 06/25/2005 **Day:** Sat **Hour:** 0am **Weather:** clear **Roadway:** dry **Light:** dark/unltd
Injuries K: 0 **Inj A:** 1 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** other
CVT: NOVI **Area:** strght.unrel **HBD:** Y **Drugs:** N **Complaint No:** 0533081

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	othr noncollisn	none	none	none	unknown	car	none

#6 **Location:** N NOVI RD (0.01) 25 feet S of 13 MILE RD **Crash ID:** 6075044

Crash Date: 07/03/2005 **Day:** Sun **Hour:** 2pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 5 **How:** rr-end
CVT: NOVI **Area:** Inter other **HBD:** N **Drugs:** N **Complaint No:** 0534841

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	N	start on road	veh in transpt	none	none	none	unable to stop	car	ctrfrnt
2	N	stop on road	veh in transpt	none	none	none	none	car	ctrrear

#7 **Location:** 13 MILE RD (2.03) 10 feet E of NOVI RD **Crash ID:** 6074268

Crash Date: 07/18/2005 **Day:** Mon **Hour:** 5pm **Weather:** cloudy **Roadway:** wet **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** rr-rt
CVT: NOVI **Area:** strght.unrel **HBD:** N **Drugs:** N **Complaint No:** 0537990

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	right turn	veh in transpt	none	none	none	unable to stop	pickup	ctrfrnt
2	W	stop on road	veh in transpt	none	none	none	none	car	ctrrear

#8 **Location:** NOVI (0.00) 10 feet N of 13 MILE RD **Crash ID:** 6079565

Crash Date: 08/05/2005 **Day:** Fri **Hour:** 2pm **Weather:** cloudy **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 1 **Inj O:** 1 **How:** angle
CVT: NOVI **Area:** w/i intersection **HBD:** N **Drugs:** N **Complaint No:** 0541452

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	left turn	veh in transpt	none	none	none	fail to yield	pickup	rtfrnt
2	N	go straight	veh in transpt	none	none	none	none	van	ctrfrnt

#9 **Location:** 13 MILE RD (2.03) 10 feet W of NOVI RD **Crash ID:** 6143915

Crash Date: 09/08/2005 **Day:** Thu **Hour:** 1pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** angle
CVT: NOVI **Area:** w/i intersection **HBD:** N **Drugs:** N **Complaint No:** 0547970

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	veh in transpt	none	none	none	disrgd traf ctl	car	rtrear
2	S	go straight	veh in transpt	none	none	none	none	car	ctrfrnt

#10 **Location:** NOVI RD (0.00) 1 feet SW of S LAKE DR **Crash ID:** 6153228

Crash Date: 10/11/2005 **Day:** Tue **Hour:** 3pm **Weather:** cloudy **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 1 **Inj O:** 2 **How:** rr-end
CVT: NOVI **Area:** w/i intersection **HBD:** N **Drugs:** N **Complaint No:** 05054634

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpt	none	none	none	unable to stop	van	ctrfrnt
2	E	stop on road	veh in transpt	none	none	none	none	car	ctrrear

#11 **Location:** 13 MILE (2.02) 75 feet NE of NOVI RD **Crash ID:** 6228836

Crash Date: 12/31/2005 **Day:** Sat **Hour:** 1am **Weather:** snow **Roadway:** snowy **Light:** dark/ltd
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 4 **How:** angle

CVT: NOVI Area: Inter other HBD: N Drugs: N Complaint No: 0571913

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	right turn	loss of control	x center/median	veh in transpt	none	too fast	car	ctrfrnt
2	W	stop on road	veh in transpt	none	none	none	none	pickup	ctrfrnt

---

#12 Location: NOVI (0.00) 10 feet N of 13 MILE Crash ID: 6254482
Crash Date: 01/22/2006 Day: Sun Hour: 2am Weather: clear Roadway: dry Light: dark/ltd
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj O: 4 How: rr-end
CVT: NOVI Area: Inter other HBD: N Drugs: N Complaint No: 2155306

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	S	stop on road	veh in transpt	none	none	none	none	pickup	rtrear
2	S	go straight	ran off road/r	none	none	none	negl drving	car	ctrfrnt

---

#13 Location: N NOVI (0.00) 0 feet X of 13 MILE Crash ID: 6255714
Crash Date: 01/27/2006 Day: Fri Hour: 3pm Weather: clear Roadway: dry Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj O: 1 How: ho-lt
CVT: NOVI Area: w/i intersection HBD: N Drugs: N Complaint No: 0626430

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	left turn	veh in transpt	none	none	none	none	pickup	rtside
2	N	go straight	veh in transpt	none	none	none	none	smltruck	ctrfrnt

---

#14 Location: S NOVI RD (0.00) 50 feet N of 13 MILE RD Crash ID: 6261750
Crash Date: 02/03/2006 Day: Fri Hour: 8am Weather: rain Roadway: wet Light: dawn
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj O: 3 How: rr-lt
CVT: NOVI Area: strght.unrel HBD: N Drugs: N Complaint No: 067953

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	S	go straight	veh in transpt	none	none	none	unable to stop	pickup	rtfrnt
2	S	slow/stop on rd	veh in transpt	none	none	none	none	car	lftrear

---

#15 Location: 13 MILE RD (2.01) 100 feet E of NOVI RD Crash ID: 6332080
Crash Date: 04/28/2006 Day: Fri Hour: 6pm Weather: clear Roadway: dry Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 2 Inj O: 3 How: rr-end
CVT: NOVI Area: Inter other HBD: N Drugs: N Complaint No: 0627662

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	parked vehicle	none	none	none	unable to stop	van	ctrfrnt
2	W	stop on road	veh in transpt	none	none	none	none	car	ctrfrnt
3	UN	unknown	none	none	none	none	none	unkn	unkn

#16 Location: 13 MILE RD (2.03) 3 feet E of NOVI RD Crash ID: 6334341
Crash Date: 05/03/2006 Day: Wed Hour: 11pm Weather: clear Roadway: dry Light: dark/unltd
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj O: 2 How: ho-lt
CVT: NOVI Area: w/i intersection HBD: N Drugs: N Complaint No: 0629237

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage

1	E	go straight	veh in transpt	none	none	none	disrgd traf ctl	car	ctrfrnt
2	E	left turn	veh in transpt	none	none	none	none	car	ctrfrnt

#17 **Location:** NOVI RD (0.00) 10 feet NE of 13 MILE **Crash ID:** 6448954

Crash Date: 09/25/2006 **Day:** Mon **Hour:** 2pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** angle
CVT: NOVI **Area:** w/i intersection **HBD:** N **Drugs:** N **Complaint No:** 0664520

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	S	unknown	none	none	none	none	none	car	rtside
2	N	unknown	none	none	none	none	none	car	ctrfrnt

#18 **Location:** NOVI RD (0.00) 0 feet X of 13 MILE RD **Crash ID:** 6455943

Crash Date: 10/03/2006 **Day:** Tue **Hour:** 4pm **Weather:** clear **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 5 **How:** other
CVT: NOVI **Area:** w/i intersection **HBD:** N **Drugs:** N **Complaint No:** 0666249

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	left turn	veh in transpt	none	none	none	fail to yield	van	rtfrnt
2	N	go straight	veh in transpt	separ of units	veh in transpt	none	none	pickup	lftfrnt
3	W	stop on road	veh in transpt	separ of units	veh in transpt	none	none	car	lftfrnt
4	W	stop on road	veh in transpt	none	none	none	none	car	ctrfrnt

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#19 **Location:** S LAKE DR (1.36) 12 feet NW of W 13 MILE RD **Crash ID:** 6786231

Crash Date: 10/04/2007 **Day:** Thu **Hour:** 9pm **Weather:** clear **Roadway:** dry **Light:** dark/ltd
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** other
CVT: NOVI **Area:** drivwy at inter **HBD:** N **Drugs:** Y **Complaint No:** 0759905

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	S	backing	veh in transpt	none	none	none	other	van	ctrrear
2	N	stop on road	veh in transpt	none	none	none	none	car	rtrear

Time Period	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Unknown	Totals
12a - 1a	0	0	0	0	0	0	1	0	1
1a - 2a	0	0	0	0	0	0	1	0	1
2a - 3a	1	0	0	0	0	0	0	0	1
3a - 4a	0	0	0	0	0	0	0	0	0
4a - 5a	0	0	0	0	0	0	0	0	0
5a - 6a	0	0	0	0	0	0	0	0	0
6a - 7a	0	0	0	0	0	0	0	0	0
7a - 8a	0	0	0	0	0	0	0	0	0
8a - 9a	0	0	0	0	0	1	0	0	1
9a - 10a	0	0	0	0	0	0	0	0	0
10a - 11a	0	0	0	0	0	0	0	0	0
11a - 12p	0	0	0	0	0	0	0	0	0
12p - 1p	0	0	0	0	0	0	0	0	0
1p - 2p	0	0	1	0	1	0	0	0	2
2p - 3p	1	1	0	0	0	1	0	0	3
3p - 4p	0	1	1	0	0	1	0	0	3
4p - 5p	0	0	2	0	0	0	0	0	2
5p - 6p	0	1	0	0	0	0	0	0	1
6p - 7p	0	0	0	0	0	1	0	0	1
7p - 8p	0	0	0	0	0	0	1	0	1
8p - 9p	0	0	0	0	0	0	0	0	0
9p - 10p	0	0	0	0	1	0	0	0	1
10p - 11p	0	0	0	0	0	0	0	0	0
11p - 12a	0	0	0	1	0	0	0	0	1
Unknown	0	0	0	0	0	0	0	0	0
Totals	2	3	4	1	2	4	3	0	19

Crash Type

Count	Type
4	angle
0	head on
2	ho-lt
4	other
6	rr-end
1	rr-lt
1	rr-rt
0	single
0	ss-opp
1	ss-same
0	unknown
Totals: 19	

Light Condition

Count	Type
3	dark/ltd
3	dark/unltd
1	dawn
12	day
0	dusk
0	other
0	unkn
Totals: 19	

Weather

Count	Type
12	clear
1	cloudy
0	fog/smke
3	rain
0	sev wind
0	sleet
3	snow
0	unkn
0	unkn
Totals: 19	

Road Condition

Count	Type
0	debris
16	dry
0	icy
0	muddy
0	slushy
1	snowy
0	unkn
0	unkn
2	wet
Totals: 19	

Vehicle Type

Count	Type
25	car
0	go-cart
0	mcycle
0	moped
0	orv/atv
0	other
8	pickup
1	smltruck
0	snowmobile
0	truck/bus
1	unkn
5	van
Totals: 40	

Crashes By Month

Count	Type
3	January
2	February
1	March
1	April
1	May
2	June
2	July
1	August
2	September
3	October
0	November
1	December
Totals: 19	

Hazardous Action

Count	Type
2	disrgd traf ctl
3	fail to yield
1	improp backing
0	improp lane use
0	improp passing
0	improp turn
0	improp/no signl
0	left of center
1	negl drving
22	none
1	other
0	reck drving
1	too fast
0	too slow
6	unable to stop
3	unknown
0	wrong way
Totals: 40	

Crash Severity

	FATAL	A	B	C	No Inj	Total
Persons	0	1	0	4	52	57
Crashes	0	1	0	3	15	19

Alcohol in Crashes

	FATAL	PI	PD	Total
Drinking	0	1	0	1
Not Drinking	0	3	15	18
Total	0	4	15	19

APPENDIX C:

PEAK-HOUR SIGNAL WARRANT +
GUIDELINES FOR MULTIWAY STOP APPLICATIONS
(Excerpts from 2005 *Michigan Manual of Uniform Traffic Control Devices*)

Guidance:

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

A. **The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and**
B. **The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour (Combines previous Warrants 10, 11)

Support:

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. **If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:**
   1. **The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach, and**

(continues on pg 4C-6)

2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to satisfy the criteria in the second category of the Standard.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that both of the following criteria are met:

A. **The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and**
B. **There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.**

The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads conforming to requirements set forth in Chapter 4E.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Option:

The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec).

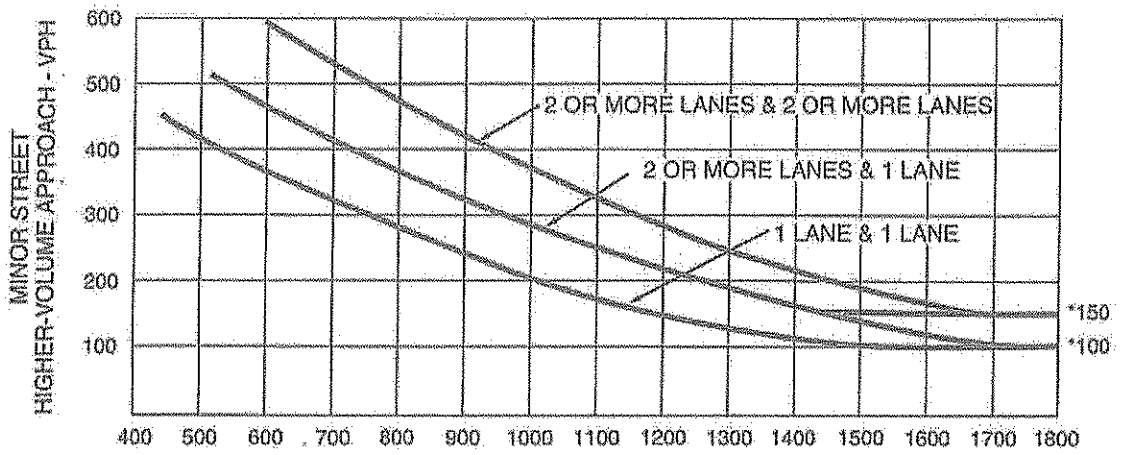
A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street, even if the rate of gap occurrence is less than one per minute.

Section 4C.06 Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

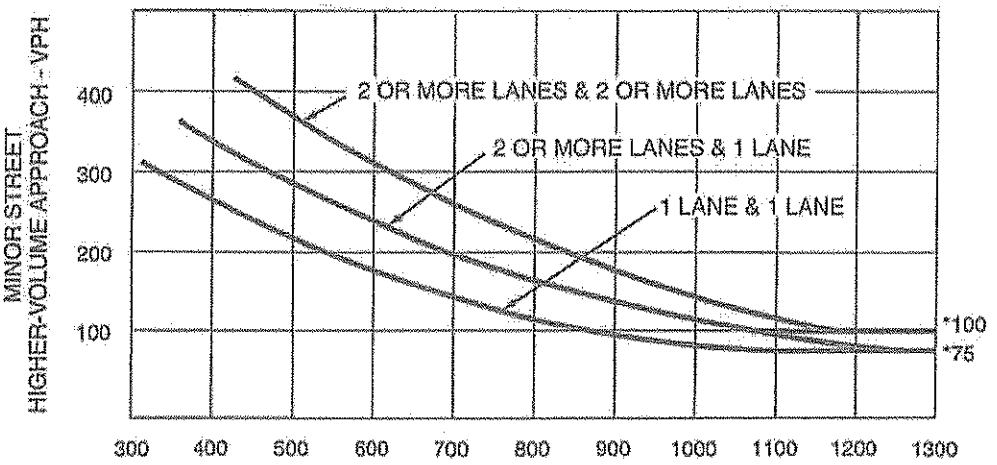
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Once the decision has been made to install two-way stop control, the decision regarding the appropriate street to stop should be based on engineering judgment. In most cases, the street carrying the lowest volume of traffic should be stopped.

A STOP sign should not be installed on the major street unless justified by a traffic engineering study.

Support:

The following are considerations that might influence the decision regarding the appropriate street upon which to install a STOP sign where two streets with relatively equal volumes and/or characteristics intersect:

A. Stopping the direction that conflicts the most with established pedestrian crossing activity or school walking routes;
B. Stopping the direction that has obscured vision, dips, or bumps that already require drivers to use lower operating speeds;
C. Stopping the direction that has the longest distance of uninterrupted flow approaching the intersection; and
D. Stopping the direction that has the best sight distance to conflicting traffic.

The use of the STOP sign at highway-railroad grade crossings is described in Section 8B.08. The use of the STOP sign at highway-light rail transit grade crossings is described in Section 10C.04.

Section 2B.06 STOP Sign Placement

Standard:

The STOP sign shall be installed on the right side of the approach to which it applies. When the STOP sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see Section 2C.29) shall be installed in advance of the STOP sign.

The STOP sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

STOP signs and YIELD signs shall not be mounted on the same post.

Guidance:

Other than a DO NOT ENTER sign, no sign should be mounted back-to-back with a STOP sign in a manner that obscures the shape of the STOP sign.

Support:

Section 2A.16 contains additional information about separate and combined mounting of other signs with STOP signs.

Guidance:

Stop lines, when used to supplement a STOP sign, should be located at the point where the road user should stop (see Section 3B.16).

If only one STOP sign is installed on an approach, the STOP sign should not be placed on the far side of the intersection.

Where two roads intersect at an acute angle, the STOP sign should be positioned at an angle, or shielded, so that the legend is out of view of traffic to which it does not apply.

Where there is a marked crosswalk at the intersection, the STOP sign should be installed in advance of the crosswalk line nearest to the approaching traffic.

Option:

At wide-throat intersections or where two or more approach lanes of traffic exist on the signed approach, observance of the stop control may be improved by the installation of an additional STOP sign on the left side of the road and/or the use of a stop line. At channelized intersections, the additional STOP sign may be effectively placed on a channelizing island.

Support:

Figure 2A-2 shows examples of some typical placements of STOP signs.

Section 2B.07 Multiway Stop Applications

Support:

Multiway stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multiway stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multiway stop control is used where the volume of traffic on the intersecting roads is approximately equal.

The restrictions on the use of STOP signs described in Section 2B.05 also apply to multiway stop applications.

Guidance:

The decision to install multiway stop control should be based on an engineering study.

The following criteria should be considered in the engineering study for a multiway STOP sign installation:

A. Where traffic control signals are justified, the multiway stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.
B. A crash problem, as indicated by 5 or more reported crashes in a 12-month period that are susceptible to correction by a multiway stop installation. Such crashes include right- and left-turn collisions as well as right-angle collisions.
C. Minimum volumes:
   1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
   2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
   3. If the 85th-percentile approach speed of the major-street traffic exceeds 65 km/h or exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the above values.
D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Option:

Other criteria that may be considered in an engineering study include:

A. The need to control left-turn conflicts;
B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to reasonably safely negotiate the intersection unless conflicting cross traffic is also required to stop; and
D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multiway stop control would improve traffic operational characteristics of the intersection.

Section 2B.08 YIELD Sign (R1-2)

Standard:

The YIELD (R1-2) sign (see Figure 2B-1) shall be a downward-pointing equilateral triangle with a wide red border and the legend YIELD in red on a white background.

Support:

The YIELD sign assigns right-of-way to traffic on certain approaches to an intersection. Vehicles controlled by a YIELD sign need to slow down or stop when necessary to avoid interfering with conflicting traffic.

Section 2B.09 YIELD Sign Applications

Option:

YIELD signs may be used instead of STOP signs if engineering judgment indicates that one or more of the following conditions exist:

A. When the ability to see all potentially conflicting traffic is sufficient to allow a road user traveling at the posted speed, the 85th-percentile speed, or the statutory speed to pass through the intersection or to stop in a reasonably safe manner.
B. If controlling a merge-type movement on the entering roadway where acceleration geometry and/or sight distance is not adequate for merging traffic operation.
C. The second crossroad of a divided highway, where the median width at the intersection is 9 m (30 ft) or greater. In this case, a STOP sign may be installed at the entrance to the first roadway of a divided highway, and a YIELD sign may be installed at the entrance to the second roadway.
D. An intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

Standard:

A YIELD (R1-2) sign shall be used to assign right-of-way at the entrance to a roundabout intersection.

APPENDIX D:

LEVEL OF SERVICE ANALYSES

INTERSECTION LEVELS OF SERVICE

Intersection capacity analyses were conducted using *Synchro 7* software, based on methodologies contained in the *Highway Capacity Manual* (*HCM*, Transportation Research Board, 2000). The primary objective is to determine level of service, a qualitative measure of the "ease" of traffic flow based on average vehicular delay. Analytical models are used to estimate the average delay per vehicle for specific movements, minor approaches – and in the case of all-way stop-controlled and signalized intersections – major approaches and the overall intersection as well. These models account for lane configuration, grade, type of traffic control, traffic volume and composition, and other traffic flow parameters.

Level of service (LOS) is expressed using a letter grading scale, with A being the highest level and F being the lowest level. The following two tables define LOS, in terms of average delay per vehicle, for signalized and unsignalized intersections, respectively. Intersections include junctions of driveways and roads as well as roads and roads.

Level of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (seconds)
A	≤ 10
B	> 10 and ≤ 20
C	> 20 and ≤ 35
D	> 35 and ≤ 55
E	> 55 and ≤ 80
F	> 80

Level of Service Criteria for Unsignalized Intersections

Level of Service	Control Delay per Vehicle (seconds)
A	≤ 10
B	> 10 and ≤ 15
C	> 15 and ≤ 25
D	> 25 and ≤ 35
E	> 35 and ≤ 50
F	> 50

According to the *Highway Capacity Manual*, level of service at a two-way stop-controlled intersection is defined only for minor movements (i.e., minor approach left and right turns and major approach left turns). LOS is not defined for the intersection as a whole, since the majority of vehicles pass through the intersection without stopping and thus experience negligible delay.

It is important to realize how *HCM* methodology computes average approach delay and average intersection delay at a one- or two-way-stop-controlled intersection where left turns from the major road share a single lane with through (and possibly right-turning) traffic. In applying the equations for weighted average delay, the methodology assumes zero delay for major-road through and right-turning traffic (believing them to be negligible), but then divides by the total approach (or intersection volume). Hence, the resulting average delay per vehicle is generally significantly lower than what the average left-turn delay per left-turn vehicle would be if, in fact, the latter was actually reported by the software (it is not). Caution should therefore be used in interpreting the reported average delay per vehicle on approaches and at intersections having shared (left-through or left-through-right) lanes on the major road.

HCM Signalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/6/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (vph)	141	34	10	11	50	49
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000
Total Lost time (s)	5.7		6.0	6.0	6.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frt	0.97		1.00	1.00	0.93	
Flt Protected	0.96		0.95	1.00	1.00	
Satd. Flow (prot)	1842		1583	2000	1761	
Flt Permitted	0.96		0.18	1.00	1.00	
Satd. Flow (perm)	1842		303	2000	1761	
Peak-hour factor, PHF	0.81	0.81	0.75	0.75	0.95	0.95
Adj. Flow (vph)	174	42	13	15	53	52
RTOR Reduction (vph)	10	0	0	0	39	0
Lane Group Flow (vph)	206	0	13	15	66	0
Heavy Vehicles (%)	2%	0%	20%	0%	6%	6%
Turn Type			custom			
Protected Phases	6				8	
Permitted Phases			4	4		
Actuated Green, G (s)	26.3		22.0	22.0	22.0	
Effective Green, g (s)	26.3		22.0	22.0	22.0	
Actuated g/C Ratio	0.30		0.25	0.25	0.25	
Clearance Time (s)	5.7		6.0	6.0	6.0	
Lane Grp Cap (vph)	551		76	500	440	
v/s Ratio Prot	c0.11				c0.04	
v/s Ratio Perm			c0.04	0.01		
v/c Ratio	0.37		0.17	0.03	0.15	
Uniform Delay, d1	24.4		25.9	24.9	25.7	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	1.9		4.8	0.1	0.7	
Delay (s)	26.3		30.7	25.0	26.4	
Level of Service	C		C	C	C	
Approach Delay (s)	26.3			27.7	26.4	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	88.0	Sum of lost time (s)	17.7
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/7/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	141	34	10	11	50	49
Peak Hour Factor	0.81	0.81	0.75	0.75	0.95	0.95
Hourly flow rate (vph)	174	42	13	15	53	52

Direction, Lane #	SE 1	NE 1	NE 2	SW 1
Volume Total (vph)	216	13	15	104
Volume Left (vph)	174	0	0	53
Volume Right (vph)	0	0	15	52
Hadj (s)	0.19	0.34	-0.70	-0.09
Departure Headway (s)	4.5	5.3	4.2	4.4
Degree Utilization, x	0.27	0.02	0.02	0.13
Capacity (veh/h)	778	659	818	773
Control Delay (s)	9.1	7.2	6.1	8.0
Approach Delay (s)	9.1	6.6		8.0
Approach LOS	A	A		A

Intersection Summary			
Delay	8.6		
HCM Level of Service	A		
Intersection Capacity Utilization	23.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/7/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	172	41	12	13	61	60
Peak Hour Factor	0.81	0.81	0.75	0.75	0.95	0.95
Hourly flow rate (vph)	212	51	16	17	64	63

Direction, Lane #	SE 1	NE 1	NE 2	SW 1
Volume Total (vph)	263	16	17	127
Volume Left (vph)	212	0	0	64
Volume Right (vph)	0	0	17	63
Hadj (s)	0.19	0.34	-0.70	-0.09
Departure Headway (s)	4.5	5.4	4.3	4.5
Degree Utilization, x	0.33	0.02	0.02	0.16
Capacity (veh/h)	766	642	790	747
Control Delay (s)	9.8	7.3	6.2	8.3
Approach Delay (s)	9.8	6.7		8.3
Approach LOS	A	A		A

Intersection Summary			
Delay	9.1		
HCM Level of Service	A		
Intersection Capacity Utilization	27.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/7/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Volume (vph)	102	34	70	74	39	191
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000
Total Lost time (s)	5.7		6.0	6.0	6.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frt	0.97		1.00	1.00	0.89	
Flt Protected	0.96		0.95	1.00	1.00	
Satd. Flow (prot)	1863		1900	1980	1761	
Flt Permitted	0.96		0.14	1.00	1.00	
Satd. Flow (perm)	1863		276	1980	1761	
Peak-hour factor, PHF	0.85	0.85	0.92	0.92	0.87	0.87
Adj. Flow (vph)	120	40	76	80	45	220
RTOR Reduction (vph)	13	0	0	0	153	0
Lane Group Flow (vph)	147	0	76	80	112	0
Heavy Vehicles (%)	0%	0%	0%	1%	0%	1%
Turn Type			custom			
Protected Phases	6				8	
Permitted Phases			4	4		
Actuated Green, G (s)	19.3		29.0	29.0	29.0	
Effective Green, g (s)	19.3		29.0	29.0	29.0	
Actuated g/C Ratio	0.20		0.31	0.31	0.31	
Clearance Time (s)	5.7		6.0	6.0	6.0	
Lane Grp Cap (vph)	378		84	604	538	
v/s Ratio Prot	c0.08				c0.06	
v/s Ratio Perm			c0.28	0.04		
v/c Ratio	0.39		0.90	0.13	0.21	
Uniform Delay, d1	32.8		31.7	23.9	24.5	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	3.0		74.4	0.5	0.9	
Delay (s)	35.8		106.1	24.3	25.4	
Level of Service	D		F	C	C	
Approach Delay (s)	35.8			64.2	25.4	
Approach LOS	D			E	C	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	17.7
Intersection Capacity Utilization	38.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/7/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	102	34	70	74	39	191
Peak Hour Factor	0.85	0.85	0.92	0.92	0.87	0.87
Hourly flow rate (vph)	120	40	76	80	45	220

Direction, Lane #	SE 1	NE 1	NE 2	SW 1
Volume Total (vph)	160	76	80	264
Volume Left (vph)	120	0	0	45
Volume Right (vph)	0	0	80	220
Hadj (s)	0.15	0.00	-0.68	-0.45
Departure Headway (s)	5.0	5.3	4.6	4.2
Degree Utilization, x	0.22	0.11	0.10	0.31
Capacity (veh/h)	684	645	736	803
Control Delay (s)	9.3	7.7	6.9	9.1
Approach Delay (s)	9.3	7.3		9.1
Approach LOS	A	A		A

Intersection Summary			
Delay	8.7		
HCM Level of Service	A		
Intersection Capacity Utilization	34.2%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
3: South Lake Dr & 13 Mile Rd

1/7/2009

Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	124	41	85	90	48	233
Peak Hour Factor	0.85	0.85	0.92	0.92	0.87	0.87
Hourly flow rate (vph)	146	48	92	98	55	268

Direction, Lane #	SE 1	NE 1	NE 2	SW 1
Volume Total (vph)	194	92	98	323
Volume Left (vph)	146	0	0	55
Volume Right (vph)	0	0	98	268
Hadj (s)	0.15	0.00	-0.68	-0.45
Departure Headway (s)	5.2	5.5	4.8	4.4
Degree Utilization, x	0.28	0.14	0.13	0.39
Capacity (veh/h)	652	615	697	770
Control Delay (s)	10.2	8.2	7.3	10.2
Approach Delay (s)	10.2	7.8		10.2
Approach LOS	B	A		B

Intersection Summary			
Delay	9.5		
HCM Level of Service	A		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		