

Watersand Development Phase 2 South Residential

City of Barrie

Traffic Impact Study for Watersand Construction Ltd.

Type of Document:
Final Report

Project Number:
JDE – 17122

Date Submitted:
June 30, 2022



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Executive Summary

This report summarizes the traffic impact study prepared for the 119 hectare property (referred to in this analysis as the Watersand Development), located in the southwest corner of the intersection of McKay Road West / Veteran's Drive in the City of Barrie [City]. The report assesses the impact of traffic related to the development on the adjacent roadway and provides recommendations to accommodate this traffic in a safe and efficient manner.

Phase 2 South of the Watersand Development includes the development of 30.5 hectares, including 204 single detached residential units, 49 townhouse units, a recreation centre and elementary school.

The residential component of Phase 2 South of the Watersand Development will include one municipal road [Street 2] onto McKay Road West and will include internal connections to IIP Street F, which is anticipated to be constructed as a part of Phase 1 of the Watersand Development connecting into McKay Road West.

The scope of this analysis includes a review of the following intersections:

- McKay Road West / Street 2; and
- McKay Road West / IIP Street F;

The scope of this analysis is limited to the residential component of Phase 2 South of the Watersand Development. A subsequent study will be provided for the recreation centre component of Phase 2 South of the Watersand Development. Additional traffic generation from the elementary school in Phase 2 South of the Watersand Development has not been included in our analysis as it is anticipated that the majority of the trips generated by the elementary school will be internal to the Watersand Development.

Conclusions

1. The residential component of Phase 2 South of the Watersand Development is expected to generate a total of 163 AM and 219 PM peak hour trips.
2. Traffic projections for the 2031 year for the McKay Road West / IIP Street F intersection were obtained from the Watersand TA.
3. An intersection operation analysis was completed at the study area intersections, using the background (2031 and 2041) traffic volumes, without the proposed development traffic. This enabled a review of existing and future traffic deficiencies that would be present without the influence of the proposed development. The following geometric lane improvements and traffic signal improvements are recommended within the study area:

At Opening

McKay Road West / IIP Street F

- Signalization of Intersection;
 - Eastbound left turn auxiliary lane with a 15 metre storage and 95 metre taper length;
 - Westbound left turn auxiliary lane with a 30 metre storage and 80 metre taper length;
 - Northbound left turn auxiliary lane with a 20 metre storage and 55 metre taper length; and
 - Southbound left turn auxiliary lane with a 40 metre storage and 55 metre taper length;
4. An estimate of the amount of traffic that would be generated by the proposed development was prepared and assigned to the study area streets and intersections.

5. An intersection operation analysis was completed under total (2031 and 2041) traffic volumes with the proposed development operational at the study area intersections. The following additional geometric lane improvements or traffic signal improvements are recommended within the study area:

At Opening

McKay Road West

- Reduce the speed limit on McKay Road West from 80km/h to 60 km/h across the west end frontage of the Watersand Development.

McKay Road West / Street 2

- Westbound left turn auxiliary lane with a 15 metre storage and 95 metre taper length.
6. It is recommended that McKay Road West is monitored closer to the 2041 horizon year to determine if widening of McKay Road West to a four-lane cross-section is required west of Reid Drive
 7. In summary, the residential component of Phase 2 South of the Watersand Development will not cause any operational issues and will not add a notable delay or congestion to the local roadway network.

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1 Introduction

1.1 Background

Watersand Construction Ltd. [The Developer] is proposing to develop a 119 hectare property (referred to in this analysis as the Watersand Development), located in the southwest corner of the intersection of McKay Road West / Veteran's Drive in the City of Barrie [City].

Phase 2 South of the Watersand Development includes the development of 30.5 hectares, including 204 single detached residential units, 49 townhouse units, a recreation centre and elementary school.

The residential component of Phase 2 South of the Watersand Development will include one municipal road [Street 2] onto McKay Road West and will include internal connections to IIP Street F, which is anticipated to be constructed as a part of Phase 1 of the Watersand Development connecting into McKay Road West.

The City has indicated that they would prefer to have right-in-right-out [RIRO] access restrictions on all future local roads (including Street 2) along McKay Road West. IIP Street F is a future collector road and is anticipated to allow for full-movements at McKay Road West.

The Developer has retained **JD Northcote Engineering Inc.** [JD Engineering] to prepare this traffic impact study in support of Phase 2 South of the Watersand Development.

1.2 Study Area

Figure 1 shows the location of the proposed development and study area intersections, in relation to the surrounding area. The Draft Plan of Subdivision by KLM Planning Partners Inc. is provided in **Appendix A**.

Phase 2 South of the Watersand Development is bound by undeveloped lands to the west and south, Phase 1 of the Watersand Development to the east and McKay Road West to the north.

The following intersections will be analysed as part of the study:

- McKay Road West / Street 2; and
- McKay Road West / IIP Street F;

The scope of this analysis is limited to the residential component of Phase 2 South of the Watersand Development. A subsequent study will be provided for the recreation centre component of Phase 2 South of the Watersand Development. Additional traffic generation from the elementary school in Phase 2 South of the Watersand Development has not been included in our analysis as it is anticipated that the majority of the trips generated by the elementary school will be internal to the Watersand Development.

Figure 1 – Proposed Site Location and Study Area



1.3 Study Scope and Objectives

The purpose of this study is to identify the potential impacts to traffic flow at the site access and on the surrounding roadway network. The study analysis includes the following tasks:

- Consult with the City to address any traffic-related issues or concerns they have with the proposed development;
- Estimate future traffic volumes if the proposed development was not constructed, including the impact of additional proposed developments in the area;
- Estimate the amount of traffic that would be generated by the proposed development and assign to the roadway network;
- Complete LOS analysis of horizon year (with the proposed development) traffic conditions and identify additional operational deficiencies;
- Identify improvement options to address operational deficiencies; and
- Document findings and recommendations in a final report.

1.4 Horizon Year and Analysis Periods

Traffic scenarios for the build-out year (2031) and 10-year post-build-out year (2041) were selected for analysis of traffic operations in the study area. The weekday morning [AM] and weekday afternoon [PM] peak hours have been selected as the analysis periods for this study.

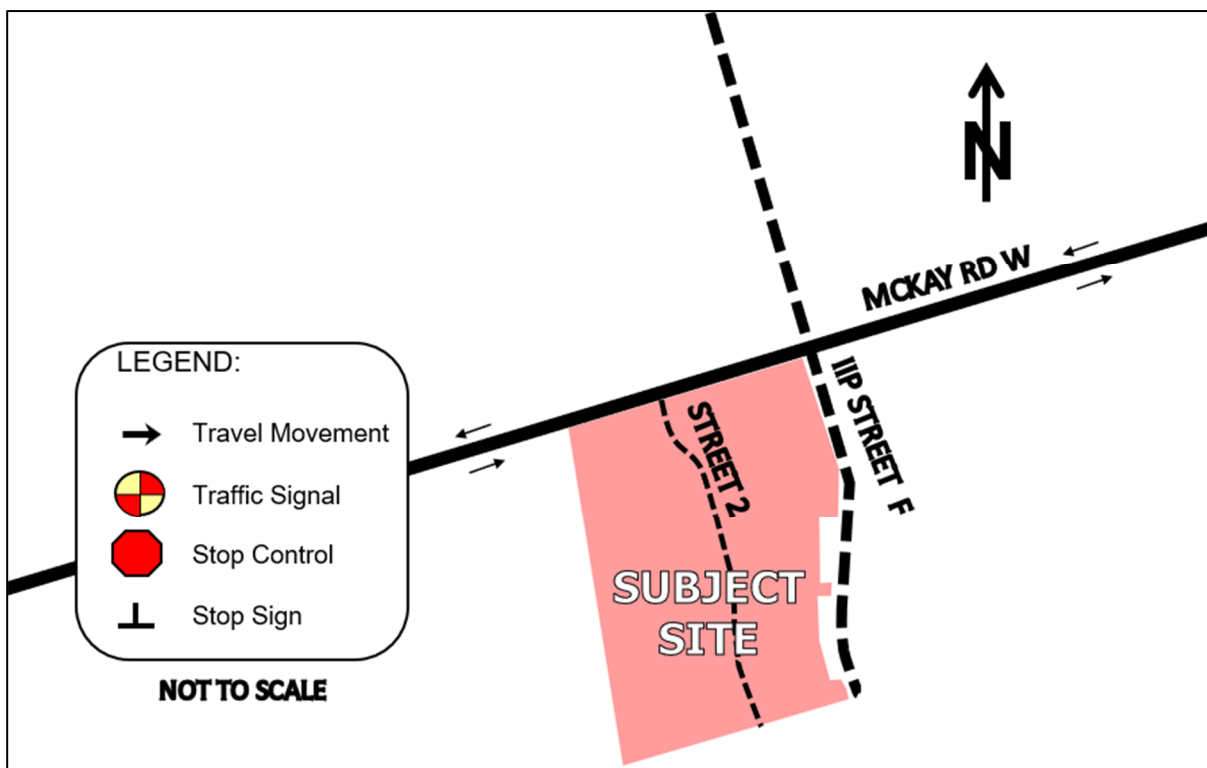
2 Information Gathering

2.1 Street and Intersection Characteristics

McKay Road West is a two-lane arterial road with a rural cross section and no sidewalks. McKay Road West has a posted speed limit of 80km/h¹. McKay Road West is under the jurisdiction of the City.

The existing lane configuration within the study area is illustrated in **Figure 2**.

Figure 2 – Existing Lane Configuration within Study Area



¹ Based on our correspondence with the City, it is our understanding that the speed limit on McKay Road West will be reduced to 60km/h as development occurs within the study area.

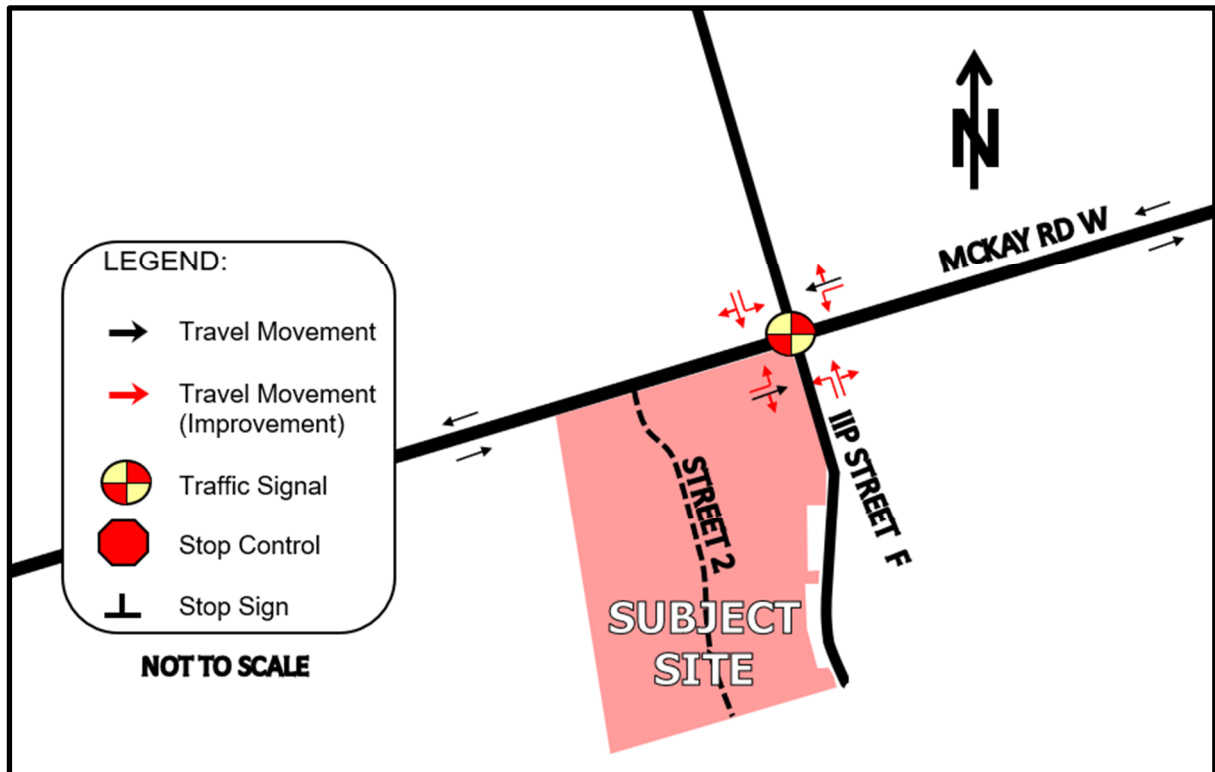
2.2 Local Transportation Infrastructure Improvements

Based on a review of the City's Transportation Master Plan [TMP] and the conclusions and recommendations from the traffic analysis in support of the Watersand Development (dated March 7, 2018) and traffic analysis addendums (dated February 15th, 2019 and September 3rd, 2022) [collectively, Watersand TA] as prepared by JD Engineering, the following infrastructure improvements are anticipated to be completed within the study area prior to the 2031 horizon year.

- McKay Road West (within the study area)
 - o Construction of a 3-lane cross section
- IIP Street F
 - o Construction of road north and south of McKay Road West as part of proposed developments.
 - o Construction of McKay Road West / IIP Street F intersection including signalization. Lane configuration in all directions anticipated to include one through-right turn lane and an auxiliary left turn lane².

The future lane configuration within the study area is illustrated in **Figure 3**.

Figure 3 – Future Lane Configuration within Study Area



² The proposed storage and taper lengths at the McKay Road West / IIP Street F intersection is discussed in Section 6.

2.3 Transit Access

There is currently no municipal transit service within the study area; however, the City's TMP identifies one bus route within the study area prior to the 2041 horizon year which would service the proposed development and provide branching service throughout the City.

2.4 Horizon Year Traffic Volumes

The background (2031) traffic volumes within the study area have been estimated based on the Watersand TA (excerpts provided in **Appendix B**). It is noted that these traffic volumes include the development of all units within Phase 1 of the Salem Secondary Plan Area, per the Forecasted Unit Projections' table issued on May 11, 2020 by KLM Planning Partners Inc. While it is anticipated that there may be some variation in the current unit count compared to the unit count at the time of the Watersand TA (May 11, 2020), the Watersand TA is based on a conservative assumption that all units in Phase 1 of the Salem Secondary Plan Area will be occupied by 2031. Based on our review, this conservative assumption would offset any minor increase in the unit count for the developments that will be occupied by 2031.

In order to calculate the background (2041) traffic volumes, a background traffic growth rate of 4.08% / year on McKay Road West has been applied to the background (2031) traffic volumes. We have used this approach (method applied in the Watersand TA), rather than applying the growth rate to the existing traffic volumes within the study area, as this approach accounts for the development of all units in Phase 1 of the Salem Secondary Plan Area and any future development and intensification of the McKay Road West corridor. While this methodology results in larger traffic volumes than the 2041 EMM model output, we believe this provides a reasonable, yet somewhat conservative estimate of the future traffic volume, based on our review of the planned future development in the Salem Secondary Plan area.

The annual background traffic growth rate outlined above has been calculated using the City's EMM transportation model output. The 2031 and 2041 EMM models were compared for McKay Road West during AM and PM peak hour.

Figures 4 and 5 illustrate the background (2031 and 2041) horizon year AM and PM peak hour traffic volumes in the study area.

3 Proposed Development Traffic Generation and Assignment

3.1 Traffic Generation

The traffic generation for the proposed development has been based on the Institute of Transportation Engineers [ITE] *Trip Generation Manual* (11th Edition) [ITE Trip Generation Manual]. The following ITE land uses have been applied to estimate the traffic from the proposed development:

- ITE land use 210 (Single-Family Detached Housing) – General Urban / Suburban Setting; and
- ITE land use 220 (Multifamily Housing (Low-Rise)) – General Urban / Suburban Setting.

The estimated trip generation of the proposed development is illustrated below in **Table 1**. The AM and PM peak traffic generation for the proposed development is not expected to exactly align with the AM and PM peak hour in the traffic data; consequently, we have applied the peak hour of adjacent street traffic values provided in the ITE Trip Generation Manual.

Table 1 – Estimated Traffic Generation of Proposed Development

Land Use	Size	AM Peak Hour			PM Peak Hour		
		IN	OUT	TOTAL	IN	OUT	TOTAL
Single-Family Detached Housing ITE Land Use: 210	204 units	37	106	143	122	72	194
Multifamily Housing (Low-Rise) ITE Land Use: 220	49 units	5	15	20	16	9	25
TOTAL TRIP GENERATION		42	121	163	138	81	219

No transportation modal split has been applied to the above-noted traffic generation calculation.

3.2 Traffic Assignment

For the purposes of this study, it has been assumed that all traffic generated by the residential component of Phase 2 South of the Watersand development will be new traffic and would not be in the study area if the development was not constructed.

In Section 3.1, the anticipated percentage of new traffic entering and exiting during the peak hour was established. The distribution of traffic entering at each access location is based on our review of the internal road network, in conjunction with the external traffic distribution.

The distribution of traffic for the residential component of Phase 2 South of the Watersand Development is based on the traffic distribution calculated in the Watersand TA, illustrated in **Table 2**.

Table 2 – Proposed Development Traffic Distribution (Residential)

Travel Direction (to / from)	Percentage of Total Traffic Generation
North via Veteran's Drive	28%
South via Veteran's Drive	3%
East via McKay Road West	59%
West via McKay Road West	10%
TOTAL	100%

Using the traffic distributions pattern noted above, the traffic assignment for the residential component of Phase 2 South of the Watersand Development was calculated for the AM and PM peak hour and is illustrated in **Figure 6**.

3.3 Total Horizon Year Traffic Volumes with the Proposed Development

For the total (2031 and 2041) horizon year traffic volumes, the proposed development traffic was added to the background (2031 and 2041) traffic volumes. The resulting total (2031 and 2041) horizon year traffic volumes for the AM and PM peak hour are illustrated in **Figures 7 and 8**.

4 Intersection Operation with Proposed Development

4.1 Introduction

Traffic operations within the study area were evaluated with the future road configuration and traffic control. The intersection performance was measured using the traffic analysis software, Synchro 11, a

deterministic model that employs Highway Capacity Manual and Intersection Capacity Utilization methodologies for analyzing intersection operations. These procedures are accepted by provincial and municipal agencies throughout North America.

Synchro 11 enables the study area to be graphically defined in terms of streets and intersections, along with their geometric and traffic control characteristics. The user is able to evaluate both signalized and unsignalized intersections in relation to each other, thus not only providing level of service for the individual intersections, but also enabling an assessment of the impact the various intersections in a network have on each other in terms of spacing, traffic congestion, delay, and queuing.

4.2 Intersection Capacity Analysis Criteria

Individual turning movements with a volume-to-capacity [V/C] ratio of 0.85 or greater are considered to be critical movements and have been highlighted in the LOS tables.

The intersection operations were also evaluated in terms of the LOS. LOS is a common measure of the quality of performance at an intersection and is defined in terms of vehicular delay. This delay includes deceleration delay, queue move-up time, stopped delay, and acceleration delay. LOS is expressed on a scale of A through F, where LOS A represents very little delay (i.e. less than 10 seconds per vehicle) and LOS F represents very high delay (i.e. greater than 50 seconds per vehicle for a stop sign controlled intersection and greater than 80 seconds per vehicle for a signalized intersection).

The LOS criteria for signalized and stop sign controlled intersections are shown in **Table 3**. A description of traffic performance characteristics is included for each LOS.

Table 3 – Level of Service Criteria for Intersections

LOS	LOS Description	Control Delay (seconds per vehicle)	
		Signalized Intersections	Stop Controlled Intersections
A	Very low delay; most vehicles do not stop (Excellent)	less than 10.0	less than 10.0
B	Higher delay; more vehicles stop (Very Good)	between 10.0 and 20.0	between 10.0 and 15.0
C	Higher level of congestion; number of vehicles stopping is significant, although many still pass through intersection without stopping (Good)	between 20.0 and 35.0	between 15.0 and 25.0
D	Congestion becomes noticeable; vehicles must sometimes wait through more than one red light; many vehicles stop (Satisfactory)	between 35.0 and 55.0	between 25.0 and 35.0
E	Vehicles must often wait through more than one red light; considered by many agencies to be the limit of acceptable delay	between 55.0 and 80.0	between 35.0 and 50.0
F	This level is considered to be unacceptable to most drivers; occurs when arrival flow rates exceed the capacity of the intersection (Unacceptable)	greater than 80.0	greater than 50.0

4.3 Total (2031) Intersection Operation

The results of the LOS analysis under total (2031) traffic volumes during the AM and PM peak hour can be found below in **Table 4**. The anticipated future intersection geometry and traffic control identified in Section 2.2 has been utilized for this scenario. Detailed output of the Synchro analysis can be found in **Appendix C**.

Table 4 – Total (2031) LOS

Location (N-S Street / E-W Street)	Weekday AM Peak Hour			Weekday PM Peak Hour		
	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS
IIP Street F / McKay Road West (signalized)	0.60	16.9	B	0.69	21.1	C
EBL	0.01	10.6	B	0.06	13.8	B
EBTR	0.81	22.1	C	0.85	29.0	C
WBL	0.38	10.3	B	0.82	27.0	C
WBTR	0.39	8.3	A	0.71	11.6	B
NBL	0.13	19.0	B	0.09	24.0	C
NBTR	0.10	18.7	B	0.07	23.7	C
SBL	0.32	21.9	C	0.23	26.1	C
SBTR	0.01	17.8	B	0.01	23.0	C
Street 2 / McKay Road West (unsignalized)	-	0.7	A	-	0.4	A
NB	0.12	13.0	B	0.08	13.0	B

The results of the LOS analysis indicate that all study area intersections are operating within the typical design limits noted in Section 3.2.

The storage and taper lengths for all auxiliary turn lanes to accommodate the anticipated 95th percentile queue length are discussed further in Section 6.

A review of the need for an auxiliary right turn lane at the unsignalized study area intersections was completed as part of our analysis. The results of the Synchro analysis indicate that there is excess capacity for all movements; consequently, an auxiliary right turn lane is not recommended.

Based on the Ontario Traffic Manual Book 12 *Signal Justification*, traffic signals are not warranted at the unsignalized study area intersections (results are provided in **Appendix D**).

It is recommended that the speed limit on McKay Road West is reduced from 80km/h to 60 km/h across the frontage of the subject site, prior to occupancy in Phase 2 South of the Watersand Development.

No additional infrastructure improvements are recommended within the study area.

4.4 Total (2041) Intersection Operation

The results of the LOS analysis under total (2041) traffic volumes during the AM and PM peak hour can be found below in **Table 5**. The anticipated future intersection geometry and traffic control identified in Section 2.2 has been utilized for this scenario. Detailed output of the Synchro analysis can be found in **Appendix C**.

Table 5 – Total (2041) LOS

Location (N-S Street / E-W Street)	Weekday AM Peak Hour			Weekday PM Peak Hour		
	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS
IIP Street F / McKay Road West (signalized)	0.75	20.5	C	0.85	34.5	C
EBL	0.01	8.2	A	0.12	12.8	B
EBTR	0.89	25.9	C	0.97	44.2	D
WBL	0.55	17.7	B	0.95	64.4	E
WBTR	0.48	7.5	A	0.87	17.3	B
NBL	0.16	28.9	C	0.12	36.2	D
NBTR	0.10	27.9	C	0.07	35.3	D
SBL	0.42	34.6	C	0.31	40.1	D
SBTR	0.01	26.8	C	0.01	34.5	C
Street 2 / McKay Road West (unsignalized)	-	0.7	A	-	0.3	B
NB	0.17	17.5	C	0.12	17.5	C

The results of the LOS analysis indicate that the V/C ratio for the eastbound and westbound movements at the IIP Street F / McKay Road West intersection is operating outside the typical design limits noted in Section 4.2. It is recommended that McKay Road West is monitored closer to the horizon year to determine if widening of McKay Road West to a four-lane cross-section is required, west of Reid Drive.

The results of the LOS analysis indicate that all other study area intersections are operating within the typical design limits noted in Section 3.2.

The storage and taper lengths for all auxiliary turn lanes to accommodate the anticipated 95th percentile queue length are discussed further in Section 6.

A review of the need for an auxiliary right turn lane at the study area intersections was completed as part of our analysis. As noted above, the eastbound through / right lane at the IIP Street F / McKay Road West intersection is anticipated to be operating beyond the typical design limits; however, the volume of right turn movements at this intersection is very low and do not warrant an auxiliary right turn lane.

The results of the Synchro analysis indicate that there is excess capacity for all other movements; consequently, an auxiliary right turn lane is not recommended. Based on the Ontario Traffic Manual Book 12 *Signal Justification*, traffic signals are not warranted at the unsignalized study area intersections (results are provided in **Appendix D**).

No additional infrastructure improvements are recommended within the study area.

4.5 Construction Parking

Based on our correspondence with the Developer, the Developer is committed to the following arrangement for construction parking:

The parking of construction vehicles and vehicles owned by staff and subcontractors employed by the Developer will be formally directed (in writing where possible) to avoid parking on municipal streets surrounding the subject site and avoid parking within private parking lots surrounding the subject site, without consent from the owner of the parking lots.

5 Supplemental Analysis – Local Road Left-In Permitted

The City has requested all future local roads (including Street 2) to be limited to RIRO on McKay Road West. This supplemental analysis has been provided to assess the impact of permitting left-in [LI] movements from McKay Road West onto Street 2.

5.1 Total (2041) Traffic Volumes – LI Permitted

5.1.1 Background (2041) Traffic Volumes – LI Permitted

The background (2041) traffic volumes within the study area with LI movements permitted at local roads have been estimated using the same methodology outlined in Section 2.4. A background traffic growth rate of 4.08% / year on McKay Road West has been applied to the background (2031) traffic volumes within the study area with LI movements permitted at local roads from the Watersand TA (excerpts provided in **Appendix B**).

Figure 9 illustrates the background (2041) horizon year AM and PM peak hour traffic volumes in the study area with LI movements permitted at local roads.

5.1.2 Proposed Development Traffic Assignment – LI Permitted

The overall traffic distribution calculated in Section 3.2 will remain unchanged with the LI movements permitted at local roads; however, the distribution of traffic entering at each access location changes.

Using the traffic distribution patterns outlined in Section 3.2, the site traffic assignment for the subject site was recalculated for the AM and PM peak hour with LI movements permitted at local roads and is illustrated in **Figure 10**.

5.1.3 Total (2041) Traffic Volumes – LI Permitted

For the total (2041) horizon year traffic volumes with LI movements permitted at local roads, the proposed development traffic with LI movements permitted at local roads was added to the background (2041) traffic volumes with LI movements permitted at local roads. The resulting total (2041) horizon year traffic volumes with LI movements permitted at local roads for the AM and PM peak hour is illustrated in **Figure 11**.

5.2 Total (2041) Intersection Operation – LI Permitted

The results of the LOS analysis under total (2041) traffic volumes with LI movements permitted at local roads during the AM and PM peak hour can be found below in **Table 6**. The anticipated future intersection geometry and traffic control identified in Section 2.2 has been utilized for this scenario with LI movements permitted at Street 2. Detailed output of the Synchro analysis can be found in **Appendix C**.

Table 6 – Total (2041) LOS – LI Permitted

Location (N-S Street / E-W Street)	Weekday AM Peak Hour			Weekday PM Peak Hour		
	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS
IIP Street F / McKay Road West (signalized)	0.74	19.7	B	0.85	26.5	C
EBL	0.01	7.9	A	0.20	10.7	B
EBTR	0.89	24.8	C	0.87	24.3	C
WBL	0.32	14.6	B	0.66	21.9	C
WBTR	0.51	8.1	A	0.95	27.8	C
NBL	0.15	27.2	C	0.11	32.9	C
NBTR	0.10	26.4	C	0.07	32.2	C
SBL	0.40	32.2	C	0.29	36.3	D
SBTR	0.01	25.4	C	0.01	31.4	C
Street 2 / McKay Road West (unsignalized)	-	0.8	A	-	0.6	B
NB	0.17	17.5	C	0.12	17.5	C

The results indicate that there will be a notable redistribution of traffic from the McKay Road West / IIP Street F intersection to the McKay Road West / Street 2 intersection. Although the redistribution of traffic is notable, the impact on the intersection operation is generally negligible, with the exception of the westbound left turn movement at the IIP Street F / McKay Road West intersection, which improves significantly.

Based on this review, we recommend the City permit the LI movement on McKay Road West at Street 2.

6 Proposed Lane Geometry and Traffic Control

6.1 McKay Road West / IIP Street F

Based on the intersection operation analysis completed in Section 4 and 5, no auxiliary right turn lanes are recommended at this intersection. **Table 7** illustrates the storage and taper lengths required for each auxiliary left turn lane. Transportation Association of Canada *Design Guide for Canadian Roads* (2017) [TAC Guidelines] have been taken into consideration when determining the auxiliary storage and taper lengths. The storage and taper lengths have been selected with the assumption that LI movements will be permitted at local roads.

Table 7 – McKay Road West / IIP Street F – Storage and Taper Lengths

Movement	Storage Length	Taper Length
EBL	15	95
WBL	30	80
NBL	20	55
SBL	40	55

6.2 McKay Road West / Street 2

Based on the intersection operation analysis completed in Section 4 and 5, an auxiliary right turn lane is not recommended at this intersection. A 15 metre storage and 95 metre taper length is recommended for the westbound left turn movement.

7 Transportation Demand Management

The study area has and will continue to experience a significant transformation with respect to land-use and transportation. A number of infrastructure initiatives currently in the design, planning or concept phase, will help to address the transportation capacity challenges in the area. However, the construction of new roads will not be enough to accommodate the projected future travel demand. The following section provides additional existing and planned techniques incorporated in the design for the subject site which will help to address the transportation demand in the study area.

7.1 Transit Network

The subject site is not adjacent to any existing Barrie Transit bus routes; however is adjacent to a future Barrie Transit bus route as identified in the City TMP. The above noted future bus route is anticipated to connect into the City's downtown bus terminal. It is recommended that the City implement the future transit route prior to occupancy of the proposed development to provide transit service within the study area.

7.2 Pedestrian and Cycling Network

According to the City's TMP, the existing cycling network in the City includes approximately 145 kilometers of cycling infrastructure. While there is no direct cycling infrastructure on McKay Road West at this time, the proposed cycling network in the City's TMP and Salem Secondary Plan area development plans include bicycle infrastructure along McKay Road West, IIP Street F and the east / west minor collector road within the Watersand Development, which will connect into the City's planned cycling network.

There is also no existing sidewalk infrastructure within the study area; however, the proposed sidewalk network in the City's TMP and Salem Secondary Plan area development plans include sidewalk on McKay Road West. IIP Street F and the east / west minor collector in the Watersand Development will include sidewalk on both sides of the road and all proposed local roads within the Watersand Development will also include sidewalk, which will provide access into the City's existing and planned sidewalk network.

Furthermore, a variety of additional active transportation infrastructure is proposed within the City's TMP, including:

- Proposed additional 484 kilometers of active transportation infrastructure within the City;
- A direct, connected and continuous network of different active transportation options to be established that accommodates safe walking, cycling, hiking and other active modes of transportation;
- Provide and prioritize connections to key destinations within the City and to public transit;
- Enhance opportunities for people to walk and bike for short trips;
- Allocate an appropriate annual maintenance budget to monitoring and maintain pedestrian and cycling facilities once they have been constructed;
- Establish a winter maintained network consisting of spine routes in order for walking and cycling to be viable modes of transportation year-round; and
- Developing and implementing programs aimed at encouraging and promoting a culture of active transportation.

7.3 Local Development

The following is a list of transportation demand management techniques that are recommended for the proposed development:

- \$25 transit pass for the first owner of each residential unit, to encourage transit use among residents; and
- Preparation and distribution of transit information packages to new residents, including bicycle maps, local transit map/schedule, information on transit incentives and any other relevant information related to active transportation, at time of distribution.

8 Summary

Watersand Construction Ltd. retained **JD Engineering** to prepare this traffic impact study in support of the residential component of Phase 2 South of the Watersand Development located at the southwest corner of the intersection of McKay Road West / Veteran's Drive in the City of Barrie [City]. The proposed Draft Plan of Subdivision is shown in **Appendix A**. This chapter summarizes the conclusions and recommendations from the study.

Phase 2 South of the Watersand Development includes the development of 30.5 hectares, including 204 single detached residential units, 49 townhouse units, a recreation centre and elementary school.

The scope of this study is limited to a review of the residential component of Phase 2 South of the Watersand Development.

1. The residential component of Phase 2 South of the Watersand Development is expected to generate a total of 163 AM and 219 PM peak hour trips.
2. Traffic projections for the 2031 year for the McKay Road West / IIP Street F intersection were obtained from the Watersand TA.
3. An intersection operation analysis was completed at the study area intersections, using the background (2031 and 2041) traffic volumes, without the proposed development traffic. This enabled a review of existing and future traffic deficiencies that would be present without the influence of the proposed development. The following geometric lane improvements and traffic signal improvements are recommended within the study area:

At Opening

McKay Road West / IIP Street F

- Signalization of Intersection;
 - Eastbound left turn auxiliary lane with a 15 metre storage and 95 metre taper length;
 - Westbound left turn auxiliary lane with a 30 metre storage and 80 metre taper length;
 - Northbound left turn auxiliary lane with a 20 metre storage and 55 metre taper length; and
 - Southbound left turn auxiliary lane with a 40 metre storage and 55 metre taper length;
4. An estimate of the amount of traffic that would be generated by the proposed development was prepared and assigned to the study area streets and intersections.
 5. An intersection operation analysis was completed under total (2031 and 2041) traffic volumes with the proposed development operational at the study area intersections. The following additional geometric lane improvements or traffic signal improvements are recommended within the study area:

At Opening

McKay Road West

- Reduce the speed limit on McKay Road West to 60 km/h to the west end of the Watersand Development.

McKay Road West / Street 2

- Westbound left turn auxiliary lane with a 15 metre storage and 95 metre taper length.
6. It is recommended that McKay Road West is monitored closer to the 2041 horizon year to determine if widening of McKay Road West to a four-lane cross-section is required west of Reid Drive.
 7. In summary, the residential component of Phase 2 South of the Watersand Development will not cause any operational issues and will not add a notable delay or congestion to the local roadway network.

Figure 4 – Background (2031) Traffic Volumes

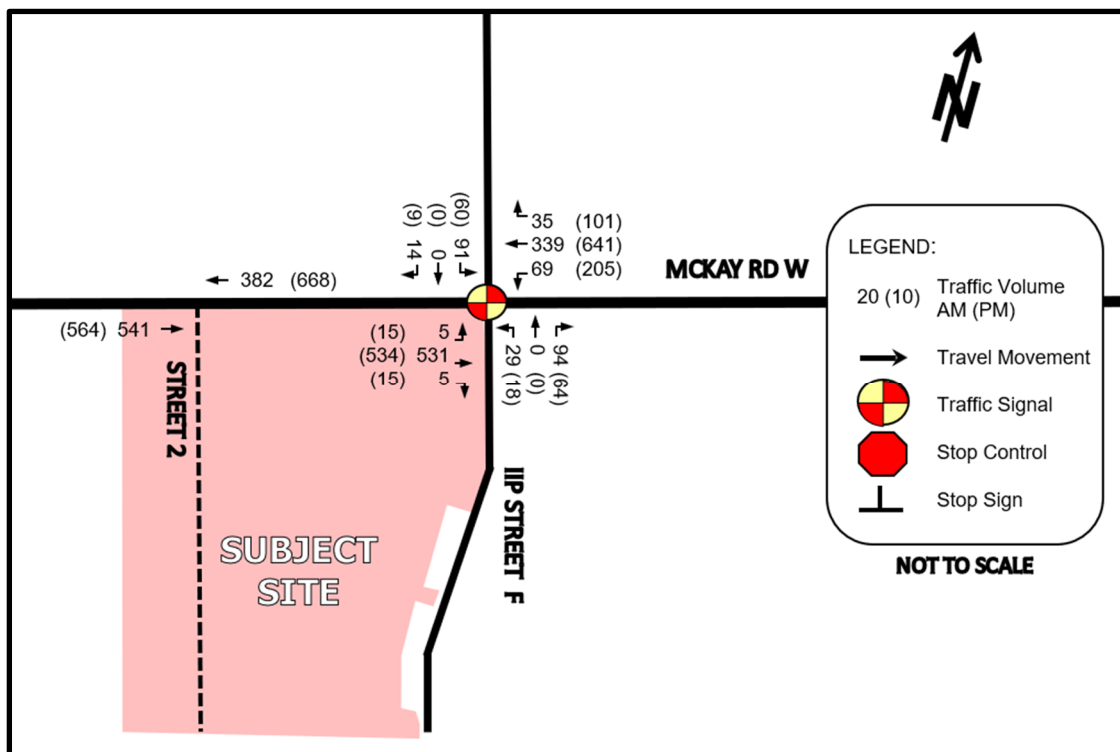


Figure 5 – Background (2041) Traffic Volumes

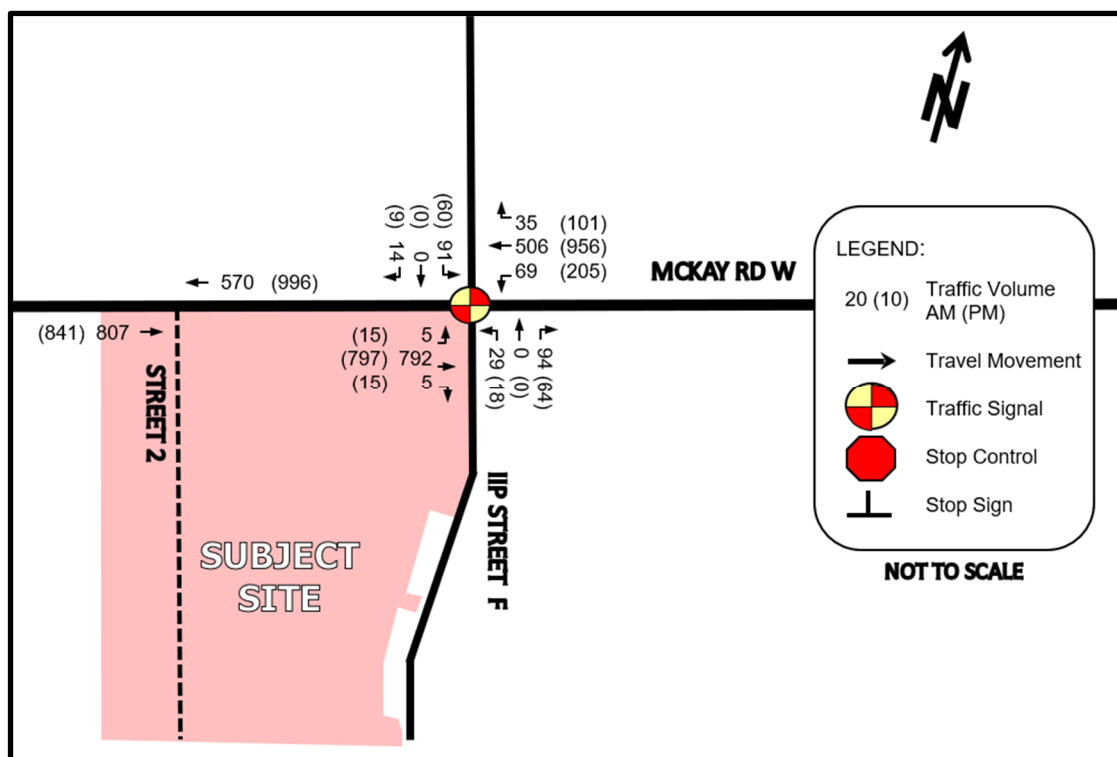


Figure 6 – Proposed Development Traffic Assignment

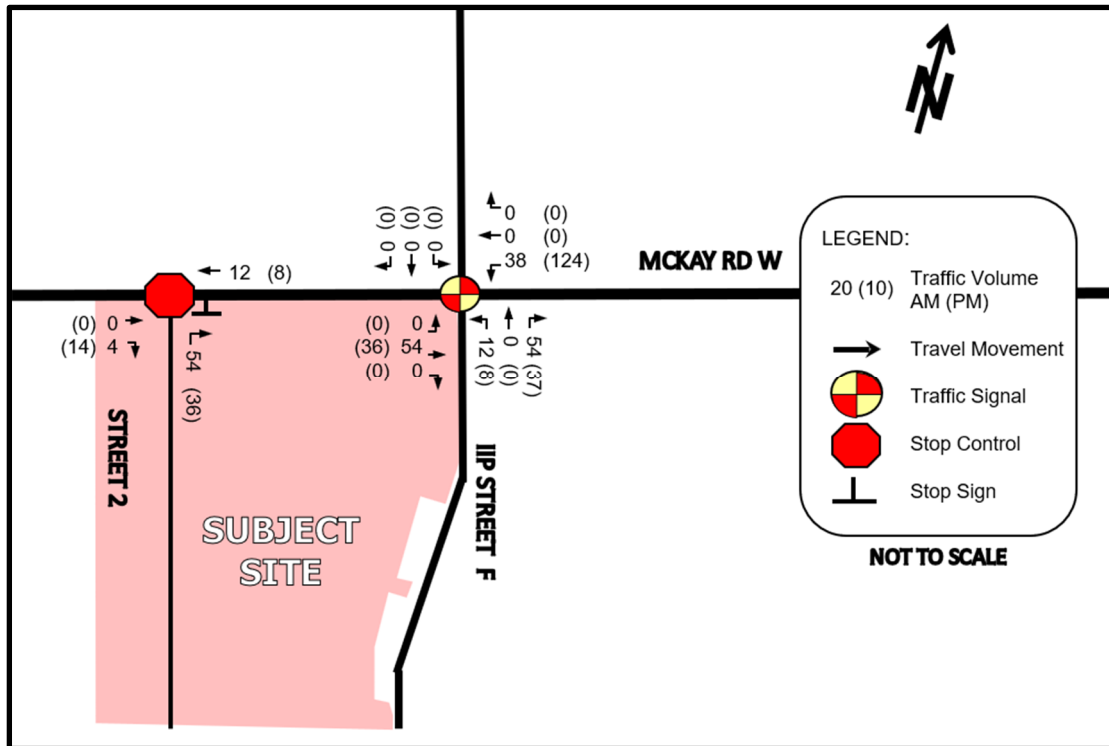


Figure 7 – Total (2031) Traffic Volumes

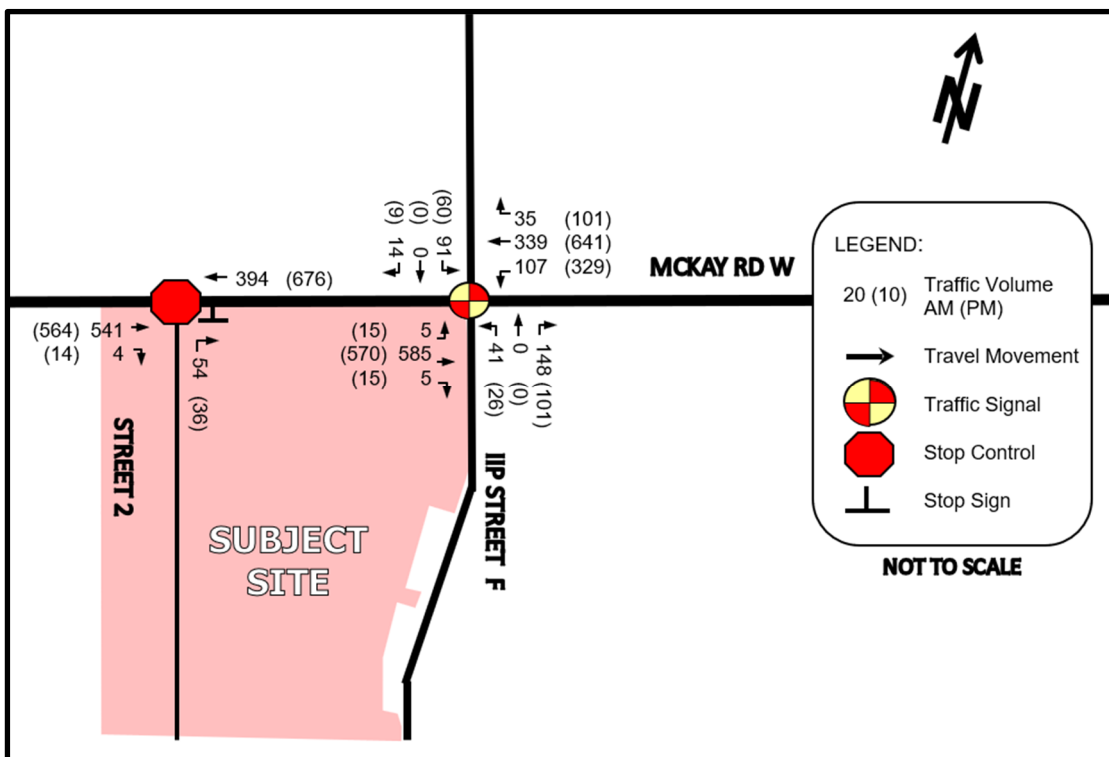


Figure 8 – Total (2041) Traffic Volumes

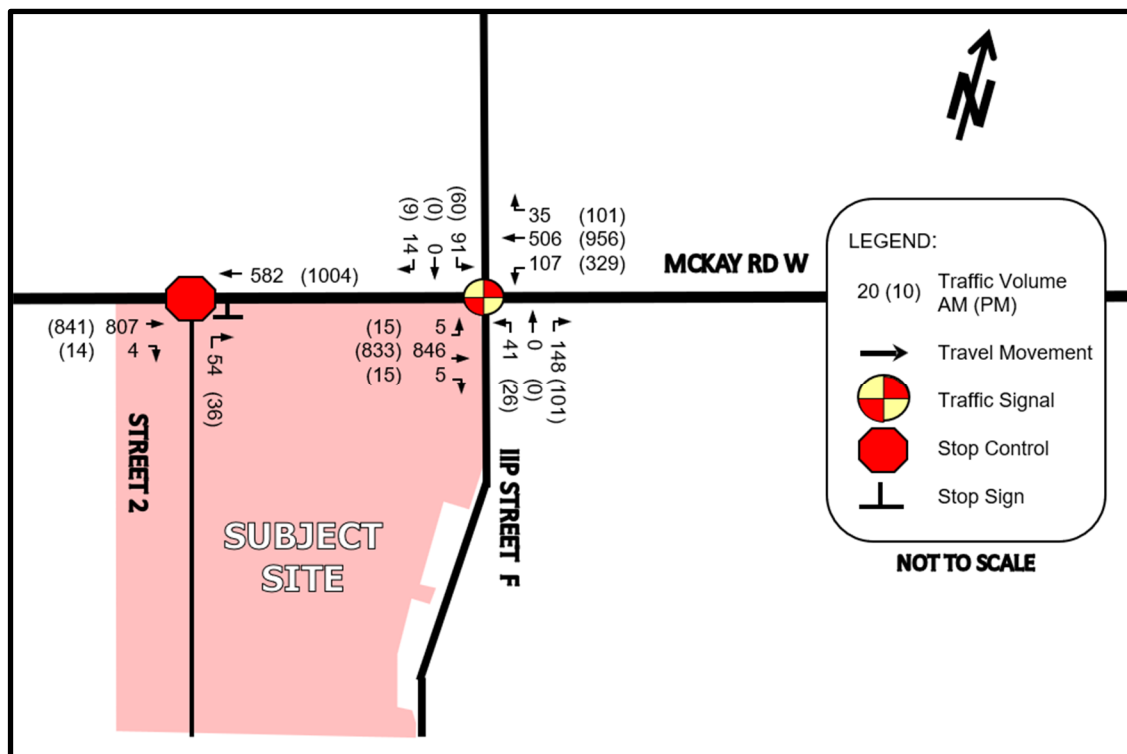


Figure 9 – Background (2041) Traffic Volumes – LI Permitted

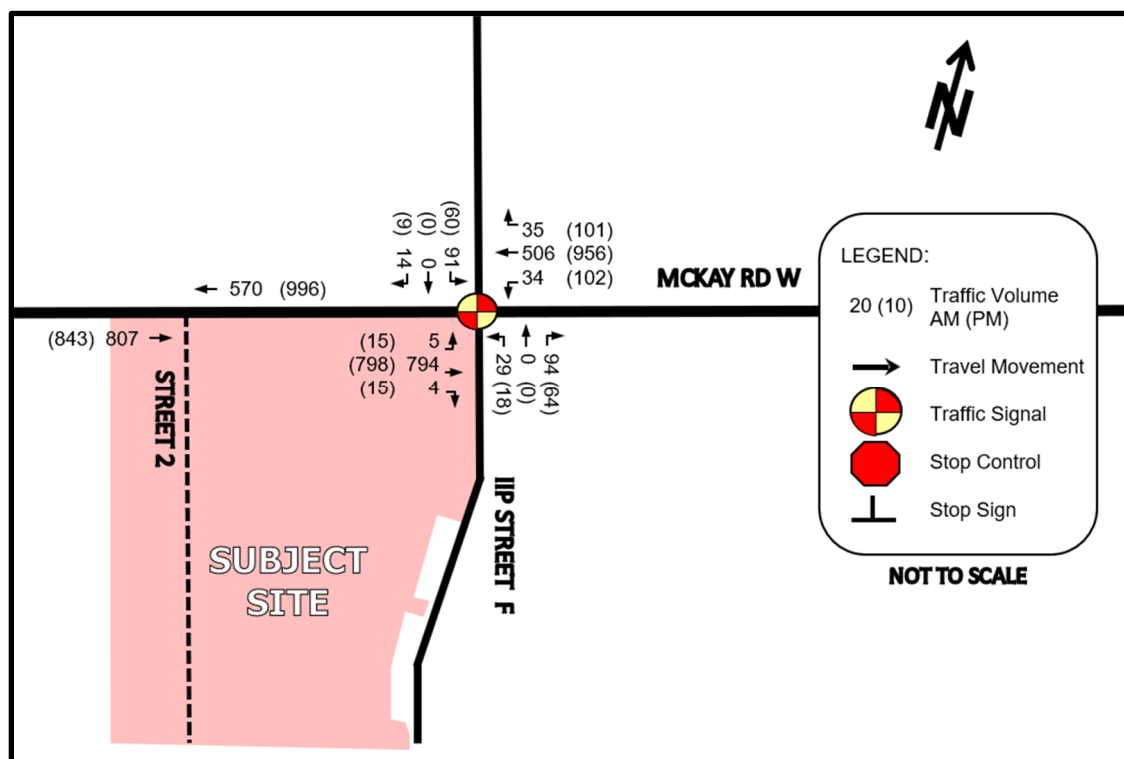


Figure 10 – Proposed Development Traffic Assignment – LI Permitted

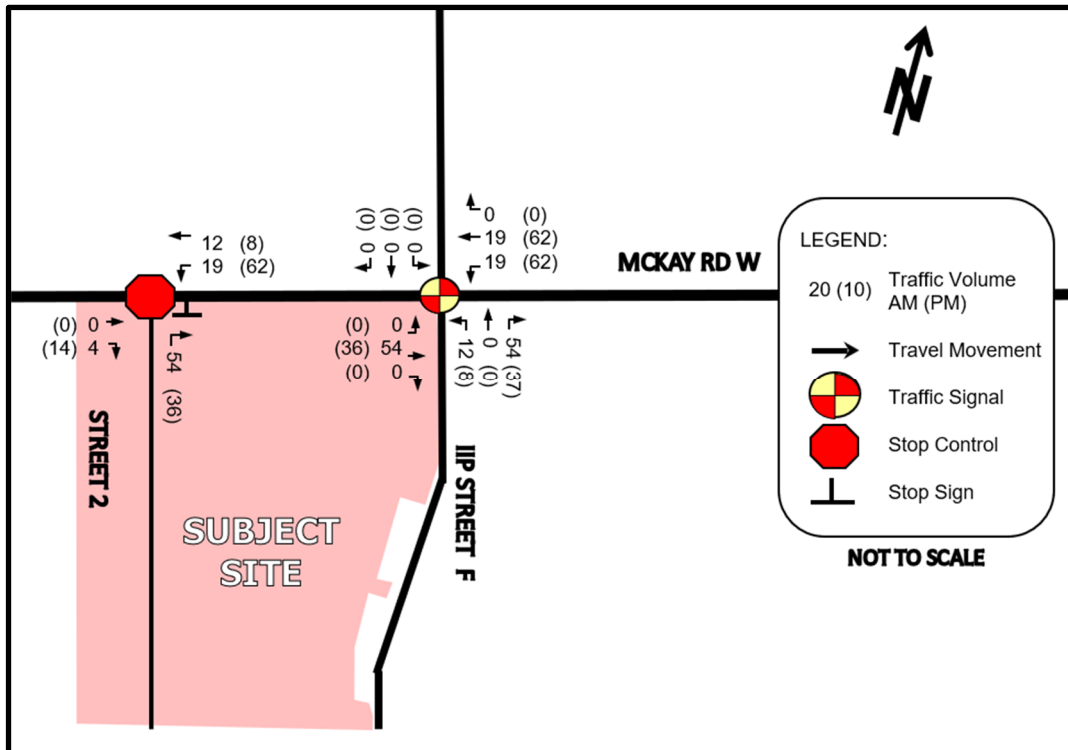
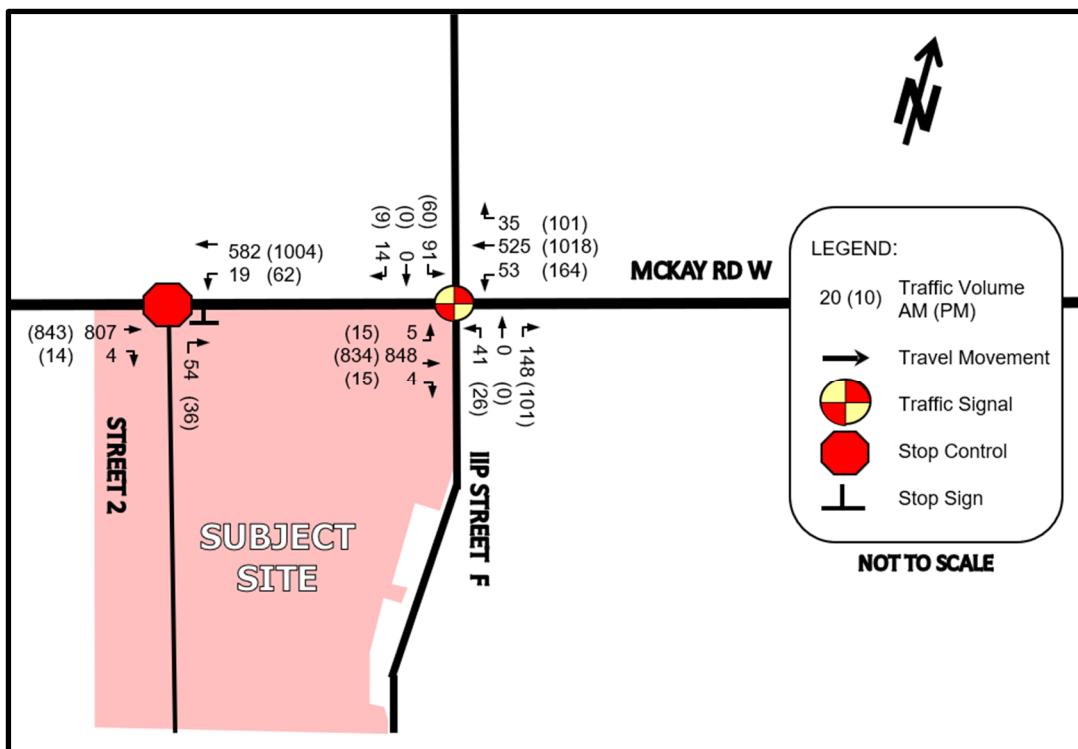


Figure 11 – Total (2041) Traffic Volumes – LI Permitted

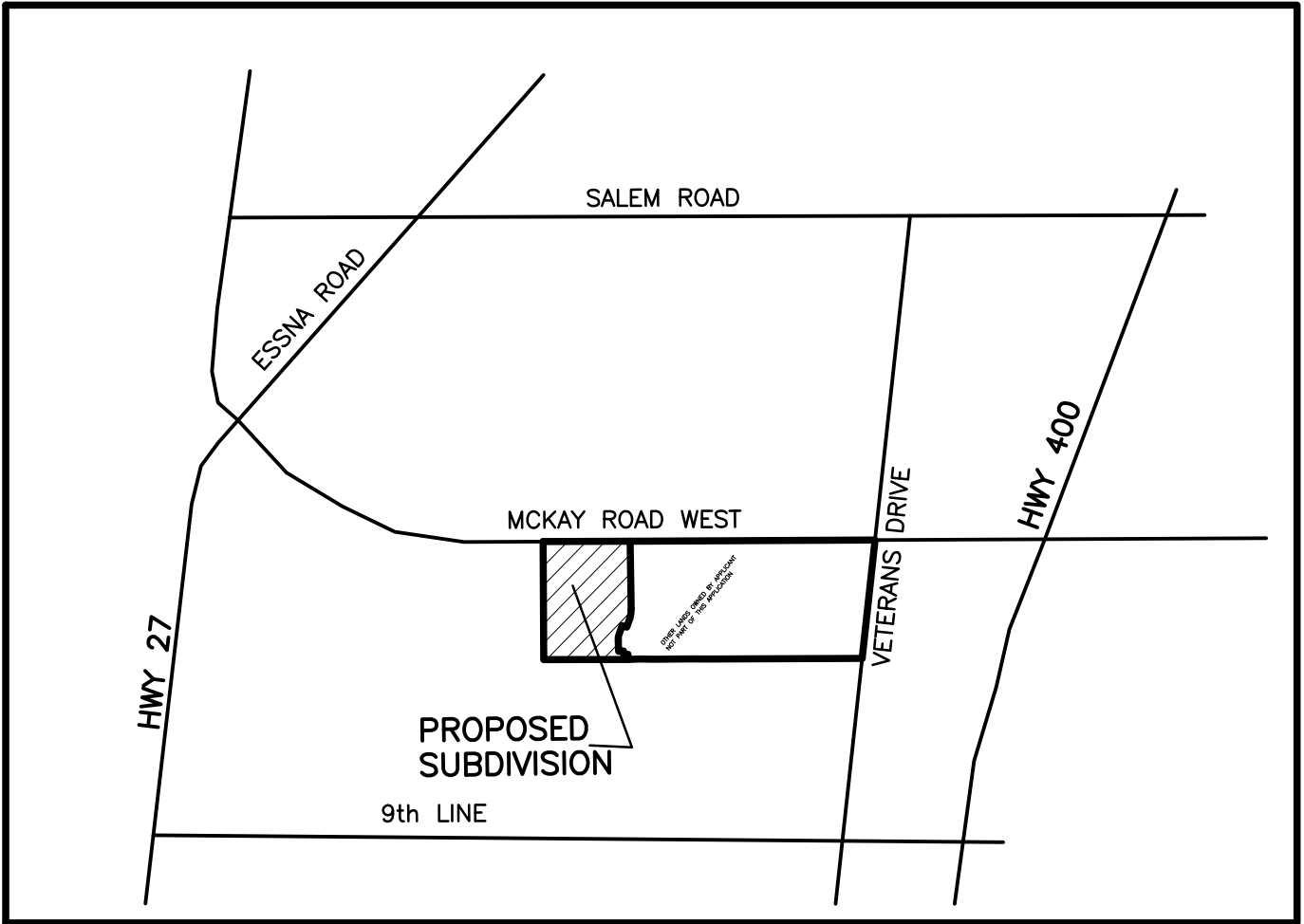


Appendix A – Site Plan

DRAFT PLAN OF SUBDIVISION
PART OF THE NORTH HALF OF LOT 3,
ALL OF THE NORTH HALF OF LOT 4
AND PART OF LOT 5, CONCESSION 9
(GEOGRAPHIC TOWNSHIP OF INNISFIL)
CITY OF BARRIE
COUNTY OF SIMCOE

SCALE 1:2000

DRAFT PLAN T-



KEY PLAN

SECTION 51, PLANNING ACT,
ADDITIONAL INFORMATION

- A. AS SHOWN ON DRAFT PLAN
- B. AS SHOWN ON DRAFT PLAN
- C. AS SHOWN ON DRAFT PLAN
- D. SEE SCHEDULE OF LAND USE
- E. AS SHOWN ON DRAFT PLAN
- F. AS SHOWN ON DRAFT PLAN
- G. AS SHOWN ON DRAFT PLAN
- H. MUNICIPAL PIPED WATER AVAILABLE AT TIME OF DEVELOPMENT
- I. CLAY-LOAM
- J. AS SHOWN ON DRAFT PLAN
- K. SANITARY AND STORM SEWERS, GARBAGE COLLECTION, FIRE PROTECTION
- L. AS SHOWN ON DRAFT PLAN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE
SUBDIVIDED AS SHOWN ON THIS PLAN, AND THEIR RELATIONSHIP TO
THE ADJACENT LAND ARE ACCURATELY AND CORRECTLY SHOWN.

DATE APRIL 20, 2022

GARY B. VANDERVEEN
ONTARIO LAND SURVEYOR

HOLDING JONES VANDERVEEN INC.

OWNER'S CERTIFICATE

I AUTHORIZE KLM PLANNING PARTNERS INC. TO PREPARE AND SUBMIT
THIS DRAFT PLAN OF SUBDIVISION TO THE CITY OF BARRIE FOR APPROVAL.

OWNER

WATERSAND CONSTRUCTION LTD.

C/O

DC GROUP
30 FLORAL PARKWAY
SUITE 300
CONCORD, ONTARIO
L4K 4R1

ROBERT De GASPERIS
A.S.O.

SCHEDULE OF LAND USE

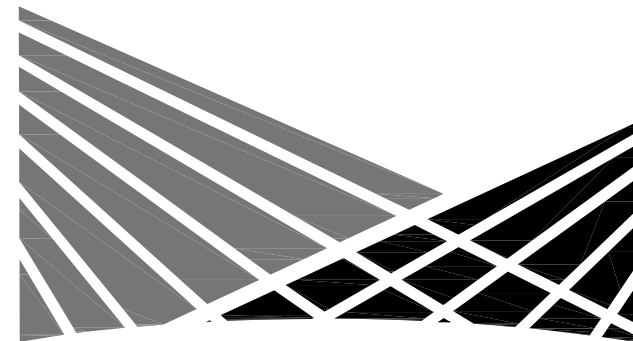
TOTAL AREA OF LAND = 119.032±Ha. (294.134±Acs.)

[PHASE 2]

TOTAL AREA FOR PHASE 2 = 30.468±Ha. (75.288±Acs.)

LOTS FOR SINGLE FAMILY DWELLINGS		BLOCKS	LOTS	UNITS	±Ha.	±Acs.
LOTS 70-84 MIN. LOT FRONTAGE=15.3m. MIN. AREA=420.75sq.m.			15	15	0.732	1.809
LOTS 7-9, 32-35, 39-41, 46, 52-57, 66-69, 85, 93-96, 101-102, 115-116, 128-131, 156-159, 170-172, 197-198, 207 and 209-212 MIN. LOT FRONTAGE=13.7m. MIN. AREA=376.75sq.m.			48	48	2.086	5.155
LOTS 1-6, 10-31, 36-38, 42-43, 47-51, 58-62, 65, 89-92, 97-100, 103-106, 110-111, 117-127, 132-155, 165-169, 174-183, 190-192, 199, 205-206 and 208 MIN. LOT FRONTAGE=11.6m. MIN. AREA=319.0sq.m.			115	115	4.319	10.672
LOTS 44-45, 63-64, 86-88, 107-109, 112-114, 160-164, 173, 186-189, 200-201 and 204 MIN. LOT FRONTAGE=10.0m. MIN. AREA=275.0sq.m.			26	26	0.848	2.095
MEDIUM DENSITY						
STREET TOWNHOUSES						
BLOCKS 184-185, 193-196 and 202-203 MIN. UNIT FRONTAGE=6.3m.		8	49	0.975	2.409	
SUBTOTAL		8	204	253	8.960	22.140
BLOCK 213 - S.W.M.		1		0.299	0.739	
BLOCK 214 - ELEMENTARY SCHOOL		1		2.419	5.977	
BLOCK 215 - RECREATIONAL CENTRE		1		8.094	20.000	
BLOCKS 216 and 217 - VALLEY		2		5.604	13.937	
BLOCK 218 - ROAD WIDENING		1		0.347	0.858	
BLOCKS 219 - 222 - 0.3m. RESERVE		4		0.002	0.005	
BLOCKS 223 and 224 - 3.0m. WALKWAY		2		0.018	0.044	
STREETS				4.689	11.588	
24.0m. WIDE TOTAL LENGTH= 463m. AREA= 1.111Ha. 18.0m. WIDE TOTAL LENGTH= 1986m. AREA= 3.578Ha. TOTAL TOTAL LENGTH= 2034m. AREA= 4.689Ha.						
TOTAL		20	204	253	30.468	75.288

NOTE - ELEVATIONS RELATED TO
CANADIAN GEODETIC DATUM



PROJECT No. P-2899

SCALE 1:2000 APR 20, 2022

(2899DES5) X-REF: (2899MAS2 & 2899TOPO)

DWG. No. - 22:1

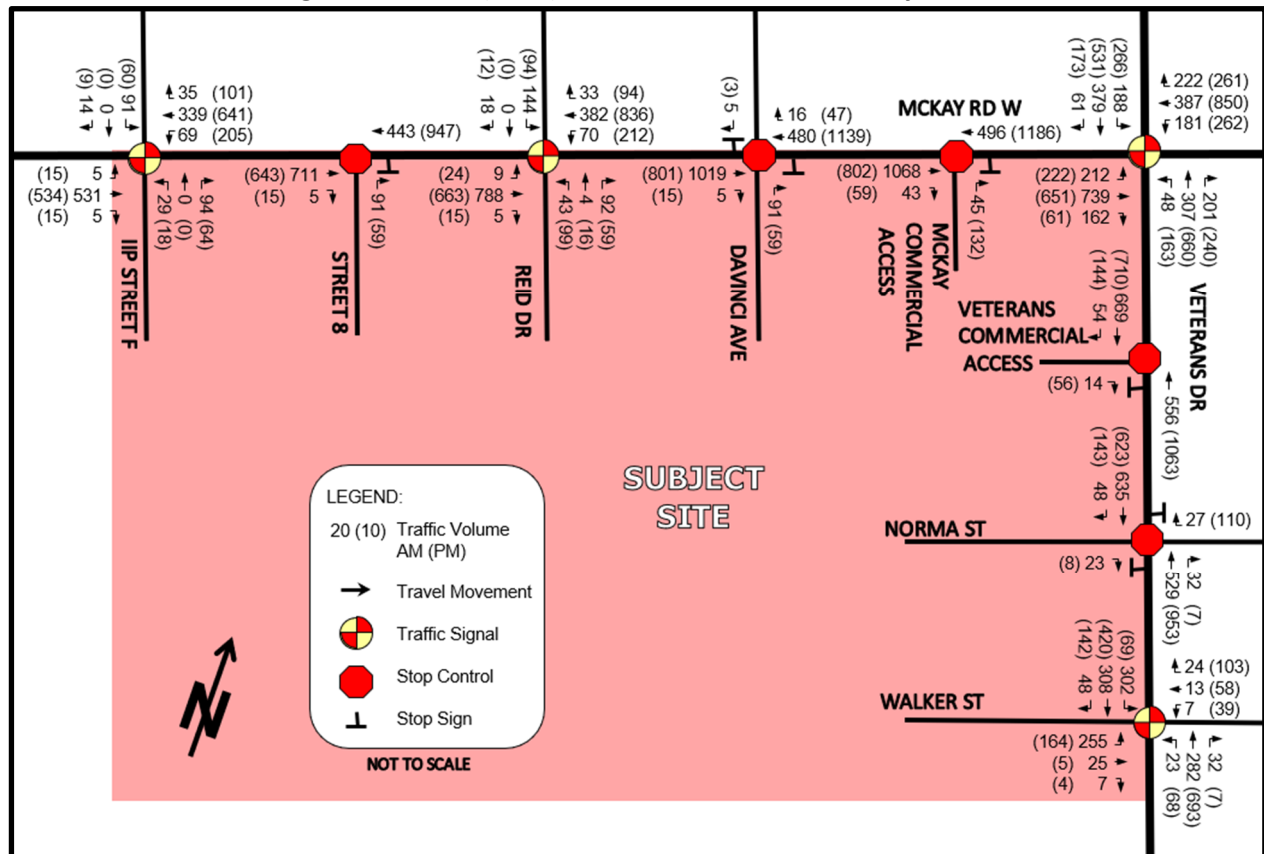
PLANNING PARTNERS INC. 64 JARDIN DRIVE - UNIT 1B, CONCORD, ONTARIO L4K 3P3

TEL: (905) 669-4055 FAX: (905) 669-0097 design@klmplanning.com

Planning • Design • Development

Appendix B – Watersand TA Excerpts

Figure 11 –Total (2031) Traffic Volumes within Study Area



4.3.3 TOTAL (2036 AND 2041) HORIZON YEAR TRAFFIC VOLUMES

In order to calculate the Total (2036 and 2041) traffic volumes, a background traffic growth rate of 2.46% / year on Veteran's Drive and 4.08% / year on McKay Road West has been applied to the Total (2031) traffic volumes. The background growth rate was applied to the total (2031) traffic volumes, rather than the background (2031) traffic volumes, in order to account for the future development and intensification of these corridors. While this methodology results in larger traffic volumes than the 2041 EMME model output, we believe this provides a reasonable, yet somewhat conservative estimate of the future traffic volume, based on our review of the Phase 1 traffic volumes and the planned future development in Phase 2 and 3 of the Salem Secondary Plan.

The annual background traffic growth rates outlined above have been calculated using the City's EMME transportation model output. The 2031 and 2041 EMME models were compared for Veteran's Drive and McKay Road West during AM and PM peak hour.

It is noted that a 2.46% / year background growth rate has also been applied to the IIP Street F and Reid Drive (north leg) total (2031) traffic volumes, to account for future development in Phase 2 that will be serviced by IIP Street F and the north leg of Reid Drive as well as additional traffic anticipated within the study area as a result of the Reid Drive extension.

6.0 SUPPLEMENTAL ANALYSIS – LOCAL ROADS AND COMMERCIAL ACCESSES LEFT-IN

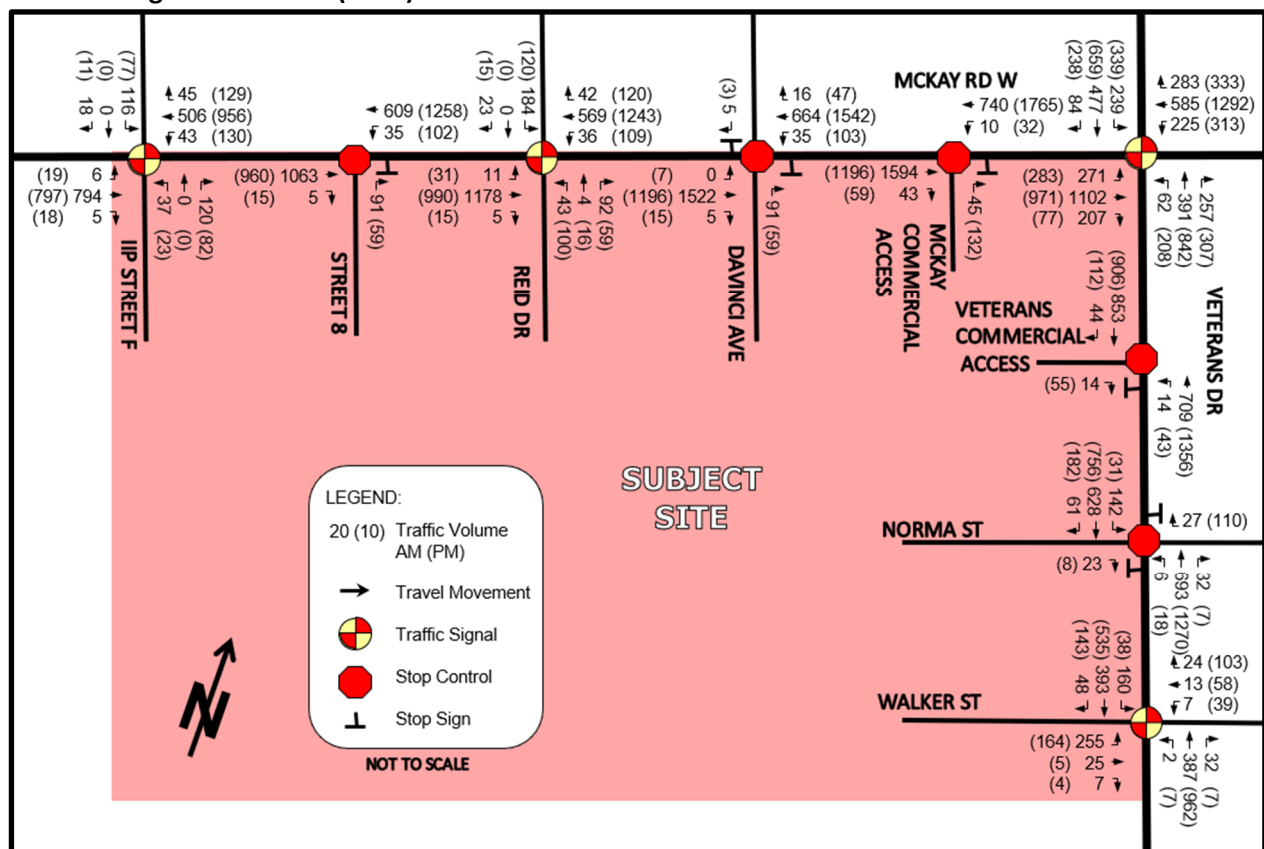
The City has requested all local roads and future commercial accesses from McKay Road West and Veteran's Drive to be limited to right-in-right-out accesses. This supplemental analysis has been provided to assess the impact of permitting left-in [LI] movements to the commercial accesses from McKay Road West and Veteran's Drive in addition to LI movements being permitted from McKay Road West and Veteran's Drive onto local roads Street 8, DaVinci Drive and Norma Street. The intent is to improve access into the Commercial Block while minimizing the impact on the local roads in the Watersand Development.

6.1 TOTAL (2041) TRAFFIC VOLUMES – LIS PERMITTED

The overall traffic assignment calculated in Table 9 in Section 4.2 will remain unchanged with the LI movements permitted at the commercial access and local roads; however, the distribution of traffic entering at each access location changes.

Using the traffic distribution patterns outlined in Table 9 in Section 4.2, the site traffic assignment for the subject site was recalculated for the AM and PM peak hour with LI movements permitted at the commercial accesses and local roads. **Figure 14** illustrates the revised traffic assignment.

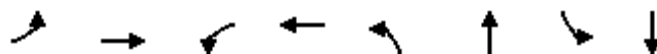
Figure 14 – Total (2041) Traffic Volumes – Commercial and Local Road LI Permitted



Appendix C – Synchro Analysis Output – Total Traffic Volumes

Watersand Phase 2 South
1: IIP Street F & Mckay Rd W

Queues
Total (2031) AM Peak Hour



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	5	585	107	339	41	0	91	0
Future Volume (vph)	5	585	107	339	41	0	91	0
Lane Group Flow (vph)	5	641	116	406	45	161	99	15
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	68.0	68.0	10.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	68.0%	68.0%	10.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.01	0.80	0.32	0.40	0.13	0.24	0.31	0.02
Control Delay	10.0	24.6	7.2	8.6	23.6	0.8	26.6	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.0	24.6	7.2	8.6	23.6	0.8	26.6	0.1
Queue Length 50th (m)	0.4	69.5	5.3	24.4	4.4	0.0	10.3	0.0
Queue Length 95th (m)	2.0	107.2	10.3	39.1	14.4	0.0	27.7	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	906	1729	362	1811	359	682	315	829
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.37	0.32	0.22	0.13	0.24	0.31	0.02

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 63.8
Natural Cycle: 60
Control Type: Semi Act-Uncoord

Splits and Phases: 1: IIP Street F & Mckay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis

Total (2031) AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	585	5	107	339	35	41	0	148	91	0	14
Future Volume (vph)	5	585	5	107	339	35	41	0	148	91	0	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1861		1770	1837		1770	1583		1770	1583	
Flt Permitted	0.52	1.00		0.18	1.00		0.75	1.00		0.66	1.00	
Satd. Flow (perm)	975	1861		337	1837		1393	1583		1220	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	636	5	116	368	38	45	0	161	99	0	15
RTOR Reduction (vph)	0	1	0	0	6	0	0	120	0	0	11	0
Lane Group Flow (vph)	5	640	0	116	400	0	45	41	0	99	4	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	27.4	27.4		35.7	35.7		16.5	16.5		16.5	16.5	
Effective Green, g (s)	27.4	27.4		35.7	35.7		16.5	16.5		16.5	16.5	
Actuated g/C Ratio	0.43	0.43		0.56	0.56		0.26	0.26		0.26	0.26	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	416	794		305	1021		358	406		313	406	
v/s Ratio Prot		c0.34		0.03	c0.22			0.03			0.00	
v/s Ratio Perm	0.01			0.18			0.03			c0.08		
v/c Ratio	0.01	0.81		0.38	0.39		0.13	0.10		0.32	0.01	
Uniform Delay, d1	10.6	16.1		9.5	8.1		18.3	18.2		19.3	17.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	6.0		0.8	0.2		0.7	0.5		2.6	0.0	
Delay (s)	10.6	22.1		10.3	8.3		19.0	18.7		21.9	17.8	
Level of Service	B	C		B	A		B	B		C	B	
Approach Delay (s)		22.0			8.8			18.8			21.4	
Approach LOS		C			A			B			C	
Intersection Summary												
HCM 2000 Control Delay			16.9			HCM 2000 Level of Service			B			
HCM 2000 Volume to Capacity ratio			0.60									
Actuated Cycle Length (s)			64.2			Sum of lost time (s)			15.0			
Intersection Capacity Utilization			70.4%			ICU Level of Service			C			
Analysis Period (min)			15									
c Critical Lane Group												

Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis

Total (2031) AM Peak Hour

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗			↖		↗
Traffic Volume (veh/h)	541	4	0	394	0	54
Future Volume (Veh/h)	541	4	0	394	0	54
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	588	4	0	428	0	59
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			592		1018	590
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			592		1018	590
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	88
cM capacity (veh/h)			984		263	508
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	592	428	59			
Volume Left	0	0	0			
Volume Right	4	0	59			
cSH	1700	1700	508			
Volume to Capacity	0.35	0.25	0.12			
Queue Length 95th (m)	0.0	0.0	3.1			
Control Delay (s)	0.0	0.0	13.0			
Lane LOS			B			
Approach Delay (s)	0.0	0.0	13.0			
Approach LOS			B			
Intersection Summary						
Average Delay		0.7				
Intersection Capacity Utilization		38.7%	ICU Level of Service	A		
Analysis Period (min)		15				

Watersand Phase 2 South
1: IIP Street F & Mckay Rd W

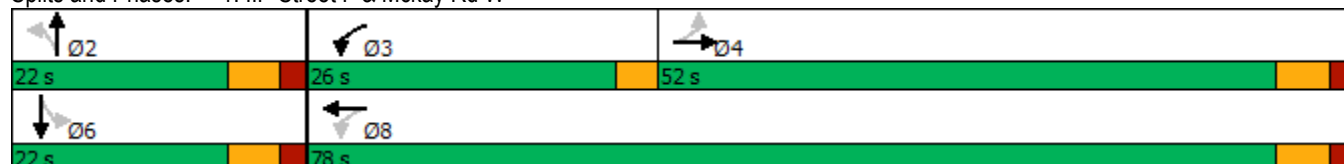
Queues
Total (2031) PM Peak Hour

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	15	570	329	641	26	0	60	0
Future Volume (vph)	15	570	329	641	26	0	60	0
Lane Group Flow (vph)	16	636	358	807	28	110	65	10
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	11.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	52.0	52.0	26.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	52.0%	52.0%	26.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.06	0.85	0.80	0.71	0.09	0.15	0.23	0.02
Control Delay	14.7	32.8	27.2	12.9	31.0	0.4	32.5	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.7	32.8	27.2	12.9	31.0	0.4	32.5	0.0
Queue Length 50th (m)	1.4	78.9	26.5	68.6	3.2	0.0	7.6	0.0
Queue Length 95th (m)	5.6	144.8	62.3	101.2	13.1	0.0	24.8	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	411	1166	653	1678	305	727	279	589
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.04	0.55	0.55	0.48	0.09	0.15	0.23	0.02

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 75.6
Natural Cycle: 70
Control Type: Semi Act-Uncoord

Splits and Phases: 1: IIP Street F & Mckay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis

Total (2031) PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	570	15	329	641	101	26	0	101	60	0	9
Future Volume (vph)	15	570	15	329	641	101	26	0	101	60	0	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.98		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1856		1770	1825		1770	1583		1770	1583	
Flt Permitted	0.35	1.00		0.15	1.00		0.75	1.00		0.69	1.00	
Satd. Flow (perm)	653	1856		281	1825		1399	1583		1278	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	620	16	358	697	110	28	0	110	65	0	10
RTOR Reduction (vph)	0	1	0	0	8	0	0	86	0	0	8	0
Lane Group Flow (vph)	16	635	0	358	799	0	28	24	0	65	2	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	30.4	30.4		46.7	46.7		16.5	16.5		16.5	16.5	
Effective Green, g (s)	30.4	30.4		46.7	46.7		16.5	16.5		16.5	16.5	
Actuated g/C Ratio	0.40	0.40		0.62	0.62		0.22	0.22		0.22	0.22	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	263	750		437	1133		306	347		280	347	
v/s Ratio Prot		0.34		c0.14	0.44			0.02			0.00	
v/s Ratio Perm	0.02			c0.36			0.02			c0.05		
v/c Ratio	0.06	0.85		0.82	0.71		0.09	0.07		0.23	0.01	
Uniform Delay, d1	13.7	20.3		15.6	9.6		23.4	23.3		24.1	22.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	8.7		11.4	2.0		0.6	0.4		1.9	0.0	
Delay (s)	13.8	29.0		27.0	11.6		24.0	23.7		26.1	23.0	
Level of Service	B	C		C	B		C	C		C	C	
Approach Delay (s)		28.6			16.4			23.7			25.7	
Approach LOS		C			B			C			C	
Intersection Summary												
HCM 2000 Control Delay			21.1			HCM 2000 Level of Service				C		
HCM 2000 Volume to Capacity ratio			0.69									
Actuated Cycle Length (s)			75.2			Sum of lost time (s)			15.0			
Intersection Capacity Utilization			72.5%			ICU Level of Service			C			
Analysis Period (min)			15									
c Critical Lane Group												

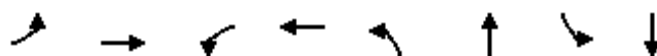
Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis
Total (2031) PM Peak Hour

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗			↖		↗
Traffic Volume (veh/h)	564	14	0	676	0	36
Future Volume (Veh/h)	564	14	0	676	0	36
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	613	15	0	735	0	39
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			628		1356	620
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			628		1356	620
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	92
cM capacity (veh/h)			954		165	488
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	628	735	39			
Volume Left	0	0	0			
Volume Right	15	0	39			
cSH	1700	1700	488			
Volume to Capacity	0.37	0.43	0.08			
Queue Length 95th (m)	0.0	0.0	2.1			
Control Delay (s)	0.0	0.0	13.0			
Lane LOS			B			
Approach Delay (s)	0.0	0.0	13.0			
Approach LOS			B			
Intersection Summary						
Average Delay		0.4				
Intersection Capacity Utilization		40.5%		ICU Level of Service		A
Analysis Period (min)		15				

Watersand Phase 2 South
1: IIP Street F & Mckay Rd W

Queues
Total (2041) AM Peak Hour



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	5	845	107	506	41	0	91	0
Future Volume (vph)	5	845	107	506	41	0	91	0
Lane Group Flow (vph)	5	923	116	588	45	161	99	15
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	68.0	68.0	10.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	68.0%	68.0%	10.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.01	0.89	0.46	0.49	0.16	0.31	0.42	0.02
Control Delay	7.8	27.5	12.1	8.2	35.1	2.0	41.2	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.8	27.5	12.1	8.2	35.1	2.0	41.2	0.1
Queue Length 50th (m)	0.4	130.3	5.3	41.5	6.6	0.0	15.2	0.0
Queue Length 95th (m)	1.8	191.9	15.3	60.2	18.7	1.2	36.1	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	628	1418	254	1573	278	516	235	642
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.65	0.46	0.37	0.16	0.31	0.42	0.02

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 83
Natural Cycle: 80
Control Type: Semi Act-Uncoord

Splits and Phases: 1: IIP Street F & Mckay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis

Total (2041) AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	845	5	107	506	35	41	0	148	91	0	14
Future Volume (vph)	5	845	5	107	506	35	41	0	148	91	0	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1861		1770	1845		1770	1583		1770	1583	
Flt Permitted	0.44	1.00		0.09	1.00		0.75	1.00		0.63	1.00	
Satd. Flow (perm)	825	1861		166	1845		1393	1583		1180	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	918	5	116	550	38	45	0	161	99	0	15
RTOR Reduction (vph)	0	0	0	0	3	0	0	129	0	0	12	0
Lane Group Flow (vph)	5	923	0	116	585	0	45	32	0	99	3	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	46.4	46.4		54.7	54.7		16.6	16.6		16.6	16.6	
Effective Green, g (s)	46.4	46.4		54.7	54.7		16.6	16.6		16.6	16.6	
Actuated g/C Ratio	0.56	0.56		0.66	0.66		0.20	0.20		0.20	0.20	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	459	1036		211	1211		277	315		235	315	
v/s Ratio Prot		c0.50		c0.03	0.32			0.02			0.00	
v/s Ratio Perm	0.01			0.33			0.03			c0.08		
v/c Ratio	0.01	0.89		0.55	0.48		0.16	0.10		0.42	0.01	
Uniform Delay, d1	8.2	16.2		14.8	7.2		27.6	27.3		29.2	26.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	9.7		2.9	0.3		1.3	0.6		5.5	0.1	
Delay (s)	8.2	25.9		17.7	7.5		28.9	27.9		34.6	26.8	
Level of Service	A	C		B	A		C	C		C	C	
Approach Delay (s)		25.8			9.2			28.1			33.6	
Approach LOS		C			A			C			C	
Intersection Summary												
HCM 2000 Control Delay			20.5			HCM 2000 Level of Service				C		
HCM 2000 Volume to Capacity ratio			0.75									
Actuated Cycle Length (s)			83.3			Sum of lost time (s)			15.0			
Intersection Capacity Utilization			84.0%			ICU Level of Service			E			
Analysis Period (min)			15									
c Critical Lane Group												

Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis

Total (2041) AM Peak Hour

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↰		↱
Traffic Volume (veh/h)	807	4	0	582	0	54
Future Volume (Veh/h)	807	4	0	582	0	54
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	877	4	0	633	0	59
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			881		1512	879
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			881		1512	879
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	83
cM capacity (veh/h)			767		132	347
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	881	633	59			
Volume Left	0	0	0			
Volume Right	4	0	59			
cSH	1700	1700	347			
Volume to Capacity	0.52	0.37	0.17			
Queue Length 95th (m)	0.0	0.0	4.8			
Control Delay (s)	0.0	0.0	17.5			
Lane LOS			C			
Approach Delay (s)	0.0	0.0	17.5			
Approach LOS			C			
Intersection Summary						
Average Delay		0.7				
Intersection Capacity Utilization		52.7%		ICU Level of Service		A
Analysis Period (min)		15				

Watersand Phase 2 South
1: IIP Street F & McKay Rd W

Queues
Total (2041) PM Peak Hour

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	15	833	329	956	26	0	60	0
Future Volume (vph)	15	833	329	956	26	0	60	0
Lane Group Flow (vph)	16	921	358	1149	28	110	65	10
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	11.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	58.0	58.0	20.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	58.0%	58.0%	20.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.12	0.97	0.93	0.87	0.12	0.20	0.31	0.03
Control Delay	15.2	46.4	60.3	19.9	37.7	0.8	42.0	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.2	46.4	60.3	19.9	37.7	0.8	42.0	0.1
Queue Length 50th (m)	1.6	170.5	54.2	147.9	5.0	0.0	11.9	0.0
Queue Length 95th (m)	5.8	#264.0	#111.0	#244.8	13.2	0.0	25.3	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	137	985	387	1352	227	552	208	395
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.94	0.93	0.85	0.12	0.20	0.31	0.03

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 98.2

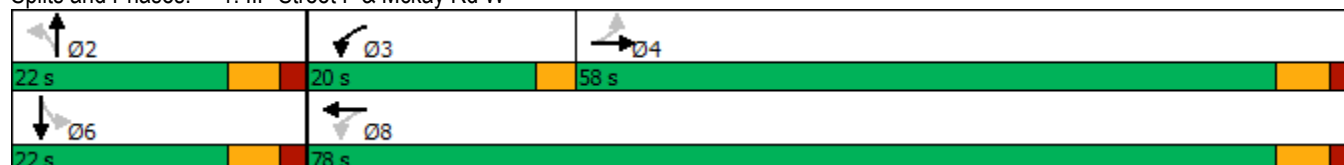
Natural Cycle: 90

Control Type: Semi Act-Uncoord

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: IIP Street F & McKay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis

Total (2041) PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	833	15	329	956	101	26	0	101	60	0	9
Future Volume (vph)	15	833	15	329	956	101	26	0	101	60	0	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1858		1770	1836		1770	1583		1770	1583	
Flt Permitted	0.14	1.00		0.07	1.00		0.75	1.00		0.69	1.00	
Satd. Flow (perm)	259	1858		140	1836		1399	1583		1278	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	905	16	358	1039	110	28	0	110	65	0	10
RTOR Reduction (vph)	0	0	0	0	4	0	0	92	0	0	8	0
Lane Group Flow (vph)	16	921	0	358	1145	0	28	18	0	65	2	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	50.4	50.4		70.2	70.2		16.0	16.0		16.0	16.0	
Effective Green, g (s)	50.4	50.4		70.2	70.2		16.0	16.0		16.0	16.0	
Actuated g/C Ratio	0.51	0.51		0.71	0.71		0.16	0.16		0.16	0.16	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	132	953		378	1312		227	257		208	257	
v/s Ratio Prot		0.50		c0.16	0.62			0.01			0.00	
v/s Ratio Perm	0.06			c0.52			0.02			c0.05		
v/c Ratio	0.12	0.97		0.95	0.87		0.12	0.07		0.31	0.01	
Uniform Delay, d1	12.4	23.1		31.9	10.6		35.1	34.8		36.2	34.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	21.1		32.6	6.7		1.1	0.5		3.9	0.0	
Delay (s)	12.8	44.2		64.4	17.3		36.2	35.3		40.1	34.5	
Level of Service	B	D		E	B		D	D		D	C	
Approach Delay (s)		43.6			28.5			35.5			39.4	
Approach LOS		D			C			D			D	
Intersection Summary												
HCM 2000 Control Delay			34.5			HCM 2000 Level of Service				C		
HCM 2000 Volume to Capacity ratio			0.85									
Actuated Cycle Length (s)			98.2			Sum of lost time (s)			15.0			
Intersection Capacity Utilization			87.3%			ICU Level of Service			E			
Analysis Period (min)			15									
c Critical Lane Group												

Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis

Total (2041) PM Peak Hour

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	841	14	0	1004	0	36
Future Volume (Veh/h)	841	14	0	1004	0	36
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	914	15	0	1091	0	39
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			929		2012	922
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			929		2012	922
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	88
cM capacity (veh/h)			736		65	328
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	929	1091	39			
Volume Left	0	0	0			
Volume Right	15	0	39			
cSH	1700	1700	328			
Volume to Capacity	0.55	0.64	0.12			
Queue Length 95th (m)	0.0	0.0	3.2			
Control Delay (s)	0.0	0.0	17.5			
Lane LOS			C			
Approach Delay (s)	0.0	0.0	17.5			
Approach LOS			C			
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization			56.2%	ICU Level of Service		B
Analysis Period (min)			15			

Watersand Phase 2 South
1: IIP Street F & Mckay Rd W

Queues

Total (2041) AM Peak Hour - Left-Turns Allowed at Local Roads

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	5	848	53	525	41	0	91	0
Future Volume (vph)	5	848	53	525	41	0	91	0
Lane Group Flow (vph)	5	926	58	609	45	161	99	15
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	68.0	68.0	10.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	68.0%	68.0%	10.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.01	0.88	0.22	0.52	0.15	0.30	0.39	0.02
Control Delay	7.6	26.0	5.5	8.8	34.8	1.9	39.6	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.6	26.0	5.5	8.8	34.8	1.9	39.6	0.1
Queue Length 50th (m)	0.4	131.2	2.5	43.6	6.6	0.0	15.3	0.0
Queue Length 95th (m)	1.8	192.8	5.5	63.5	18.7	1.4	36.0	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	602	1458	262	1595	294	531	253	643
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.01	0.64	0.22	0.38	0.15	0.30	0.39	0.02

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 80.1

Natural Cycle: 80

Control Type: Semi Act-Uncoord

Splits and Phases: 1: IIP Street F & Mckay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis

Total (2041) AM Peak Hour - Left-Turns Allowed at Local Roads

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	848	4	53	525	35	41	0	148	91	0	14
Future Volume (vph)	5	848	4	53	525	35	41	0	148	91	0	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1862		1770	1845		1770	1583		1770	1583	
Flt Permitted	0.41	1.00		0.09	1.00		0.75	1.00		0.64	1.00	
Satd. Flow (perm)	770	1862		170	1845		1393	1583		1200	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	5	922	4	58	571	38	45	0	161	99	0	15
RTOR Reduction (vph)	0	0	0	0	3	0	0	127	0	0	12	0
Lane Group Flow (vph)	5	926	0	58	606	0	45	34	0	99	3	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	45.3	45.3		51.9	51.9		16.9	16.9		16.9	16.9	
Effective Green, g (s)	45.3	45.3		51.9	51.9		16.9	16.9		16.9	16.9	
Actuated g/C Ratio	0.56	0.56		0.64	0.64		0.21	0.21		0.21	0.21	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	431	1043		180	1185		291	331		250	331	
v/s Ratio Prot		c0.50		0.01	c0.33			0.02			0.00	
v/s Ratio Perm	0.01			0.19			0.03			c0.08		
v/c Ratio	0.01	0.89		0.32	0.51		0.15	0.10		0.40	0.01	
Uniform Delay, d1	7.8	15.5		13.5	7.7		26.1	25.8		27.5	25.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	9.3		1.0	0.4		1.1	0.6		4.6	0.1	
Delay (s)	7.9	24.8		14.6	8.1		27.2	26.4		32.2	25.4	
Level of Service	A	C		B	A		C	C		C	C	
Approach Delay (s)		24.8			8.6			26.6			31.3	
Approach LOS		C			A			C			C	
Intersection Summary												
HCM 2000 Control Delay	19.7			HCM 2000 Level of Service			B					
HCM 2000 Volume to Capacity ratio	0.74											
Actuated Cycle Length (s)	80.8			Sum of lost time (s)			15.0					
Intersection Capacity Utilization	74.9%			ICU Level of Service			D					
Analysis Period (min)	15											
c Critical Lane Group												

Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis
Total (2041) AM Peak Hour - Left-Turns Allowed at Local Roads

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗		↘	↗		↘
Traffic Volume (veh/h)	807	4	19	582	0	54
Future Volume (Veh/h)	807	4	19	582	0	54
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	877	4	21	633	0	59
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			881		1554	879
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			881		1554	879
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		100	83
cM capacity (veh/h)			767		121	347
Direction, Lane #	EB 1	WB 1	WB 2	NB 1		
Volume Total	881	21	633	59		
Volume Left	0	21	0	0		
Volume Right	4	0	0	59		
cSH	1700	767	1700	347		
Volume to Capacity	0.52	0.03	0.37	0.17		
Queue Length 95th (m)	0.0	0.7	0.0	4.8		
Control Delay (s)	0.0	9.8	0.0	17.5		
Lane LOS		A		C		
Approach Delay (s)	0.0	0.3		17.5		
Approach LOS				C		
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			52.7%		ICU Level of Service	A
Analysis Period (min)			15			

Watersand Phase 2 South
1: IIP Street F & McKay Rd W

Queues

Total (2041) PM Peak Hour - Left-Turns Allowed at Local Roads

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	15	834	164	1018	26	0	60	0
Future Volume (vph)	15	834	164	1018	26	0	60	0
Lane Group Flow (vph)	16	923	178	1217	28	110	65	10
Turn Type	Perm	NA	pm+pt	NA	Perm	NA	Perm	NA
Protected Phases		4	3	8		2		6
Permitted Phases	4		8		2		6	
Detector Phase	4	4	3	8	2	2	6	6
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	22.0	22.0	11.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	66.0	66.0	12.0	78.0	22.0	22.0	22.0	22.0
Total Split (%)	66.0%	66.0%	12.0%	78.0%	22.0%	22.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	0.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	3.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead					
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	None	None	None	None	Max	Max	Max	Max
v/c Ratio	0.20	0.87	0.64	0.95	0.11	0.22	0.29	0.03
Control Delay	16.1	26.9	20.9	29.8	37.2	1.0	40.6	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.1	26.9	20.9	29.8	37.2	1.0	40.6	0.1
Queue Length 50th (m)	1.3	135.3	8.4	174.3	5.0	0.0	11.9	0.0
Queue Length 95th (m)	5.9	204.3	29.9	#316.6	13.2	0.0	25.3	0.0
Internal Link Dist (m)		467.0		364.4		154.3		102.5
Turn Bay Length (m)	10.0		30.0		10.0		20.0	
Base Capacity (vph)	93	1226	292	1454	245	502	224	396
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.17	0.75	0.61	0.84	0.11	0.22	0.29	0.03

Intersection Summary

Cycle Length: 100

Actuated Cycle Length: 92.4

Natural Cycle: 90

Control Type: Semi Act-Uncoord

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: IIP Street F & McKay Rd W



Watersand Phase 2 South
1: IIP Street F & McKay Rd W

HCM Signalized Intersection Capacity Analysis
Total (2041) PM Peak Hour - Left-Turns Allowed at Local Roads

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	834	15	164	1018	101	26	0	101	60	0	9
Future Volume (vph)	15	834	15	164	1018	101	26	0	101	60	0	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1858		1770	1837		1770	1583		1770	1583	
Flt Permitted	0.08	1.00		0.10	1.00		0.75	1.00		0.69	1.00	
Satd. Flow (perm)	141	1858		187	1837		1399	1583		1278	1583	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	907	16	178	1107	110	28	0	110	65	0	10
RTOR Reduction (vph)	0	1	0	0	4	0	0	91	0	0	8	0
Lane Group Flow (vph)	16	922	0	178	1213	0	28	19	0	65	2	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	52.8	52.8		64.0	64.0		16.2	16.2		16.2	16.2	
Effective Green, g (s)	52.8	52.8		64.0	64.0		16.2	16.2		16.2	16.2	
Actuated g/C Ratio	0.57	0.57		0.69	0.69		0.18	0.18		0.18	0.18	
Clearance Time (s)	6.0	6.0		3.0	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	80	1064		270	1275		245	278		224	278	
v/s Ratio Prot		0.50		0.06	c0.66			0.01			0.00	
v/s Ratio Perm	0.11			0.40			0.02			c0.05		
v/c Ratio	0.20	0.87		0.66	0.95		0.11	0.07		0.29	0.01	
Uniform Delay, d1	9.5	16.7		16.2	12.7		32.0	31.7		33.0	31.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2	7.6		5.7	15.1		0.9	0.5		3.3	0.0	
Delay (s)	10.7	24.3		21.9	27.8		32.9	32.2		36.3	31.4	
Level of Service	B	C		C	C		C	C		D	C	
Approach Delay (s)		24.1			27.0			32.3			35.6	
Approach LOS		C			C			C			D	
Intersection Summary												
HCM 2000 Control Delay			26.5			HCM 2000 Level of Service			C			
HCM 2000 Volume to Capacity ratio			0.85									
Actuated Cycle Length (s)			92.2			Sum of lost time (s)			15.0			
Intersection Capacity Utilization			90.5%			ICU Level of Service			E			
Analysis Period (min)			15									
c Critical Lane Group												

Watersand Phase 2 South
13: Street 2 & McKay Rd W

HCM Unsignalized Intersection Capacity Analysis
Total (2041) PM Peak Hour - Left-Turns Allowed at Local Roads

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗		↘	↗		↘
Traffic Volume (veh/h)	843	14	62	1004	0	36
Future Volume (Veh/h)	843	14	62	1004	0	36
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	916	15	67	1091	0	39
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			931		2148	924
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			931		2148	924
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			91		100	88
cM capacity (veh/h)			735		48	327
Direction, Lane #	EB 1	WB 1	WB 2	NB 1		
Volume Total	931	67	1091	39		
Volume Left	0	67	0	0		
Volume Right	15	0	0	39		
cSH	1700	735	1700	327		
Volume to Capacity	0.55	0.09	0.64	0.12		
Queue Length 95th (m)	0.0	2.4	0.0	3.2		
Control Delay (s)	0.0	10.4	0.0	17.5		
Lane LOS		B		C		
Approach Delay (s)	0.0	0.6		17.5		
Approach LOS				C		
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			56.2%	ICU Level of Service		B
Analysis Period (min)			15			

Appendix D – OTM Signal Justification Sheets

Justification No. 7 - 2041 Total Traffic (Critical Case)

McKay Road West / Street 2

Justification	Description		Compliance			Signal Warrant	Underground Provisions Warrant
			Sectional		Entire %		
			Rest. Flow	Numerical			
1. Minimum Vehicular Volume	A. Vehicle volume, all approaches (average hour)	720	856	119%	6%	NO	YES
	B. Vehicle volume, along minor streets (average hour)	255	23	9%		NO	NO
2. Delay to cross traffic	A. Vehicle volume, major street (average hour)	720	829	115%	0%	NO	YES
	B. Combined vehicle and pedestrian volume crossing artery from minor streets (average hour)	75	0	0%		NO	NO