

RESEARCH PARK DEVELOPMENT TRAFFIC IMPACT STUDY

ROCHESTER HILLS, MICHIGAN

OCTOBER 15, 2019

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| Agency Review | Date | Comments |
|--------------------------------|-------------|----------------------------------|
| City of Rochester Hills | 8/9/2019 | DPS/Engineering Review Letter |
| RCOC | 9/25/2019 | Traffic Engineering Review-Email |



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REFERENCES

- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO). (2011). *A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS*. WASHINGTON DC.
- FEDERAL HIGHWAY ADMINISTRATION, MICHIGAN DEPARTMENT OF TRANSPORTATION, MICHIGAN STATE POLICE. (2011). *MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES*.
- INSTITUTE OF TRANSPORTATION ENGINEERS. (2017). *TRIP GENERATION MANUAL, 10TH EDITION*. WASHINGTON DC.
- NATIONAL RESEARCH COUNCIL (U.S.) TRANSPORTATION RESEARCH BOARD. (2016). *HIGHWAY CAPACITY MANUAL, 6TH EDITION (HCM6)*. WASHINGTON, D.C.: TRANSPORTATION RESEARCH BOARD.
- PAPACOSTAS, & PREVEDOUROS. (2001). *TRANSPORTATION ENGINEERING AND PLANNING*.
- STOVER, V. G., & KOEPKE, F. J. (2006). *TRANSPORTATION AND LAND DEVELOPMENT (VOL. 2ND EDITION)*. WASHINGTON DC: INSTITUTE OF TRANSPORTATION ENGINEERS (ITE).

1 INTRODUCTION

This report presents the results of the Traffic Impact Study (TIS) for a proposed industrial research park development in the City of Rochester Hills, Michigan. The project site is located adjacent to Livernois Road, between Drexelgate Parkway and Horizon Court; the site location is shown on **Figure 1**. As part of the development, a new loop road is proposed through the research park and will connect Horizon Court and Drexelgate Parkway. Several new offices and warehouses are proposed on the property; in addition to the existing land uses, which are currently occupied and will remain.

The purpose of this study is to identify the traffic related impacts, if any, of the proposed development project on the adjacent road network. Specific tasks undertaken for this study include the following:

1. **Study Area:** Provide a description of the study area including: surrounding land uses, intersection and roadway geometries, speed limits, functional classifications and traffic volume data (where available). In addition, a study area site map showing the site location and the study intersections will also be provided.
2. **Proposed Land Use:** Obtain and review the proposed site plan which includes the proposed land uses, densities, and desired site access locations. A description of the current and proposed land uses will be accompanied with a complete project site plan (with buildings identified as to proposed use).
3. **Existing Conditions:**
 - a. Provide an analysis of the traffic-related impacts of the proposed development at the following study intersections:
 - Livernois Road & Drexelgate Parkway
 - Livernois Road & Horizon Court
 - b. Collect AM (7:00 AM to 9:00 AM) and PM (4:00 PM to 6:00 PM) peak period turning movement counts at the study intersections. Traffic counts will be taken when school is in session unless otherwise approved by the City of Rochester Hills Traffic Engineer.
 - c. Identify the Existing AM and PM peak hour traffic volumes at the study intersections based on turning movement count data.
 - d. Calculate the **Existing** vehicle delays, LOS, and vehicle queues at the study intersections during the AM and PM. The analysis will be performed at each of the study intersections. Intersection analysis shall include LOS determination for all approaches and movements. The LOS will be based on the procedures outlined in the HCM 6th Edition, the latest edition of Transportation Research Board's Highway Capacity Manual.
 - e. Identify improvements (if any) for the study road network that would be required to accommodate the existing traffic volumes.
4. **Future Background Growth:**
 - a. If the planned completion date for the project or the last phase of the project is beyond one year of the study, an estimate of background traffic growth for the adjacent street network will be made and included in the analysis.
 - b. Calculate the future background traffic volumes based on an appropriate traffic growth determined from local or statewide data to the project build-out year and/or any background developments in the vicinity of this project as identified by the City of Rochester Hills Traffic Engineer.
5. **Background Conditions (No Build):**
 - a. Calculate the **Background (without the proposed development)** vehicle delays, LOS, and vehicle queues at the study intersections during the AM and PM peak periods. Intersection analysis shall include LOS determination for all approaches and movements. The LOS will be based on the procedures outlined in the HCM 6th Edition.
 - b. Any state, local, or private transportation improvement projects in the project study area that will be underway in the build-out year and traffic that is generated by other proposed developments in the study area will be included as background conditions.
 - c. Identify improvements (if any) for the study road network that would be required to accommodate the background traffic volumes.

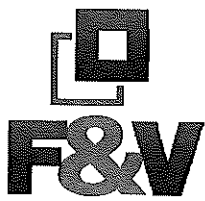


FIGURE 1 SITE LOCATION MAP

ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI

LEGEND

 SITE LOCATION



NORTH
SCALE: NOT TO SCALE

6. Trip Generation:

- a. Forecast the number of AM and PM peak hour trips that would be generated by the proposed development based on data published by the Institute of Transportation Engineers (ITE) in *Trip Generation, 10th Edition* and/or local development data as approved for use in the study by the City of Rochester Hills Traffic Engineer.
- b. A table will be provided in the report outlining the categories and quantities of land uses, with the corresponding trip generation rates or equations, and the resulting number of trips.

7. Trip Distribution and Traffic Assignment:

- a. Assign the trips that would be generated by the proposed development to the adjacent road network based on existing traffic patterns. The distribution of the estimated trip generation to the adjacent street network and nearby intersections shall be included in the report and the basis will be explained.
- b. Combine the site-generated traffic assignments with the background traffic forecasts to establish the Future AM and PM peak hour traffic volumes.

8. Future Conditions:

- a. Calculate the **Future (with the proposed development)** vehicle delays, LOS, and vehicle queues at the study intersections. Intersection analysis shall include LOS determination for all approaches and movements. The LOS will be based on the procedures outlined in the HCM 6th Edition, the latest edition of Transportation Research Board's Highway Capacity Manual.
 - b. Identify improvements (if any) for the study road network that would be required to accommodate the site-generated traffic volumes.
9. Complete a technical report consistent with accepted standards and suitable for submission to City of Rochester Hills, which outlines the methodologies, analyses, results, and recommendations of the traffic study. All work will follow accepted traffic engineering practice and the standards documented by ITE, FHWA, and the City of Rochester Hills.

The scope of the study was developed based on Fleis & VandenBrink's (F&V) knowledge of the study area, understanding of the development program, accepted traffic engineering practice and methodologies published by the Institute of Transportation Engineers (ITE). Additionally, F&V solicited input regarding the scope of work from the City of Rochester Hills.

Sources of data for this study include traffic counts conducted by F&V subconsultant Traffic Data Collection, Inc. (TDC), information provided by RCOC, City of Rochester Hills, MDOT and ITE. All background information is provided in **Appendix A**.

2 BACKGROUND DATA

2.1 EXISTING ROAD NETWORK

Vehicle transportation for the study area is provided by Livernois Road. The lane use and traffic control at the study intersections are shown on **Figure 2** and the study roadways are further described below. For the purposes of this study, all minor streets and driveways are assumed to have an operating speed of 25 miles per hour (mph).

Livernois Road runs in the north and south directions with a posted speed limit of 45 mph. Livernois Road is under the jurisdiction of the Road Commission of Oakland County (RCOC) and is classified a *Minor Arterial*. The study segment of Livernois Road has an AADT of 21,750 vehicles per day (SEMCOG 2018). Livernois Road has a typical 2-lane cross section, with one lane in each direction.

Drexelgate Parkway runs generally in the east and west directions with a posted speed limit of 25 mph. Drexelgate Parkway is under the jurisdiction of the City of Rochester Hills and is classified a *local road*. Drexelgate Parkway has a typical 2-lane cross section, with one lane in each direction.

Horizon Court runs in the east and west directions with a posted speed limit of 25 mph. Horizon Court is under the jurisdiction of the City of Rochester Hills and is classified a *local road*. Horizon Court has a typical 2-lane cross section, with one lane in each direction. At the intersection of Livernois Road and Horizon Court, there is an emergency traffic signal; for use by the Rochester Hills Fire Department, which is located along Horizon Court. When the emergency signal is not activated, it operates in flashing mode; therefore, for the purpose of this analysis, the intersection was treated as minor street (Horizon Ct.) stop-controlled.

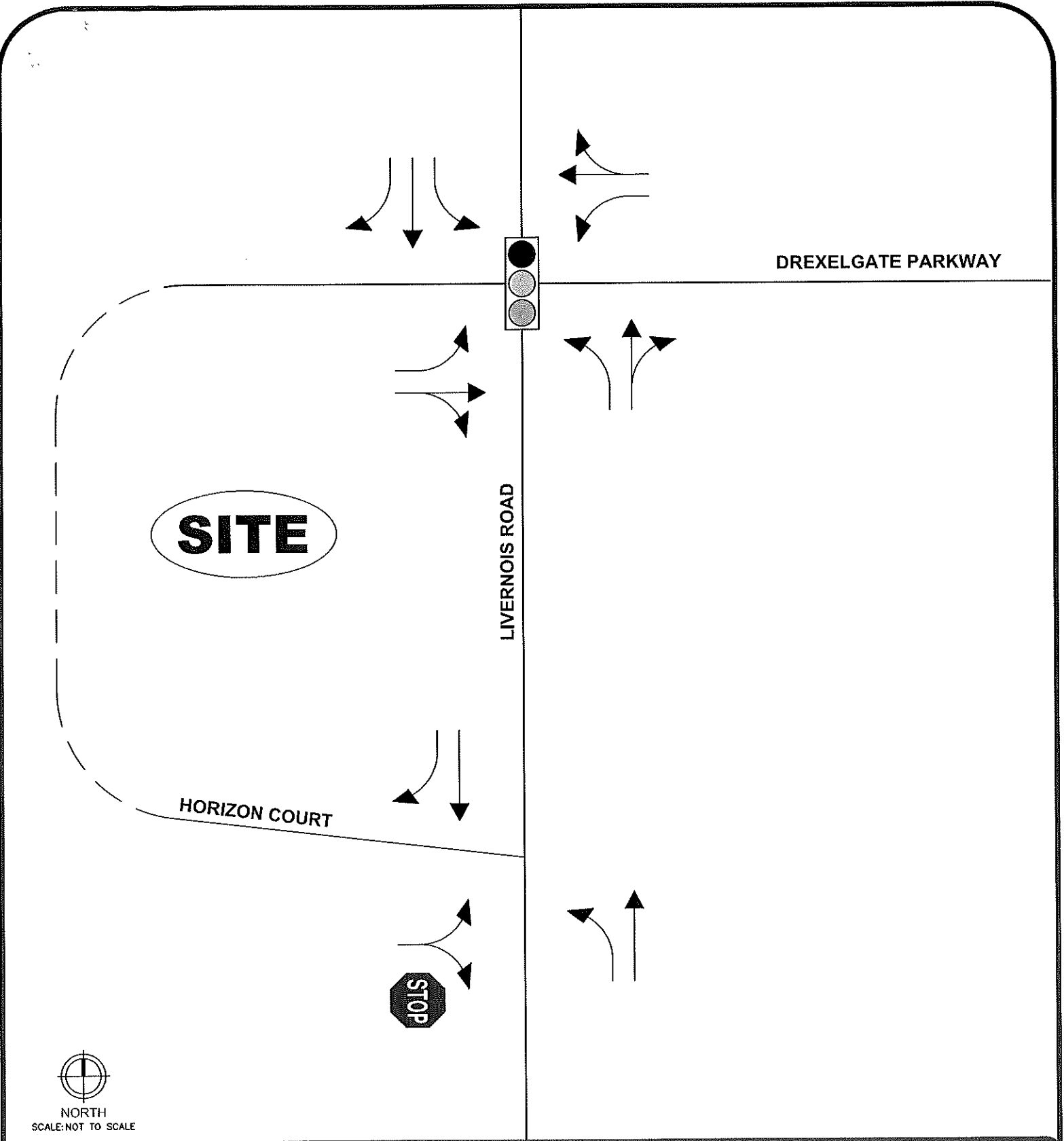
2.2 EXISTING TRAFFIC VOLUMES

The existing weekday turning movement traffic volume data were collected by F&V subconsultant Traffic Data Collection, Inc. (TDC) on Wednesday, March 21, 2019. Intersection turning movement counts were collected during the weekday AM (7:00 AM to 9:00 AM) and PM (4:00 PM to 6:00 PM) peak periods at the study intersections. F&V also collected an inventory of existing lane use and traffic controls at the study intersections and obtained existing traffic signal timing information from RCOC. The existing AM and PM peak hour traffic volumes were identified based on the data collection.

This data was used as a baseline to establish the current peak hour traffic volumes for the analysis of existing traffic conditions. During collection of the turning movement counts, pedestrian data and commercial truck percentages were recorded and used in the traffic analysis. Peak Hour Factors (PHFs) were also calculated for each study intersection approach.

The peak hour volumes for each intersection were utilized for this study and the volumes were balanced upward through the study network. The peak hours of existing network traffic were identified to occur between 7:00 AM to 8:00 AM and 4:45 PM to 5:45 PM for the weekday.

The traffic volume data are included in **Appendix A** and the existing peak hour traffic volumes are summarized in **Figure 3**.



NORTH
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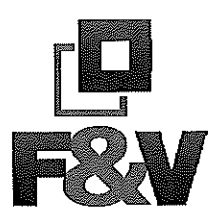
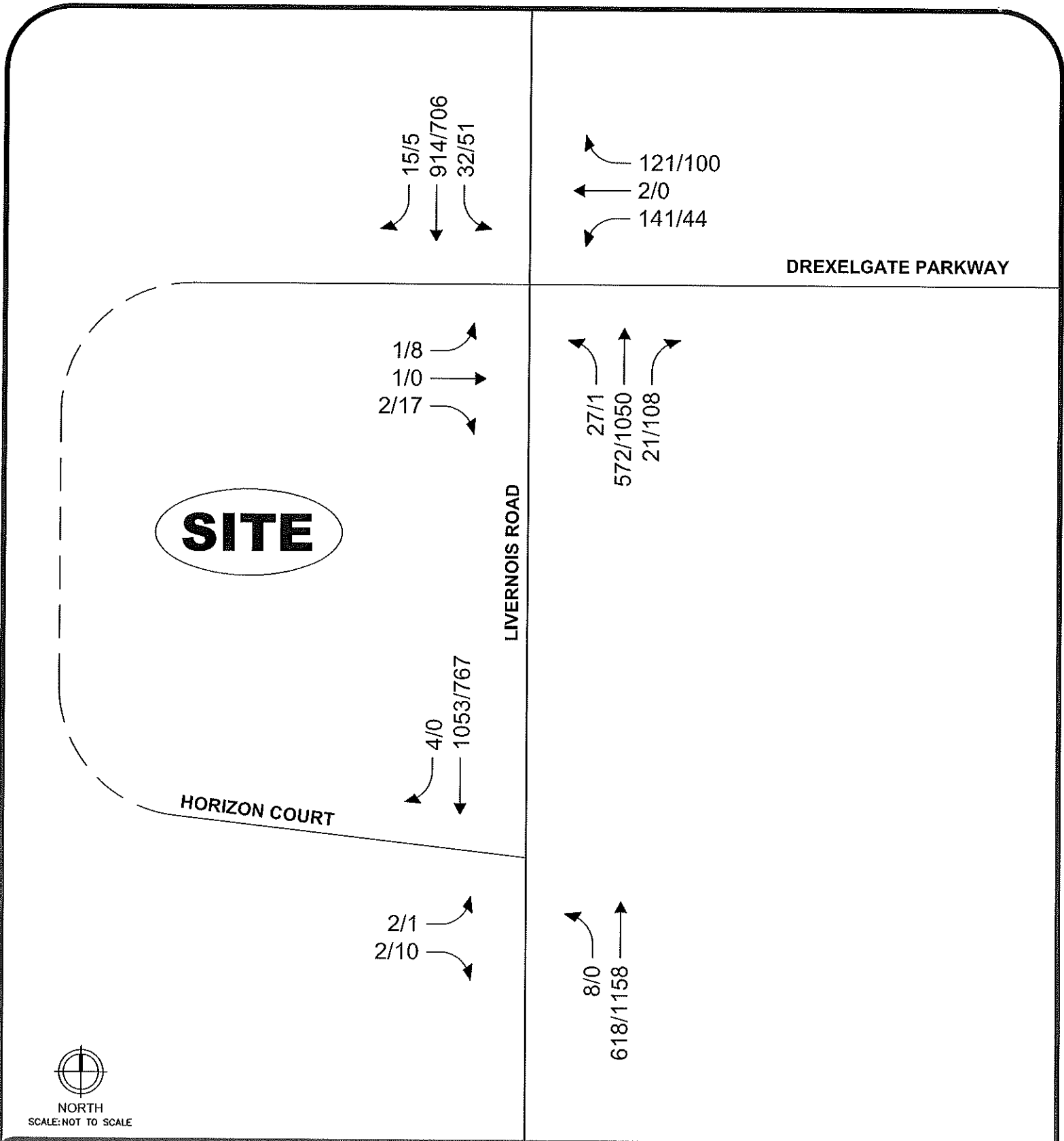


FIGURE 2
LANE USE AND TRAFFIC CONTROL

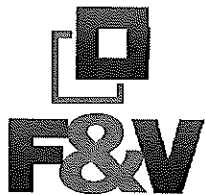
ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI

| LEGEND | |
|--------|---------------------------|
| | ROADS |
| | LANE USE |
| | SIGNALIZED INTERSECTION |
| | UNSIGNALIZED INTERSECTION |



**FIGURE 3
EXISTING TRAFFIC
VOLUMES**

ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI



LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

3 ANALYSIS

3.1 EXISTING CONDITIONS

The existing AM and PM peak hour vehicle delays and Levels of Service (LOS) were calculated at the study intersections using Synchro (Version 10) traffic analysis software. The results of the existing conditions analysis were based on the existing lane use and traffic control shown on **Figure 2**, the existing traffic volumes provided in **Figure 3**, and the methodologies presented in the HCM (6th Edition).

Descriptions of LOS "A" through "F" as defined in the HCM are provided in **Appendix B** for signalized and unsignalized intersections. Typically, LOS D is considered acceptable, with LOS A representing minimal delay, and LOS F indicating failing conditions. The results of the analysis of existing conditions are presented in **Appendix B** and are summarized in **Table 1**. Microsimulation was also conducted at the study intersections using SimTraffic to further evaluate the network performance; the average and 95th percentile queues are summarized in **Table 2**.

The results of the existing conditions analysis indicate that all approaches and movements at the study intersections currently operate at LOS D or better during both peak hours, with exception to the following:

Livernois Road & Drexelgate Parkway:

- The eastbound left-turn and westbound through/right movements currently operate at LOS E during the PM peak hour.
- Review of SimTraffic network simulations indicates acceptable traffic operations during both peak periods. Minor vehicle queues (1-6 vehicles) were observed at the eastbound and westbound approaches; however, these vehicle queues were serviced within each cycle length.

Livernois Road & Horizon Court:

- The eastbound approach currently operates at LOS E during the AM peak hour.
- Review of network simulations indicates acceptable traffic operations during the AM and PM peak periods. Eastbound egress vehicles were observed to find adequate gaps in traffic along Livernois Road and experienced minimal delays

Table 1: Existing Intersection Operations

| Intersection | Control | Approach | Existing Conditions | | | |
|--------------|--------------|----------------|-----------------------|----------|-----------------------|----------|
| | | | AM Peak Delay (s/veh) | LOS | PM Peak Delay (s/veh) | LOS |
| 1 | Signalized | EBL | 53.1 | D | 58.2 | E |
| | | EBTR | 45.2 | D | 51.6 | D |
| | | WBL | 54.2 | D | 54.6 | D |
| | | WBTR | 52.1 | D | 62.1 | E |
| | | NBL | 13.4 | B | 6.0 | A |
| | | NBTR | 6.2 | A | 8.9 | A |
| | | SBL | 8.8 | A | 17.8 | B |
| | | SBT | 8.3 | A | 4.6 | A |
| | | SBR | 3.3 | A | 2.1 | A |
| | | Overall | 13.9 | B | 11.6 | B |
| 2 | Stop (Minor) | EB | 36.5 | E | 24.2 | C |
| | | NB LT | 10.8 | B | 0.0* | A |
| | | SB | Free | | Free | |

* Indicates no vehicle volume present

Table 2: Existing Vehicle Queues (feet)

| Intersection | Control | Approach | Existing Conditions | | | | |
|--------------|-------------------------------------|--------------|---------------------|--------|---------|--------|-----|
| | | | AM Peak | | PM Peak | | |
| | | | Avg. | 95th % | Avg. | 95th % | |
| 1 | Livernois Road & Drexelgate Parkway | Signalized | EBL | 1 | 11 | 5 | 22 |
| | | | EBTR | 3 | 19 | 9 | 28 |
| | | | WBL | 97 | 167 | 44 | 92 |
| | | | WBTR | 48 | 89 | 68 | 121 |
| | | | NBL | 21 | 60 | 0 | 6 |
| | | | NBTR | 104 | 204 | 202 | 391 |
| | | | SBL | 24 | 81 | 53 | 123 |
| | | | SBT | 150 | 277 | 84 | 181 |
| 2 | Livernois Road & Horizon Court | Stop (Minor) | EB | 3 | 17 | 12 | 42 |
| | | | NB LT | 4 | 21 | 0* | 0* |
| | | | SB | Free | | Free | |

* Indicates no vehicle volume present

3.2 BACKGROUND CONDITIONS

In order to determine the applicable traffic growth rate for the existing traffic volumes to the project buildout year of 2024, historical traffic data and community profiles in Rochester Hills were obtained. Historical traffic volume data indicates that traffic volumes have a stagnant or negative growth trend in recent years. Therefore, population and employment projections from 2015 to 2045 were obtained from the Southeast Michigan Council of Governments (SEMCOG) and show an average annual growth of 0.26% and 0.30%, respectively. Therefore, a conservative background growth rate of **0.5%** per year was assumed for this study in the analysis of background conditions *without the proposed development*.

In addition to background growth, it is important to account for traffic that will be generated by approved developments within the vicinity of the study area that have yet to be constructed or are currently under construction. No background developments were identified near the study area that are expected to be completed prior to the site buildout of the proposed development. Background peak hour traffic volumes are shown in **Figure 4**.

3.3 BACKGROUND OPERATIONS

Background peak hour vehicle delays and LOS were calculated based on the existing lane use and traffic control shown on **Figure 2**, the background traffic volumes shown on **Figure 4**, and the methodologies presented in the HCM (6th Edition). The results of the analysis of background conditions and vehicle queues are presented in **Appendix C** and are summarized in **Table 3** and **Table 4**, respectively.

The results of the background conditions analysis indicate that all study intersection approaches and movements will continue to operate in a manner similar to existing conditions. Review of the network simulations indicates that background traffic conditions will operate acceptably during both peak periods, similar to the existing conditions observations.

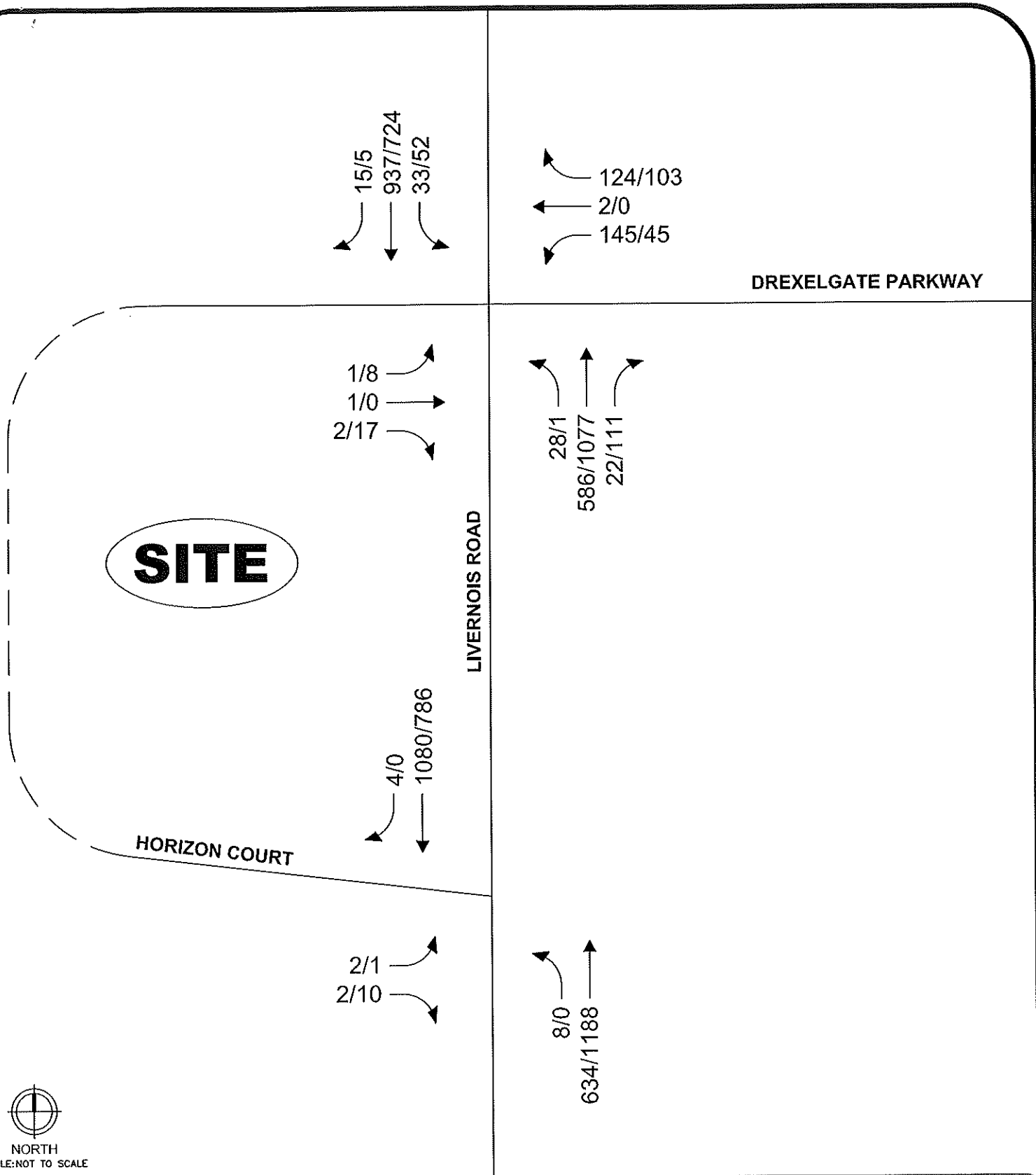


FIGURE 4
BACKGROUND TRAFFIC VOLUMES

ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI

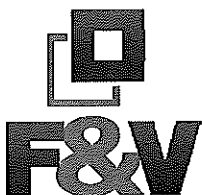


Table 3: Background Intersection Operations

| Intersection | Control | Approach | Existing Conditions | | | | Background Conditions | | | |
|------------------------------------------|--------------|----------------|---------------------|----------|---------------|----------|-----------------------|----------|---------------|----------|
| | | | AM Peak | | PM Peak | | AM Peak | | PM Peak | |
| | | | Delay (s/veh) | LOS | Delay (s/veh) | LOS | Delay (s/veh) | LOS | Delay (s/veh) | LOS |
| 1 Livernois Road & Drexelgate Parkway | Signalized | EBL | 53.1 | D | 58.2 | E | 53.0 | D | 58.2 | E |
| | | EBTR | 45.2 | D | 51.6 | D | 45.0 | D | 51.3 | D |
| | | WBL | 54.2 | D | 54.6 | D | 54.1 | D | 54.4 | D |
| | | WBTR | 52.1 | D | 62.1 | E | 51.8 | D | 62.1 | E |
| | | NBL | 13.4 | B | 6.0 | A | 14.4 | B | 6.3 | A |
| | | NBTR | 6.2 | A | 8.9 | A | 6.5 | A | 9.6 | A |
| | | SBL | 8.8 | A | 17.8 | B | 9.3 | A | 20.0 | C |
| | | SBT | 8.3 | A | 4.6 | A | 8.8 | A | 4.9 | A |
| | | SBR | 3.3 | A | 2.1 | A | 3.4 | A | 2.1 | A |
| | | Overall | 13.9 | B | 11.6 | B | 14.3 | B | 12.2 | B |
| 2 Livernois Road & Horizon Court | Stop (Minor) | EB | 36.5 | E | 24.2 | C | 38.5 | E | 25.4 | D |
| | | NB LT | 10.8 | B | 0.0* | A | 11.0 | B | 0.0* | A |
| | | SB | Free | | Free | | Free | | Free | |

* Indicates no vehicle volume present

Table 4: Background Vehicle Queues (feet)

| Intersection | Control | Approach | Existing Conditions | | | | Background Conditions | | | |
|------------------------------------------|--------------|----------|---------------------|--------|---------|--------|-----------------------|--------|---------|--------|
| | | | AM Peak | | PM Peak | | AM Peak | | PM Peak | |
| | | | Avg. | 95th % | Avg. | 95th % | Avg. | 95th % | Avg. | 95th % |
| 1 Livernois Road & Drexelgate Parkway | Signalized | EBL | 1 | 11 | 5 | 22 | 1 | 9 | 5 | 23 |
| | | EBTR | 3 | 19 | 9 | 28 | 4 | 22 | 10 | 30 |
| | | WBL | 97 | 167 | 44 | 92 | 97 | 175 | 39 | 80 |
| | | WBTR | 48 | 89 | 68 | 121 | 45 | 80 | 65 | 121 |
| | | NBL | 21 | 60 | 0 | 6 | 21 | 67 | 0 | 0 |
| | | NBTR | 104 | 204 | 202 | 391 | 100 | 200 | 229 | 448 |
| | | SBL | 24 | 81 | 53 | 123 | 21 | 50 | 58 | 126 |
| | | SBT | 150 | 277 | 84 | 181 | 153 | 289 | 80 | 187 |
| | | SBR | 5 | 51 | 1 | 9 | 2 | 14 | 1 | 6 |
| 2 Livernois Road & Horizon Court | Stop (Minor) | EB | 3 | 17 | 12 | 42 | 4 | 21 | 12 | 43 |
| | | NB LT | 4 | 21 | 0* | 0* | 5 | 23 | 0* | 0* |
| | | SB | Free | | Free | | Free | | Free | |

* Indicates no vehicle volume present

3.4 SITE TRIP GENERATION

The number of AM and PM peak hour vehicle trips that would be generated by the proposed development was forecast based on data published by ITE in the *Trip Generation Manual, 10th Edition* and the *ITE Trip Generation Handbook, 3rd Edition*. The proposed development includes the addition of 99,630 SF of additional office space and 51,580 SF of additional warehouse space. The site trip generation forecast was reviewed by the City for use in this analysis and is summarized in **Table 5**.

Table 5: Site Trip Generation Summary

| Land Use | ITE Code | Amount | Units | Average Daily Traffic (vpd) | AM Peak Hour (vph) | | | PM Peak Hour (vph) | | |
|-------------------------|----------|--------|-------|-----------------------------|--------------------|-----------|------------|--------------------|------------|------------|
| | | | | | In | Out | Total | In | Out | Total |
| General Office Building | 710 | 99,630 | SF | 1,057 | 103 | 17 | 120 | 18 | 95 | 113 |
| Warehousing | 150 | 51,580 | SF | 127 | 25 | 7 | 32 | 9 | 25 | 34 |
| Total Trips | | | | 1,184 | 128 | 24 | 152 | 27 | 120 | 147 |

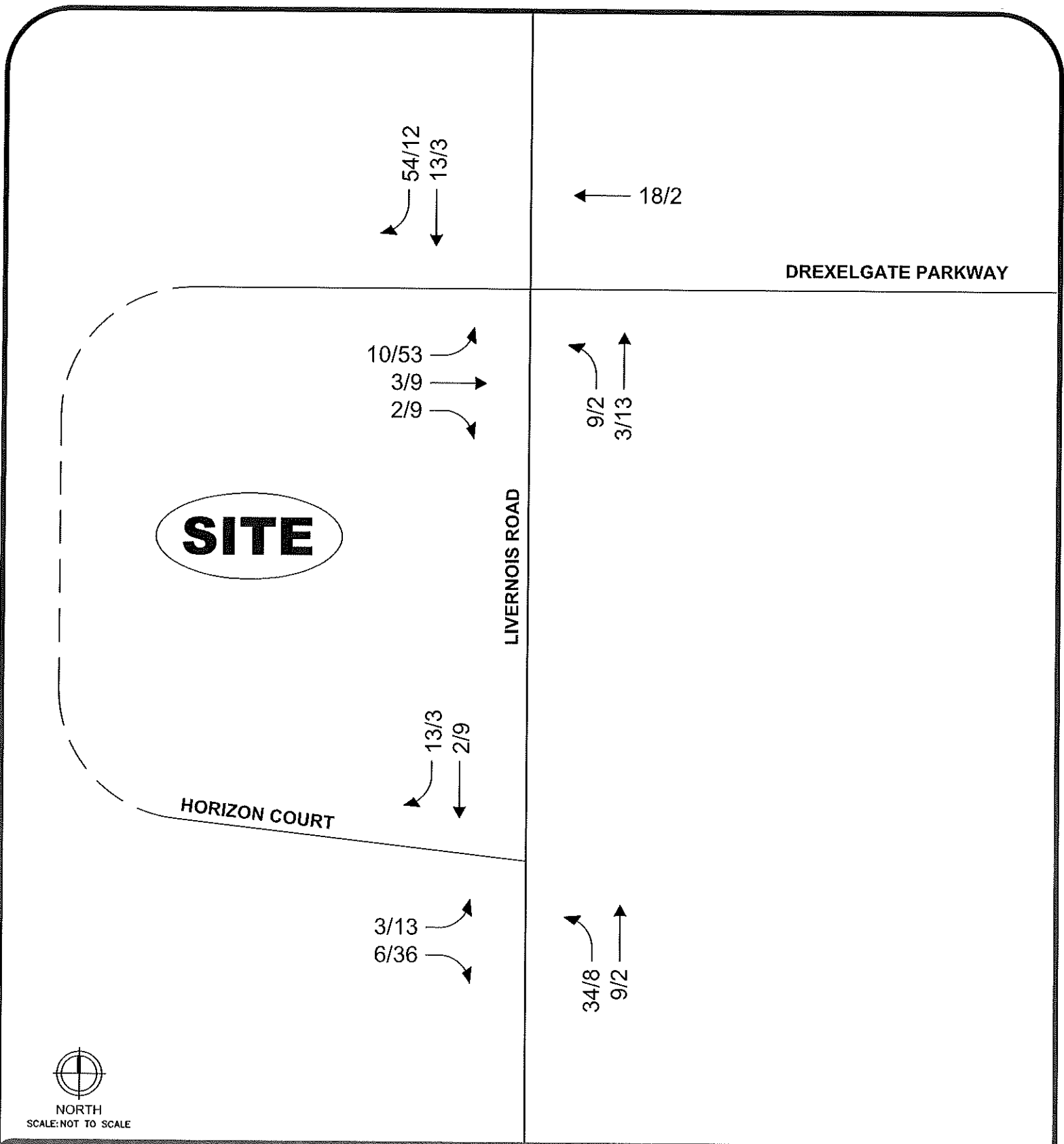
3.5 SITE TRIP DISTRIBUTION

The vehicular trips that would be generated by the proposed development were assigned to the study roads based on existing peak hour traffic patterns in the adjacent roadway network and the methodologies published by ITE. To determine trips distribution for office developments using the adjacent street traffic it is assumed that the trips in the AM are home-to-work based trips, and in the PM are work-to-home based trips. Therefore, the global trip generation is based on trips in the AM entering the study network and traveling to the development and exiting the study network in the PM. The ITE trip distribution methodology assumes that new trips will return to their direction of origin. The site trip distributions used in the analysis are summarized in **Table 6**.

Table 6: Site Trip Distribution Summary

| To/From | Via | AM | PM |
|--------------|--------------------|-------------|-------------|
| North | Livernois Road | 52% | 55% |
| South | Livernois Road | 34% | 37% |
| East | Drexelgate Parkway | 14% | 8% |
| Total | | 100% | 100% |

The site-generated traffic volumes in **Table 5** were distributed to the adjacent roadway network based on the distribution shown in **Table 6**. The site generated traffic volumes, as shown on **Figure 5**, were added to the background traffic volumes to calculate the future traffic volumes with the proposed development. Future traffic volumes are provided in **Figure 6**.



NORTH
SCALE: NOT TO SCALE

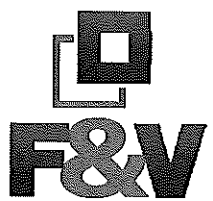


FIGURE 5 SITE-GENERATED TRAFFIC VOLUMES

ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

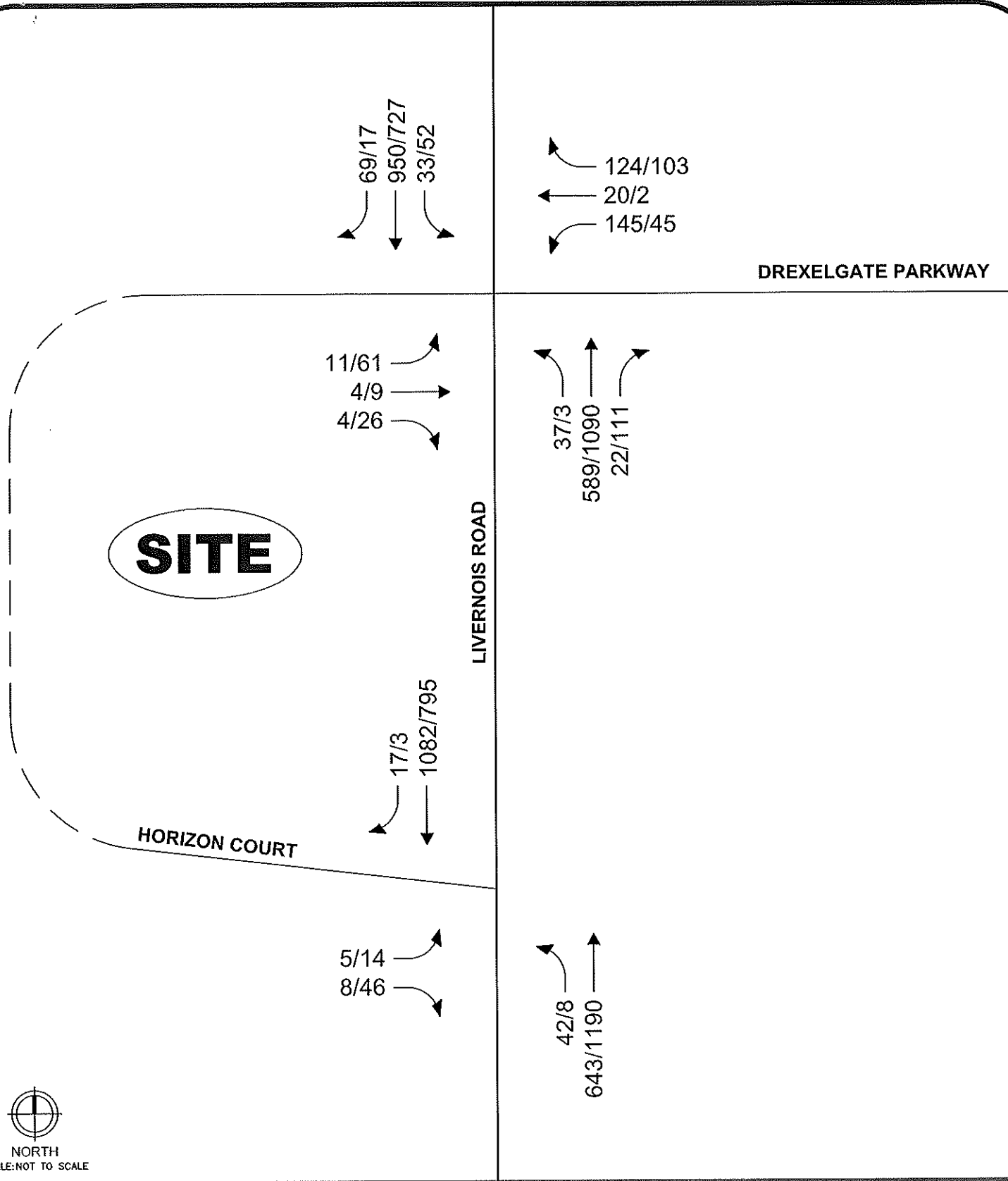
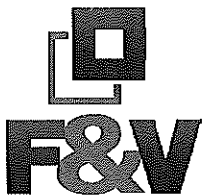


FIGURE 6 FUTURE TRAFFIC VOLUMES

ROCHESTER RESEARCH PARK TIS - ROCHESTER HILLS, MI



LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

3.6 FUTURE CONDITIONS

Future peak hour vehicle delays and LOS **with the proposed development** were calculated based on the existing lane use and traffic control shown on **Figure 2**, the proposed site access plan, the future traffic volumes shown on **Figure 6**, and the methodologies presented in the HCM 6th. The results of the future conditions analysis and vehicle queues are presented in **Appendix D** and are summarized in **Table 7** and **Table 8**, respectively.

The results of the future conditions analysis indicate that all study intersection approaches and movements are expected to operate acceptably, at a LOS D or better, with exception of the following:

Livernois Road & Drexelgate Parkway:

- The eastbound left-turn movement is expected to operate at LOS E during the PM peak hour.
- Review of SimTraffic network simulations indicates acceptable traffic operations during both peak periods. Minor vehicle queues (4-5 vehicles) were present at the eastbound approach; however, these vehicle queues were observed to be serviced within each cycle length.

Livernois Road & Horizon Court:

- The eastbound approach is expected to operate at LOS F during the PM peak hour. Additionally, the eastbound approach will continue to operate at LOS E during the AM peak hour.
- Review of network simulations indicates acceptable traffic operations during the AM and PM peak periods. Eastbound egress vehicles were observed to find adequate gaps in traffic along Livernois Road and experienced minimal delays.
 - Although a failing LOS is reported for the eastbound approach during the PM peak period, microsimulations indicate acceptable operations. Therefore, it is recommended to monitor this intersection after the development is completed and occupied; in order to determine if mitigation measures are necessary.

Table 7: Future Intersection Operations

| Intersection | Control | Approach | Background Conditions | | | | Future Conditions | | | |
|------------------------------------------|--------------|----------------|-----------------------|----------|---------------|----------|-------------------|----------|---------------|----------|
| | | | AM Peak | | PM Peak | | AM Peak | | PM Peak | |
| | | | Delay (s/veh) | LOS | Delay (s/veh) | LOS | Delay (s/veh) | LOS | Delay (s/veh) | LOS |
| 1 Livernois Road & Drexelgate Parkway | Signalized | EBL | 53.0 | D | 58.2 | E | 54.9 | D | 57.5 | E |
| | | EBTR | 45.0 | D | 51.3 | D | 44.6 | D | 46.6 | D |
| | | WBL | 54.1 | D | 54.4 | D | 53.9 | D | 49.6 | D |
| | | WBTR | 51.8 | D | 62.1 | E | 52.0 | D | 50.5 | D |
| | | NBL | 14.4 | B | 6.3 | A | 16.4 | B | 9.8 | A |
| | | NBTR | 6.5 | A | 9.6 | A | 6.9 | A | 14.6 | B |
| | | SBL | 9.3 | A | 20.0 | C | 9.9 | A | 32.3 | C |
| | | SBT | 8.8 | A | 4.9 | A | 9.4 | A | 7.1 | A |
| | | SBR | 3.4 | A | 2.1 | A | 3.7 | A | 3.3 | A |
| | | Overall | 14.3 | B | 12.2 | B | 15.2 | B | 16.4 | B |
| 2 Livernois Road & Horizon Court | Stop (Minor) | EB | 38.5 | E | 25.4 | D | 44.7 | E | 57.6 | F |
| | | NB LT | 11.0 | B | 0.0* | A | 11.5 | B | 9.9 | A |
| | | SB | Free | | Free | | Free | | Free | |

* Indicates no vehicle volume present

** Improved LOS on minor approaches is the result of higher ratio of vehicles arriving on a green light

Table 8: Future Vehicle Queues (feet)

| Intersection | Control | Approach | Background Conditions | | | | Future Conditions | | | |
|------------------------------------------|--------------|----------|-----------------------|--------|---------|--------|-------------------|--------|---------|--------|
| | | | AM Peak | | PM Peak | | AM Peak | | PM Peak | |
| | | | Avg. | 95th % | Avg. | 95th % | Avg. | 95th % | Avg. | 95th % |
| 1 Livernois Road & Drexelgate Parkway | Signalized | EBL | 1 | 9 | 5 | 23 | 11 | 40 | 54 | 113 |
| | | EBTR | 4 | 22 | 10 | 30 | 8 | 31 | 21 | 51 |
| | | WBL | 97 | 175 | 39 | 80 | 100 | 176 | 34 | 73 |
| | | WBTR | 45 | 80 | 65 | 121 | 66 | 128 | 72 | 128 |
| | | NBL | 21 | 67 | 0 | 0 | 35 | 98 | 3 | 30 |
| | | NBTR | 100 | 200 | 229 | 448 | 120 | 230 | 305 | 590 |
| | | SBL | 21 | 50 | 58 | 126 | 18 | 44 | 56 | 119 |
| | | SBT | 153 | 289 | 80 | 187 | 173 | 326 | 104 | 206 |
| 2 Livernois Road & Horizon Court | Stop (Minor) | SBR | 2 | 14 | 1 | 6 | 20 | 96 | 3 | 18 |
| | | EB | 4 | 21 | 12 | 43 | 11 | 38 | 46 | 108 |
| | | NB LT | 5 | 23 | 0* | 0* | 23 | 54 | 4 | 20 |
| | | SB | Free | | Free | | Free | | Free | |

* Indicates no vehicle volume present

3.7 SIGNAL WARRANT ANALYSIS

A signal warrant analysis was performed at the study intersection of Livernois Road & Horizon Court, with the addition of the site generated traffic. The *Michigan Manual on Uniform Traffic Control Devices (MMUTCD)* documents eight warrants by which traffic signal control may or should be considered. Warrant 1 (8-Hour Vehicular Volume), Warrant 2 (4-Hour Vehicular Volume) and Warrant 3 (Peak-Hour) were evaluated for this study using the four hours of traffic volume data collected.

The site-generated hourly traffic volumes used in this signal warrant analysis were determined based on hourly variations in daily traffic data published by ITE in *Trip Generation, 10th Edition*. The corresponding hourly volumes for the Warehouse (LUC #150) and the General Office Building (LUC #710) land uses were projected and combined with the background traffic volumes to provide 4-hours of traffic volume data with the proposed development. The global distribution for the site-generated traffic was determined based on the adjacent street traffic volumes. The ingress/egress percentages provided in the ITE *Trip Generation Manual* for the AM and PM peak hour of the adjacent street were also utilized.

Table 9: Future Signal Warrant Analysis Summary

| Livernois Road and Horizon Court | | |
|----------------------------------|-------------|-----------|
| Warrant 1: Eight-Hour | Hours Met | 0 |
| | Warrant Met | NO |
| Warrant 2: Four-Hour | Hours Met | 0 |
| | Warrant Met | NO |
| Warrant 3: Peak-Hour | Hours Met | 0 |
| | Warrant Met | NO |

The results of the signal warrant evaluation indicate that, with the addition of the site generated traffic, the future traffic volumes **do not meet** the thresholds to satisfy Warrant 2 or Warrant 3. Furthermore, a preliminary evaluation of Warrant 1: 8-Hour Volumes shows that 0 hours are met. If Warrant 1 was close to meeting the thresholds, it would be expected to see the four highest hours evaluated met. However, since 0 hours were met, it is not expected that four additional hours of off-peak traffic volumes will exceed the thresholds.

4 CONCLUSIONS

The conclusions of this TIS are as follows:

1. The results of the existing conditions analysis show that all study intersection approaches and movements currently operate acceptably at a LOS D or better during the AM and PM peak periods, with exception of the following:
 - The eastbound left-turn and westbound through/right movements, at the signalized intersection of Livernois Road and Drexelgate Parkway, currently operate at LOS E during the PM peak hour.
 - The eastbound approach at the intersection of Livernois Road and Horizon Court currently operates at LOS E during the AM peak hour.
2. The background traffic operations **without the proposed development** will continue to operate acceptably, in a manner similar to existing conditions.
3. In future conditions **with the proposed development**, the study intersections are expected to operate acceptably, in a manner similar to background conditions.
 - The eastbound approach at the intersection of Livernois Road and Horizon Court is expected to operate at LOS F during the PM peak period.
 - Network simulations indicate acceptable operations, with egress vehicles able to find adequate gaps in traffic along Livernois Road. Egress vehicle queues of approximately 4-5 vehicles are expected at this intersection during the PM peak hour, which is not significant.
4. A traffic signal warrant analysis was performed for the intersection of Livernois Road & Horizon Court, with the addition of the site-generated traffic. The results of the analysis indicate that a signal **is not warranted**.

5 RECOMMENDATIONS

The recommendations of this TIS are as follows:

1. The results of the analysis show that the existing intersection geometry and operations can adequately accommodate the projected site generated traffic volume. No off-site improvements are recommended.

Appendix A

BACKGROUND INFORMATION

Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 4BT NE

File Name : TMC_1 Livernois & Drexelgate_3-21-19
 Site Code : TMC_1
 Start Date : 3/21/2019
 Page No : 1

4 Hour traffic study was conducted during typical weekday (Tuesday) from 7:00 AM - 9:00 AM morning & 4:00 PM - 6:00 PM afternoon peak hours, while school was in session.

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds

| Start Time | Livernois Road Southbound | | | | | Drexelgate Pkwy. Westbound | | | | | Livernois Road Northbound | | | | | Business 1400 Livernois Eastbound | | | | | Int. Total |
|-----------------------|---------------------------|-------------|-------------|----------|-------------|----------------------------|------------|-------------|------------|-------------|---------------------------|-------------|------------|----------|-------------|-----------------------------------|------------|-------------|------------|-------------|-------------|
| | Right | Thru | Left | Peds | App. Total | Right | Thru | Left | Peds | App. Total | Right | Thru | Left | Peds | App. Total | Right | Thru | Left | Peds | App. Total | |
| 07:00 AM | 4 | 201 | 10 | 0 | 215 | 39 | 0 | 31 | 0 | 70 | 9 | 177 | 3 | 0 | 189 | 0 | 0 | 0 | 0 | 0 | 474 |
| 07:15 AM | 4 | 236 | 9 | 0 | 249 | 35 | 1 | 35 | 0 | 71 | 2 | 129 | 1 | 0 | 132 | 2 | 0 | 0 | 0 | 0 | 454 |
| 07:30 AM | 3 | 244 | 6 | 0 | 253 | 20 | 0 | 35 | 2 | 57 | 4 | 115 | 7 | 0 | 126 | 0 | 1 | 1 | 0 | 0 | 438 |
| 07:45 AM | 4 | 231 | 7 | 0 | 242 | 27 | 1 | 40 | 0 | 68 | 6 | 147 | 16 | 0 | 169 | 0 | 0 | 0 | 0 | 0 | 479 |
| Total | 15 | 912 | 32 | 0 | 959 | 121 | 2 | 141 | 2 | 266 | 21 | 568 | 27 | 0 | 616 | 2 | 1 | 1 | 0 | 4 | 1845 |
| 08:00 AM | 1 | 220 | 8 | 0 | 229 | 16 | 0 | 45 | 0 | 61 | 13 | 106 | 11 | 0 | 130 | 0 | 0 | 0 | 0 | 0 | 420 |
| 08:15 AM | 0 | 209 | 9 | 0 | 218 | 17 | 0 | 39 | 0 | 56 | 11 | 135 | 2 | 0 | 148 | 0 | 0 | 0 | 0 | 0 | 422 |
| 08:30 AM | 0 | 198 | 5 | 0 | 203 | 24 | 0 | 47 | 0 | 71 | 4 | 155 | 0 | 0 | 159 | 1 | 0 | 0 | 0 | 0 | 434 |
| 08:45 AM | 1 | 166 | 6 | 0 | 173 | 21 | 0 | 24 | 0 | 45 | 5 | 145 | 1 | 0 | 151 | 0 | 0 | 0 | 0 | 0 | 369 |
| Total | 2 | 793 | 28 | 0 | 823 | 78 | 0 | 155 | 0 | 233 | 33 | 541 | 14 | 0 | 588 | 1 | 0 | 0 | 0 | 1 | 1645 |
| *** BREAK *** | | | | | | | | | | | | | | | | | | | | | |
| 04:00 PM | 2 | 145 | 14 | 0 | 161 | 29 | 0 | 7 | 0 | 36 | 12 | 235 | 0 | 0 | 247 | 2 | 0 | 3 | 0 | 5 | 449 |
| 04:15 PM | 2 | 162 | 4 | 0 | 168 | 18 | 0 | 16 | 0 | 34 | 25 | 238 | 0 | 0 | 263 | 9 | 1 | 1 | 0 | 11 | 476 |
| 04:30 PM | 0 | 143 | 17 | 0 | 160 | 25 | 0 | 11 | 0 | 36 | 17 | 272 | 0 | 0 | 289 | 8 | 2 | 5 | 0 | 15 | 500 |
| 04:45 PM | 0 | 172 | 12 | 0 | 184 | 27 | 0 | 11 | 0 | 38 | 19 | 271 | 1 | 0 | 291 | 5 | 0 | 2 | 0 | 7 | 520 |
| Total | 4 | 622 | 47 | 0 | 673 | 99 | 0 | 45 | 0 | 144 | 73 | 1016 | 1 | 0 | 1090 | 24 | 3 | 11 | 0 | 38 | 1945 |
| 05:00 PM | 2 | 209 | 10 | 0 | 221 | 24 | 0 | 10 | 0 | 34 | 26 | 251 | 0 | 0 | 277 | 4 | 0 | 2 | 1 | 7 | 539 |
| 05:15 PM | 0 | 151 | 18 | 0 | 169 | 23 | 0 | 12 | 0 | 35 | 30 | 266 | 0 | 0 | 296 | 2 | 0 | 1 | 0 | 3 | 503 |
| 05:30 PM | 3 | 168 | 11 | 0 | 182 | 26 | 0 | 11 | 3 | 40 | 33 | 262 | 0 | 0 | 295 | 6 | 0 | 3 | 0 | 9 | 526 |
| 05:45 PM | 0 | 159 | 13 | 0 | 172 | 32 | 0 | 13 | 0 | 45 | 27 | 249 | 0 | 0 | 276 | 2 | 0 | 2 | 0 | 4 | 497 |
| Total | 5 | 687 | 52 | 0 | 744 | 105 | 0 | 46 | 3 | 154 | 116 | 1028 | 0 | 0 | 1144 | 14 | 0 | 8 | 1 | 23 | 2065 |
| Grand Total | 26 | 3014 | 159 | 0 | 3199 | 403 | 2 | 387 | 5 | 797 | 243 | 3153 | 42 | 0 | 3438 | 41 | 4 | 20 | 1 | 66 | 7500 |
| Apprch % | 0.8 | 94.2 | 5 | 0 | | 50.6 | 0.3 | 48.6 | 0.6 | | 7.1 | 91.7 | 1.2 | 0 | | 62.1 | 6.1 | 30.3 | 1.5 | | |
| Total % | 0.3 | 40.2 | 2.1 | 0 | 42.7 | 5.4 | 0 | 5.2 | 0.1 | 10.6 | 3.2 | 42 | 0.6 | 0 | 45.8 | 0.5 | 0.1 | 0.3 | 0 | 0.9 | |
| Pass Cars | 24 | 2968 | 156 | 0 | 3148 | 397 | 2 | 382 | 0 | 781 | 240 | 3092 | 42 | 0 | 3374 | 40 | 3 | 20 | 0 | 63 | 7366 |
| % Pass Cars | 92.3 | 98.5 | 98.1 | 0 | 98.4 | 98.5 | 100 | 98.7 | 0 | 98 | 98.8 | 98.1 | 100 | 0 | 98.1 | 97.6 | 75 | 100 | 0 | 95.5 | 98.2 |
| Single Units | 1 | 39 | 3 | 0 | 43 | 6 | 0 | 4 | 0 | 10 | 3 | 53 | 0 | 0 | 56 | 1 | 1 | 0 | 0 | 2 | 111 |
| % Single Units | 3.8 | 1.3 | 1.9 | 0 | 1.3 | 1.5 | 0 | 1 | 0 | 1.3 | 1.2 | 1.7 | 0 | 0 | 1.6 | 2.4 | 25 | 0 | 0 | 3 | 1.5 |
| Heavy Trucks | 1 | 7 | 0 | 0 | 8 | 0 | 0 | 1 | 0 | 1 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 17 |
| % Heavy Trucks | 3.8 | 0.2 | 0 | 0 | 0.3 | 0 | 0 | 0.3 | 0 | 0.1 | 0 | 0.3 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.2 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 1.5 | 0.1 |

TDC Traffic Comments: SCATS signalized intersection, with ped. signals for north & east legs. Push buttons for north leg. Video VCU camera was located within NE intersection quadrant. Note: Peds. are excluded from peak hour reports. Traffic study was performed for City of Rochester Hills Design Haus / Rochester Hills Research Park Traffic Impact Study for Fleis & Vandenbrink.

Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

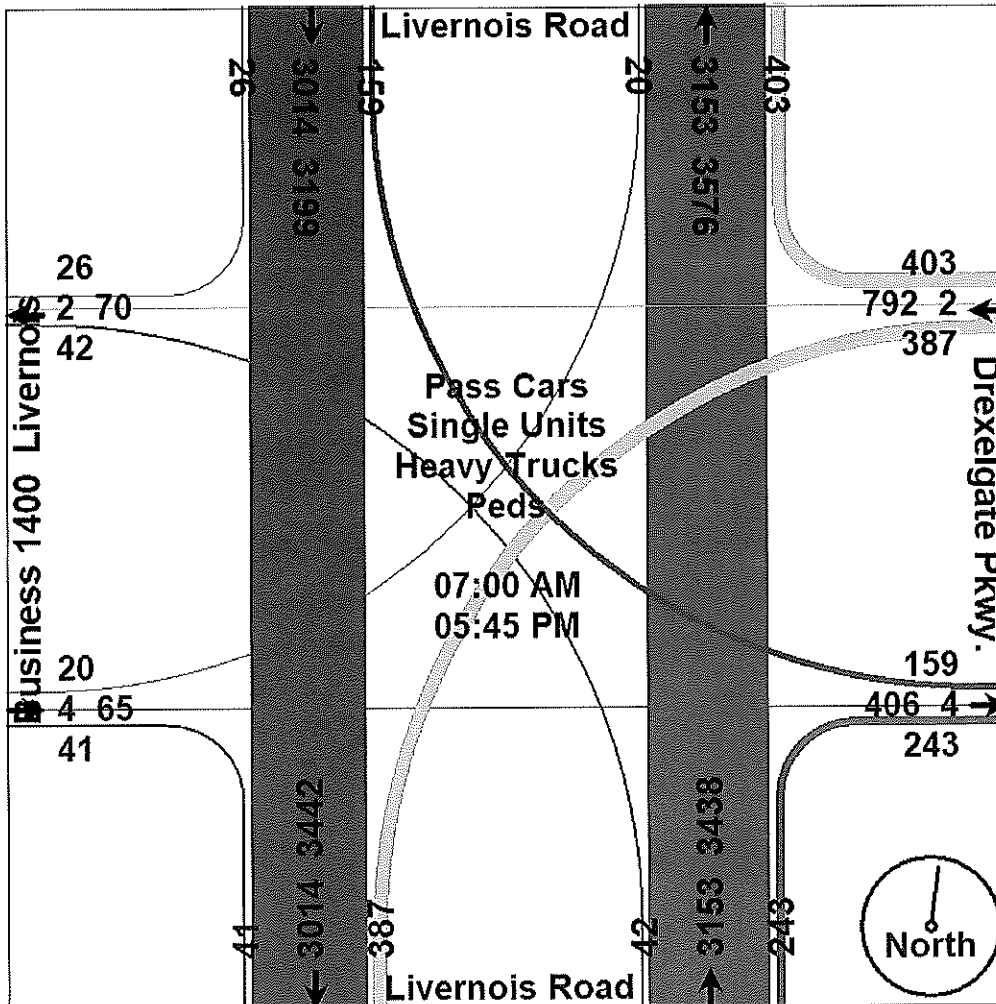
Traffic Study Performed For:

Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
Study: 4 Hr. Video Turning Movement Count
Weather: Sunny/Cldy. Deg's 30s
Count By: Miovision Video VCU 4BT NE

File Name : TMC_1 Livernois & Drexelgate_3-21-19
Site Code : TMC_1
Start Date : 3/21/2019
Page No : 2



Traffic Data Collection, LLC

www:tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

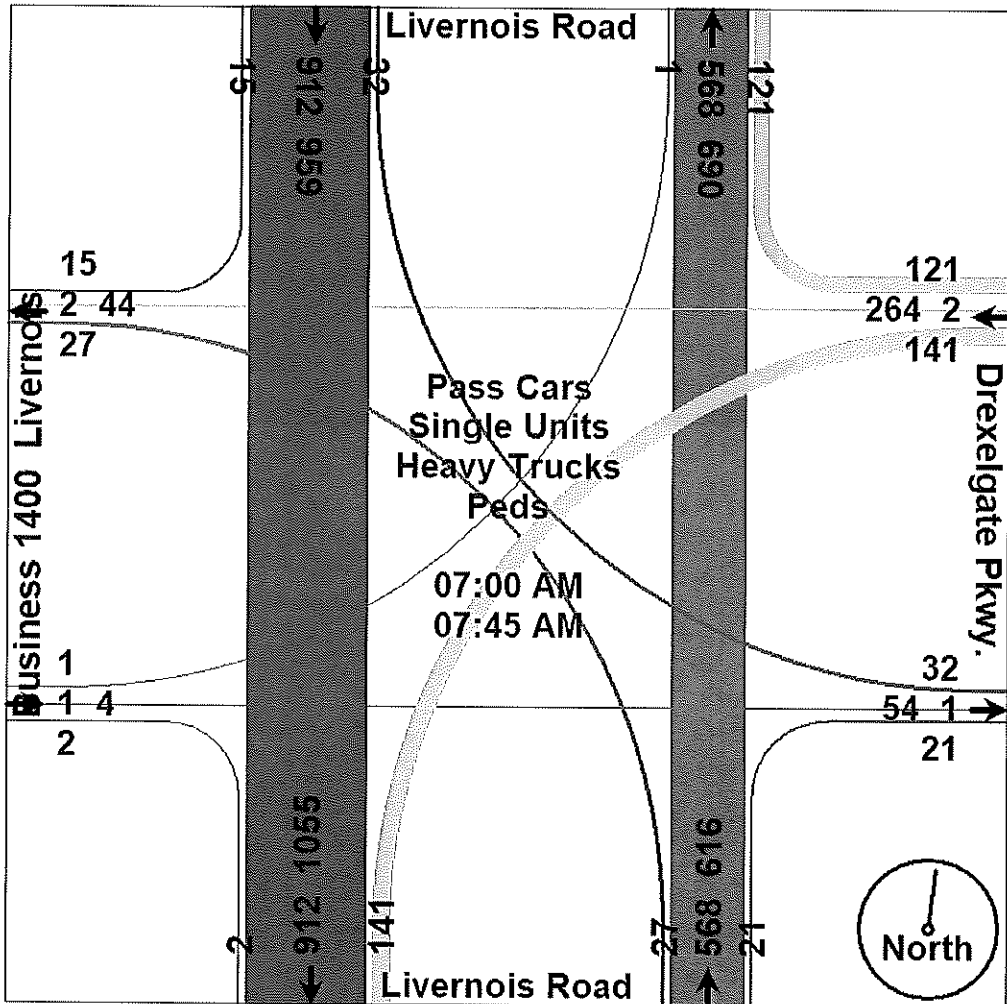
Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 4BT NE

File Name : TMC_1 Livernois & Drexelgate_3-21-19
 Site Code : TMC_1
 Start Date : 3/21/2019
 Page No : 3

| Start Time | Livernois Road Southbound | | | | Drexelgate Pkwy. Westbound | | | | Livernois Road Northbound | | | | Business 1400 Livernois Eastbound | | | | Int. Total |
|------------------------------------------------------------|---------------------------|------|------|------------|----------------------------|------|------|------------|---------------------------|------|------|------------|-----------------------------------|------|------|------------|------------|
| | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | |
| Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:00 AM | | | | | | | | | | | | | | | | | |
| 07:00 AM | 4 | 201 | 10 | 215 | 39 | 0 | 31 | 70 | 9 | 177 | 3 | 189 | 0 | 0 | 0 | 0 | 474 |
| 07:15 AM | 4 | 236 | 9 | 249 | 35 | 1 | 35 | 71 | 2 | 129 | 1 | 132 | 2 | 0 | 0 | 2 | 454 |
| 07:30 AM | 3 | 244 | 6 | 253 | 20 | 0 | 35 | 55 | 4 | 115 | 7 | 126 | 0 | 1 | 1 | 2 | 436 |
| 07:45 AM | 4 | 231 | 7 | 242 | 27 | 1 | 40 | 68 | 6 | 147 | 16 | 169 | 0 | 0 | 0 | 0 | 479 |
| Total Volume | 15 | 912 | 32 | 959 | 121 | 2 | 141 | 264 | 21 | 568 | 27 | 616 | 2 | 1 | 1 | 4 | 1843 |
| % App. Total | 1.6 | 95.1 | 3.3 | | 45.8 | 0.8 | 53.4 | | 3.4 | 92.2 | 4.4 | | 50 | 25 | 25 | | |
| PHF | .938 | .934 | .800 | .948 | .776 | .500 | .881 | .930 | .583 | .802 | .422 | .815 | .250 | .250 | .250 | .500 | .962 |
| Pass Cars | 13 | 905 | 31 | 949 | 120 | 2 | 141 | 263 | 21 | 555 | 27 | 603 | 2 | 0 | 1 | 3 | 1818 |
| % Pass Cars | 86.7 | 99.2 | 96.9 | 99.0 | 99.2 | 100 | 100 | 99.6 | 100 | 97.7 | 100 | 97.9 | 100 | 0 | 100 | 75.0 | 98.6 |
| Single Units | 1 | 6 | 1 | 8 | 1 | 0 | 0 | 1 | 0 | 11 | 0 | 11 | 0 | 1 | 0 | 1 | 21 |
| % Single Units | 6.7 | 0.7 | 3.1 | 0.8 | 0.8 | 0 | 0 | 0.4 | 0 | 1.9 | 0 | 1.8 | 0 | 100 | 0 | 25.0 | 1.1 |
| Heavy Trucks | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| % Heavy Trucks | 6.7 | 0.1 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0.2 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

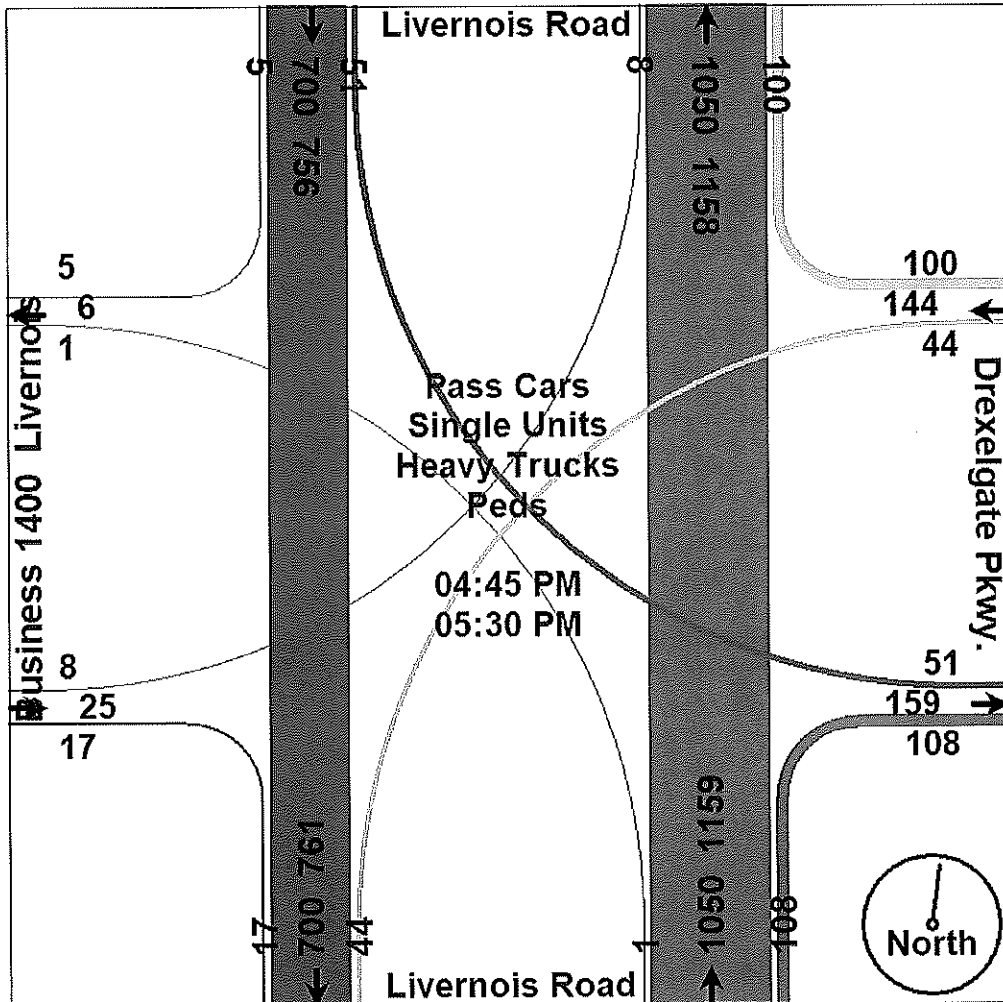
Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 4BT NE

File Name : TMC_1 Livernois & Drexelgate_3-21-19
 Site Code : TMC_1
 Start Date : 3/21/2019
 Page No : 4

| Start Time | Livernois Road Southbound | | | | Drexelgate Pkwy. Westbound | | | | Livernois Road Northbound | | | | Business 1400 Livernois Eastbound | | | | Int. Total |
|------------------------------------------------------------|---------------------------|------|------|------------|----------------------------|------|------|------------|---------------------------|------|------|------------|-----------------------------------|------|------|------------|------------|
| | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | Right | Thru | Left | App. Total | |
| Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 04:45 PM | | | | | | | | | | | | | | | | | |
| 04:45 PM | 0 | 172 | 12 | 184 | 27 | 0 | 11 | 38 | 19 | 271 | 1 | 291 | 5 | 0 | 2 | 7 | 520 |
| 05:00 PM | 2 | 209 | 10 | 221 | 24 | 0 | 10 | 34 | 26 | 251 | 0 | 277 | 4 | 0 | 2 | 6 | 538 |
| 05:15 PM | 0 | 151 | 18 | 169 | 23 | 0 | 12 | 35 | 30 | 266 | 0 | 296 | 2 | 0 | 1 | 3 | 503 |
| 05:30 PM | 3 | 168 | 11 | 182 | 26 | 0 | 11 | 37 | 33 | 262 | 0 | 295 | 6 | 0 | 3 | 9 | 523 |
| Total Volume | 5 | 700 | 51 | 756 | 100 | 0 | 44 | 144 | 108 | 1050 | 1 | 1159 | 17 | 0 | 8 | 25 | 2084 |
| % App. Total | 0.7 | 92.6 | 6.7 | | 69.4 | 0 | 30.6 | | 9.3 | 90.6 | 0.1 | | 68 | 0 | 32 | | |
| PHF | .417 | .837 | .708 | .855 | .926 | .000 | .917 | .947 | .818 | .969 | .250 | .979 | .708 | .000 | .667 | .694 | .968 |
| Pass Cars | 5 | 691 | 51 | 747 | 100 | 0 | 44 | 144 | 107 | 1046 | 1 | 1154 | 17 | 0 | 8 | 25 | 2070 |
| % Pass Cars | 100 | 98.7 | 100 | 98.8 | 100 | 0 | 100 | 100 | 99.1 | 99.6 | 100 | 99.6 | 100 | 0 | 100 | 100 | 99.3 |
| Single Units | 0 | 7 | 0 | 7 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 4 | 0 | 0 | 0 | 0 | 11 |
| % Single Units | 0 | 1.0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0.9 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0.5 |
| Heavy Trucks | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| % Heavy Trucks | 0 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0.1 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



Traffic Data Collection, LLC

www:tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 2Z4 SE

File Name : TMC_2 Livernois & HorizonCt_3-21-19
 Site Code : TMC_2
 Start Date : 3/21/2019
 Page No : 1

4 Hour traffic study was conducted during typical weekday (Tuesday) from 7:00 AM - 9:00 AM morning & 4:00 PM - 6:00 PM afternoon peak hours, while school was in session.

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds

| Start Time | Livernois Road Southbound | | | | Livernois Road Northbound | | | | Horizon Court / Fire Station Eastbound | | | | Int. Total |
|----------------|---------------------------|------|------|------------|---------------------------|------|------|------------|----------------------------------------|------|------|------------|------------|
| | Right | Thru | Peds | App. Total | Thru | Left | Peds | App. Total | Right | Left | Peds | App. Total | |
| 07:00 AM | 1 | 224 | 0 | 225 | 188 | 1 | 0 | 189 | 0 | 1 | 0 | 1 | 415 |
| 07:15 AM | 1 | 277 | 0 | 278 | 133 | 0 | 0 | 133 | 2 | 0 | 0 | 2 | 413 |
| 07:30 AM | 1 | 275 | 0 | 276 | 130 | 2 | 0 | 132 | 0 | 1 | 0 | 1 | 409 |
| 07:45 AM | 1 | 277 | 0 | 278 | 167 | 5 | 0 | 172 | 0 | 0 | 0 | 0 | 450 |
| Total | 4 | 1053 | 0 | 1057 | 618 | 8 | 0 | 626 | 2 | 2 | 0 | 4 | 1687 |
| 08:00 AM | 0 | 256 | 0 | 256 | 126 | 5 | 0 | 131 | 1 | 0 | 0 | 1 | 388 |
| 08:15 AM | 0 | 253 | 0 | 253 | 146 | 1 | 0 | 147 | 1 | 0 | 0 | 1 | 401 |
| 08:30 AM | 0 | 243 | 0 | 243 | 161 | 1 | 0 | 162 | 0 | 0 | 0 | 0 | 405 |
| 08:45 AM | 3 | 188 | 0 | 191 | 150 | 2 | 0 | 152 | 1 | 0 | 0 | 1 | 344 |
| Total | 3 | 940 | 0 | 943 | 583 | 9 | 0 | 592 | 3 | 0 | 0 | 3 | 1538 |
| *** BREAK *** | | | | | | | | | | | | | |
| 04:00 PM | 0 | 155 | 0 | 155 | 251 | 1 | 0 | 252 | 2 | 2 | 0 | 4 | 411 |
| 04:15 PM | 1 | 184 | 0 | 185 | 274 | 0 | 0 | 274 | 5 | 1 | 0 | 6 | 465 |
| 04:30 PM | 0 | 161 | 0 | 161 | 282 | 2 | 0 | 284 | 0 | 0 | 0 | 0 | 445 |
| 04:45 PM | 0 | 192 | 0 | 192 | 283 | 0 | 0 | 283 | 3 | 1 | 0 | 4 | 479 |
| Total | 1 | 692 | 0 | 693 | 1090 | 3 | 0 | 1093 | 10 | 4 | 0 | 14 | 1800 |
| 05:00 PM | 0 | 225 | 0 | 225 | 270 | 0 | 0 | 270 | 1 | 0 | 1 | 2 | 497 |
| 05:15 PM | 0 | 166 | 0 | 166 | 301 | 0 | 0 | 301 | 4 | 0 | 0 | 4 | 471 |
| 05:30 PM | 0 | 184 | 0 | 184 | 285 | 0 | 0 | 285 | 2 | 0 | 0 | 2 | 471 |
| 05:45 PM | 0 | 174 | 0 | 174 | 298 | 2 | 0 | 300 | 2 | 0 | 0 | 2 | 476 |
| Total | 0 | 749 | 0 | 749 | 1154 | 2 | 0 | 1156 | 9 | 0 | 1 | 10 | 1915 |
| Grand Total | 8 | 3434 | 0 | 3442 | 3445 | 22 | 0 | 3467 | 24 | 6 | 1 | 31 | 6940 |
| Apprch % | 0.2 | 99.8 | 0 | | 99.4 | 0.6 | 0 | | 77.4 | 19.4 | 3.2 | | |
| Total % | 0.1 | 49.5 | 0 | 49.6 | 49.6 | 0.3 | 0 | 50 | 0.3 | 0.1 | 0 | 0.4 | |
| Pass Cars | 7 | 3385 | 0 | 3392 | 3383 | 16 | 0 | 3399 | 15 | 5 | 0 | 20 | 6811 |
| % Pass Cars | 87.5 | 98.6 | 0 | 98.5 | 98.2 | 72.7 | 0 | 98 | 62.5 | 83.3 | 0 | 64.5 | 98.1 |
| Single Units | 1 | 41 | 0 | 42 | 54 | 6 | 0 | 60 | 9 | 1 | 0 | 10 | 112 |
| % Single Units | 12.5 | 1.2 | 0 | 1.2 | 1.6 | 27.3 | 0 | 1.7 | 37.5 | 16.7 | 0 | 32.3 | 1.6 |
| Heavy Trucks | 0 | 8 | 0 | 8 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 16 |
| % Heavy Trucks | 0 | 0.2 | 0 | 0.2 | 0.2 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.2 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 3.2 | 0 |

TDC Traffic Comments: Emergency signalized intersection in flashing mode. Video VCU camera was located within SE intersection quadrant. Note: Peds. are excluded from peak hour reports. Traffic study was performed for City of Rochester Hills Design Haus / Rochester Hills Research Park Traffic Impact Study for Fleis & Vandenbrink.

Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

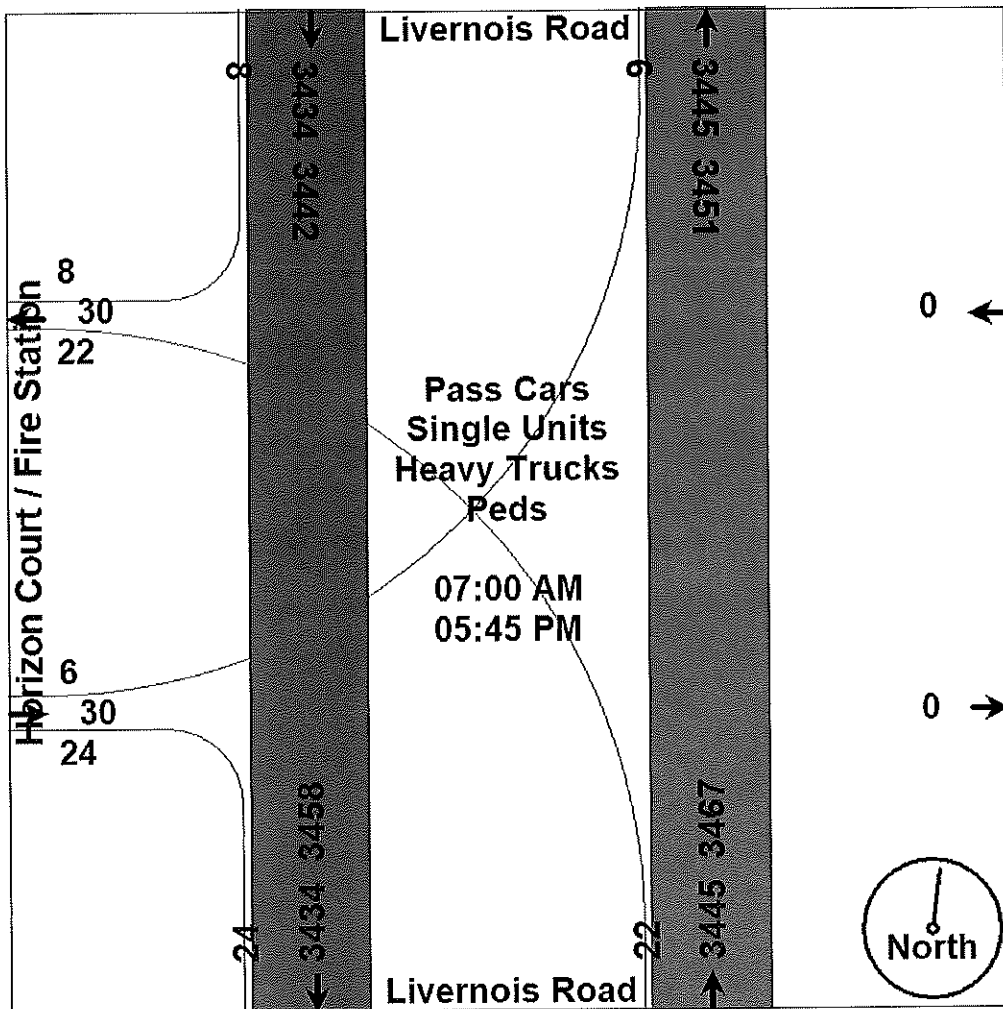
Traffic Study Performed For:

Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
Study: 4 Hr. Video Turning Movement Count
Weather: Sunny/Cldy. Deg's 30s
Count By: Miovision Video VCU 2Z4 SE

File Name : TMC_2 Livernois & HorizonCt_3-21-19
Site Code : TMC_2
Start Date : 3/21/2019
Page No : 2



Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

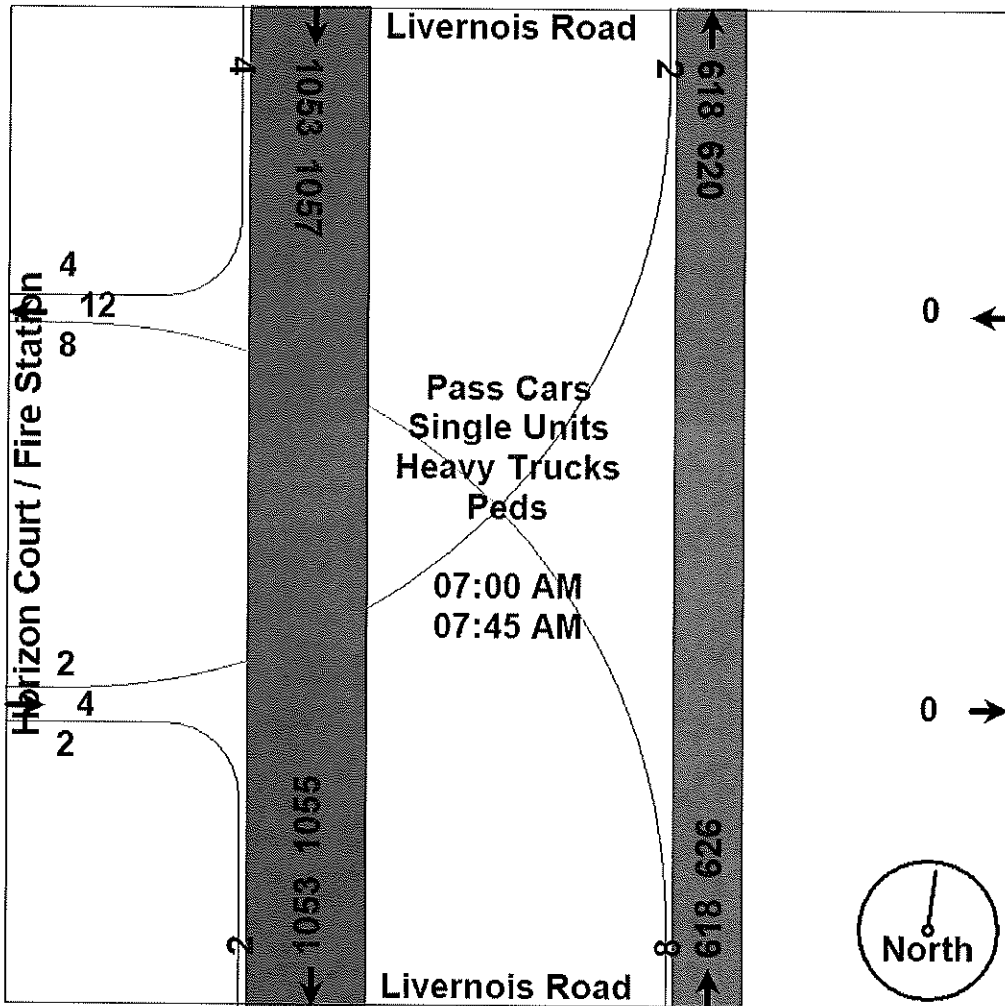
Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 2Z4 SE

File Name : TMC_2 Livernois & HorizonCt_3-21-19
 Site Code : TMC_2
 Start Date : 3/21/2019
 Page No : 3

| Start Time | Livernois Road Southbound | | | Livernois Road Northbound | | | Horizon Court / Fire Station Eastbound | | | Int. Total |
|------------------------------------------------------------|---------------------------|------|------------|---------------------------|------|------------|----------------------------------------|------|------------|------------|
| | Right | Thru | App. Total | Thru | Left | App. Total | Right | Left | App. Total | |
| Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1 | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 07:00 AM | | | | | | | | | | |
| 07:00 AM | 1 | 224 | 225 | 188 | 1 | 189 | 0 | 1 | 1 | 415 |
| 07:15 AM | 1 | 277 | 278 | 133 | 0 | 133 | 2 | 0 | 2 | 413 |
| 07:30 AM | 1 | 275 | 276 | 130 | 2 | 132 | 0 | 1 | 1 | 409 |
| 07:45 AM | 1 | 277 | 278 | 167 | 5 | 172 | 0 | 0 | 0 | 450 |
| Total Volume | 4 | 1053 | 1057 | 618 | 8 | 626 | 2 | 2 | 4 | 1687 |
| % App. Total | 0.4 | 99.6 | | 98.7 | 1.3 | | 50 | 50 | | |
| PHF | 1.00 | .950 | .951 | .822 | .400 | .828 | .250 | .500 | .500 | .937 |
| Pass Cars | 4 | 1046 | 1050 | 606 | 7 | 613 | 2 | 2 | 4 | 1667 |
| % Pass Cars | 100 | 99.3 | 99.3 | 98.1 | 87.5 | 97.9 | 100 | 100 | 100 | 98.8 |
| Single Units | 0 | 6 | 6 | 10 | 1 | 11 | 0 | 0 | 0 | 17 |
| % Single Units | 0 | 0.6 | 0.6 | 1.6 | 12.5 | 1.8 | 0 | 0 | 0 | 1.0 |
| Heavy Trucks | 0 | 1 | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 3 |
| % Heavy Trucks | 0 | 0.1 | 0.1 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0.2 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



Traffic Data Collection, LLC

www.tdccounts.com

Phone: 586.786-5407

Traffic Study Performed For:

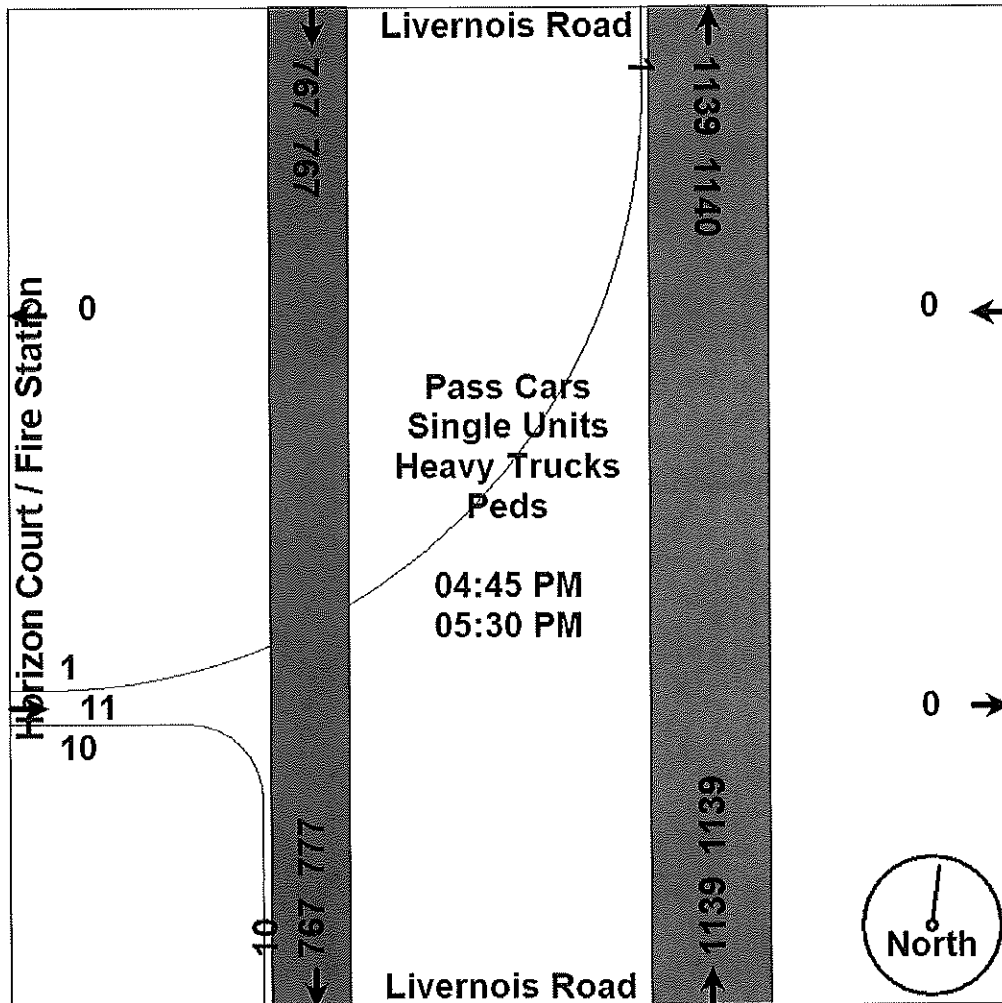
Fleis & Vandenbrink



Project: Rochester Hills Design Haus TIS
 Study: 4 Hr. Video Turning Movement Count
 Weather: Sunny/Cldy. Deg's 30s
 Count By Miovision Video VCU 2Z4 SE

File Name : TMC_2 Livernois & HorizonCt_3-21-19
 Site Code : TMC_2
 Start Date : 3/21/2019
 Page No : 4

| Start Time | Livernois Road Southbound | | | Livernois Road Northbound | | | Horizon Court / Fire Station Eastbound | | | Int. Total |
|------------------------------------------------------------|---------------------------|------|------------|---------------------------|------|------------|----------------------------------------|------|------------|------------|
| | Right | Thru | App. Total | Thru | Left | App. Total | Right | Left | App. Total | |
| Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1 | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 04:45 PM | | | | | | | | | | |
| 04:45 PM | 0 | 192 | 192 | 283 | 0 | 283 | 3 | 1 | 4 | 479 |
| 05:00 PM | 0 | 225 | 225 | 270 | 0 | 270 | 1 | 0 | 1 | 496 |
| 05:15 PM | 0 | 166 | 166 | 301 | 0 | 301 | 4 | 0 | 4 | 471 |
| 05:30 PM | 0 | 184 | 184 | 285 | 0 | 285 | 2 | 0 | 2 | 471 |
| Total Volume | 0 | 767 | 767 | 1139 | 0 | 1139 | 10 | 1 | 11 | 1917 |
| % App. Total | 0 | 100 | | 100 | 0 | | 90.9 | 9.1 | | |
| PHF | .000 | .852 | .852 | .946 | .000 | .946 | .625 | .250 | .688 | .966 |
| Pass Cars | 0 | 759 | 759 | 1134 | 0 | 1134 | 7 | 1 | 8 | 1901 |
| % Pass Cars | 0 | 99.0 | 99.0 | 99.6 | 0 | 99.6 | 70.0 | 100 | 72.7 | 99.2 |
| Single Units | 0 | 7 | 7 | 4 | 0 | 4 | 3 | 0 | 3 | 14 |
| % Single Units | 0 | 0.9 | 0.9 | 0.4 | 0 | 0.4 | 30.0 | 0 | 27.3 | 0.7 |
| Heavy Trucks | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| % Heavy Trucks | 0 | 0.1 | 0.1 | 0.1 | 0 | 0.1 | 0 | 0 | 0 | 0.1 |
| Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % Peds | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



Community Profiles

YOU ARE VIEWING DATA FOR:

City of Rochester Hills

1000 Rochester Hills Dr
Rochester Hills, MI 48309-3033
<http://www.rochesterhills.org>

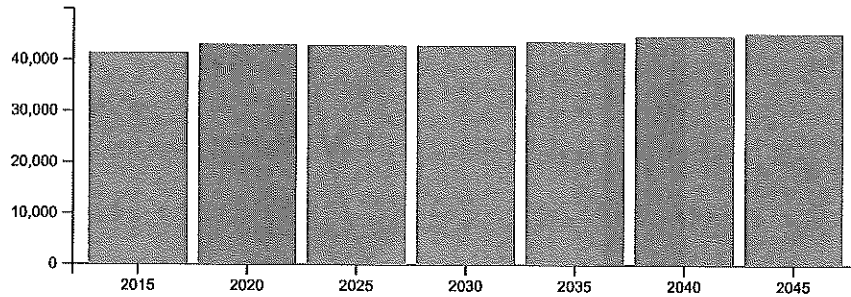
SEMCOG
MEMBER

Census 2010 Population:
70,995
Area: 32.9 square miles

Economy & Jobs

Link to American Community Survey (ACS) Profiles: **Select a Year** **Economic**

Forecasted Jobs



Source: SEMCOG 2045 Regional Development Forecast

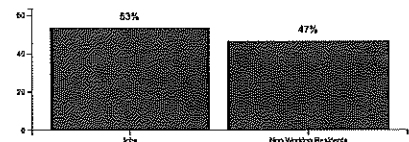
Forecasted Jobs by Industry Sector

| Forecasted Jobs By Industry Sector | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | Change 2015-2045 | Pct Change 2015-2045 |
|---------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|---------------------|-------------------------|
| Natural Resources, Mining, & Construction | 1,755 | 2,005 | 1,907 | 1,886 | 1,911 | 1,938 | 1,967 | 212 | 12.1% |
| Manufacturing | 5,018 | 4,705 | 4,429 | 4,098 | 3,886 | 3,704 | 3,505 | -1,513 | -30.2% |
| Wholesale Trade | 1,437 | 1,484 | 1,482 | 1,465 | 1,465 | 1,464 | 1,454 | 17 | 1.2% |
| Retail Trade | 6,186 | 6,284 | 5,952 | 5,927 | 5,740 | 5,662 | 5,599 | -587 | -9.5% |
| Transportation, Warehousing, & Utilities | 699 | 723 | 721 | 719 | 730 | 743 | 756 | 57 | 8.2% |
| Information & Financial Activities | 3,877 | 4,008 | 3,960 | 3,911 | 3,955 | 3,973 | 3,952 | 75 | 1.9% |
| Professional and Technical Services & Corporate HQ | 3,552 | 3,647 | 3,850 | 4,080 | 4,551 | 5,061 | 5,412 | 1,860 | 52.4% |
| Administrative, Support, & Waste Services | 3,708 | 3,835 | 3,885 | 3,906 | 3,992 | 4,080 | 4,134 | 426 | 11.5% |
| Education Services | 2,261 | 2,377 | 2,375 | 2,363 | 2,389 | 2,419 | 2,449 | 188 | 8.3% |
| Healthcare Services | 6,774 | 7,303 | 7,578 | 7,758 | 8,230 | 8,705 | 9,124 | 2,350 | 34.7% |
| Leisure & Hospitality | 3,951 | 4,433 | 4,527 | 4,572 | 4,660 | 4,776 | 4,818 | 867 | 21.9% |
| Other Services | 1,982 | 2,041 | 1,993 | 1,956 | 1,950 | 1,937 | 1,910 | -72 | -3.6% |
| Public Administration | 359 | 361 | 359 | 354 | 354 | 351 | 351 | -8 | -2.2% |
| Total Employment Numbers | 41,559 | 43,206 | 43,018 | 42,995 | 43,813 | 44,813 | 45,431 | 3,872 | 9.3% |

Source: SEMCOG 2045 Regional Development Forecast

Daytime Population

| Daytime Population | SEMCOG and ACS 2015 |
|-----------------------|---------------------|
| Jobs | 41,559 |
| Non-Working Residents | 36,257 |
| Age 15 and under | 14,348 |
| Not in labor force | 19,738 |
| Unemployed | 2,171 |
| Daytime Population | 77,816 |



Source: SEMCOG 2045 Regional Development Forecast and 2015 American Community Survey 5-Year Estimates

Note: The number of residents attending school outside Southeast Michigan is not available.

Likewise, the number of students commuting into Southeast Michigan to attend school is also not known.

Community Profiles

YOU ARE VIEWING DATA FOR:

City of Rochester Hills

1000 Rochester Hills Dr
Rochester Hills, MI 48309-3033
<http://www.rochesterhills.org>

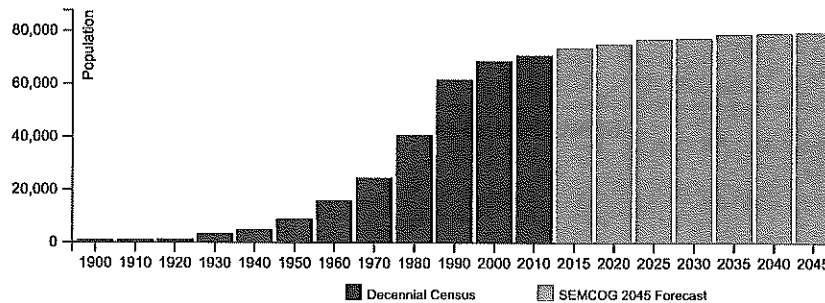
SEMCOG
MEMBER

Census 2010 Population:
70,995
Area: 32.9 square miles

Population and Households

Link to American Community Survey (ACS) Profiles: **Select a Year** **Social | Demographic**
Population and Household Estimates for Southeast Michigan, 2018

Population Forecast



Note for City of Rochester Hills : Incorporated in 1984 from Avon Charter Township. Population numbers prior to 1984 are of the township.

Population and Households

| Population and Households | Census 2010 | Change 2000-2010 | Pct Change 2000-2010 | SEMCOG Jul 2018 | SEMCOG 2045 |
|------------------------------------|-------------|------------------|----------------------|-----------------|-------------|
| Total Population | 70,995 | 2,170 | 3.2% | 74,556 | 79,709 |
| Group Quarters Population | 1,181 | 398 | 50.8% | 1,112 | 1,494 |
| Household Population | 69,814 | 1,772 | 2.6% | 73,444 | 78,215 |
| Housing Units | 29,494 | 2,231 | 8.2% | 30,595 | - |
| Households (Occupied Units) | 27,578 | 1,263 | 4.8% | 29,155 | 32,471 |
| Residential Vacancy Rate | 6.5% | 3.0% | - | 4.7% | - |
| Average Household Size | 2.53 | -0.05 | - | 2.52 | 2.41 |

Source: U.S. Census Bureau, SEMCOG Population and Household Estimates, and SEMCOG 2045 Regional Development Forecast

Components of Population Change

| Components of Population Change | 2000-2005 Avg. | 2006-2010 Avg. | 2011-2015 Avg. |
|-----------------------------------------------------------------|-------------------|-------------------|-------------------|
| Natural Increase (Births - Deaths) | 384 | 233 | 194 |
| Births | 950 | 755 | 750 |
| Deaths | 566 | 522 | 556 |
| Net Migration (Movement In - Movement Out) | -368 | 185 | 351 |
| Population Change (Natural Increase + Net Migration) | 16 | 418 | 545 |

Source: Michigan Department of Community Health Vital Statistics, U.S. Census Bureau, and SEMCOG



Transportation Data Management System

List View All DIRs

| | | | | |
|----------------|-----------|-------------|-------------|----|
| Record | 1 | of 1 | Goto Record | go |
| Location ID | 2256 | MPO ID | 12815 | |
| Type | LINK | HPMS ID | | |
| On NHS | | On HPMS | | |
| LRS ID | | LRS Loc Pt. | | |
| SF Group | | Route Type | | |
| AF Group | | Route | | |
| GF Group | | Active | Yes | |
| Class Dist Grp | | Category | HPMS | |
| Seas Class Grp | | | | |
| WIM Group | | | | |
| Funct'l Class | - | Milepost | | |
| Located On | LIVERNOIS | | | |
| Loc On Alias | | | | |
| From Road | HAMLIN | | | |
| To Road | AVON | | | |
| More Detail ▶ | | | | |
| STATION DATA | | | | |

Directions: 2-WAY

AADT

| Year | AADT | DHV-30 | K % | D % | PA | BC | Src |
|------|--------|--------|-----|-----|----|----|-----|
| 2018 | 21,750 | | | | | | |
| 2012 | 14,910 | | | | | | |
| 2009 | 17,190 | | | | | | |
| 2006 | 18,730 | | | | | | |
| 2003 | 16,330 | | | | | | |

1-5 of 7

| Travel Demand Model | | | | | | | | | | |
|---------------------|------------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| Model Year | Model AADT | AM PHV | AM PPV | MD PHV | MD PPV | PM PHV | PM PPV | NT PHV | NT PPV | |

| VOLUME COUNT | | | |
|--------------|----------------|-----|--------|
| | Date | Int | Total |
| 📅 | Mon 4/30/2018 | 60 | 22,739 |
| 📅 | Thu 11/29/2012 | 60 | 15,682 |
| 📅 | Wed 7/15/2009 | 60 | 16,330 |

| VOLUME TREND | |
|--------------|---------------|
| Year | Annual Growth |
| 2018 | 6% |
| 2012 | -5% |

Appendix B

EXISTING TRAFFIC CONDITIONS

Level of Service Criteria for Stop Sign Controlled Intersections

The level of service criteria are given in Table 17-2. As used here, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue until the vehicle departs from the stop line; this time includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in queue.

The average total delay for any particular minor movement is a function of the service rate or capacity of the approach and the degree of saturation. . . .

Exhibit 17-2. Level of Service Criteria for TWSC Intersections

| LEVEL OF SERVICE | AVERAGE CONTROL DELAY (sec/veh) |
|------------------|------------------------------------|
| A | ≤ 10 |
| B | > 10 and ≤ 15 |
| C | > 15 and ≤ 25 |
| D | > 25 and ≤ 35 |
| E | > 35 and ≤ 50 |
| F | > 50 |

Average total delay less than 10 sec/veh is defined as Level of Service (LOS) A. Follow-up times of less than 5 sec have been measured when there is no conflicting traffic for a minor street movement, so control delays of less than 10 sec/veh are appropriate for low flow conditions. To remain consistent with the AWSC intersection analysis procedure described later in this chapter, a total delay of 50 sec/veh is assumed as the break point between LOS E and F.

The proposed level of service criteria for TWSC intersections are somewhat different from the criteria used in Chapter 16 for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, several driver behavior considerations combine to make delays at signalized intersections less onerous than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, where drivers on the minor approaches to unsignalized intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized than signalized intersections. For these reasons, it is considered that the total delay threshold for any given level of service is less for an unsignalized intersection than for a signalized intersection. . . .

LOS F exists when there are insufficient gaps of suitable size to allow a side street demand to cross safely through a major street traffic stream. This level of service is generally evident from extremely long total delays experienced by side street traffic and by queueing on the minor approaches. The method, however, is based on a constant critical gap size - that is, the critical gap remains constant, no matter how long the side street motorist waits. LOS F may also appear in the form of side street vehicles' selecting smaller-than-usual gaps. In such cases, safety may be a problem and some disruption to the major traffic stream may result. It is important to note that LOS F may not always result in long queues but may result in adjustments to normal gap acceptance behavior. The latter is more difficult to observe on the field than queueing, which is more obvious.

Source: Highway Capacity Manual, 2010. Transportation Research Board, National Research Council

Level of Service for Signalized Intersections

Level of service for signalized intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average stopped delay per vehicle for a 15-min analysis period. The criteria are given in Exhibit 16-2. Delay may be measured in the field or estimated using procedures presented later in this chapter. Delay is a complex measure and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group in question.

LOS A describes operations with very low delay, up to 10 sec per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes operations with delay greater than 10 and up to 20 sec per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

Exhibit 16-2. Level-of-Service Criteria for Signalized Intersections

| LEVEL OF SERVICE | STOPPED DELAY PER VEHICLE (SEC) |
|------------------|---------------------------------|
| A | ≤ 10.0 |
| B | > 10.0 and ≤ 20.0 |
| C | > 20.0 and ≤ 35.0 |
| D | > 35.0 and ≤ 55.0 |
| E | > 55.0 and ≤ 80.0 |
| F | > 80.0 |

LOS C describes operations with delay greater than 20 and up to 35 sec per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with delay greater than 35 and up to 55 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.






















LOS E describes operations with delay greater than 55 and up to 80 sec per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

LOS F describes operations with delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Source: Highway Capacity Manual, 2010. Transportation Research Board, National Research Council

HCM 6th Signalized Intersection Summary
 1: Livernois Road & Drexelgate Parkway

Existing Conditions
 AM Peak Hour

| |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  | |  |  | |  |  | |  |  |  |
| Traffic Volume (veh/h) | 1 | 1 | 2 | 141 | 2 | 121 | 27 | 572 | 21 | 32 | 914 | 15 |
| Future Volume (veh/h) | 1 | 1 | 2 | 141 | 2 | 121 | 27 | 572 | 21 | 32 | 914 | 15 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 1610 | 1610 | 1610 | 2000 | 2000 | 2000 | 1969 | 1969 | 1969 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 2 | 2 | 3 | 152 | 2 | 130 | 33 | 698 | 26 | 34 | 962 | 16 |
| Peak Hour Factor | 0.60 | 0.60 | 0.60 | 0.93 | 0.93 | 0.93 | 0.82 | 0.82 | 0.82 | 0.95 | 0.95 | 0.95 |
| Percent Heavy Veh, % | 25 | 25 | 25 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 |
| Cap, veh/h | 123 | 78 | 117 | 248 | 3 | 224 | 376 | 1448 | 54 | 524 | 1524 | 1291 |
| Arrive On Green | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| Sat Flow, veh/h | 1029 | 581 | 872 | 1434 | 26 | 1673 | 575 | 1886 | 70 | 735 | 1984 | 1682 |
| Grp Volume(v), veh/h | 2 | 0 | 5 | 152 | 0 | 132 | 33 | 0 | 724 | 34 | 962 | 16 |
| Grp Sat Flow(s),veh/h/ln | 1029 | 0 | 1453 | 1434 | 0 | 1699 | 575 | 0 | 1956 | 735 | 1984 | 1682 |
| Q Serve(g_s), s | 0.2 | 0.0 | 0.4 | 12.4 | 0.0 | 8.8 | 3.3 | 0.0 | 16.4 | 2.1 | 26.2 | 0.3 |
| Cycle Q Clear(g_c), s | 9.0 | 0.0 | 0.4 | 12.7 | 0.0 | 8.8 | 29.5 | 0.0 | 16.4 | 18.5 | 26.2 | 0.3 |
| Prop In Lane | 1.00 | | 0.60 | 1.00 | | 0.98 | 1.00 | | 0.04 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 123 | 0 | 194 | 248 | 0 | 227 | 376 | 0 | 1502 | 524 | 1524 | 1291 |
| V/C Ratio(X) | 0.02 | 0.00 | 0.03 | 0.61 | 0.00 | 0.58 | 0.09 | 0.00 | 0.48 | 0.06 | 0.63 | 0.01 |
| Avail Cap(c_a), veh/h | 208 | 0 | 315 | 366 | 0 | 368 | 376 | 0 | 1502 | 524 | 1524 | 1291 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 53.0 | 0.0 | 45.2 | 50.7 | 0.0 | 48.8 | 12.9 | 0.0 | 5.1 | 8.5 | 6.3 | 3.3 |
| Incr Delay (d2), s/veh | 0.1 | 0.0 | 0.1 | 3.5 | 0.0 | 3.3 | 0.5 | 0.0 | 1.1 | 0.2 | 2.0 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.1 | 0.0 | 0.1 | 4.7 | 0.0 | 4.0 | 0.4 | 0.0 | 5.2 | 0.3 | 8.6 | 0.1 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 53.1 | 0.0 | 45.2 | 54.2 | 0.0 | 52.1 | 13.4 | 0.0 | 6.2 | 8.8 | 8.3 | 3.3 |
| LnGrp LOS | D | A | D | D | A | D | B | A | A | A | A | A |
| Approach Vol, veh/h | | 7 | | | 284 | | | 757 | | | 1012 | |
| Approach Delay, s/veh | | 47.5 | | | 53.2 | | | 6.6 | | | 8.2 | |
| Approach LOS | | D | | | D | | | A | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 97.9 | | 22.1 | | 97.9 | | 22.1 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+1), s | | 31.5 | | 11.0 | | 28.2 | | 14.7 | | | | |
| Green Ext Time (p_c), s | | 5.8 | | 0.0 | | 9.4 | | 1.3 | | | | |
| Intersection Summary | | | | | | | | | | | | |
| HCM 6th Ctrl Delay | | | | 13.9 | | | | | | | | |
| HCM 6th LOS | | | | B | | | | | | | | |

HCM 6th TWSC
2: Livernois Road & Horizon Court

Existing Conditions
AM Peak Hour

| Intersection | | | | | | |
|--------------------------|------|------|------|------|------|------|
| Int Delay, s/veh | 0.2 | | | | | |
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
| Lane Configurations | ↘ | | ↘ | ↑ | ↑ | ↗ |
| Traffic Vol, veh/h | 2 | 2 | 8 | 618 | 1053 | 4 |
| Future Vol, veh/h | 2 | 2 | 8 | 618 | 1053 | 4 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 60 | 60 | 83 | 83 | 95 | 95 |
| Heavy Vehicles, % | 0 | 0 | 2 | 2 | 1 | 1 |
| Mvmt Flow | 3 | 3 | 10 | 745 | 1108 | 4 |






















| Major/Minor | Minor2 | Major1 | Major2 | | | |
|----------------------|--------|--------|--------|---|---|---|
| Conflicting Flow All | 1873 | 1108 | 1112 | 0 | - | 0 |
| Stage 1 | 1108 | - | - | - | - | - |
| Stage 2 | 765 | - | - | - | - | - |
| Critical Hdwy | 6.4 | 6.2 | 4.12 | - | - | - |
| Critical Hdwy Stg 1 | 5.4 | - | - | - | - | - |
| Critical Hdwy Stg 2 | 5.4 | - | - | - | - | - |
| Follow-up Hdwy | 3.5 | 3.3 | 2.218 | - | - | - |
| Pot Cap-1 Maneuver | 80 | 258 | 628 | - | - | - |
| Stage 1 | 319 | - | - | - | - | - |
| Stage 2 | 463 | - | - | - | - | - |
| Platoon blocked, % | | | | - | - | - |
| Mov Cap-1 Maneuver | 79 | 258 | 628 | - | - | - |
| Mov Cap-2 Maneuver | 79 | - | - | - | - | - |
| Stage 1 | 314 | - | - | - | - | - |
| Stage 2 | 463 | - | - | - | - | - |

| Approach | EB | NB | SB |
|----------------------|------|-----|----|
| HCM Control Delay, s | 36.5 | 0.1 | 0 |
| HCM LOS | E | | |

| Minor Lane/Major Mvmt | NBL | NBT | EBLn1 | SBT | SBR |
|-----------------------|-------|-----|-------|-----|-----|
| Capacity (veh/h) | 628 | - | 121 | - | - |
| HCM Lane V/C Ratio | 0.015 | - | 0.055 | - | - |
| HCM Control Delay (s) | 10.8 | - | 36.5 | - | - |
| HCM Lane LOS | B | - | E | - | - |
| HCM 95th %tile Q(veh) | 0 | - | 0.2 | - | - |

HCM 6th Signalized Intersection Summary
1: Livernois Road & Drexelgate Parkway

Existing Conditions
PM Peak Hour

| |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  | |  |  | |  |  | |  |  |  |
| Traffic Volume (veh/h) | 8 | 0 | 17 | 44 | 0 | 100 | 1 | 1050 | 108 | 51 | 706 | 5 |
| Future Volume (veh/h) | 8 | 0 | 17 | 44 | 0 | 100 | 1 | 1050 | 108 | 51 | 706 | 5 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 12 | 0 | 25 | 46 | 0 | 105 | 1 | 1105 | 114 | 59 | 821 | 6 |
| Peak Hour Factor | 0.69 | 0.69 | 0.69 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.86 | 0.86 | 0.86 |
| Percent Heavy Veh, % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Cap, veh/h | 95 | 0 | 147 | 163 | 0 | 147 | 521 | 1453 | 150 | 297 | 1617 | 1370 |
| Arrive On Green | 0.09 | 0.00 | 0.09 | 0.09 | 0.00 | 0.09 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 |
| Sat Flow, veh/h | 1309 | 0 | 1695 | 1408 | 0 | 1695 | 673 | 1783 | 184 | 461 | 1984 | 1682 |
| Grp Volume(v), veh/h | 12 | 0 | 25 | 46 | 0 | 105 | 1 | 0 | 1219 | 59 | 821 | 6 |
| Grp Sat Flow(s), veh/h/ln | 1309 | 0 | 1695 | 1408 | 0 | 1695 | 673 | 0 | 1967 | 461 | 1984 | 1682 |
| Q Serve(g_s), s | 1.1 | 0.0 | 1.6 | 3.8 | 0.0 | 7.2 | 0.1 | 0.0 | 36.2 | 8.6 | 15.7 | 0.1 |
| Cycle Q Clear(g_c), s | 8.3 | 0.0 | 1.6 | 5.4 | 0.0 | 7.2 | 15.7 | 0.0 | 36.2 | 44.8 | 15.7 | 0.1 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.09 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 95 | 0 | 147 | 163 | 0 | 147 | 521 | 0 | 1603 | 297 | 1617 | 1370 |
| V/C Ratio(X) | 0.13 | 0.00 | 0.17 | 0.28 | 0.00 | 0.71 | 0.00 | 0.00 | 0.76 | 0.20 | 0.51 | 0.00 |
| Avail Cap(c_a), veh/h | 265 | 0 | 367 | 346 | 0 | 367 | 521 | 0 | 1603 | 297 | 1617 | 1370 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 57.4 | 0.0 | 50.8 | 53.3 | 0.0 | 53.3 | 6.0 | 0.0 | 5.4 | 16.3 | 3.5 | 2.1 |
| Incr Delay (d2), s/veh | 0.8 | 0.0 | 0.8 | 1.3 | 0.0 | 8.8 | 0.0 | 0.0 | 3.5 | 1.5 | 1.1 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.4 | 0.0 | 0.7 | 1.4 | 0.0 | 3.5 | 0.0 | 0.0 | 9.9 | 1.0 | 4.2 | 0.0 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 58.2 | 0.0 | 51.6 | 54.6 | 0.0 | 62.1 | 6.0 | 0.0 | 8.9 | 17.8 | 4.6 | 2.1 |
| LnGrp LOS | E | A | D | D | A | E | A | A | A | B | A | A |
| Approach Vol, veh/h | | 37 | | | 151 | | | 1220 | | | 886 | |
| Approach Delay, s/veh | | 53.7 | | | 59.8 | | | 8.9 | | | 5.5 | |
| Approach LOS | | D | | | E | | | A | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 103.6 | | 16.4 | | 103.6 | | 16.4 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 38.2 | | 10.3 | | 46.8 | | 9.2 | | | | |
| Green Ext Time (p_c), s | | 15.1 | | 0.1 | | 7.5 | | 0.9 | | | | |

Intersection Summary

| | |
|--------------------|------|
| HCM 6th Ctrl Delay | 11.6 |
| HCM 6th LOS | B |

HCM 6th TWSC
2: Livernois Road & Horizon Court

Existing Conditions
PM Peak Hour

Intersection

Int Delay, s/veh 0.2

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|--------------------------|------|------|------|------|------|------|
| Lane Configurations | Y | | Y | ↑ | ↑ | ↑ |
| Traffic Vol, veh/h | 1 | 10 | 0 | 1158 | 767 | 0 |
| Future Vol, veh/h | 1 | 10 | 0 | 1158 | 767 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 69 | 69 | 95 | 95 | 85 | 85 |
| Heavy Vehicles, % | 27 | 27 | 0 | 0 | 1 | 1 |
| Mvmt Flow | 1 | 14 | 0 | 1219 | 902 | 0 |

| Major/Minor | Minor2 | Major1 | Major2 |
|-------------|--------|--------|--------|
|-------------|--------|--------|--------|

| | | | | | | |
|----------------------|-------|-------|-----|---|---|---|
| Conflicting Flow All | 2121 | 902 | 902 | 0 | - | 0 |
| Stage 1 | 902 | - | - | - | - | - |
| Stage 2 | 1219 | - | - | - | - | - |
| Critical Hdwy | 6.67 | 6.47 | 4.1 | - | - | - |
| Critical Hdwy Stg 1 | 5.67 | - | - | - | - | - |
| Critical Hdwy Stg 2 | 5.67 | - | - | - | - | - |
| Follow-up Hdwy | 3.743 | 3.543 | 2.2 | - | - | - |
| Pot Cap-1 Maneuver | 47 | 303 | 762 | - | - | - |
| Stage 1 | 358 | - | - | - | - | - |
| Stage 2 | 249 | - | - | - | - | - |
| Platoon blocked, % | | | | - | - | - |
| Mov Cap-1 Maneuver | 47 | 303 | 762 | - | - | - |
| Mov Cap-2 Maneuver | 47 | - | - | - | - | - |
| Stage 1 | 358 | - | - | - | - | - |
| Stage 2 | 249 | - | - | - | - | - |

| Approach | EB | NB | SB |
|----------|----|----|----|
|----------|----|----|----|

| | | | |
|----------------------|------|---|---|
| HCM Control Delay, s | 24.2 | 0 | 0 |
| HCM LOS | C | | |

| Minor Lane/Major Mvmt | NBL | NBT EBLn1 | SBT | SBR |
|-----------------------|-----|-----------|-----|-----|
|-----------------------|-----|-----------|-----|-----|

| | | | | |
|-----------------------|-----|---|-------|---|
| Capacity (veh/h) | 762 | - | 203 | - |
| HCM Lane V/C Ratio | - | - | 0.079 | - |
| HCM Control Delay (s) | 0 | - | 24.2 | - |
| HCM Lane LOS | A | - | C | - |
| HCM 95th %tile Q(veh) | 0 | - | 0.3 | - |

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | NB | SB | SB | SB |
|-----------------------|-----|-----|-----|------|-----|------|-----|-----|-----|
| Directions Served | L | TR | L | TR | L | TR | L | T | R |
| Maximum Queue (ft) | 25 | 35 | 199 | 120 | 89 | 251 | 125 | 366 | 88 |
| Average Queue (ft) | 1 | 3 | 97 | 48 | 21 | 104 | 24 | 150 | 5 |
| 95th Queue (ft) | 11 | 19 | 167 | 89 | 60 | 204 | 81 | 277 | 51 |
| Link Distance (ft) | | 808 | | 1074 | | 1346 | | 848 | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | 300 | | 250 | | 125 | | 250 | | 250 |
| Storage Blk Time (%) | | | 0 | | 3 | | 1 | | |
| Queuing Penalty (veh) | | | 0 | | 1 | | 0 | | |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB | NB |
|-----------------------|-----|----|
| Directions Served | LR | L |
| Maximum Queue (ft) | 27 | 32 |
| Average Queue (ft) | 3 | 4 |
| 95th Queue (ft) | 17 | 21 |
| Link Distance (ft) | 859 | |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (ft) | | 60 |
| Storage Blk Time (%) | | 0 |
| Queuing Penalty (veh) | | 0 |

Zone Summary

Zone wide Queuing Penalty: 2

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | NB | SB | SB | SB |
|-----------------------|-----|-----|-----|------|-----|------|-----|-----|-----|
| Directions Served | L | TR | L | TR | L | TR | L | T | R |
| Maximum Queue (ft) | 39 | 35 | 104 | 145 | 12 | 463 | 142 | 209 | 22 |
| Average Queue (ft) | 5 | 9 | 44 | 68 | 0 | 202 | 53 | 84 | 1 |
| 95th Queue (ft) | 22 | 28 | 92 | 121 | 6 | 391 | 123 | 181 | 9 |
| Link Distance (ft) | | 808 | | 1074 | | 1346 | | 848 | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | 300 | | 250 | | 125 | | 250 | | 250 |
| Storage Blk Time (%) | | | | | | 11 | 0 | 0 | |
| Queuing Penalty (veh) | | | | | | 0 | 0 | 0 | |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB |
|-----------------------|-----|
| Directions Served | LR |
| Maximum Queue (ft) | 62 |
| Average Queue (ft) | 12 |
| 95th Queue (ft) | 42 |
| Link Distance (ft) | 859 |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (ft) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

Zone Summary






















Zone wide Queuing Penalty: 0

Appendix C

BACKGROUND TRAFFIC CONDITIONS

HCM 6th Signalized Intersection Summary
1: Livernois Road & Drexelgate Parkway

Background Conditions
AM Peak Hour

| |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  | |  |  | |  |  | |  |  |  |
| Traffic Volume (veh/h) | 1 | 1 | 2 | 145 | 2 | 124 | 28 | 586 | 22 | 33 | 937 | 15 |
| Future Volume (veh/h) | 1 | 1 | 2 | 145 | 2 | 124 | 28 | 586 | 22 | 33 | 937 | 15 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 1610 | 1610 | 1610 | 2000 | 2000 | 2000 | 1969 | 1969 | 1969 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 2 | 2 | 3 | 156 | 2 | 133 | 34 | 715 | 27 | 35 | 986 | 16 |
| Peak Hour Factor | 0.60 | 0.60 | 0.60 | 0.93 | 0.93 | 0.93 | 0.82 | 0.82 | 0.82 | 0.95 | 0.95 | 0.95 |
| Percent Heavy Veh, % | 25 | 25 | 25 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 |
| Cap, veh/h | 124 | 79 | 119 | 252 | 3 | 229 | 360 | 1442 | 54 | 509 | 1518 | 1287 |
| Arrive On Green | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| Sat Flow, veh/h | 1026 | 581 | 872 | 1434 | 25 | 1674 | 562 | 1885 | 71 | 723 | 1984 | 1682 |
| Grp Volume(v), veh/h | 2 | 0 | 5 | 156 | 0 | 135 | 34 | 0 | 742 | 35 | 986 | 16 |
| Grp Sat Flow(s),veh/h/ln | 1026 | 0 | 1453 | 1434 | 0 | 1699 | 562 | 0 | 1956 | 723 | 1984 | 1682 |
| Q Serve(g_s), s | 0.2 | 0.0 | 0.4 | 12.7 | 0.0 | 8.9 | 3.6 | 0.0 | 17.2 | 2.3 | 27.8 | 0.3 |
| Cycle Q Clear(g_c), s | 9.2 | 0.0 | 0.4 | 13.1 | 0.0 | 8.9 | 31.5 | 0.0 | 17.2 | 19.5 | 27.8 | 0.3 |
| Prop In Lane | 1.00 | | 0.60 | 1.00 | | 0.99 | 1.00 | | 0.04 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 124 | 0 | 199 | 252 | 0 | 232 | 360 | 0 | 1496 | 509 | 1518 | 1287 |
| VC Ratio(X) | 0.02 | 0.00 | 0.03 | 0.62 | 0.00 | 0.58 | 0.09 | 0.00 | 0.50 | 0.07 | 0.65 | 0.01 |
| Avail Cap(c_a), veh/h | 206 | 0 | 315 | 366 | 0 | 368 | 360 | 0 | 1496 | 509 | 1518 | 1287 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 52.9 | 0.0 | 44.9 | 50.5 | 0.0 | 48.6 | 13.9 | 0.0 | 5.3 | 9.0 | 6.6 | 3.3 |
| Incr Delay (d2), s/veh | 0.1 | 0.0 | 0.1 | 3.5 | 0.0 | 3.3 | 0.5 | 0.0 | 1.2 | 0.3 | 2.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.1 | 0.0 | 0.1 | 4.8 | 0.0 | 4.0 | 0.5 | 0.0 | 5.6 | 0.4 | 9.3 | 0.1 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 53.0 | 0.0 | 45.0 | 54.1 | 0.0 | 51.8 | 14.4 | 0.0 | 6.5 | 9.3 | 8.8 | 3.4 |
| LnGrp LOS | D | A | D | D | A | D | B | A | A | A | A | A |
| Approach Vol, veh/h | | 7 | | | 291 | | | 776 | | | 1037 | |
| Approach Delay, s/veh | | 47.2 | | | 53.0 | | | 6.9 | | | 8.7 | |
| Approach LOS | | D | | | D | | | A | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 97.6 | | 22.4 | | 97.6 | | 22.4 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 33.5 | | 11.2 | | 29.8 | | 15.1 | | | | |
| Green Ext Time (p_c), s | | 6.1 | | 0.0 | | 9.9 | | 1.3 | | | | |
| Intersection Summary | | | | | | | | | | | | |
| HCM 6th Ctrl Delay | | | | 14.3 | | | | | | | | |
| HCM 6th LOS | | | | B | | | | | | | | |

HCM 6th TWSC
2: Livernois Road & Horizon Court

Background Conditions
AM Peak Hour

Intersection

Int Delay, s/veh 0.2

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|--------------------------|------|------|------|------|------|------|
| Lane Configurations | ↘↗ | | ↘ | ↑ | ↑ | ↗ |
| Traffic Vol, veh/h | 2 | 2 | 8 | 634 | 1080 | 4 |
| Future Vol, veh/h | 2 | 2 | 8 | 634 | 1080 | 4 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 60 | 60 | 83 | 83 | 95 | 95 |
| Heavy Vehicles, % | 0 | 0 | 2 | 2 | 1 | 1 |
| Mvmt Flow | 3 | 3 | 10 | 764 | 1137 | 4 |

Major/Minor

| | Minor2 | Major1 | Major2 | | |
|----------------------|--------|--------|--------|---|---|
| Conflicting Flow All | 1921 | 1137 | 1141 | 0 | 0 |
| Stage 1 | 1137 | - | - | - | - |
| Stage 2 | 784 | - | - | - | - |
| Critical Hdwy | 6.4 | 6.2 | 4.12 | - | - |
| Critical Hdwy Stg 1 | 5.4 | - | - | - | - |
| Critical Hdwy Stg 2 | 5.4 | - | - | - | - |
| Follow-up Hdwy | 3.5 | 3.3 | 2.218 | - | - |
| Pot. Cap-1 Maneuver | 75 | 248 | 612 | - | - |
| Stage 1 | 309 | - | - | - | - |
| Stage 2 | 453 | - | - | - | - |
| Platoon blocked, % | | | | - | - |
| Mov Cap-1 Maneuver | 74 | 248 | 612 | - | - |
| Mov Cap-2 Maneuver | 74 | - | - | - | - |
| Stage 1 | 304 | - | - | - | - |
| Stage 2 | 453 | - | - | - | - |

Approach

HCM Control Delay, s 38.5 0.1 0
HCM LOS E

Minor Lane/Major Mvmt

| | NBL | NBT | EBLn1 | SBT | SBR |
|-----------------------|-------|-----|-------|-----|-----|
| Capacity (veh/h) | 612 | - | 114 | - | - |
| HCM Lane V/C Ratio | 0.016 | - | 0.058 | - | - |
| HCM Control Delay (s) | 11 | - | 38.5 | - | - |
| HCM Lane LOS | B | - | E | - | - |
| HCM 95th %ile Q(veh) | 0 | - | 0.2 | - | - |

HCM 6th Signalized Intersection Summary
1: Livernois Road & Drexelgate Parkway

Background Conditions
PM Peak Hour



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|------------------------------|------|-------|------|------|------|-------|------|------|------|------|------|------|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 8 | 0 | 17 | 45 | 0 | 103 | 1 | 1077 | 111 | 52 | 724 | 5 |
| Future Volume (veh/h) | 8 | 0 | 17 | 45 | 0 | 103 | 1 | 1077 | 111 | 52 | 724 | 5 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 12 | 0 | 25 | 47 | 0 | 108 | 1 | 1134 | 117 | 60 | 842 | 6 |
| Peak Hour Factor | 0.69 | 0.69 | 0.69 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.86 | 0.86 | 0.86 |
| Percent Heavy Veh, % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Cap, veh/h | 95 | 0 | 150 | 165 | 0 | 150 | 506 | 1450 | 150 | 278 | 1614 | 1367 |
| Arrive On Green | 0.09 | 0.00 | 0.09 | 0.09 | 0.00 | 0.09 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 |
| Sat Flow, veh/h | 1306 | 0 | 1695 | 1408 | 0 | 1695 | 660 | 1783 | 184 | 448 | 1984 | 1682 |
| Grp Volume(v), veh/h | 12 | 0 | 25 | 47 | 0 | 108 | 1 | 0 | 1251 | 60 | 842 | 6 |
| Grp Sat Flow(s),veh/h/ln | 1306 | 0 | 1695 | 1408 | 0 | 1695 | 660 | 0 | 1967 | 448 | 1984 | 1682 |
| Q Serve(g_s), s | 1.1 | 0.0 | 1.6 | 3.8 | 0.0 | 7.4 | 0.1 | 0.0 | 39.2 | 9.5 | 16.5 | 0.1 |
| Cycle Q Clear(g_c), s | 8.5 | 0.0 | 1.6 | 5.5 | 0.0 | 7.4 | 16.6 | 0.0 | 39.2 | 48.7 | 16.5 | 0.1 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.09 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 95 | 0 | 150 | 165 | 0 | 150 | 506 | 0 | 1599 | 278 | 1614 | 1367 |
| V/C Ratio(X) | 0.13 | 0.00 | 0.17 | 0.28 | 0.00 | 0.72 | 0.00 | 0.00 | 0.78 | 0.22 | 0.52 | 0.00 |
| Avail Cap(c_a), veh/h | 262 | 0 | 367 | 346 | 0 | 367 | 506 | 0 | 1599 | 278 | 1614 | 1367 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 57.4 | 0.0 | 50.6 | 53.1 | 0.0 | 53.2 | 6.3 | 0.0 | 5.8 | 18.3 | 3.6 | 2.1 |
| Incr Delay (d2), s/veh | 0.8 | 0.0 | 0.7 | 1.3 | 0.0 | 8.9 | 0.0 | 0.0 | 3.9 | 1.8 | 1.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.4 | 0.0 | 0.7 | 1.4 | 0.0 | 3.6 | 0.0 | 0.0 | 10.9 | 1.1 | 4.5 | 0.0 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 58.2 | 0.0 | 51.3 | 54.4 | 0.0 | 62.1 | 6.3 | 0.0 | 9.6 | 20.0 | 4.9 | 2.1 |
| LnGrp LOS | E | A | D | D | A | E | A | A | A | C | A | A |
| Approach Vol, veh/h | | 37 | | | 155 | | | 1252 | | | 908 | |
| Approach Delay, s/veh | | 53.6 | | | 59.8 | | | 9.6 | | | 5.8 | |
| Approach LOS | | D | | | E | | | A | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 103.4 | | 16.6 | | 103.4 | | 16.6 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 41.2 | | 10.5 | | 50.7 | | 9.4 | | | | |
| Green Ext Time (p_c), s | | 15.7 | | 0.1 | | 7.6 | | 0.9 | | | | |
| Intersection Summary | | | | | | | | | | | | |
| HCM 6th Ctrl Delay | | | | 12.2 | | | | | | | | |
| HCM 6th LOS | | | | B | | | | | | | | |

HCM 6th TWSC
2: Livernois Road & Horizon Court

Background Conditions
PM Peak Hour

Intersection

Int Delay, s/veh 0.2

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|--------------------------|------|------|------|------|------|------|
| Lane Configurations | Y | | Y | ↑ | ↑ | ↑ |
| Traffic Vol, veh/h | 1 | 10 | 0 | 1188 | 786 | 0 |
| Future Vol, veh/h | 1 | 10 | 0 | 1188 | 786 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 69 | 69 | 95 | 95 | 85 | 85 |
| Heavy Vehicles, % | 27 | 27 | 0 | 0 | 1 | 1 |
| Mvmt Flow | 1 | 14 | 0 | 1251 | 925 | 0 |

| Major/Minor | Minor2 | Major1 | Major2 | | |
|----------------------|--------|--------|--------|---|---|
| Conflicting Flow All | 2176 | 925 | 925 | 0 | 0 |
| Stage 1 | 925 | - | - | - | - |
| Stage 2 | 1251 | - | - | - | - |
| Critical Hdwy | 6.67 | 6.47 | 4.1 | - | - |
| Critical Hdwy Stg 1 | 5.67 | - | - | - | - |
| Critical Hdwy Stg 2 | 5.67 | - | - | - | - |
| Follow-up Hdwy | 3.743 | 3.543 | 2.2 | - | - |
| Pot Cap-1 Maneuver | 43 | 294 | 747 | - | - |
| Stage 1 | 349 | - | - | - | - |
| Stage 2 | 240 | - | - | - | - |
| Platoon blocked, % | | | | - | - |
| Mov Cap-1 Maneuver | 43 | 294 | 747 | - | - |
| Mov Cap-2 Maneuver | 43 | - | - | - | - |
| Stage 1 | 349 | - | - | - | - |
| Stage 2 | 240 | - | - | - | - |

| Approach | EB | NB | SB |
|----------------------|------|----|----|
| HCM Control Delay, s | 25.4 | 0 | 0 |
| HCM LOS | D | | |

| Minor Lane/Major Mvmt | NBL | NBT | EBLn1 | SBT | SBR |
|-----------------------|-----|-----|-------|-----|-----|
| Capacity (veh/h) | 747 | - | 192 | - | - |
| HCM Lane V/C Ratio | - | - | 0.083 | - | - |
| HCM Control Delay (s) | 0 | - | 25.4 | - | - |
| HCM Lane LOS | A | - | D | - | - |
| HCM 95th %tile Q(veh) | 0 | - | 0.3 | - | - |

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | NB | SB | SB | SB |
|-----------------------|-----|----|------|----|------|-----|-----|-----|-----|
| Directions Served | L | TR | L | TR | L | TR | L | T | R |
| Maximum Queue (ft) | 14 | 36 | 222 | 98 | 118 | 291 | 64 | 357 | 29 |
| Average Queue (ft) | 1 | 4 | 97 | 45 | 21 | 100 | 21 | 153 | 2 |
| 95th Queue (ft) | 9 | 22 | 175 | 80 | 67 | 200 | 50 | 289 | 14 |
| Link Distance (ft) | 808 | | 1074 | | 1346 | | 848 | | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | 300 | | 250 | | 125 | | 250 | | 250 |
| Storage Blk Time (%) | | | 0 | | 3 | | 2 | | |
| Queuing Penalty (veh) | | | 0 | | 1 | | 1 | | |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB | NB |
|-----------------------|-----|----|
| Directions Served | LR | L |
| Maximum Queue (ft) | 32 | 37 |
| Average Queue (ft) | 4 | 5 |
| 95th Queue (ft) | 21 | 23 |
| Link Distance (ft) | 859 | |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (ft) | 60 | |
| Storage Blk Time (%) | 0 | |
| Queuing Penalty (veh) | 0 | |

Zone Summary

Zone wide Queuing Penalty: 2

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | SB | SB | SB |
|-----------------------|-----|-----|-----|------|------|-----|-----|-----|
| Directions Served | L | TR | L | TR | TR | L | T | R |
| Maximum Queue (ft) | 34 | 39 | 87 | 152 | 522 | 156 | 258 | 15 |
| Average Queue (ft) | 5 | 10 | 39 | 65 | 229 | 58 | 80 | 1 |
| 95th Queue (ft) | 23 | 30 | 80 | 121 | 448 | 126 | 187 | 6 |
| Link Distance (ft) | | 808 | | 1074 | 1346 | | 848 | |
| Upstream Blk Time (%) | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | |
| Storage Bay Dist (ft) | 300 | | 250 | | | 250 | | 250 |
| Storage Blk Time (%) | | | | | 11 | 0 | 0 | |
| Queuing Penalty (veh) | | | | | 0 | 0 | 0 | |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB |
|-----------------------|-----|
| Directions Served | LR |
| Maximum Queue (ft) | 60 |
| Average Queue (ft) | 12 |
| 95th Queue (ft) | 43 |
| Link Distance (ft) | 859 |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (ft) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

Zone Summary

Zone wide Queuing Penalty: 0

Appendix D

FUTURE TRAFFIC CONDITIONS

HCM 6th Signalized Intersection Summary
1: Livernois Road & Drexelgate Parkway

Future Conditions
AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 11 | 4 | 4 | 145 | 20 | 124 | 37 | 589 | 22 | 33 | 950 | 69 |
| Future Volume (veh/h) | 11 | 4 | 4 | 145 | 20 | 124 | 37 | 589 | 22 | 33 | 950 | 69 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 1610 | 1610 | 1610 | 2000 | 2000 | 2000 | 1969 | 1969 | 1969 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 18 | 7 | 7 | 156 | 22 | 133 | 45 | 718 | 27 | 35 | 1000 | 73 |
| Peak Hour Factor | 0.60 | 0.60 | 0.60 | 0.93 | 0.93 | 0.93 | 0.82 | 0.82 | 0.82 | 0.95 | 0.95 | 0.95 |
| Percent Heavy Veh, % | 25 | 25 | 25 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 |
| Cap, veh/h | 120 | 106 | 106 | 252 | 35 | 213 | 330 | 1430 | 54 | 500 | 1505 | 1275 |
| Arrive On Green | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| Sat Flow, veh/h | 1007 | 739 | 739 | 1422 | 246 | 1487 | 526 | 1885 | 71 | 721 | 1984 | 1682 |
| Grp Volume(v), veh/h | 18 | 0 | 14 | 156 | 0 | 155 | 45 | 0 | 745 | 35 | 1000 | 73 |
| Grp Sat Flow(s),veh/h/ln | 1007 | 0 | 1477 | 1422 | 0 | 1732 | 526 | 0 | 1956 | 721 | 1984 | 1682 |
| Q Serve(g_s), s | 2.1 | 0.0 | 1.0 | 12.8 | 0.0 | 10.1 | 5.5 | 0.0 | 17.8 | 2.4 | 29.5 | 1.3 |
| Cycle Q Clear(g_c), s | 12.2 | 0.0 | 1.0 | 13.8 | 0.0 | 10.1 | 34.9 | 0.0 | 17.8 | 20.2 | 29.5 | 1.3 |
| Prop In Lane | 1.00 | | 0.50 | 1.00 | | 0.86 | 1.00 | | 0.04 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 120 | 0 | 212 | 252 | 0 | 248 | 330 | 0 | 1483 | 500 | 1505 | 1275 |
| V/C Ratio(X) | 0.15 | 0.00 | 0.07 | 0.62 | 0.00 | 0.62 | 0.14 | 0.00 | 0.50 | 0.07 | 0.66 | 0.06 |
| Avail Cap(c_a), veh/h | 193 | 0 | 320 | 356 | 0 | 375 | 330 | 0 | 1483 | 500 | 1505 | 1275 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 54.1 | 0.0 | 44.5 | 50.4 | 0.0 | 48.4 | 15.6 | 0.0 | 5.7 | 9.6 | 7.1 | 3.7 |
| Incr Delay (d2), s/veh | 0.8 | 0.0 | 0.2 | 3.5 | 0.0 | 3.6 | 0.9 | 0.0 | 1.2 | 0.3 | 2.3 | 0.1 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.6 | 0.0 | 0.4 | 4.8 | 0.0 | 4.7 | 0.7 | 0.0 | 5.9 | 0.4 | 10.0 | 0.4 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 54.9 | 0.0 | 44.6 | 53.9 | 0.0 | 52.0 | 16.4 | 0.0 | 6.9 | 9.9 | 9.4 | 3.7 |
| LnGrp LOS | D | A | D | D | A | D | B | A | A | A | A | A |
| Approach Vol, veh/h | | 32 | | | 311 | | | 790 | | | 1108 | |
| Approach Delay, s/veh | | 50.4 | | | 53.0 | | | 7.4 | | | 9.0 | |
| Approach LOS | | D | | | D | | | A | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 96.8 | | 23.2 | | 96.8 | | 23.2 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 36.9 | | 14.2 | | 31.5 | | 15.8 | | | | |
| Green Ext Time (p_c), s | | 6.3 | | 0.1 | | 10.4 | | 1.4 | | | | |
| Intersection Summary | | | | | | | | | | | | |
| HCM 6th Ctrl Delay | | | | 15.2 | | | | | | | | |
| HCM 6th LOS | | | | B | | | | | | | | |

Intersection

Int Delay, s/veh 0.8

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|--------------------------|------|------|------|------|------|------|
| Lane Configurations | ↘ | | ↘ | ↑ | ↑ | ↗ |
| Traffic Vol, veh/h | 5 | 8 | 42 | 643 | 1082 | 17 |
| Future Vol, veh/h | 5 | 8 | 42 | 643 | 1082 | 17 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 60 | 60 | 83 | 83 | 95 | 95 |
| Heavy Vehicles, % | 0 | 0 | 2 | 2 | 1 | 1 |
| Mvmt Flow | 8 | 13 | 51 | 775 | 1139 | 18 |

Major/Minor

| | Minor2 | Major1 | Major2 | | |
|----------------------|--------|--------|--------|---|---|
| Conflicting Flow All | 2016 | 1139 | 1157 | 0 | 0 |
| Stage 1 | 1139 | - | - | - | - |
| Stage 2 | 877 | - | - | - | - |
| Critical Hdwy | 6.4 | 6.2 | 4.12 | - | - |
| Critical Hdwy Stg 1 | 5.4 | - | - | - | - |
| Critical Hdwy Stg 2 | 5.4 | - | - | - | - |
| Follow-up Hdwy | 3.5 | 3.3 | 2.218 | - | - |
| Pot Cap-1 Maneuver | 65 | 247 | 604 | - | - |
| Stage 1 | 308 | - | - | - | - |
| Stage 2 | 410 | - | - | - | - |
| Platoon blocked, % | | | | - | - |
| Mov Cap-1 Maneuver | 60 | 247 | 604 | - | - |
| Mov Cap-2 Maneuver | 60 | - | - | - | - |
| Stage 1 | 282 | - | - | - | - |
| Stage 2 | 410 | - | - | - | - |

Approach






















| | EB | NB | SB |
|----------------------|------|-----|----|
| HCM Control Delay, s | 44.7 | 0.7 | 0 |
| HCM LOS | E | | |

Minor Lane/Major Mvmt

| | NBL | NBT | EBLn1 | SBT | SBR |
|-----------------------|-------|-----|-------|-----|-----|
| Capacity (veh/h) | 604 | - | 112 | - | - |
| HCM Lane V/C Ratio | 0.084 | - | 0.193 | - | - |
| HCM Control Delay (s) | 11.5 | - | 44.7 | - | - |
| HCM Lane LOS | B | - | E | - | - |
| HCM 95th %tile Q(veh) | 0.3 | - | 0.7 | - | - |

HCM 6th Signalized Intersection Summary
 1: Livernois Road & Drexelgate Parkway

Future Conditions
 PM Peak Hour

| |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  | |  |  | |  |  | |  |  |  |
| Traffic Volume (veh/h) | 61 | 9 | 26 | 45 | 2 | 103 | 3 | 1090 | 111 | 52 | 727 | 17 |
| Future Volume (veh/h) | 61 | 9 | 26 | 45 | 2 | 103 | 3 | 1090 | 111 | 52 | 727 | 17 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Work Zone On Approach | | No | | | No | | | No | | | No | |
| Adj Sat Flow, veh/h/ln | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1984 | 1984 | 1984 |
| Adj Flow Rate, veh/h | 71 | 10 | 30 | 47 | 2 | 108 | 3 | 1147 | 117 | 60 | 845 | 20 |
| Peak Hour Factor | 0.86 | 0.86 | 0.86 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.86 | 0.86 | 0.86 |
| Percent Heavy Veh, % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Cap, veh/h | 155 | 59 | 176 | 217 | 4 | 222 | 448 | 1372 | 140 | 216 | 1525 | 1293 |
| Arrive On Green | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| Sat Flow, veh/h | 1304 | 441 | 1322 | 1389 | 31 | 1669 | 650 | 1785 | 182 | 442 | 1984 | 1682 |
| Grp Volume(v), veh/h | 71 | 0 | 40 | 47 | 0 | 110 | 3 | 0 | 1264 | 60 | 845 | 20 |
| Grp Sat Flow(s),veh/h/ln | 1304 | 0 | 1762 | 1389 | 0 | 1700 | 650 | 0 | 1967 | 442 | 1984 | 1682 |
| Q Serve(g_s), s | 6.4 | 0.0 | 2.4 | 3.7 | 0.0 | 7.2 | 0.2 | 0.0 | 49.9 | 12.2 | 20.6 | 0.3 |
| Cycle Q Clear(g_c), s | 13.6 | 0.0 | 2.4 | 6.1 | 0.0 | 7.2 | 20.8 | 0.0 | 49.9 | 62.1 | 20.6 | 0.3 |
| Prop In Lane | 1.00 | | 0.75 | 1.00 | | 0.98 | 1.00 | | 0.09 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 155 | 0 | 234 | 217 | 0 | 226 | 448 | 0 | 1512 | 216 | 1525 | 1293 |
| V/C Ratio(X) | 0.46 | 0.00 | 0.17 | 0.22 | 0.00 | 0.49 | 0.01 | 0.00 | 0.84 | 0.28 | 0.55 | 0.02 |
| Avail Cap(c_a), veh/h | 264 | 0 | 382 | 333 | 0 | 368 | 448 | 0 | 1512 | 216 | 1525 | 1293 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 54.5 | 0.0 | 46.1 | 48.9 | 0.0 | 48.2 | 9.8 | 0.0 | 9.0 | 29.1 | 5.6 | 3.3 |
| Incr Delay (d2), s/veh | 3.0 | 0.0 | 0.5 | 0.7 | 0.0 | 2.3 | 0.0 | 0.0 | 5.6 | 3.2 | 1.5 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 2.2 | 0.0 | 1.1 | 1.4 | 0.0 | 3.2 | 0.0 | 0.0 | 17.0 | 1.4 | 6.7 | 0.1 |
| Unsig. Movement Delay, s/veh | | | | | | | | | | | | |
| LnGrp Delay(d),s/veh | 57.5 | 0.0 | 46.6 | 49.6 | 0.0 | 50.5 | 9.8 | 0.0 | 14.6 | 32.3 | 7.1 | 3.3 |
| LnGrp LOS | E | A | D | D | A | D | A | A | B | C | A | A |
| Approach Vol, veh/h | | 111 | | | 157 | | | 1267 | | | 925 | |
| Approach Delay, s/veh | | 53.6 | | | 50.2 | | | 14.6 | | | 8.6 | |
| Approach LOS | | D | | | D | | | B | | | A | |
| Timer - Assigned Phs | | 2 | | 4 | | 6 | | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 98.0 | | 22.0 | | 98.0 | | 22.0 | | | | |
| Change Period (Y+Rc), s | | 5.8 | | 6.0 | | 5.8 | | 6.0 | | | | |
| Max Green Setting (Gmax), s | | 82.2 | | 26.0 | | 82.2 | | 26.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 51.9 | | 15.6 | | 64.1 | | 9.2 | | | | |
| Green Ext Time (p_c), s | | 14.2 | | 0.4 | | 6.4 | | 0.9 | | | | |
| Intersection Summary | | | | | | | | | | | | |
| HCM 6th Ctrl Delay | | | 16.4 | | | | | | | | | |
| HCM 6th LOS | | | B | | | | | | | | | |

| Intersection | | | | | | |
|--------------------------|------|------|------|------|------|------|
| Int Delay, s/veh | 1.8 | | | | | |
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
| Lane Configurations | ↙↘ | | ↙ | ↑ | ↑ | ↗ |
| Traffic Vol, veh/h | 14 | 46 | 8 | 1190 | 795 | 3 |
| Future Vol, veh/h | 14 | 46 | 8 | 1190 | 795 | 3 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | 60 | - | - | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 88 | 88 | 95 | 95 | 85 | 85 |
| Heavy Vehicles, % | 7 | 7 | 0 | 0 | 1 | 1 |
| Mvmt Flow | 16 | 52 | 8 | 1253 | 935 | 4 |

| Major/Minor | Minor2 | Major1 | Major2 | | |
|----------------------|--------|--------|--------|---|---|
| Conflicting Flow All | 2204 | 935 | 939 | 0 | 0 |
| Stage 1 | 935 | - | - | - | - |
| Stage 2 | 1269 | - | - | - | - |
| Critical Hdwy | 6.47 | 6.27 | 4.1 | - | - |
| Critical Hdwy Stg 1 | 5.47 | - | - | - | - |
| Critical Hdwy Stg 2 | 5.47 | - | - | - | - |
| Follow-up Hdwy | 3.563 | 3.363 | 2.2 | - | - |
| Pot Cap-1 Maneuver | 47 | 315 | 738 | - | - |
| Stage 1 | 374 | - | - | - | - |
| Stage 2 | 258 | - | - | - | - |
| Platoon blocked, % | | | | - | - |
| Mov Cap-1 Maneuver | 46 | 315 | 738 | - | - |
| Mov Cap-2 Maneuver | 46 | - | - | - | - |
| Stage 1 | 370 | - | - | - | - |
| Stage 2 | 258 | - | - | - | - |

| Approach | EB | NB | SB |
|----------------------|------|-----|----|
| HCM Control Delay, s | 57.6 | 0.1 | 0 |
| HCM LOS | F | | |

| Minor Lane/Major Mvmt | NBL | NBT | EBLn1 | SBT | SBR |
|-----------------------|-------|-----|-------|-----|-----|
| Capacity (veh/h) | 738 | - | 133 | - | - |
| HCM Lane V/C Ratio | 0.011 | - | 0.513 | - | - |
| HCM Control Delay (s) | 9.9 | - | 57.6 | - | - |
| HCM Lane LOS | A | - | F | - | - |
| HCM 95th %tile Q(veh) | 0 | - | 2.4 | - | - |

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | NB | SB | SB | SB |
|-----------------------|-----|----|------|-----|------|-----|-----|-----|-----|
| Directions Served | L | TR | L | TR | L | TR | L | T | R |
| Maximum Queue (ft) | 58 | 48 | 215 | 175 | 153 | 264 | 51 | 450 | 206 |
| Average Queue (ft) | 11 | 8 | 100 | 66 | 35 | 120 | 18 | 173 | 20 |
| 95th Queue (ft) | 40 | 31 | 176 | 128 | 98 | 230 | 44 | 326 | 96 |
| Link Distance (ft) | 808 | | 1074 | | 1346 | | 848 | | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | 300 | | 250 | | 125 | | 250 | | 250 |
| Storage Blk Time (%) | | | 0 | | 0 | | 5 | | 2 |
| Queuing Penalty (veh) | | | 0 | | 0 | | 2 | | 3 |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB | NB | NB |
|-----------------------|-----|----|------|
| Directions Served | LR | L | T |
| Maximum Queue (ft) | 45 | 64 | 41 |
| Average Queue (ft) | 11 | 23 | 1 |
| 95th Queue (ft) | 38 | 54 | 21 |
| Link Distance (ft) | 859 | | 1135 |
| Upstream Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |
| Storage Bay Dist (ft) | 60 | | |
| Storage Blk Time (%) | 1 | | 0 |
| Queuing Penalty (veh) | 6 | | 0 |

Zone Summary

Zone wide Queuing Penalty: 11

Intersection: 1: Livernois Road & Drexelgate Parkway

| Movement | EB | EB | WB | WB | NB | NB | SB | SB | SB |
|-----------------------|-----|-----|------|-----|------|-----|-----|-----|----|
| Directions Served | L | TR | L | TR | L | TR | L | T | R |
| Maximum Queue (ft) | 140 | 62 | 95 | 145 | 54 | 664 | 133 | 281 | 29 |
| Average Queue (ft) | 54 | 21 | 34 | 72 | 3 | 305 | 56 | 104 | 3 |
| 95th Queue (ft) | 113 | 51 | 73 | 128 | 30 | 590 | 119 | 206 | 18 |
| Link Distance (ft) | 808 | | 1074 | | 1346 | | 848 | | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | 300 | 250 | | 125 | | 250 | | 250 | |
| Storage Blk Time (%) | | | | | | 17 | 0 | | |
| Queuing Penalty (veh) | | | | | | 0 | 0 | | |

Intersection: 2: Livernois Road & Horizon Court

| Movement | EB | NB |
|-----------------------|-----|----|
| Directions Served | LR | L |
| Maximum Queue (ft) | 156 | 28 |
| Average Queue (ft) | 46 | 4 |
| 95th Queue (ft) | 108 | 20 |
| Link Distance (ft) | 859 | |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (ft) | 60 | |
| Storage Blk Time (%) | | |
| Queuing Penalty (veh) | | |

Zone Summary

| |
|------------------------------|
| Zone wide Queuing Penalty: 1 |
|------------------------------|

Appendix E

SIGNAL WARRANT ANALYSIS

Appendix E

SIGNAL WARRANT ANALYSIS

Summary of Warrants

| | | | |
|-------------------------|---------------------------------|---------------|---------------|
| Spot Number: | 0 | | |
| Major Street: | Livernois Road | Minor Street: | Horizon Court |
| Intersection: | Livernois Road at Horizon Court | | |
| City/Twp: | Rochester Hills | | |
| Date Performed: | 10/14/2019 | Performed By: | F&V |
| Date Volumes Collected: | 3/21/2019 | | |

| Warrant | Condition | Is Warrant Met |
|------------------------------------------------------|------------------|----------------|
| Data Validation Error | | |
| WARRANT 1: Eight-Hour Vehicular Volume | | |
| | Condition A | |
| | Condition B | |
| | Condition A&B | N/A |
| WARRANT 2: Four-Hour Vehicular Volume | (70%) | |
| WARRANT 3: Peak-Hour Vehicular Volume | (70%) | |
| | Condition A | |
| | Condition B | |
| WARRANT 4: Pedestrian Volume | (70%) | |
| | Four Hour | N/A |
| | Peak Hour | N/A |
| | (Threshold) HAWK | |
| | (Threshold) RRFB | |
| WARRANT 5: School Crossing | | NO |
| WARRANT 6: Coordinated Signal System | | NO |
| WARRANT 7: Crash Experience | | NO |
| | Condition A | NO |
| | Condition B | NO |
| WARRANT 8: Roadway Network | | NO |
| WARRANT 9: Intersection Near a Grade Crossing | | #N/A |

Issue to Be Addressed by Signalization:

0

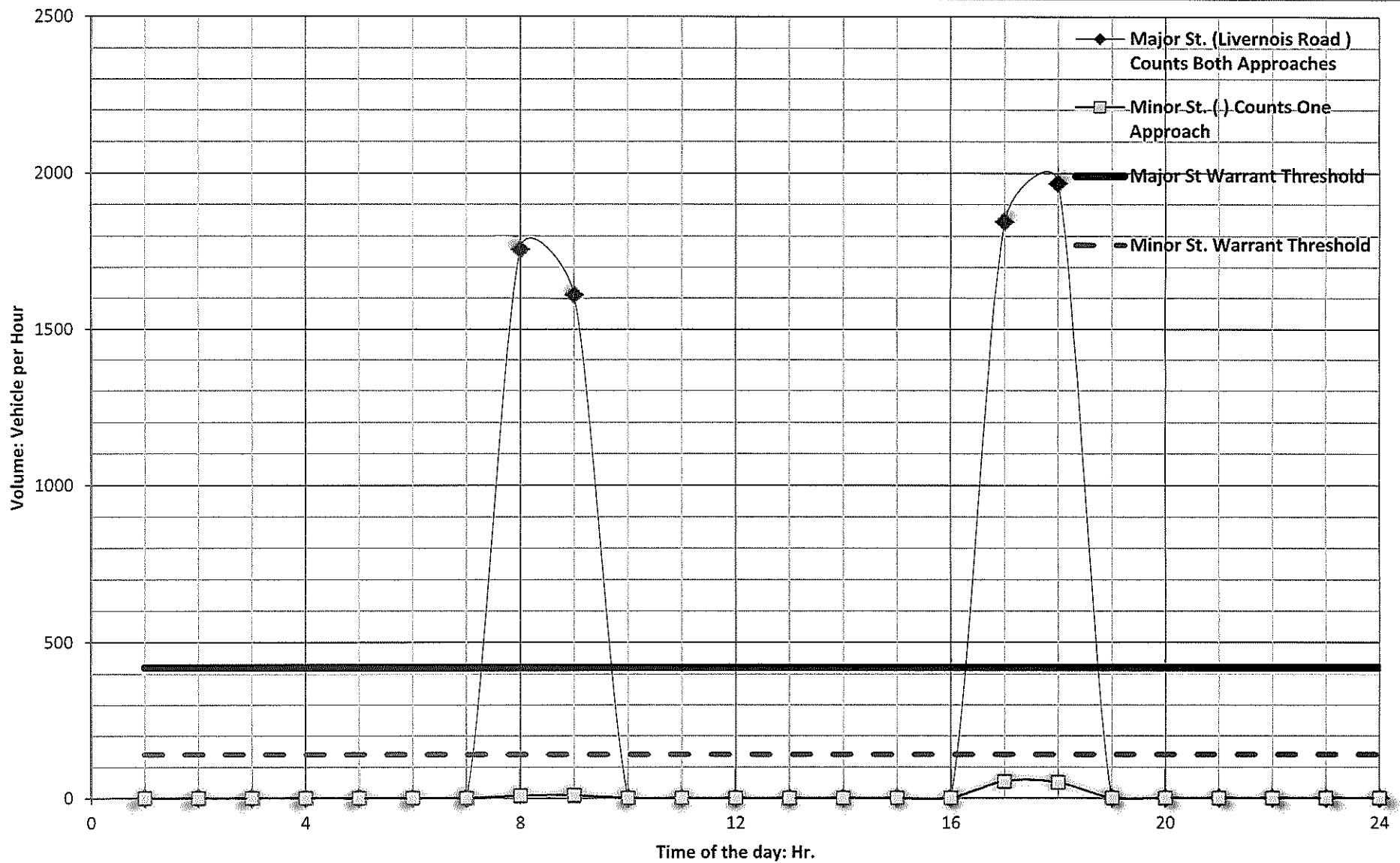


FIGURE 1: WARRANT 1A

IS THERE A REDUCTION IN THE WARRANT THRESHOLDS TO 70% ...

1- DUE TO SPEED? YES

2- DUE TO ISOLATED COMMUNITY WITH POPULATION LESS THAN 10,000? NO

Spot Number:

Livernois Road @ Horizon Court

NO. OF LANES ON MAJOR ST.? 2

NO. OF LANES ON MINOR ST.? 2

Number of Hours that met the Warrant: 0

Does this intersection meet Warrant 1A for signal installation? NO

Data Collection Date: 3/21/2019

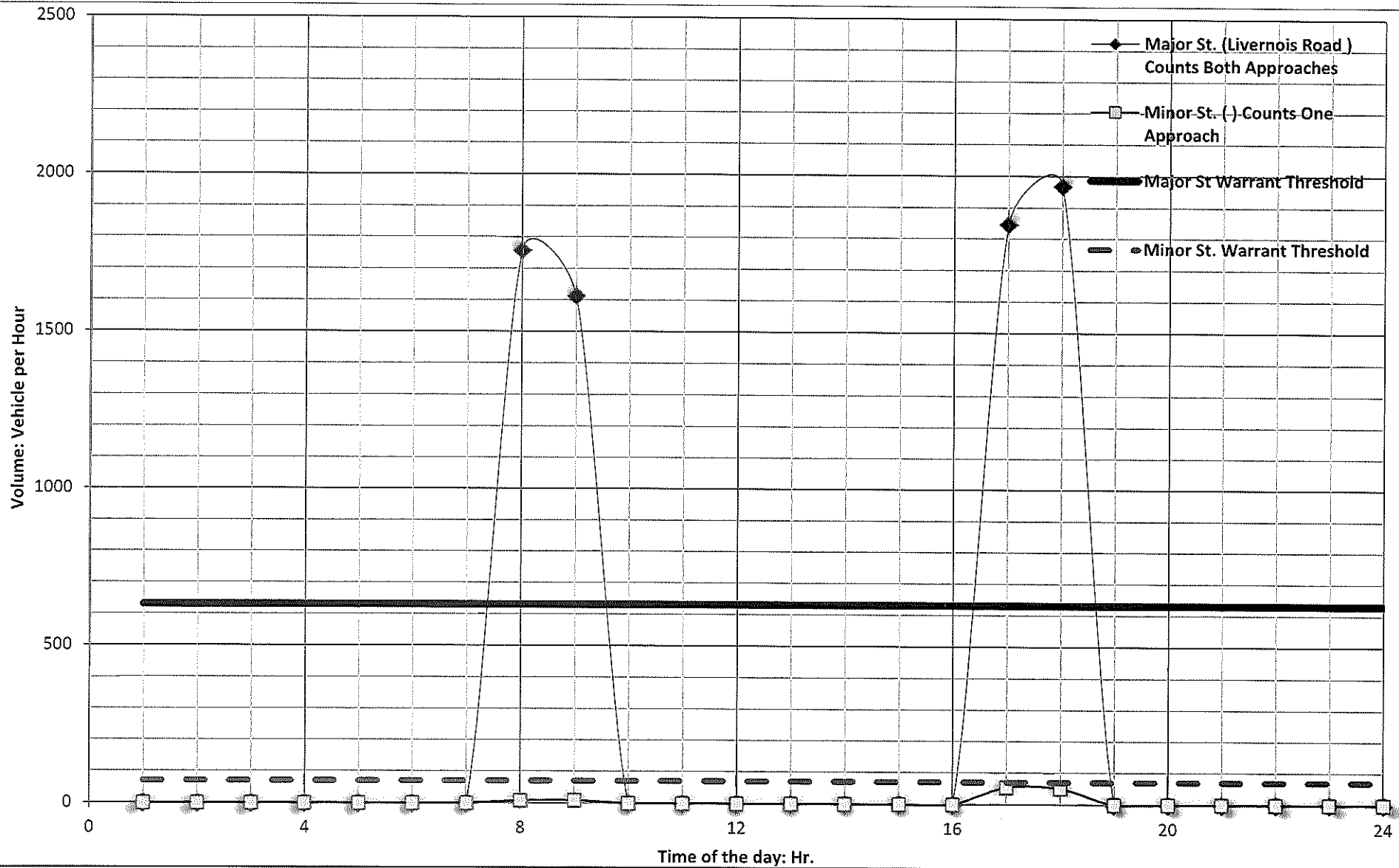


FIGURE 1: WARRANT 1B

IS THERE A REDUCTION IN THE WARRANT THRESHOLDS TO 70% ...

1- DUE TO SPEED? YES

2- DUE TO ISOLATED COMMUNITY WITH POPULATION LESS THAN 10,000? NO

Spot Number:

Livornois Road @ Horizon Court

NO. OF LANES ON MAJOR ST.? 2

NO. OF LANES ON MINOR ST.? 2

Number of Hours that met the Warrant: 0

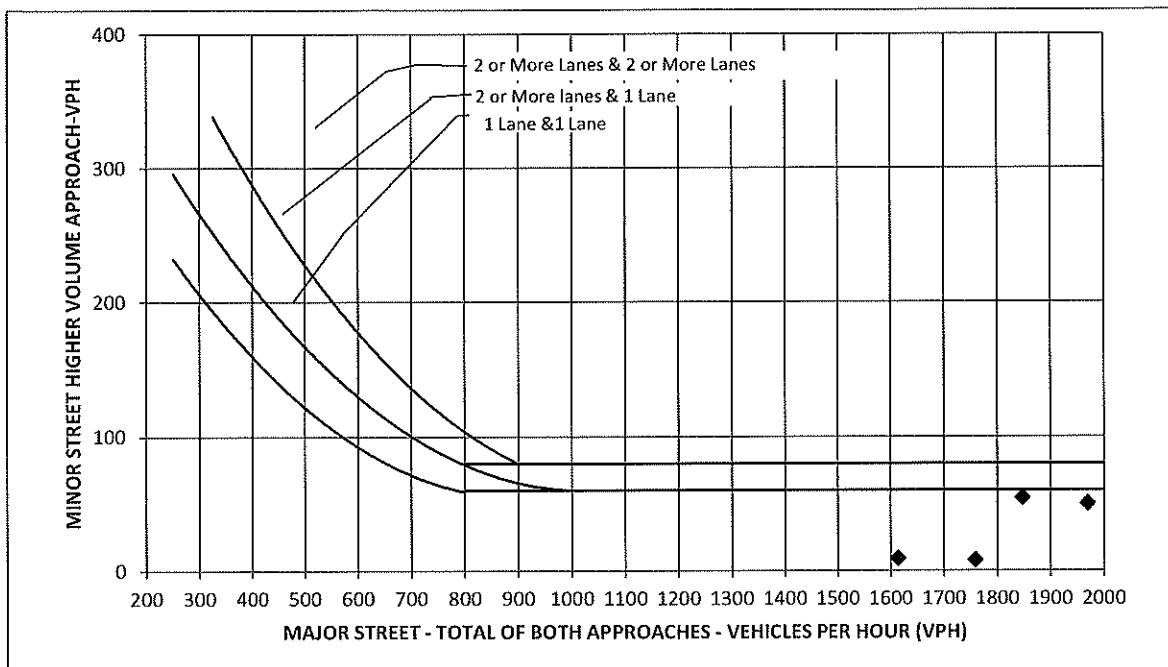
Does this intersection meet Warrant 1B for signal installation? NO

Data Collection Date: 3/21/2019

**Michigan Manual of Uniform Traffic Control Devices
Worksheet for Signal Warrants (Section 4C)
WARRANT 2: Four-Hour Vehicular Volume**

| | | | |
|---------------|--------------------------------|-----|-----|
| Spot Number: | 0 | | |
| Intersection: | Livernois Road @ Horizon Court | | |
| Date: | 10/14/2019 | by: | F&V |

| | |
|----|-----------------------------------------------------|
| 2 | : No. of Lanes on Major St. |
| 2 | : No. of Lanes on Minor St. |
| 45 | : Speed limit or 85th Percentile? (MPH) |
| NO | : Is the intersection within an isolated community? |
| 0 | : What is the of the population isolated community? |



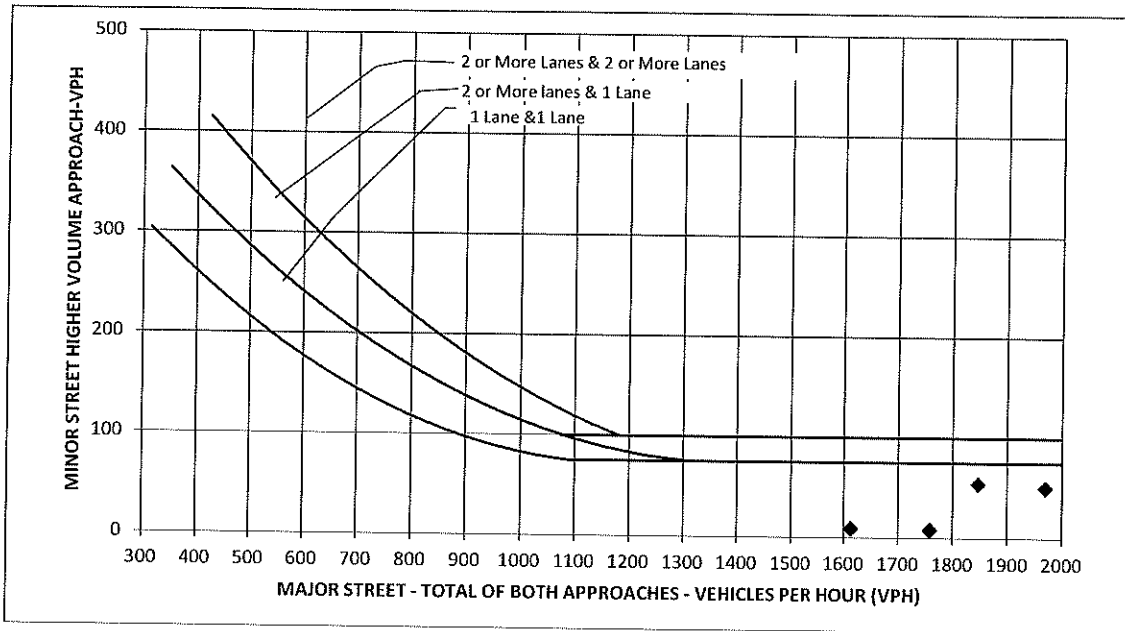
| | |
|------------------------|----|
| How Many Hours Are Met | 0 |
| Is Warrant (70%) Met? | NO |

| Michigan Manual of Uniform Traffic Control Devices Worksheet for Signal Warrants (Section 4C) WARRANT 3 A: Peak-Hour Vehicular Volume | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----|-----------------------------|
| Spot Number: | 0 | | |
| Intersection: | Livernois Road @ Horizon Court | | |
| Date | 10/14/2019 | by | F&V |
| NOT MET | 0.96 | : | Total Stop Time Delay (hrs) |
| | 2 | : | Minor Street Approach Lanes |
| | 3 | : | Total Approaches |
| NOT MET | 50 | : | Minor Approach Volume |
| | 2019 | : | Total Entering Volume |
| | 17:00 - 18:00 | : | Peak Hour |
| Is Warrant 3 A Met? | | | NO |

**Michigan Manual of Uniform Traffic Control Devices
Worksheet for Signal Warrants (Section 4C)
WARRANT 3 B(70%): Peak-Hour Vehicular Volume**

| | |
|---------------|--------------------------------|
| Spot Number: | 0 |
| Intersection: | Livernois Road @ Horizon Court |
| Date | 10/14/2019 by F&V |

| | |
|----|-----------------------------------------------------|
| 2 | : No. of Lanes on Major St. |
| 2 | : No. of Lanes on Minor St. |
| 45 | : Speed limit or 85th Percentile? (MPH) |
| NO | : Is the intersection within an Isolated community? |
| 0 | : What is the of the population isolated community? |



| | |
|------------------------|----|
| How Many Hours Are Met | 0 |
| Is Warrant (70%) Met? | NO |

