
# Barton-Tiffany Urban Design Study

## Part 2

## Technical Studies

August 2014

- **Traffic Impact Study and TDM Guidelines**
  (Paradigm Transportation Solutions)
- **Functional Servicing Report**
  (MTE Consultants)
- **Noise and Vibration Feasibility Study**
  (HGC Engineering)

Hamilton

# Barton – Tiffany Urban Design Study
# Traffic Impact Study and TDM Guidelines
## FINAL Report


**Preferred Design Concept**
**(GSP Group Inc.)**

**Submitted by:**

**Paradigm Transportation Solutions Ltd.**
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**August 15, 2014**

# Project Summary

Project Name:....................................... Barton-Tiffany Urban Design Study
Transportation Strategy Report
Final Report

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Report Date: ...................................................................... August 2014
Project Number: ........................................................................ 131400

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# Preamble

## Study Context

The City of Hamilton is currently undertaking an Urban Design Study for the lands herein referred to as the Barton-Tiffany Study Area, located within the West Harbour Secondary Planning Area. To assist in the development of an Urban Design Concept and Guidelines, the study will include the preparation of a number of technical studies including:

- Functional Servicing Report;
- Traffic Impact Study;
- Transportation Demand Management (TDM) Guidelines; and
- A comprehensive review of previous studies.

The Urban Design Study will serve as the form and functional benchmark in which future development within the study area must achieve. The study will address all applicable policies within the Secondary Plan, the performance standards contained within the zoning by-law, and will also communicate the "vision" in which to create a healthy and sustainable community within the West Harbour. Furthermore, the Urban Design Study will serve to provide site-specific Urban Design Guidelines for development applications within the Study Area.

## Study Background

Over the past decade, various studies have been undertaken in the surrounding area as well as within the overall Study Area. The resulting Urban Design Study builds upon previous studies in order to develop a preferred land use concept, and ultimately to provide a framework for all future studies related to development within the Barton-Tiffany Study Area. Background studies referenced and information relevant to this study include:

1) **Setting Sail: West Harbour Secondary Plan**[1] contains the preferred land uses within the West Harbour Secondary Planning area, the planning principles, guidelines and general policies for development areas within the West Harbour Secondary Planning Area. This report states that an urban design study should be carried out for the Barton-Tiffany Special Policy Area. The study should include information regarding the following:
    a) Appropriate building heights, setbacks and landscaping, and built form controls,
    b) Provision of an east-west continuous open space linkage between Dundurn Park and Bay Street;
    c) Noise attenuation;
    d) Development of a neighbourhood commercial node at the intersection of Barton Street West and Hess Street;
    e) Relocate the City Public Works facilities and expand Central Park into this area; and
    f) Permit additional residential density where the City determines there is a need to increase density.

[1] Setting Sail Secondary Plan for West Harbour, City of Hamilton, May 2005

2) **Downtown Transportation Master Plan Five Year Review**[2] has been used to determine future pedestrian and cycling improvements within the Study Area, and how planned improvements to the south of the Barton-Tiffany Urban Design Study area may be affected;

3) **Shifting Gears 2009, Hamilton's Cycling Master Plan**[3] has been referenced for planned cycling network improvements;

4) **West Harbour Waterfront Recreation Master Plan**[4]; and

5) **North End Traffic Management Plan**[5] contains information regarding traffic calming and speed management measures currently implemented at various locations within the North End, and identifies potential traffic calming measures that may be applicable to the Barton-Tiffany Study Area.

## Study Objectives

The Barton-Tiffany Urban Design Study will serve as the implementation of the form and functional benchmark in which future development will strive to achieve. The study will address all applicable principles within the Secondary Plan and performance standards contained within the zoning by-law. Additionally, it will serve as the Urban Design Guidelines for development applications within the study area and will assist in the creation of a mixed-use, pedestrian-oriented community within the West Harbour area.

The Urban Design Study process will identify and analyze the Opportunities and Constraints location within the Study Area and will incorporate the goals and objectives identified throughout the stakeholder and public consultation process.

The objectives of Urban Design Study will be met by applying the following select core planning principles from the West Harbour Secondary Plan:

***Principle 1: Promote a Healthy Harbor***

- Identify and protect key views and improve public access to the harbour.

***Principle 2: Strengthen Existing Neighbourhoods***

- Encourage new commercial uses that cater to the local neighbourhood; and
- Augment existing parkland with additional publicly-accessible open spaces.

***Principle 5: Enhance Physical and Visual Connections***

- Mitigate or eliminate physical barriers to the waterfront;
- Promote a connected open space system along the waterfront, through the neighbourhoods and between downtown and the waterfront; and
- Establish a pedestrian connection between Dundurn Park and the Waterfront Trail.

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[2] Downtown Transportation Master Plan Five Year Review, City of Hamilton, August 2008

[3] Shifting Gears 2009, Hamilton's Cycling Master Plan - Municipal Class Environmental Assessment (Ecoplans Limited), May 2010

[4] Hamilton West Harbour Waterfront Recreation Master Plan, City of Hamilton, April 2010

[5] North End Traffic Management Plan, City of Hamilton, June 2008

***Principle 6: Promote a Balanced Transportation Network***

- Establish a clear street hierarchy that recognizes the function and character of existing streets;
- Promote a more balanced multi-modal transportation system;
- Ensure that most residential areas are located within a 400 metre radius (walking distance) of a transit stop; and
- Minimize traffic impacts to the exiting local street networks and identify mitigation measures and/or monitoring processes where impacts are unavoidable.

The study will also focus on the development of a connected pedestrian and cycling network to nearby City facilities such as the future James Street North Mobility Hub as well as significant parks and open spaces such as Central Park, Dundurn Park, the Waterfront Trail and Bayfront Park.

## Study Organization

The resulting Transportation Strategy Report has been structured to address two key components of the Study, all of which build upon previous analyses and recommendations:

- Part A – Traffic Impact Study
- Part B – Transportation Demand Management Guidelines

The findings and recommendations of the Transportation Strategy Report will be used in the development and refinement of Urban Design Guidelines, as related to complete streets; providing a special emphasis on active transportation, provision of adequate cycling and trail network and connections, implementation of traffic calming techniques and general community safety initiatives.

### Part A – Traffic Impact Study

The goal of the traffic impact study is to assess existing and future total traffic conditions based on an ultimate design concept which includes the expected build-out of the Barton-Tiffany Study Area given the timeframe of the study. The purpose of the study is to assess potential impacts of traffic changes as a result of proposed development in relation to municipal roads, as well as to identify any infrastructure improvements or mitigation measure required in order to ensure the roadway network will operate acceptably and safely upon intensification of the Study Area.

### Part B – Transportation Demand Management Guidelines

The goal of the Transportation Demand Management (TDM) Guidelines is to identify a wide range of TDM strategies which will serve to form the TDM "Toolbox" and aim to emphasize the promotion of active transportation while supporting transit-oriented development. The resulting strategies will form the basis for future development with the intention of guiding the design and layout of the Barton-Tiffany Study Area in a manner that supports alternate modes of travel and reduces reliance on auto-oriented transportation.

In addition to identifying broad TDM principles and guidelines, a range of specific TDM strategies will be identified based on applicable land use, which can then be recommended by the review agency for consideration and implementation at site design (on a development-by-development basis) as the area evolves.

# Part A

# Traffic Impact Study

# 1.0 Introduction

## 1.1 Overview

The following traffic impact study details the assessment of existing and future traffic conditions based on the proposed redevelopment of the Barton-Tiffany Study Area. The purpose of this study is to identify the extent of transportation impacts associated with the proposed redevelopment and recommend road network improvements, as well as appropriate mitigation measures, in attempts to ensure that the City's transportation system continues to function with a high level of service upon intensification of the Study Area, while also balancing the transportation needs of future development and minimizing impact to adjacent residential neighbourhoods.

## 1.2 Study Area

The Barton-Tiffany Study Area is located within the West Harbour Secondary Planning Area and is contained within two municipal Wards; the west side of the Study Area is located within Ward 1 (Strathcona Neighbourhood) and the east side is located within Ward 2 (Central Neighbourhood). The area is approximately 17.12 hectares (42.30 acres) in size with approximately 11.72 hectares (28.96 acres) slated for development. The study area has been planned to accommodate approximately 1,161 residential units (2,025 persons) and 58,367 $m^2$ (628,257 $ft^2$) of commercial space (1,630 jobs).

The Study Area is bounded by the following:

- Stuart Street / CN Rail Yards to the north;
- Bay Street North to the east;
- Barton Street West to the south; and
- Conservation Authority regulated lands (Iroquois Shore Line) to the West.

The Study Area is extended beyond the area listed above to include the following sites:

- The former City of Hamilton Public Works site located on the south side of Barton Street West (at Tiffany Street);
- Central Park, located on the south side of Barton Street West – extending south towards Cannon Street West;
- The future James Street North Mobility Hub; and
- Potential pedestrian links to key recreational destinations including Bayfront Park, the Waterfront Trail and Dundurn National Historic Site (including the Hamilton Military Museum).

The Secondary Plan identifies three significant physical barriers associated with the Barton-Tiffany Urban Design Study Area: The Stuart Street (CN) rail yard, the CN main line, and the bluffs. The CN rail yard is an active site located on the north edge of the study area (adjacent to Stuart Street). As such, any future development located adjacent to these lands will be limited to commercial uses only. The CN main line is located within the rail yard area and creates a physical barrier between the Barton-Tiffany lands and the waterfront. The westerly limits of the Barton-Tiffany lands are regulated by the Hamilton Conservation

Authority due to the hazardous nature of the lands. This area consists of bluffs (originally part of the Iroquois shore line) and as a result, potential for development is limited. The location of the Barton-Tiffany Urban Design Study Area in relation to the surrounding transportation network is illustrated in **Figure 1.1**.

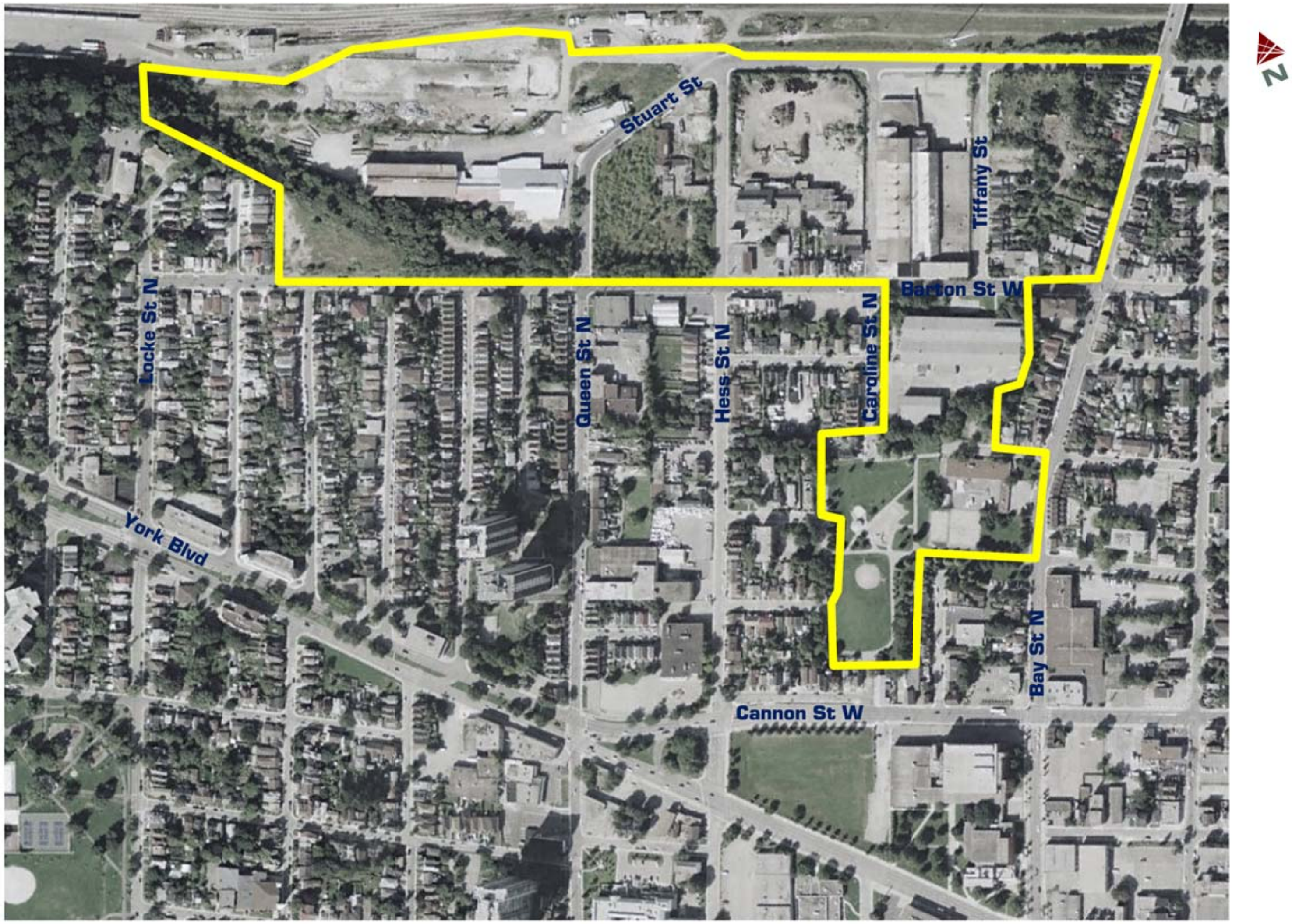


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**Figure 1.1**
**Study Area**

Study Area intersections selected for analyses were confirmed through consultation with City of Hamilton staff and include the following locations:

- Bay Street North and Barton Street West (signalized);
- Bay Street North and Stuart Street (all-way stop control);
- Barton Street West and Tiffany Street (minor-street stop control);
- Barton Street West and Caroline Street North (minor-street stop control);
- Barton Street West and Hess Street North (minor-street stop control);
- Barton Street West and Queen Street North/Stuart Street (all-way stop control); and
- Barton Street West and Locke Street North (all-way stop control).

Although the intersection of Barton Street West and Locke Street North is located outside the primary Study Area, it has been included in the analyses as it has been identified as a primary point of ingress / egress to and from the Study Area.

## 1.3 Horizon Year and Analysis Periods

The analysis of traffic impacts have been based on the assumption that development may commence as soon as 2021. Through consultation with City staff, it was confirmed that both 2021 and 2031 horizon years are required for analysis periods.

Given the combined residential/commercial nature of the proposed redevelopment, and recognizing the potential commuter characteristics of the adjacent transportation facilities, the weekday AM and PM peak hours of adjacent street traffic have been selected for analysis purposes, representing a “worst case” scenario.

## 1.4 Analysis Methodology

The operation of Study Area intersections has been analyzed in order to determine intersection level of service (LOS) with and without traffic contributions from the proposed development. This has been done in an effort to quantify the impact site traffic will have on operational performance of nearby intersections using measures such as volume-to-capacity ratio, control delay, and critical movement level of service.

### 1.4.1 Signalized Intersections

Capacity analysis for signalized intersections is based on the procedures described in the Highway Capacity Manual (HCM). For signalized intersections, the analysis focuses on performance measures such as intersection level of service (LOS), volume-to-capacity ratios (v/c) and control delay (measured in seconds).

LOS is a qualitative measure of operational performance which is based on control delay. The LOS criteria for signalized intersections are summarized in **Table 1.1**. LOS A is represented by a control delay of less than 10 seconds per vehicles (referred to as free-flow operating conditions) while LOS F is represented by a control delay greater than 80 seconds per vehicles (referred to as restricted flow operating conditions).

**TABLE 1.1: LOS CRITERIA FOR SIGNALIZED INTERSECTIONS**

| Level-of-Service | Average Control Delay (seconds per vehicle) | General Description |
|---|---|---|
| A | 0 - 10 | Free Flow |
| B | >10 - 20 | Stable Flow (slight delays) |
| C | >20 - 35 | Stable Flow (acceptable delays) |
| D | >35 - 55 | Approaching Unstable Flow (tolerable delays) |
| E | >55 - 80 | Unstable Flow (intolerable delays) |
| F | >80 | Forced Flow (unacceptable delays) |

In determining the LOS performance for signalized intersections, the average control delay per vehicle is estimated for each lane group and is aggregated for each approach, and for the intersection as a whole. In accordance with City of Hamilton standards, acceptable intersection operations are defined as v/c ratios of 0.85 or less for through movements, and/or shared through/turning movements; and v/c ratios of 0.90 or less for exclusive movements. Individual movements experiencing a v/c ratio greater than that noted are deemed to be "critical" in terms of operation and are to be considered for geometric improvement.

### 1.4.2 Unsignalized Intersections

When analyzing unsignalized intersections, LOS is determined by the computed or measured control delay and is defined for each minor ("critical") movement.

In the determination of the performance of unsignalized intersections, the average control delay per vehicle is estimated for each lane group and is aggregated for each approach. Control delay includes the initial deceleration delay, queue move-up time, stopped delay and the final acceleration delay. The LOS criteria for unsignalized intersections are somewhat different from the criteria used for signalized intersections, primarily because different transportation facilities create different driver perceptions. The expectation is that a signalized intersection is designed to carry higher volumes of traffic and experience greater delay than that of an unsignalized intersection.

The LOS criteria for unsignalized intersections are summarized in **Table 1.2**. Acceptable operations are normally defined a LOS E or better for individual movements, conditional on the estimated maximum queue length for individual movements being less than the available storage. LOS F occurs where there are not enough gaps of suitable size to allow the minor street demand to safely cross, turn into, or through, traffic on the major street. This is evident from long control delays experienced by minor street traffic and by queuing on the minor street approaches. LOS E represents effective capacity of a movement.

### TABLE 1.2: LOS CRITERIA FOR UNSIGNALIZED INTERSECTIONS

| Level-of-Service | Average Control Delay (seconds per vehicle) |
|---|---|
| A | 0 - 10 |
| B | >10 - 15 |
| C | >15 - 25 |
| D | >25 - 35 |
| E | >35 - 50 |
| F | >50 |

It is important to use caution when using the HCM methodology to assess unsignalized intersections. Even under low-volume traffic conditions, the HCM delay equation will often predict greater than 50 seconds of delay (LOS F) for many unsignalized intersections that permit minor street left-turn movements. LOS F is commonly predicted regardless of the volume of minor street left-turning traffic. HCM notes that *"even with a LOS F estimate, most low volume minor-street approaches would not meet any of the Manual on Uniform Traffic Control Devices (MUTCD) volume or delay warrants for signalization. As a result, analysts that use the HCM level of service thresholds to determine the design adequacy of two-way stop controlled intersections should do so with caution."*

# 2.0 Existing Conditions

## 2.1 Area Road Network

The existing road network consists of a grid of major east-west and north-south arterial roadways with a network of collector and local roads serving existing residential uses. The Setting Sail Secondary Plan Study categorizes urban streets into three distinct street types which are summarized as follows:

- **Primary Mobility Streets** - provide for the mobility of through traffic, people and goods, connecting major activity centres and neighbourhoods within the West Harbour, and connecting to points outside the area. Primary Mobility Streets typically have two to four through lanes; on-street parking is permitted but may be restricted; cycling provisions include shared or dedicated bike lanes; sidewalks are provided on both sides of the roadway; boulevards are provided in residential areas (where feasible); frequent transit service is provided; and the right-of-way width is about 20 metres.

- **Neighbourhood Mobility Streets** - provide for the mobility of traffic, people and goods within the West Harbour and serve the local land uses. Neighbourhood Mobility Streets typically have two through lanes; on-street parking is permitted but may be restricted; cycling provisions include shared or dedicated bike lanes; sidewalks are provided on both sides of the roadway; boulevards are provided adjacent to through and bike lanes; transit service may be provided and with less frequency; and the right-of-way width is about 20 metres.

- **Local Streets** - provide access to businesses and residences, on-street parking and pedestrian movement has priority over traffic movement. Local Streets typically have two through lanes; on-street parking is permitted on one or both sides of the roadway; provision for cyclists typically include shared bike lanes; sidewalks are provided on both sides of the roadway; boulevards are provided (where feasible); transit service is not provided; and the right-of-way width is 18 to 20 metres.

Details of the existing roadway network, including roadway classifications, are described below and illustrated in **Figure 2.1**.

**Barton Street West** is an east-west arterial roadway that falls under the classification of a Primary Mobility Street. The roadway consists of a four-lane urban cross-section and operates with an assumed maximum speed limit of 50 km/h. Four traffic lanes are maintained from Bay Street to Queen Street as on-street parking is prohibited throughout this section. On-street curb-side parking is permitted at all times on both the north and south sides of Barton Street West from Queen Street to Locke Street, effectively reducing roadway capacity to two lanes. Sidewalk facilities are provided along the south side of Barton Street West throughout the study limits, with sections of sidewalk provided on the north side adjacent to residential developments. Within the study limits, Barton Street West is designated as a signed on-street bike route which provides linkages to key recreational destinations including Bayfront Park, Chedoke Radial Trail, Dundurn Park and the Waterfront Trail.

**Bay Street North** is a north-south arterial roadway that falls under the classification of a Primary Mobility Street. Within the study limits, the roadway consists of a two-lane urban cross-section and operates with a maximum assumed speed limit of 50 km/h. Parking is permitted on the west side of Bay Street and sidewalks are provided along both the east and west sides of the roadway throughout the study limits. Bay Street North, north of Stuart Street, is designated as a signed on-street bike route, providing cycling access to Bayfront Park and the lands north of Strachan Street.

**Stuart Street** is an east-west local roadway that falls under the classification of a Neighbourhood Mobility Street. The roadway consists of a four-lane urban cross-section and operates with a maximum assumed speed limit of 50 km/h. Sidewalk facilities are provided along the north side of throughout the study limits, with south side sidewalks provided between Caroline Street and Bay Street. Within the study limits, Stuart Street is a designated truck route, and the section of roadway between Bay Street North and Tiffany Street is designated as a signed on-street bike route, providing key linkages to Bayfront Park and the Waterfront Trail.

**Tiffany Street** is a north-south local residential roadway that falls under the classification of a Local Street. The roadway consists of a two-lane semi-urban cross-section and operates with an assumed maximum speed limit of 50 km/h. Time-limited on-street parking is currently permitted on the east side of the roadway. Sidewalk facilities are provided on the east side and the roadway is designated as a signed on-street bike route which provides a connection between the Barton Street West and Stuart Street / Bay Street North routes.

**Caroline Street** is a north-south local roadway that previously serviced adjacent industrial uses. Paved pedestrian facilities are located on the west side of the roadway and are noted to be in poor condition. The overall condition of Caroline Street is poor and the roadway experiences very little traffic volume, presumable due to the vacant lands and present condition of the roadway.

**Hess Street** is a north-south local roadway that falls under the classification of a Neighbourhood Mobility Street. The section of Hess Street from Cannon Street to Barton Street West operates one-way northbound with a two-lane urban cross-section (two travel lanes plus on-street parking) with a posted maximum speed limit of 40 km/h. North of Harriet Street the posted maximum speed limit increases to 50 km/h and parking is permitted on the east side of the roadway. The City has noted that the future conversion of Hess Street to two-way operation is currently planned for 2018. North of Barton Street West, Hess Street converts to two-way operation with parking prohibited between Barton Street West and Stuart Street. Sidewalks are provided on the east side of the roadway.

**Queen Street** is a north-south arterial roadway that falls under the classification of a Neighbourhood Mobility Street. The section of Queen Street from Cannon Street to Barton Street West operates one-way southbound with a three-lane urban cross-section (two travel lanes plus on-street parking) with an assumed speed limit of 50 km/h. The section north of Barton Street West has recently been converted to two-way operation to tie into Stuart Street. Sidewalk facilities are provided along the east side of Queen Street and are non-continuous with the existing north side sidewalk located along Stuart Street.

**Locke Street** is a north-south collector roadway that falls under the classification of a Local Street. Within the study limits, the roadway consists of a four-lane urban cross-section and operates with a maximum assumed speed limit of 50 km/h. On-street parking is currently permitted along the east and west sides of the roadway, effectively reducing capacity to two-lanes. Sidewalk facilities are provided along both the east and west sides and the roadway is designated as a signed on-street bike route providing linkages to Dundurn Castle and the Waterfront Trail.

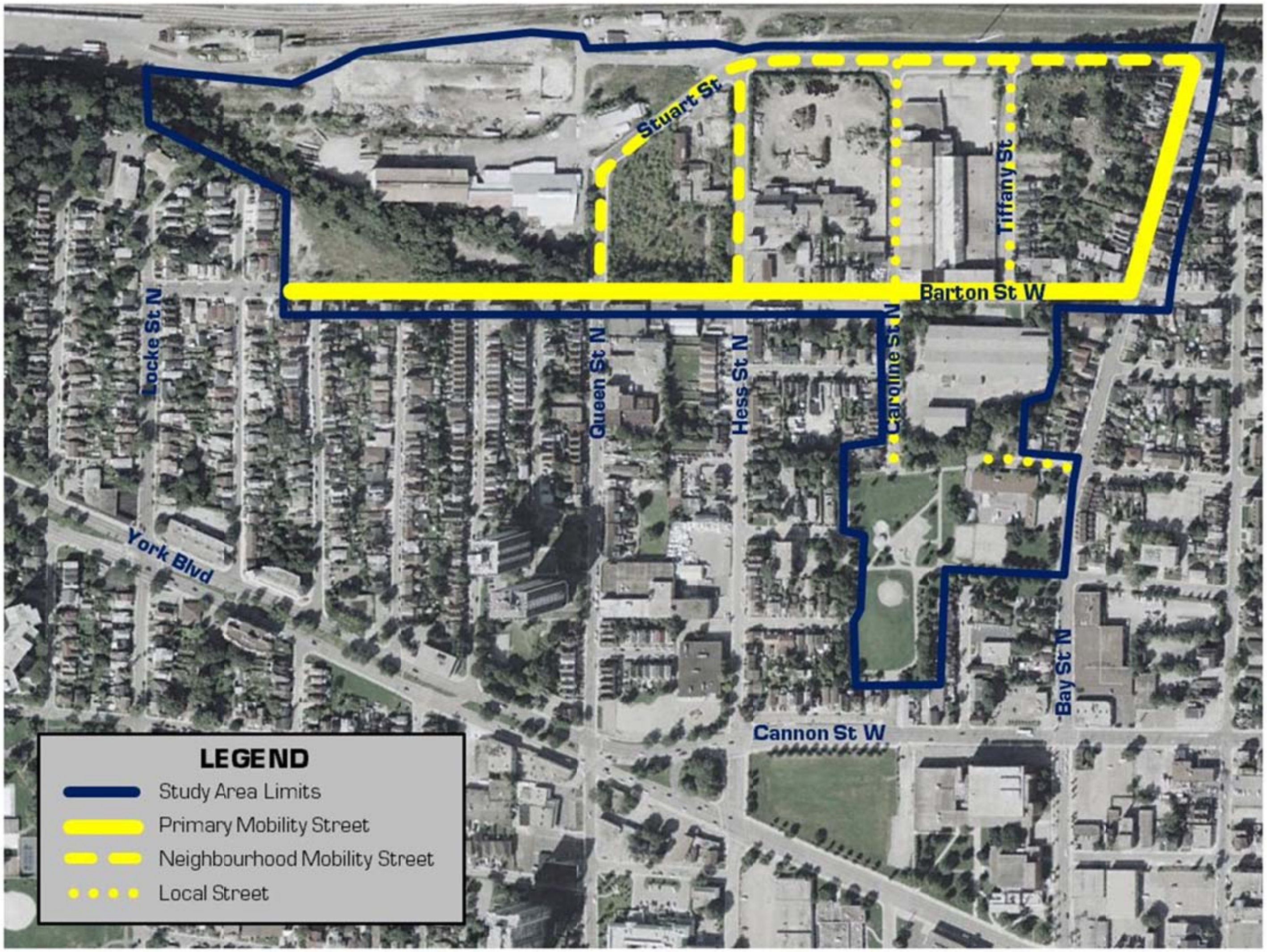


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**Figure 2.1**
**Roadway Classifications**

## 2.2 Transit Service

Transit service is not currently provided within the limits of the Study Area; however transit service is available within a 400-metre walking distance from the centre of the Study Area (i.e. transit service is provided on York Boulevard at Hess Street, approximately 400 metres from the intersection of Barton Street West and Hess Street North).

Hamilton Street Railway (HSR) operates both *Route 8 - York* and *Route 9 - Rock Gardens* on Cannon Street West and York Boulevard between Dundurn Street North and James Street. Weekday, Saturday and Sunday service is provided on *Route 8 - York* with headways varying from 20 minutes during the weekday peak periods to 60 minutes during evening, late night and weekend time periods. Service operates between approximately 5:30 AM and 1:30 AM during weekdays and Saturdays, and between approximately 7:30 AM and 9:30 PM on Sundays. *Route 9 - Rock Gardens* operates only on Sundays between Mother's Day and the second Sunday in November. Service runs from downtown Hamilton to Holy Sepulchre Cemetery in Burlington and is provided every 60 minutes between 10:00 AM and 6:00 PM. The transit routes servicing the Study Area are illustrated in **Figure 2.2**.

## 2.3 Pedestrian and Cycling Facilities

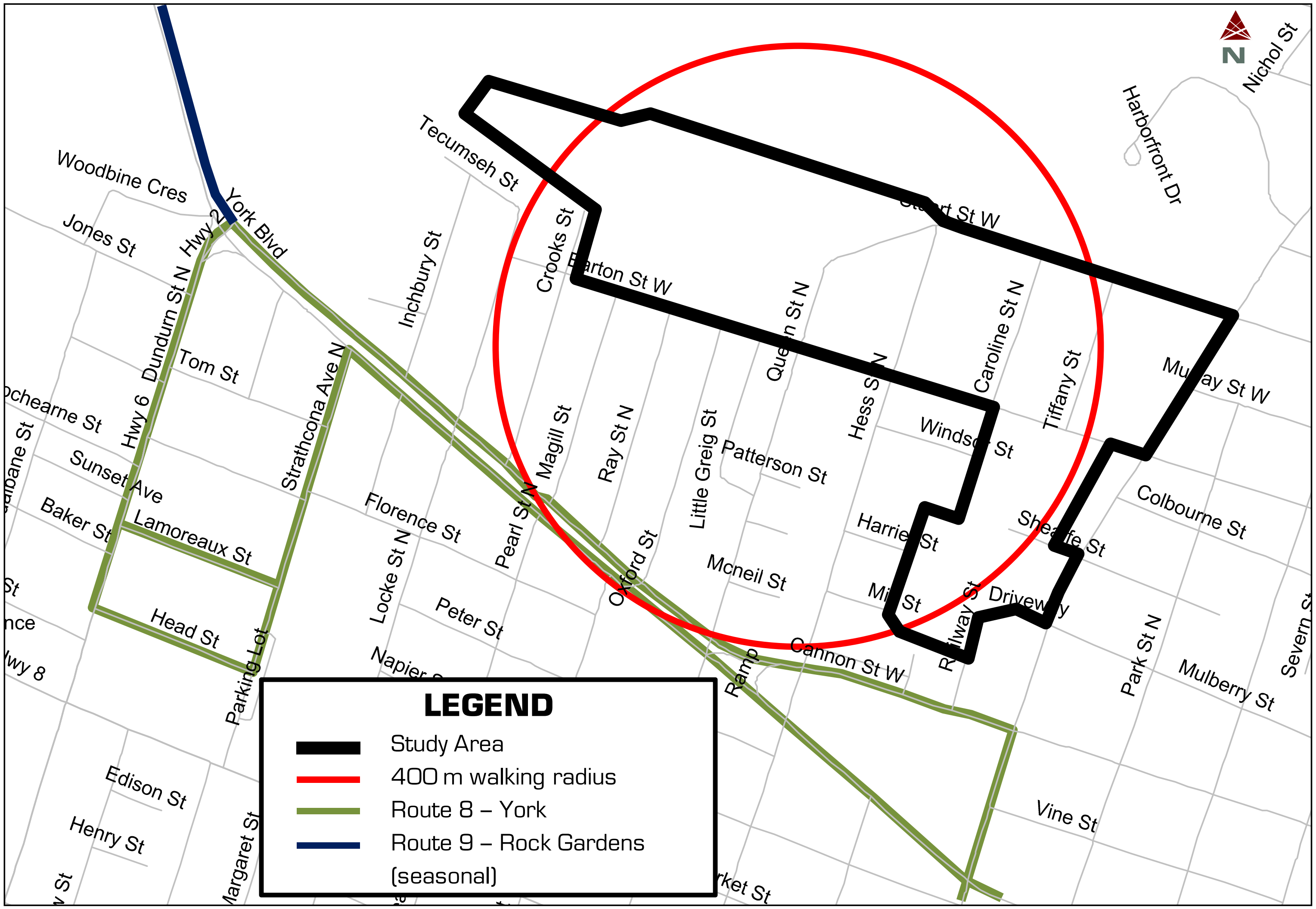
Within the Study Area, on-street signed bike routes are provided on Barton Street West, Tiffany Street, Stuart Street and Bay Street North. In addition to the on-road facilities, the Waterfront Trail is located at the northerly limits of the CN Rail Yards and is accessed via Bay Street North. The Waterfront Trail is a paved-multi-use trail linking the eastern and western areas of the Harbour. The existing cycling facilities (current as of 2013) are illustrated in **Figure 2.3**.

## 2.4 Parking

A parking inventory was undertaken during the initial site visit to the Study Area. The majority of parking within the Study Area is on-street (with and without posted restrictions). The signed parking restrictions range from one-hour time-limited parking to general parking prohibitions between 7:00 AM and 5:00 PM with parking being permitted at all other times.

A total of approximately 238 on-street parking spaces area available within the Study Area as determined by dividing the available curb face length by a vehicle length of 7.5 metres in areas where parking would "typically" occur (this does not include driveway approaches, etc.).

A municipally owned and operated off-street parking lot is located at the southeast corner of Barton Street West and Caroline Street North. A total of 41 stalls are provided, 33 of which are signed as permit parking only (for overnight parking), while the remaining 8 stall are metered and available for public use. This parking lot is listed as three hour time-limited between 9:00 AM and 9:00 PM (except Sundays and Holidays) with a fee of $0.50/hr. During the site visit it was noted that given the type and extent of existing land use within the Study Area, there are ample parking opportunities available both on-street and in the municipal lot. The approximate location and estimation of available parking is illustrated in **Figure 2.4**.

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## Figure 2.2
**Existing Transit Service**

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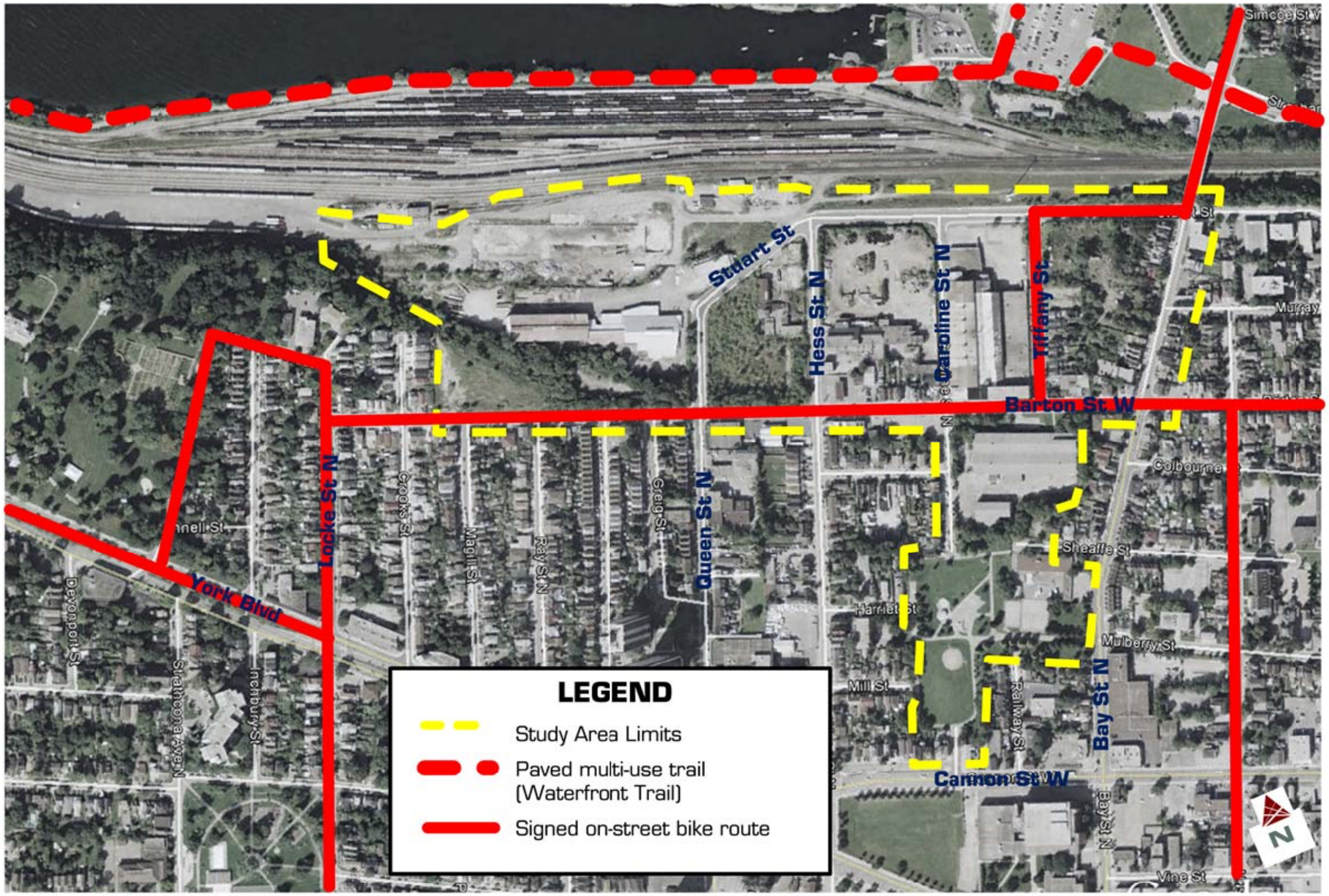


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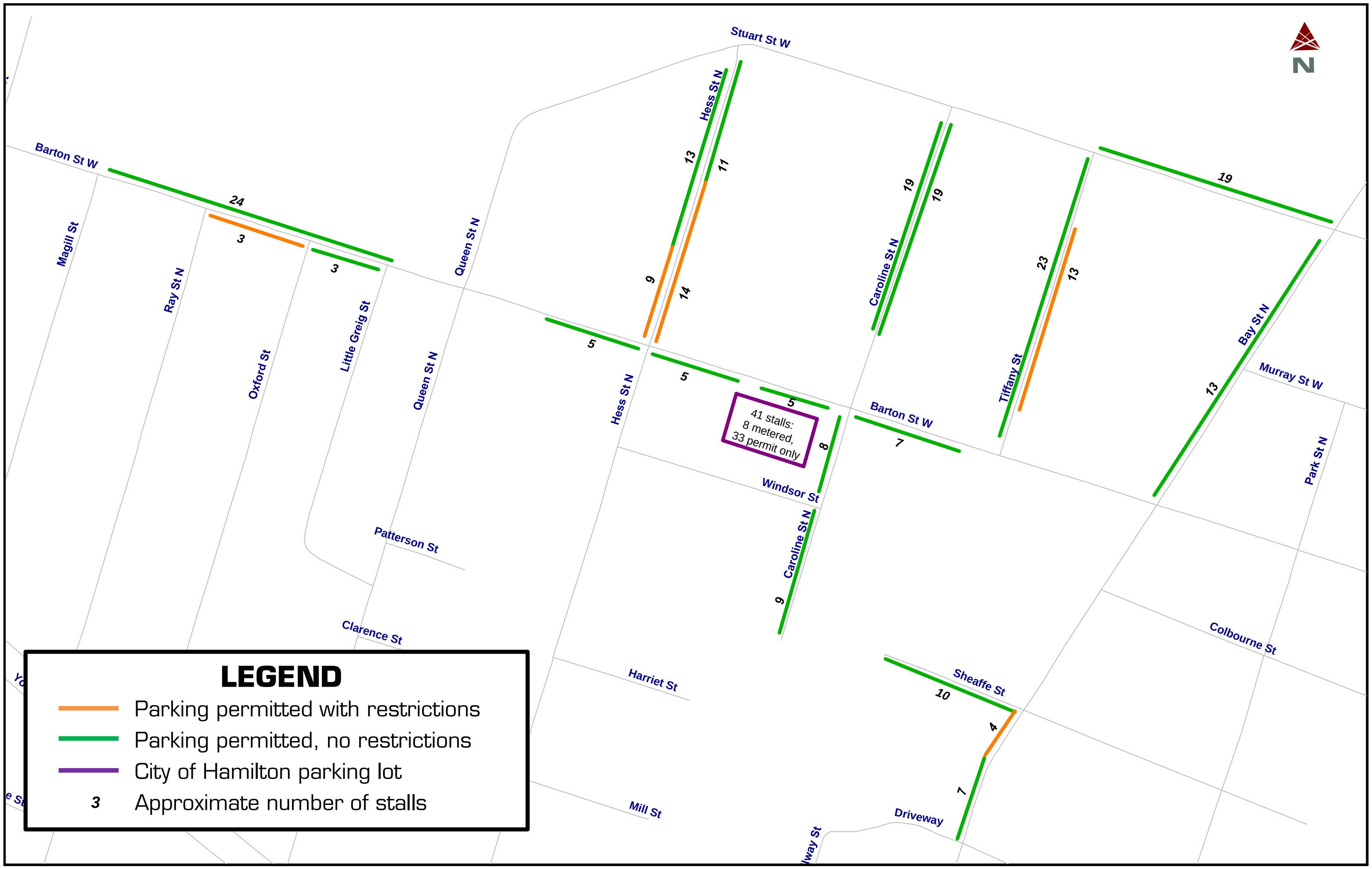
# Figure 2.3
## Existing Cycling Network

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# Figure 2.4
## Existing Parking Supply

## 2.5 Existing Traffic Volumes

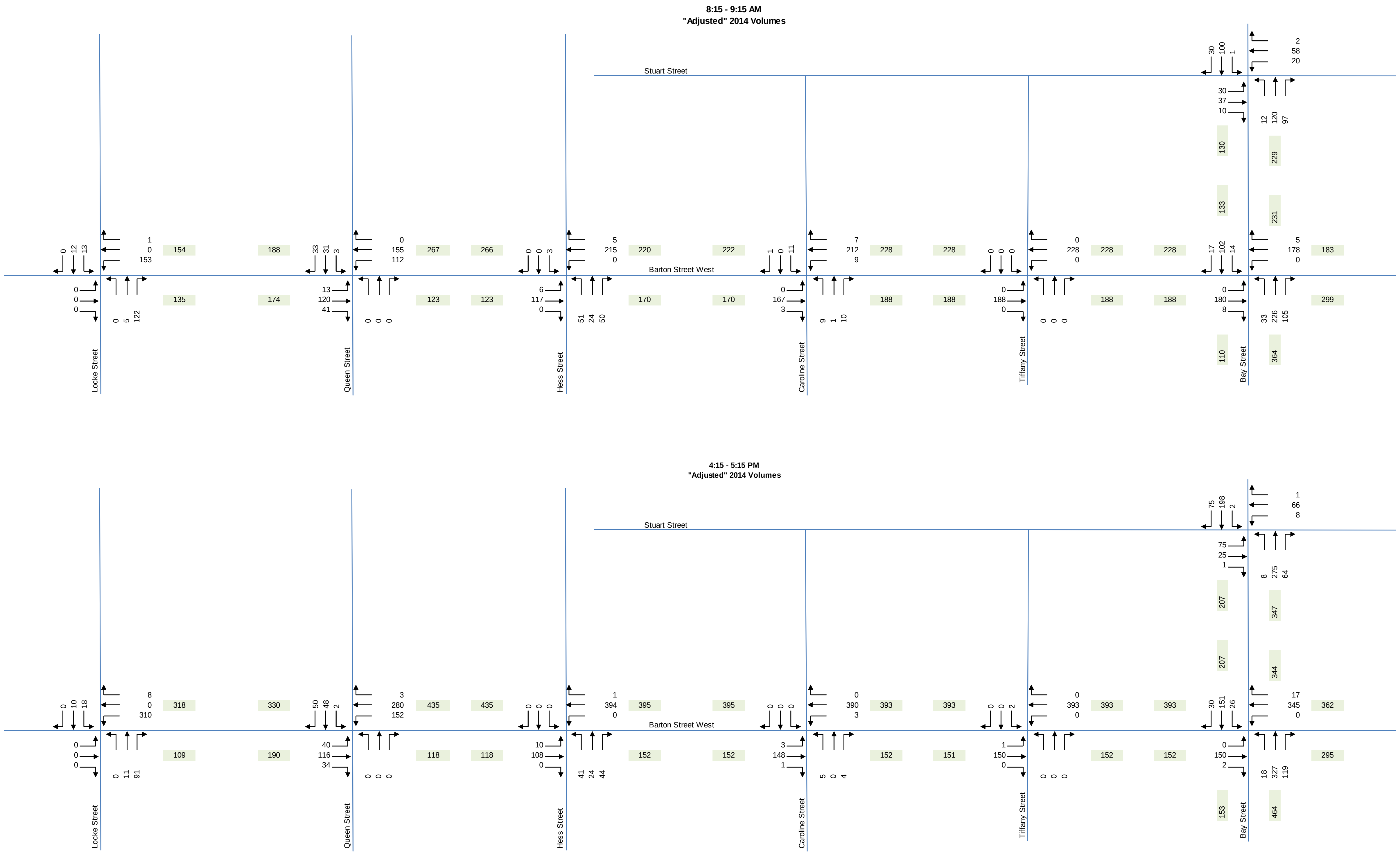
Weekday AM and PM peak hour turning movement counts were conducted by Pyramid Traffic Incorporated (Pyramid) on Wednesday February 12, 2014 and Thursday February 13, 2014 between the hours of 7:00 AM to 10:00 AM and 2:00 PM to 6:00 PM in order to capture "typical" weekday AM and PM peak hour conditions.

For the purpose of continuity and to achieve balanced mainline flows, standardized peak hours were applied to all Study Area intersections (8:15 AM to 9:15 AM; 4:15 PM to 5:15 PM) and the mainline eastbound/westbound through volumes along Barton Street West were manually adjusted in order to reflect traffic volumes observed at adjacent intersections. It is noted that any minor variance in mainline flows can be satisfactorily attributed to turning movements to and from local residential roadways that were not included as part of the data collection.

A particular challenge of this study was in the determination of existing traffic volumes in the study area. During the duration of this study the Bay Street Bridge was, and currently still is under construction and as a result, traffic demands that would have presumably used Bay Street North are now required to divert to adjacent north-south roadways such as MacNab Street or James Street North. In attempts to accurately model "existing" traffic conditions under a scenario where the Bay Street Bridge is open and all traffic movements are permitted, a review of historical TMC data and existing traffic demands on adjacent arterials was undertaken. For the purposes of reviewing historical TMC data, the 2013 traffic volumes illustrated in the James Street North GO Station Transportation Impact Study[6] were used.

Turning movements at the intersections of Bay Street North at Barton Street West; and Bay Street North at Stuart Street were manually adjusted in order to estimate 2014 traffic conditions representing a scenario where the Bay Street Bridge is open to traffic. The resulting peak hour traffic forecasts are illustrated in **Figure 2.5** and the summarized TMC Data is provided in **Appendix A** for further reference.

[6] James Street North GO Station – Transportation Impact Study (Draft Report), IBI Group, July 2013.

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# Figure 2.5

## Existing (2014) Peak Hour Traffic Volumes

## 2.6 Collision Review

The City of Hamilton provided 5 years' of collision data (2008 to 2013) for the Study Area intersections. A total of 18 collisions occurred over the five-year period and all of the collisions were recorded as either non-fatal, or property damage only (PDO); the majority of which occurred during clear weather and dry roadway conditions. Both of the collisions recorded at the intersection of Barton Street West and Locke Street North involved pedestrians. A review of available collision data confirmed that this is was the only intersection where pedestrian-vehicle collisions occurred.

In general terms, collision experience is considered relatively low throughout the Study Area. However, the high number of collisions (primarily right-angle collisions) experienced at the intersection of Barton Street West and Hess Street North is a strong indicator that mitigation measures may be required at this location.

Overall collision experience at Study Area intersections over the five-year period is illustrated in **Figure 2.6** and a detailed collision analyses, summarized by intersection location, is contained in **Appendix B** for further reference. The focus of the future roadway improvements will include consideration of mitigation measures aimed at reducing vehicle-pedestrian conflicts and right angle collisions.

Study Area collision rates were compared to the City's Network Screening (2005 to 2009) Overrepresentation Ranking[7] by road segment/intersection to determine if mitigation measures are required immediately, or can be addressed through future site design and infrastructure improvements.

The top 10 overrepresented City road segments/intersections are shown in **Table 2.1** and indicate that the lowest intersection collision rate was six collisions in a five-year period at the intersection of Eleventh Road and Ridge Road; conversely, the highest road segment collision rate was 57 collisions in a five-year period along Upper James Street between Mohawk Road and the Lincoln Alexander Parkway. When the Study Area collision data was compared to the 10 highest intersections in the City, it becomes apparent that Study Area collision rates are much lower. Through site design, the intersection of Barton Street West and Hess Street North should be considered for geometric improvements in attempts to mitigate current collision experience.

### TABLE 2.1: TOP 10 CITY-INTERSECTION COLLISION OVERREPRESENTATION

| No. | Group | Descrption | Network Risk Indicator | Total # of Collisions in 5 Years | Collisions per KM |
|---|---|---|---|---|---|
| 1 | Urban Road | King: James to Catharine | 66.47 | 28 | 80.1 |
| 2 | Urban Road | Barton: Wellington to Wentworth | 62.94 | 36 | 47.7 |
| 3 | All-way Stop | Eleventh Rd & Ridge Rd | 53.05 | 6 | |
| 4 | Onramp | Mud: Mud SB to EB off ramp - RHVP | 52.14 | 23 | 35.0 |
| 5 | Rural Road | Centre: Concession 11 E to Campbellville | 45.17 | 11 | 2.7 |
| 6 | Urban Road | Quigley: Greenhill to King | 43.38 | 17 | 12.4 |
| 7 | Urban Road | Queenston: Nash to Centennial Pkwy | 32.53 | 56 | 67.4 |
| 8 | Urban Road | Upper James: Mohawk to LINC WB off ramp | 31.72 | 57 | 61.6 |
| 9 | Rural Road | Sulphur Springs: Governors to Mineral Springs | 30.69 | 10 | 4.9 |
| 10 | Urban Road | Main: Longwood to Paradise | 30.21 | 10 | 77.5 |

[7] 2010 Traffic Safety Status Report Volume 1, City of Hamilton, 2010.

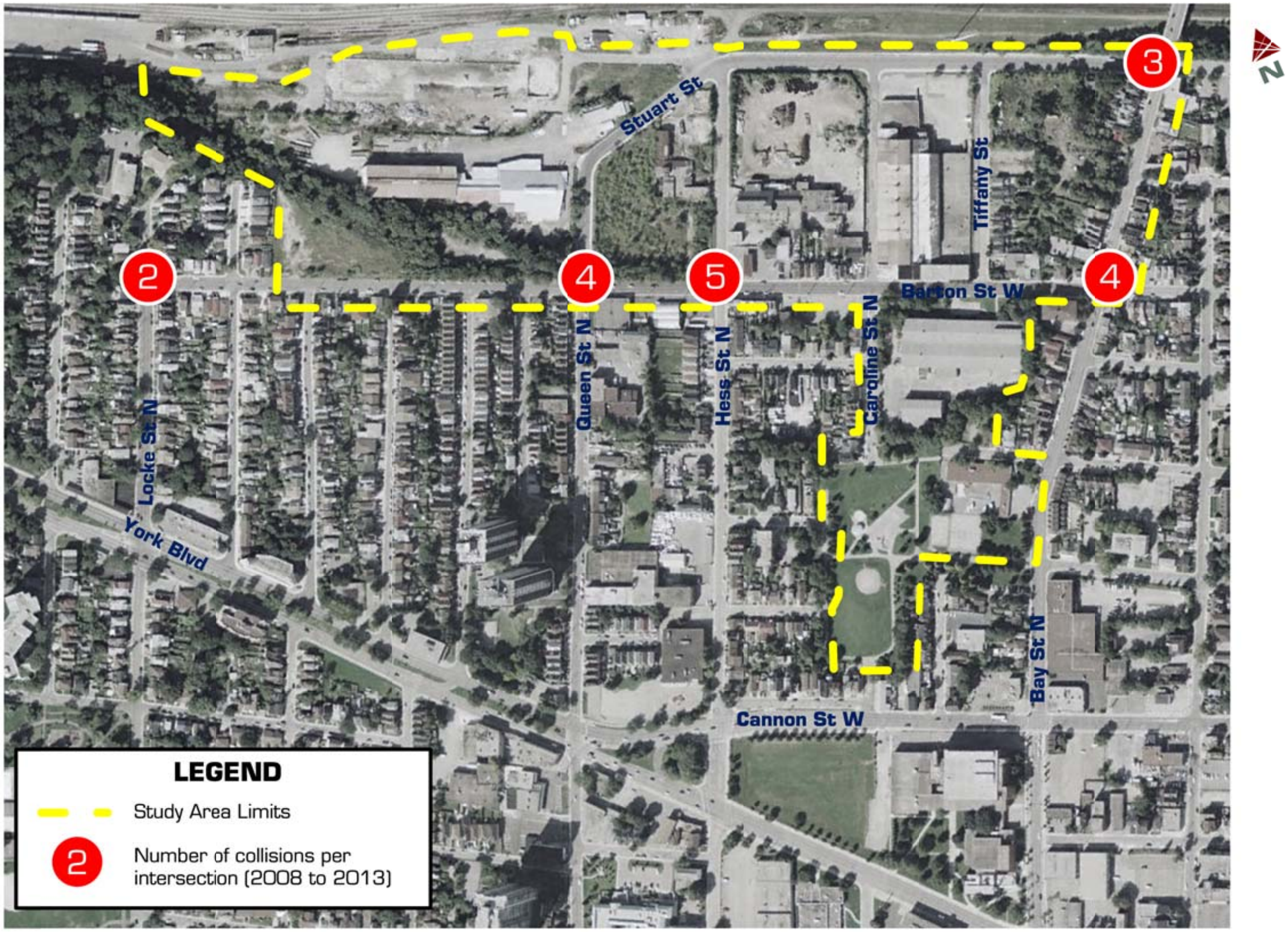


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**Figure 2.6**
**Historic Collision Experience (2008 – 2013)**

## 2.7 Analysis of Existing Traffic Operations

In order to provide a "benchmark" which is representative of current operating conditions, capacity analyses have been undertaken to determine existing intersection operations and level-of-service (LOS). The analysis reflects existing traffic volumes (manually adjusted to reflect Bay Street Bridge being open, and balanced east-west link volumes), existing traffic control, current peak hour signal timings (as provided by the City of Hamilton), and existing lane configurations.

For the purposes of reporting critical movements, the maximum acceptable level of service thresholds were used (as per the City of Hamilton TIS Guidelines[8]):

**Signalized Intersections**

- Through or shared through/turning movements – v/c of 0.85;
- Exclusive turning movements – v/c 0.90; and
- Estimated 95th percentile queues for an individual movement are projected to exceed available turning lane storage.

**Unsignalized Intersections**

- LOS (based on average delay per vehicle or individual movement) is LOS D or greater; and
- Estimated 95th percentile queues for critical movements.

The peak hour analyses results are summarized in **Table 2.2** and the projected 95th percentile queues for critical movements are summarized in **Table 2.3**. Detailed Synchro 7.0 summary reports and SimTraffic Traffic Queuing and Blocking reports are provided in **Appendix C** for further reference.

[8] City of Hamilton, Traffic Impact Study Guidelines, July 2009

## Table 2.2: Existing (2014) Traffic Operations

| | Intersection | Traffic Control | Analysis Period | Movement | Measure of Effectiveness | | |
|---|---|---|---|---|---|---|---|
| | | | | | LOS | Delay (sec) | V/C |
| 1 | Barton Street at Bay Street | Signalized | AM | Overall | B | 15.9 | 0.32 |
| | | | PM | | B | 17.3 | 0.48 |
| 2 | Barton Street at Tiffany Street | Minor Street Stop Control | AM | Overall | A | 0.0 | - |
| | | | PM | | B | 12.4 | - |
| 3 | Barton Street at Caroline Street | Minor Street Stop Control | AM | Overall | B | 11.9 | - |
| | | | PM | | B | 10.4 | - |
| 4 | Barton Street at Hess Street | Minor Street Stop Control | AM | Overall | B | 12.9 | - |
| | | | PM | | B | 11.5 | - |
| 5 | Barton Street at Queen Street | All Way Stop | AM | Overall | A | 8.1 | - |
| | | | PM | | A | 9.6 | - |
| 6 | Barton Street at Locke Street | All Way Stop | AM | Overall | A | 7.8 | - |
| | | | PM | | A | 8.9 | - |
| 7 | Bay Street at Stuart Street | All Way Stop | AM | Overall | A | 8.9 | - |
| | | | PM | | B | 11.6 | - |

Analyses findings are summarized as follows:

### AM Peak Hour

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS B or better and no movements were flagged as having a critical v/c ratio or level-of-service.

### PM Peak Hour

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS B or better and no movements were flagged as having a critical v/c ratio or level-of-service.

## Table 2.3: Existing (2014) Queuing Conditions

| | Intersection | Traffic Control | Critical Movement | Storage Length (metres) | 95th %ile Queue (m) | |
|---|---|---|---|---|---|---|
| | | | | | AM | PM |
| 1 | Barton Street at Bay Street | Signalized | EB T | 85 m | 37 m | 30 m |
| | | | EB R | 85 m | 5 m | 3 m |
| 2 | Barton Street at Tiffany Street | Stop Control | EB L | 45 m | - | - |
| | | | SB LR | 65 m | - | 5 m |
| 3 | Barton Street at Caroline Street | Stop Control | EB L | 50 m | - | - |
| | | | WB LT | 45 m | 5 m | - |
| | | | NB LTR | 50 m | 14 m | 9 m |
| | | | SB LTR | 50 m | 12 m | - |
| 4 | Barton Street at Hess Street | Stop Control | EB LT | 50 m | - | 5 m |
| | | | NB L | 50 m | 15 m | 13 m |
| | | | SB L | 50 m | 8 m | - |
| 5 | Barton Street at Queen Street | All Way Stop | EB LT | 35 m | 22 m | 17 m |
| | | | WB LT | 50 m | 23 m | 48 m |
| 6 | Barton Street at Locke Street | All Way Stop | WB L | 50 m | 13 m | 14 m |
| | | | WB LR | 30 m | 13 m | 17 m |
| 7 | Bay Street at Stuart Street | All Way Stop | EB LT | 110 m | 18 m | 16 m |

The queuing analysis has confirmed that existing 95th percentile queue lengths (recorded in metres) do not currently exceed available storage lengths.

## 2.8 Study Area Strengths, Weaknesses, Opportunities and Threats

As part of the existing conditions summary, an analysis of the Study Area Strengths, Weaknesses, Opportunities and Threats (S.W.O.T.), within the context of the local streetscape, neighbourhood and community was completed. The analyses outline the strengths, weaknesses, opportunities and threats for various components (roadway network, local streetscape, etc.) of the existing neighbourhood and should be used to assist in the urban design of the Barton-Tiffany Study Area.

The purpose of this analysis is to identify areas where improvement may or may not be necessary, identify measures to be considered in the design phase and outlines the threats/negative aspects of each component. The S.W.O.T. information is summarized in **Table 2.4** and illustrates that overall; there are ample opportunities throughout the design phase in which to improve upon the strengths of the Study Area in order to achieve the goals of the overall study. The identified potential threats are anticipated to be satisfactorily mitigated through roadway and intersection design, providing special emphasis on accommodating all modes of transportation including vulnerable road users.

## Table 2.4: Study Area Strengths, Weaknesses, Opportunities and Threats

| | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| **Roadway Network** | Existing grid-pattern provides a strong foundation for future development and expansion of vehicular, pedestrian and cycling networks. | Existing roadway network may limit improvement opportunities due to current right-of-way widths, driver familiarity and lack of direct connections to Downtown. | ▸ Provide additional roadway capacity (as needed) throughout study area;<br>▸ Provide dedicated bike lanes and pedestrian facilities;<br>▸ Provide linkages to Waterfront Trail and the Harbour | ▸ Increased roadway capacity may increase overall traffic throughout Study Area;<br>▸ Increased roadway capacity may affected safety for pedestrians and cyclists;<br>▸ Decreased roadway capacity may increase delay at Study Area intersections. |
| **Local Streetscape** | Lack of existing streetscaping provides for flexibility and opportunities when in the design phase. | Majority of Study Area is vacant land with little or no existing streetscaping. | ▸ Provision of pedestrian and cycling amenities;<br>▸ Incorporation of TDM measures into design elements. | ▸ Decreased visibility (sight lines) at some key intersections;<br>▸ Directional signage may be perceived as "clutter". |
| **Neighbourhood & Community** | Located in an area with connections to main arterial roadways linking Downtown and the Waterfront. | Lack of transit service and pedestrian facilities | ▸ Creation of direct pedestrian and cycling links between the neighbourhood and the Waterfront / Downtown;<br>▸ Provide transit service within the neighbourhood. | ▸ Intensification within the Study Area may increase traffic demands on adjacent roadways. |
| **James Street North Mobility Hub** | Opportunity to provide additional travel mode options linking the Study Area to the wider transportation network;<br><br>May potentially decrease the auto traffic within the neighbourhood as trips shift away from auto to walking and cycling. | May increase the overall traffic within the Study Area as vehicles navigate to parking and pick-up/drop- off areas at the Mobility Hub; | ▸ Provide advanced signage directing drivers to the parking and pick-up/drop-off areas of the station;<br>▸ Review and improve parking regulations within the Study Area;<br>▸ Provide pedestrian linkages to Waterfront Trail and the Harbour;<br>▸ Provision of dedicated cycling route(s) to station. | ▸ Additional traffic may increase the overall collision rates throughout the Study Area;<br>▸ Additional traffic may conflict with pedestrians and cyclists, especially during peak periods. |

# 3.0 Development Concept

## 3.1 Preferred Land Use Concept

The preferred urban design concept developed for the Barton-Tiffany Urban Design Study Area is illustrated in **Figure 3.1**. The urban design concept, as proposed, encompasses approximately 17.12 hectares (42.30 acres) of land, with approximately 11.72 hectares (28.96 acres) slated for development. Development blocks range in size from 0.28 hectares (0.69 acres) to 1.95 hectares (4.82 acres). Within the Study Area, four primary categories of development have been identified:

- **Low Density Residential** – approximately 133 low-density residential units (single, semi-detached and stacked townhouse units);
- **Medium Density Residential** – approximately 868 medium-density residential units (range of 4-storey to 8-storey apartment buildings);
- **High Density Residential** – approximately 160 high-density residential units located within the 12 and 16-storey Point Towers; and
- **Commercial** – proposed uses consist of retail and general office, totaling 628,257 $ft^2$ (58,367 $m^2$) of gross floor area (GFA).

## 3.2 Development Phasing

The proposed development is anticipated to be built-out in three distinct phases:

- **Phase 1** – the first phase of development is anticipated to be built-out and occupied by the 2021 horizon year and includes the residential component of the proposed White Star development (Area 1) which consists of an 8-storey apartment for a total of 168 residential units;
- **Phase 2** – the second phase of development is anticipated to be built-out and occupied by the 2031 horizon year and includes the development and occupancy of the remainder of Area 1, as well as the development of occupancy of Areas 2 through 5. Phase 2 development is to include approximately 40 low-density residential units, 486 medium-density residential units (4 to 8-storey apartments), 160 high-density residential units (12 and 16-storey Point Towers), and approximately 44,076 $m^2$ of commercial uses; and
- **Phase 3** – the remaining development is anticipated to be built-out and occupied post 2031 and as such, has not been included in the analysis of traffic impacts. The final phase of development includes Areas 6 through 11 and includes approximately 93 low-density residential units, 214 medium-density residential units (4-storey apartments), and approximately 14,291 $m^2$ of commercial uses. Traffic impacts associated with Phase 3 of development were not analyzed due to the fact that industry standard practice generally only examines future forecasts in the 5 – 10 year horizon. Given the significance of planned development and change in land use, as well as shift from predominately auto-modes of travel to include higher transit and active transportation shares within the next 10 years, it is difficult to accurately estimate traffic impacts beyond a 2031 horizon.

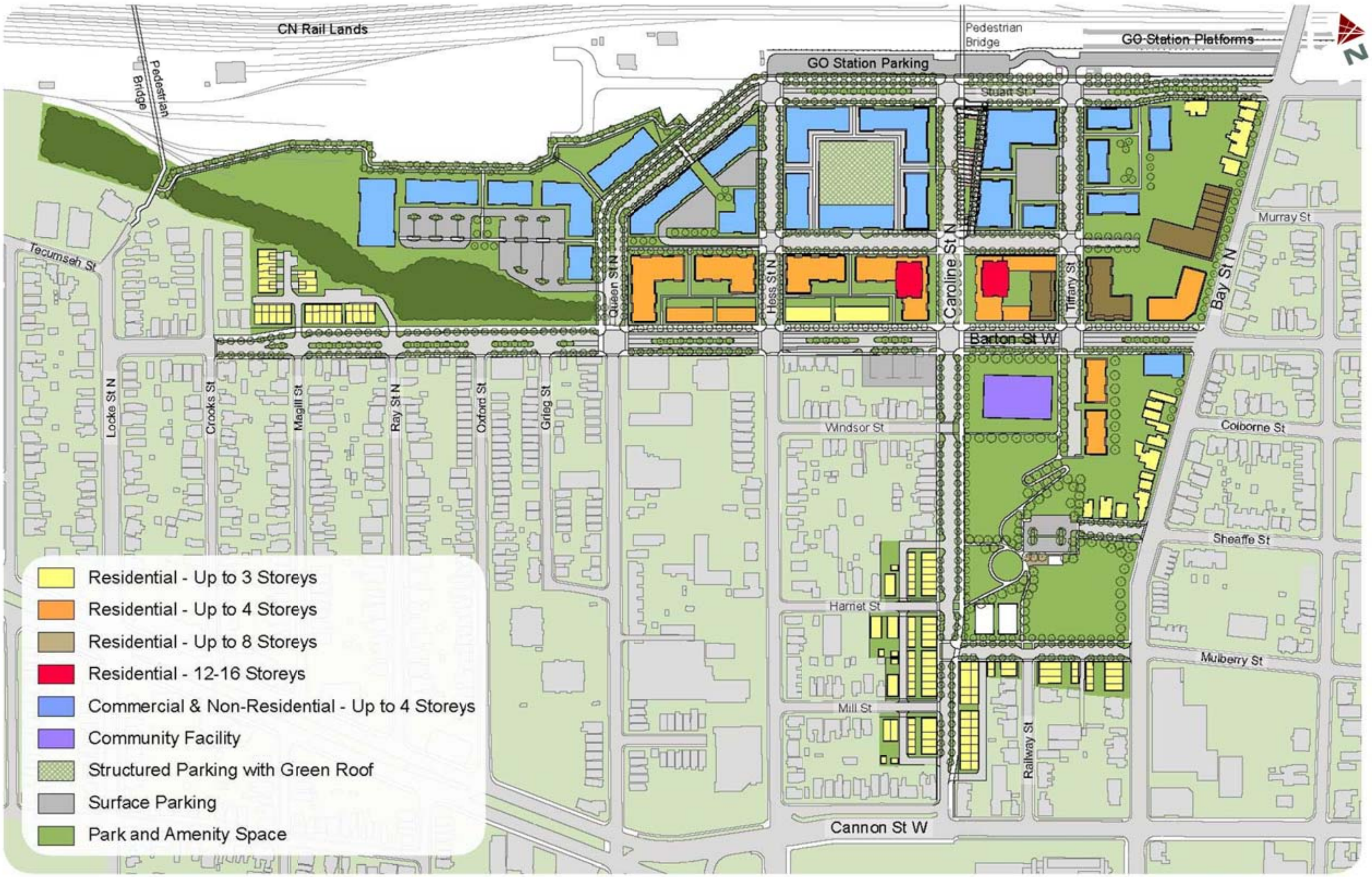


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**Figure 3.1**
**Preferred Land Use Concept**
**as provided by GSP Group Inc.**
**(July 30, 2014)**

## 3.3 Relationship between Land Use and Transportation

It is recognized that transportation demand can be significantly affected by land use patterns. Low-density developments that are based on automobile-oriented site design tend to utilize a hierarchical street system which provide for a generous road allowance and abundance of parking supply – thereby increasing automobile dependency and resulting in higher levels of auto use. High-density developments can achieve sustainability if they are planned in a manner that utilizes transit-oriented design principles and encourages the use of alternative modes of transportation.

Accordingly, the preferred concept plan developed as part of the Barton-Tiffany Urban Design Study considers the relationship between land use and transportation. The relationship is reflected in the proposed high-density, transit-supportive land uses, recommended road pattern, and the creation of a linked open space system. It is recognized that with the future construction of the James Street North Mobility Hub, Barton Street West will be designated as a primary east-west link and as such, will be required to meet the needs of increased automobile traffic, as well as support transit-oriented development and accommodate non-motorized modes of travel to facilitate safe and efficient means of travel to and from the Mobility Hub.

The preferred concept plan includes a mix of residential and commercial uses, with the majority of commercial uses being situated along the north end of the Study Area. The mix of commercial uses provides a focus on pedestrian-generating, ground floor retail uses in the areas adjacent to the Mobility Hub, with general office and other commercial uses located in upper storey locations.

The creation of a interconnected and accessible cycling and pedestrian system will connect the proposed parklands and existing open space systems to the rest of the Barton-Tiffany Urban Design Study Area and will connect with existing and planned cycling facilities within roadway system. Combined with public transit, these are important elements of the roadway system that will be required in order to support development and growth within the Barton-Tiffany Urban Design Area.

The resulting traffic operations analyses addresses the correlation between private autos, transit, walking and cycling and the required components of the overall transportation system required to achieve the safe and efficient movement of people within, and around, the Barton-Tiffany Urban Design Study Area.

# 4.0 Future Background Traffic

## 4.1 Planned Improvements

Through consultation with City of Hamilton Staff it was confirmed that aside from the reconstruction of the Bay Street Bridge (anticipated completion – 2015) there are no additional transportation network improvements planned as part of the short-term capital works program within the Study Area.

It is noted that Queen Street, north of Barton Street West, was recently converted to two-way operation. The section of Queen Street between Barton Street West and York Boulevard is identified as future two-way conversion, but the ultimate design will be determined through the upcoming five-year review of the City's Transportation Master Plan and as such, a timeframe for future conversion has not yet been identified.

It is pertinent to note that the *James Street North GO Station Traffic Impact Study*[9] (TIS) made specific reference to the current operation of Queen Street North, noting that within the vicinity of the Study Area, Queen Street is significantly underutilized, operating one-way southbound from Barton Street West to York Street. The TIS recommended that the City of Hamilton consider the conversion of Queen Street North to two-way, from York Boulevard to Stuart Street, noting that the conversion will result in improved access to the proposed Mobility Hub with the added benefit of "providing some traffic calming measures and reduction of traffic speeds". For the purposes of the James Street North GO Station TIS, Queen Street was analyzed based on the assumption that Queen Street would be converted to two-way operation by 2015 (one northbound lane and two southbound lanes).

## 4.2 Other Area Development

Government of Ontario (GO) Transit / Metrolinx is currently in the process of constructing a new GO Station and layover facility at James Street North and Murray Street. This location, identified as a Mobility Hub by Metrolinx, will be where the existing CN main line intersects with the future City of Hamilton rapid transit A-Line. The Primary Zone of Influence extends east to John Street North, west to Locke Street, north to Picton Street and south to Barton Street West and contains the Barton-Tiffany Urban Design Study Area. It is anticipated that the first phase of development, consisting of the James Street North Mobility Hub, is anticipated to be completed in the summer of 2015 with the goal of being operational by the start of the PanAm games. The full build-out is expected to occur over the next 20 years.

Upon completion, access to parking and pick-up/drop-off areas will be provided via Stuart Street (west of Bay Street North), located along the northern limits of the Barton-Tiffany Study Area as well as via James Street North. The location of the James Street North Mobility Hub is illustrated in **Figure 4.1** and the projected trip generation[10] (automobile trips) is summarized in **Table 4.1**.

**Table 4.1: James Street North Mobility Hub – Projected Auto Trip Generation**

| | 2015 | | 2020 | |
|---|---|---|---|---|
| | IN | OUT | IN | OUT |
| AM | 375 | 57 | 393 | 75 |
| PM | 57 | 375 | 75 | 393 |

[9] James Street North GO Station – Transportation Impact Study (Draft Report), IBI Group, July 2013.

[10] James Street North GO Station – Transportation Impact Study (Draft Report), Exhibit 4.4, IBI Group, July 2013.


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# Figure 4.1

## Location of Future James Street North GO Station

As described by Metrolinx, Mobility Hubs[11] consist of major transit stations and the surrounding areas (approximately a 10-minute walk / 800-metre radius) with significant levels of transit service planned and high development potential. Mobility Hubs are centres of connectivity along the regional transportation network (i.e. GO Transit Lakeshore West Rail Line) and offer an intensive concentration of jobs, homes, shops, restaurants and recreation. Mobility Hubs have the potential to become major destinations with vibrant places of activity. The six key elements of a successful Mobility Hub are summarized as follows:

1) **Multimodal Transportation:** A range of higher-order transportation options with seamless transfer;

2) **Residential and Employment Density:** Critical mass of people work, live, shop and enjoy themselves;

3) **High levels of Pedestrian Priority:** Spaces and connections designed with pedestrian priority;

4) **Embedded Technology:** Access to real time travel information;

5) **Economic Vitality and Competitiveness:** Significant development potential and strong economic anchors; and

6) **Strong Sense of Place:** A vibrant and vital place to support the transportation experience.

It is anticipated that if the James Street North GO Station meets the six key elements outlined above, the vehicular, pedestrian, bicycle and transit traffic in the Barton-Tiffany Study Area may increase since: 1) Service frequency to/from Toronto and Niagara will be provided from this station; and 2) Additional Hamilton Street Railway (HSR) service, both by bus and ultimately rapid transit (on James Street North only) will be provided within the area with the intent to provide the seamless transition from local to regional transit. However, it is noted that ultimately, vehicular trips within the Study Area may decline upon completion of the Mobility Hub since many people living in the area will be able to walk or cycle to the station.

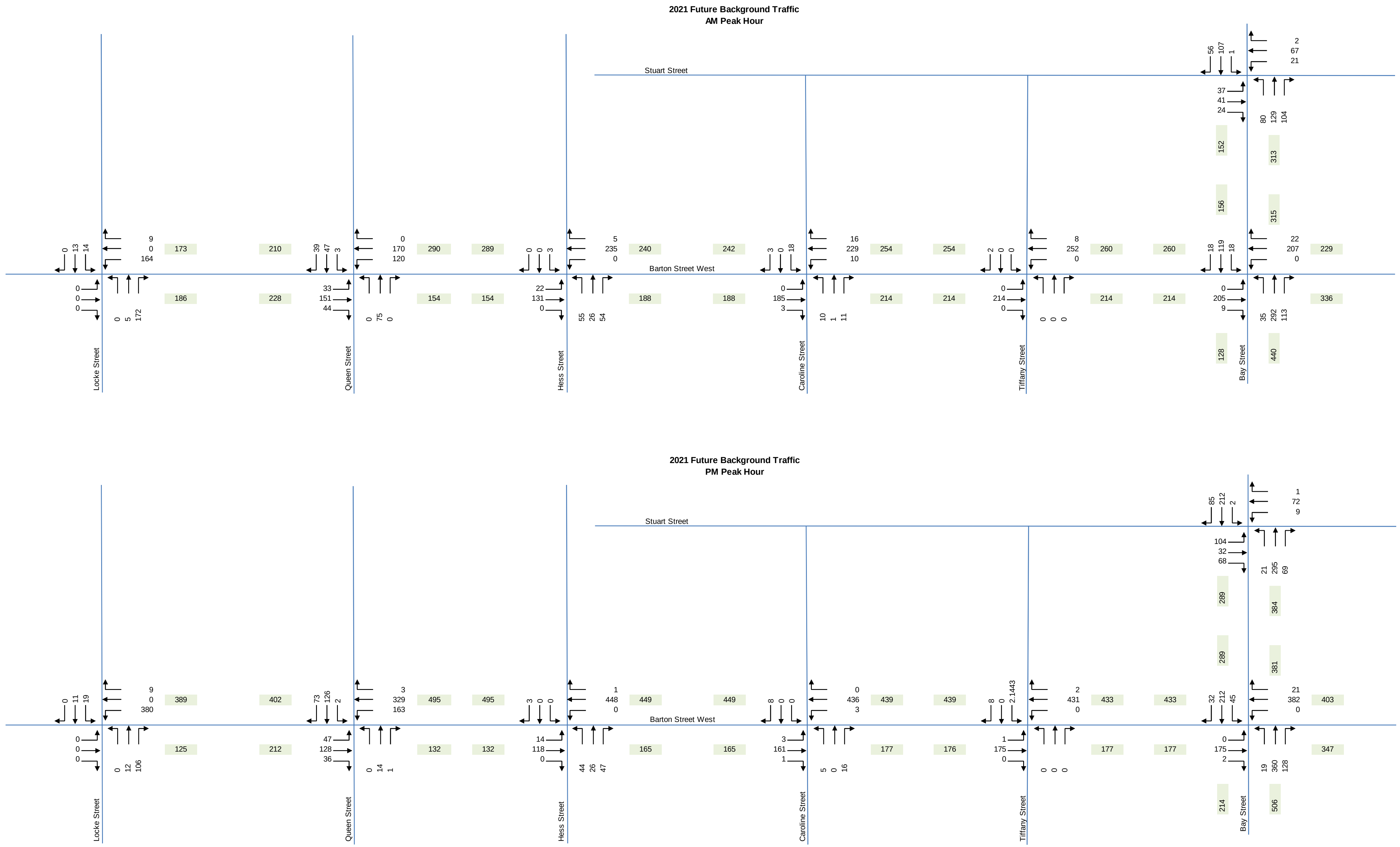
## 4.3 Traffic Growth

Estimates of growth in background traffic have been based on the application of a 1% growth rate (compounded annually), as provided by the City of Hamilton, reflecting generalized growth of approximately 7.2% by 2021, and 18.4% by 2031.

## 4.4 Future Background Traffic Volumes

The resulting 2021 and 2031 future background traffic volumes have been based on the application of a 1% annual growth rate, as well as traffic contributions from the planned James Street North Mobility Hub. The resulting future background peak hour traffic volumes are illustrated in **Figures 4.2** and **4.3**. It is noted that future background traffic volumes were not analyzed as part of this study. However, the James Street North GO Station TIS analyzed a 2020 total traffic condition (based on a 1% background growth rate and full build-out) which identified that the overall road network is anticipated to operate satisfactorily and will be able to accommodate future traffic demands.

[11] Mobility Hub Guidelines for the Greater Toronto and Hamilton Area, Metrolinx, September 2011.

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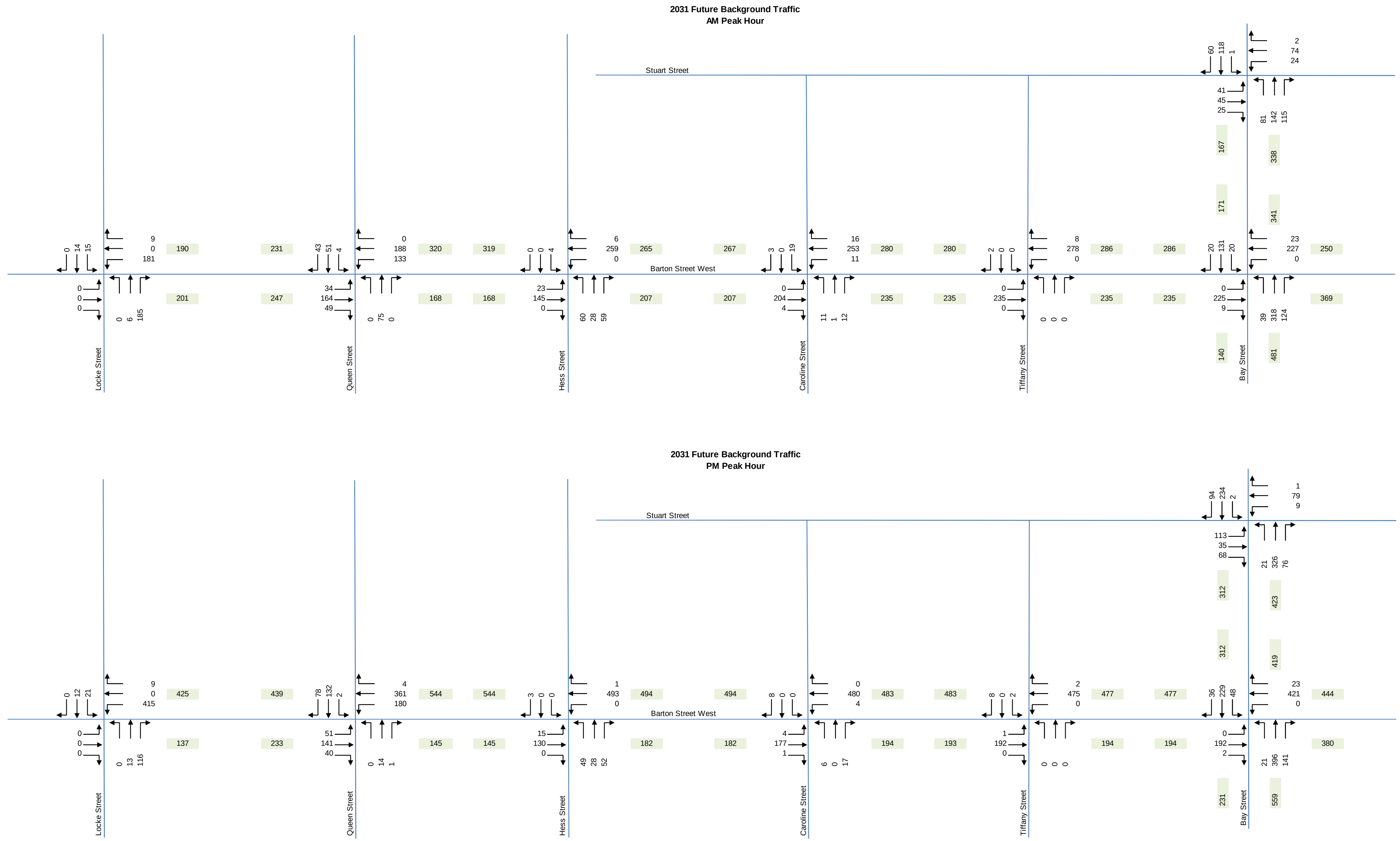
# Figure 4.2

## Future Background (2021) Peak Hour Traffic Volumes

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# Figure 4.3

## Future Background (2031) Peak Hour Traffic Volumes

# 5.0 Demand Forecasting

The forecasting approach used throughout this study recognizes the importance of understanding the role that all modes of travel can play in accommodating future intensification. In order to assess the adequacy of existing and planned infrastructure within the Barton-Tiffany Urban Design Study Area, forecasts of future travel demands have been estimated based on the expected levels of development occurring within the 2021 and 2031 horizon periods.

## 5.1 Site Generated Traffic

The anticipated travel demands associated with the intensification of the Barton-Tiffany Urban Design Study Area are a direct function of the type and use of lands proposed. Generally speaking, residential land uses typically generate travel demands based on the number of dwelling units within a specific area, the type of dwelling unit provided, and/or the expected population of new residents. Non-residential land uses tend to generate travel demands based on the type of land use (i.e. commercial, industrial, institutional, etc.), the number of employees that work within the Study Area, and the types of services offered.

The Institute of Transportation Engineers (ITE) publishes a document titled Trip Generation (9th Edition)[12] which provides a method for calculating trip ends as a function of an independent variable for specific land uses. The data contained in the ITE Trip Generation provides statistically valid, empirically based estimates of trip generation characteristics for various types and sizes of development based on travel demand patterns observed in communities throughout North America. Local sources can also be used to estimate trip generation characteristics of different land uses such as local trip generation studies and Transportation Tomorrow Survey (TTS) data which provide trip origin/destination data as well as travel mode.

Estimation of travel demand for the Barton-Tiffany Urban Design Study Area has been based on observed or estimated trip generation rates published by the ITE for each of the anticipated land uses. In estimating the trip generation for the development, the following ITE land use types have been assumed:

- **Land Use Code 210** – Single Family Detached
- **Land Use Code 230** – Residential Condominium / Townhouse
- **Land Use Code 220** – Apartment
- **Land Use Code 710** – General Office
- **Land Use Code 820** – Shopping Centre

### 5.1.1 Modal Split Reduction

Assumptions regarding the share of future trips which will use auto, transit and other non-motorized modes of travel were based on a review of *2011 Transportation Tomorrow Survey* (TTS)[13] data, categorized by the following modes:

[12] Trip Generation 9th Edition, Institute of Transportation Engineers, Washington D.C., 2012.

[13] Transportation Tomorrow Survey, University of Toronto, www.jpint.utoronto.ca/drs.

- Auto – auto driver, auto passenger and motorcycle;
- Transit – local transit (HSR) and regional transit (GO Transit);
- Walking;
- Cycling; and
- Other (school bus, taxi, etc.).

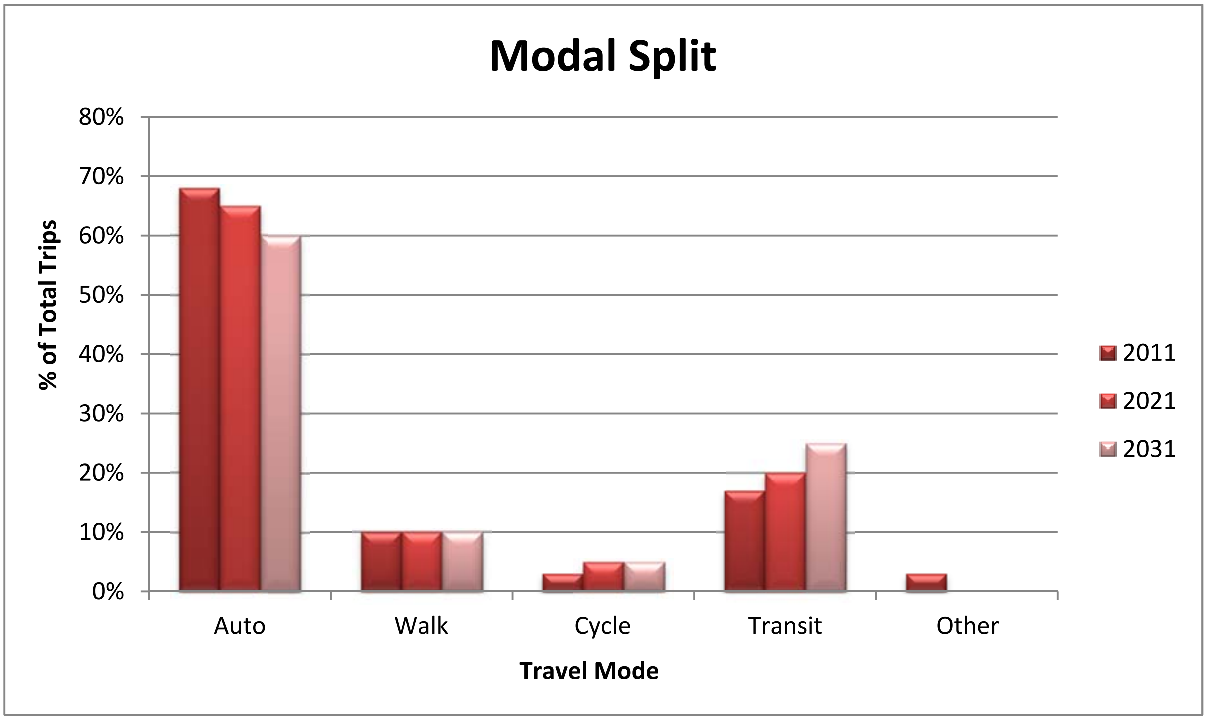
Survey data was obtained for TTS zones 5201 and 5204 which are generally bound by Stuart Street to the north, James Street North to the east, York Boulevard / Cannon Street to the south, and Dundurn Castle to the west. The TTS survey area includes the Barton-Tiffany Urban Design Study Area and is expected to accurately reflect current transportation characteristics within the Study Area.

Based on the travel mode data summarized as part of the TTS Survey Data, and the transit and active transportation mode share targets outlined in the Transportation Master Plan, the following Modal Split assumptions have been made (as summarized in **Table 5.1**) and are graphically illustrated in **Figure 5.1** for further reference.

### TABLE 5.1: MODAL SPLIT

| Modal Split | | | |
|---|---|---|---|
| **Travel Mode** | **2011** | **2021** | **2031** |
| Auto | 68% | 65% | 60% |
| Transit (HSR and GO Transit) | 17% | 20% | 25% |
| Walking | 10% | 10% | 10% |
| Cycling | 3% | 5% | 5% |
| Other (school bus, taxi, etc.) | 2% | 0% | 0% |
| | **100%** | **100%** | **100%** |

**Figure 5.1: Modal Split Assumptions 2011 - 2031**




As illustrated in **Figure 5.1**, the 2011 TTS data has provided the basis for the modal split trip reduction assumptions. Under the 2021 horizon, it is anticipated that active modes (walking and cycling combined) will account for approximately 15% of trips, and transit usage will increase to approximately 20% of all trips. Under the 2031 horizon, it has been assumed that public transit will play a greater role within the Study Area and that the James Street North Mobility Hub will be well established, with potential for future enhancements to the Lakeshore West rail service, as well as the proposed HSR A-Line rapid transit service, thereby increasing transit usage to 25% of all trips. The increase in active transportation mode share under both the 2021 and 2031 horizon is consistent with the goals and objectives of the City's Active Transportation Policies.

### 5.1.2 Overlap, Pass-By and Multi-Purpose Trip Reduction

Research has shown that neighborhoods containing a mix of land uses, which have been planned with the focus of creating safe and convenient pedestrian and cycling environments, and are located near transit-supportive developments; generally allow residents and employees to drive significantly less when compared to traditional neighbourhoods. In the most centrally located, well-designed neighborhoods with a supportive transit system and interconnected pedestrian and cycling network, residents may drive as little as half as much as residents of suburban areas.

Standard trip generation estimation procedures are generally based on data collected from single-use, automobile-dependant suburban sites. However, the consideration of trip overlap, pass-by trips and/or multi-purpose trips are all important factors when estimating the extent in which trips made within a mixed-use area are internalized, or satisfied, with both the origin and destination being located within the neighbourhood. The resulting estimates are important in accurately determining the quantity of external trips generated by the development, thereby resulting in impact to the roadway system external to the site.

There is some allowance for trip overlap and/or multi-purpose trip making when examining commercial land uses, but in general the ITE trip generation methods do not adequately account for the effects of transit-oriented development, mixed-use neighbourhoods, site design, walkability, transit or regional accessibility – all of which are the key elements of smart growth strategies that result in a sustainable community.

Application of available ITE trip generation rates are appropriate when determining *total traffic* estimates. However, there are instances when the total number of trips generated by a site is different from the amount of *new* traffic added to the adjacent road network. For example, retail and commercial-oriented developments are typically located adjacent to busy streets in order to *attract the motorists already on the street*. These sites attract a portion of their trips from traffic passing the site on the way from an origin (i.e. home) to a primary destination (i.e. work) and may not add new traffic to the adjacent street system.

Pass-by trips are defined as trips made as an intermediate stop on the way from an origin (i.e. home) to a primary destination (i.e. work) without requiring a route diversion. Pass-by trips are attracted from traffic passing the site on an adjacent roadway that offers direct access to the development and are already included in the existing traffic stream and therefore does not result in a *new* trip. In order to account for trip overlap, pass-by and multi-purpose trip making phenomenon a general reduction of 30% has been applied to commercial and office uses, which is consistent with the assumptions made as part of the West Harbour Planning Area Study TMP[14] which stated *"in summary, new commercial trips generated by proposed developments are estimated to be 20 to 45% of the typical trip rates for stand-alone commercial and office developments".*

### 5.1.3 Trip Generation Estimates

Based on the residential dwelling unit and commercial gross floor area data summarized in Section 3.2, and a review of modal split characteristics as well as overlap, pass-by and multi-trip interactions, an estimation of net "new" auto trips generated by each phase of development has been completed. The resulting trip generation estimates are summarized in **Tables 5.2** through **5.4**. Detailed trip generation tables which identify land use categories, independent variable selection, quantity, and trip reduction factors are contained in **Appendix D** for further reference.

## TABLE 5.2: 2021 AUTO TRIP GENERATION

| BTUDS Trip Generation Estimates - ITE Trip Generation 9th Edition | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | AM Peak Hour | | | PM Peak Hour | | |
| Horizon | | | In | Out | Total | In | Out | Total |
| 2021 | *Area 1 New Trips* | *8-Storey Apartment* | 11 | 45 | 56 | 47 | 25 | 72 |
| | | ***2021 Site Generated Trips*** | **11** | **45** | **56** | **47** | **25** | **72** |

[14] West Harbour Planning Area Study – Transportation Master Plan, Stantec, 2005.

### TABLE 5.3: 2031 AUTO TRIP GENERATION

| BTUDS Trip Generation Estimates - ITE Trip Generation 9th Edition | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | AM Peak Hour | | | PM Peak Hour | | |
| Horizon | | | In | Out | Total | In | Out | Total |
| 2031 | *Area 1 Remaining Trips* | *Residential & Commercial* | 42 | 69 | 110 | 113 | 107 | 220 |
| | *Area 2 New Trips* | *Apartments & Townhomes* | 13 | 56 | 70 | 62 | 34 | 95 |
| | *Area 3 New Trips* | *Office & Commercial* | 38 | 15 | 53 | 69 | 95 | 164 |
| | *Area 4 New Trips* | *Apartments & Townhomes* | 15 | 64 | 79 | 68 | 37 | 105 |
| | *Area 5 New Trips* | *Office & Commercial* | 44 | 18 | 62 | 81 | 109 | 190 |
| | | ***2031 Site Generated Trips*** | **152** | **222** | **374** | **393** | **381** | **774** |

### TABLE 5.4: POST-2031 AUTO TRIP GENERATION

| BTUDS Trip Generation Estimates - ITE Trip Generation 9th Edition | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | AM Peak Hour | | | PM Peak Hour | | |
| Horizon | | | In | Out | Total | In | Out | Total |
| > 2031 | *Area 6 New Trips* | *Apartments & Townhomes* | 10 | 41 | 51 | 43 | 23 | 65 |
| | *Area 7 New Trips* | *Office & Commercial* | 16 | 6 | 23 | 29 | 49 | 78 |
| | *Area 8 New Trips* | *Office & Commercial* | 22 | 9 | 31 | 39 | 61 | 100 |
| | *Area 9 New Trips* | *Townhomes* | 2 | 8 | 10 | 7 | 4 | 11 |
| | *Area 10 New Trips* | *Apartments* | 5 | 20 | 26 | 24 | 13 | 37 |
| | *Area 11 New Trips* | *Single, Semi and Towns* | 4 | 19 | 23 | 15 | 8 | 23 |
| | | ***Post-2031 Site Generated Trips*** | **60** | **103** | **162** | **158** | **157** | **315** |

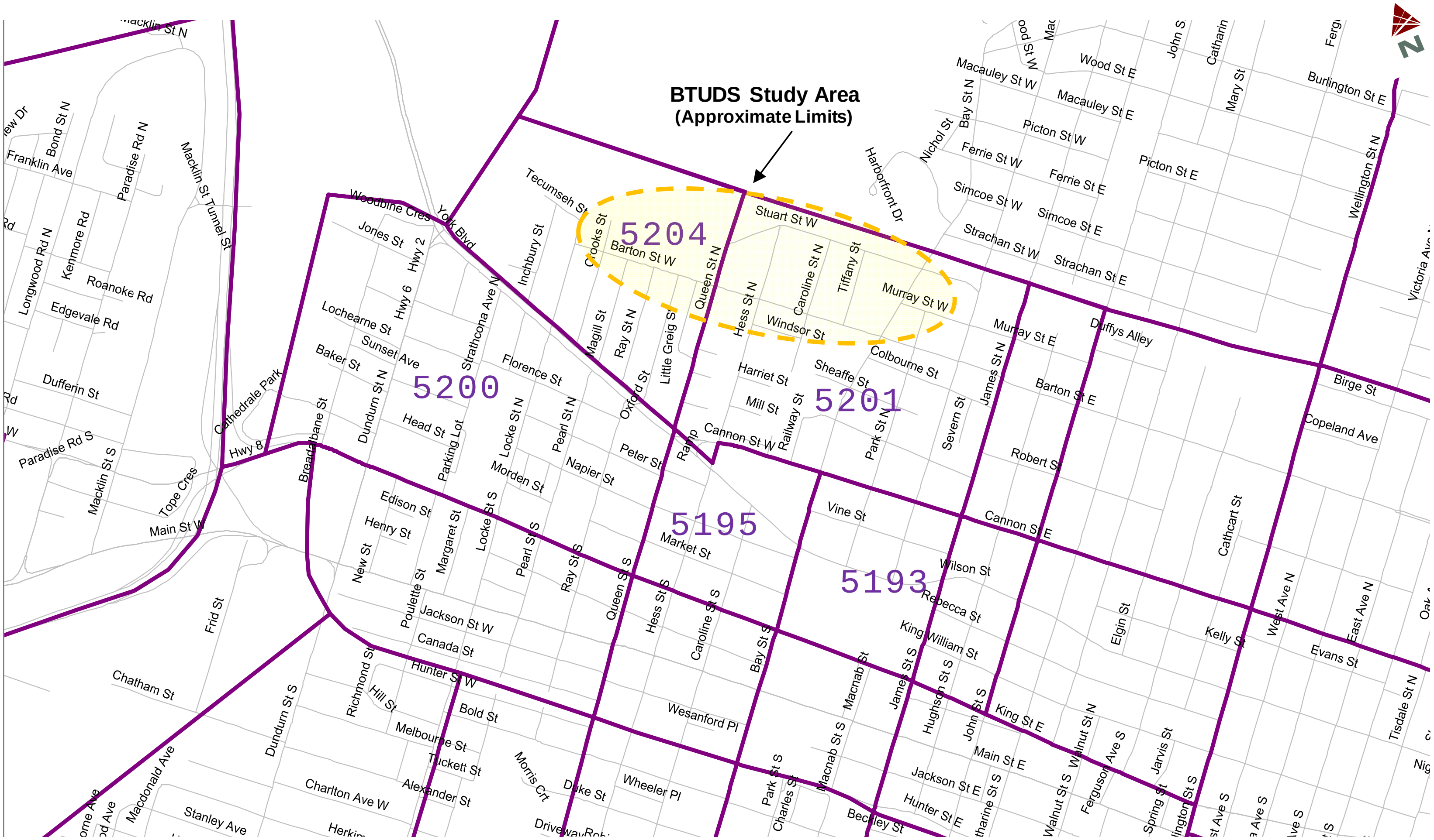
## 5.2 Trip Distribution and Assignment

Distribution of site-generated auto trips was based on a review of 2011 TTS trip distribution data which summarized origin/destination patterns for internal and external trips made within the Downtown Core area. For the purpose of reviewing origin/destination data, TTS data was pulled for an area which included the Barton-Tiffany Study Area (as illustrated in **Figure 5.2**) and is bounded by the following roadways:

- James Street North;
- King Street West;
- Stuart Street West; and
- Highway 403.

A review of the trip distribution data indicates that a considerable amount of peak hour trips remain internal to the City, with the majority of external trips being primarily oriented to and from the GTA (Burlington, Oakville, Mississauga, Toronto, etc.).

Site-generated trips were then assigned to the area roadway network based on the overall directness of travel, accessibility to adjacent freeway facilities and knowledge of local Study Area travel patterns. Consideration was also given to planned roadway improvements within the Study Area including the opening of the Bay Street Bridge, as well as the future conversion of Queen Street from one-way to two-way, north of York Boulevard. The resulting trip distribution assumptions are summarized in **Table 5.5**.

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## Figure 5.2
### TTS Zone Mapping

### TABLE 5.5: PEAK HOUR TRIP DISTRIBUTION

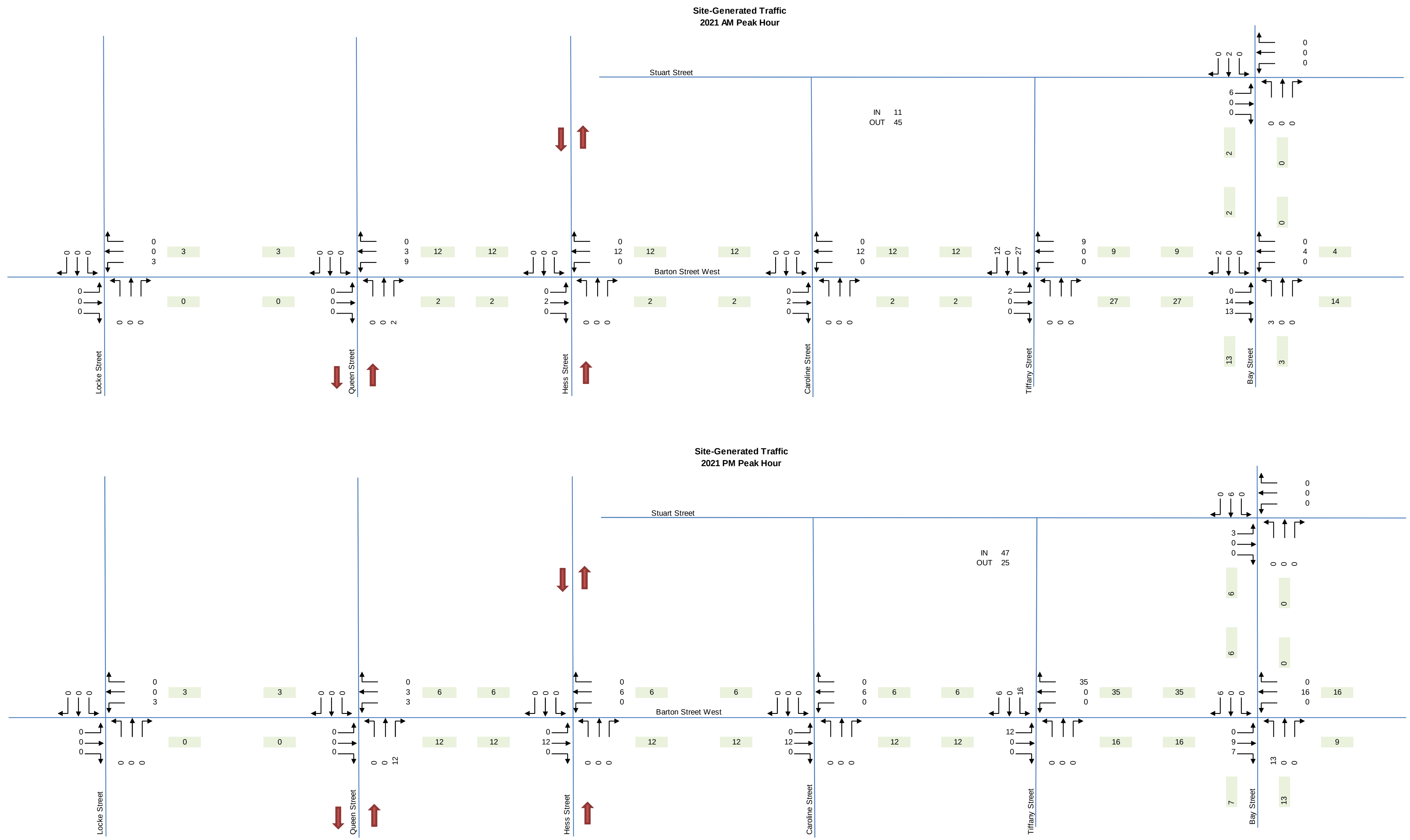
| AM Peak Hour (6:00 AM - 9:00 AM) | | | |
|---|---|---|---|
| | | Outbound | Inbound |
| North East | (via York Blvd. / Hwy 403) | 17% | 10% |
| North West | (via York Blvd. / Hwy 6) | 3% | 2% |
| West / South West | (via King Street / Hwy 403) | 7% | 9% |
| East | (via Burlington Street / QEW) | 3% | 11% |
| South | (internal to City) | 28% | 27% |
| East | (internal to City) | 28% | 27% |
| North | (internal to City) | 14% | 14% |
| | | 100% | 100% |

| PM Peak Hour (3:00 PM - 6:00 PM) | | | |
|---|---|---|---|
| | | Outbound | Inbound |
| North East | (via York Blvd. / Hwy 403) | 11% | 16% |
| North West | (via York Blvd. / Hwy 6) | 3% | 3% |
| West / South West | (via King Street / Hwy 403) | 10% | 6% |
| East | (via Burlington Street / QEW) | 9% | 7% |
| South | (internal to City) | 27% | 27% |
| East | (internal to City) | 27% | 27% |
| North | (internal to City) | 13% | 14% |
| | | 100% | 100% |

The assignment of site-generated traffic resulted in projected link and intersection turning movements at each of the study area intersections. The resulting 2021 and 2031 peak hour site-generated traffic forecasts assignments are illustrated in **Figures 5.3** and **5.4**.

## 5.4 Future Total Traffic

Future total traffic is the combination of future background traffic (background traffic growth plus additional traffic associated with background development such as the James Street North Mobility Hub) and site-generated traffic. The resulting future total traffic forecasts for the 2021 and 2031 horizon years are illustrated in **Figures 5.5** and **5.6**.

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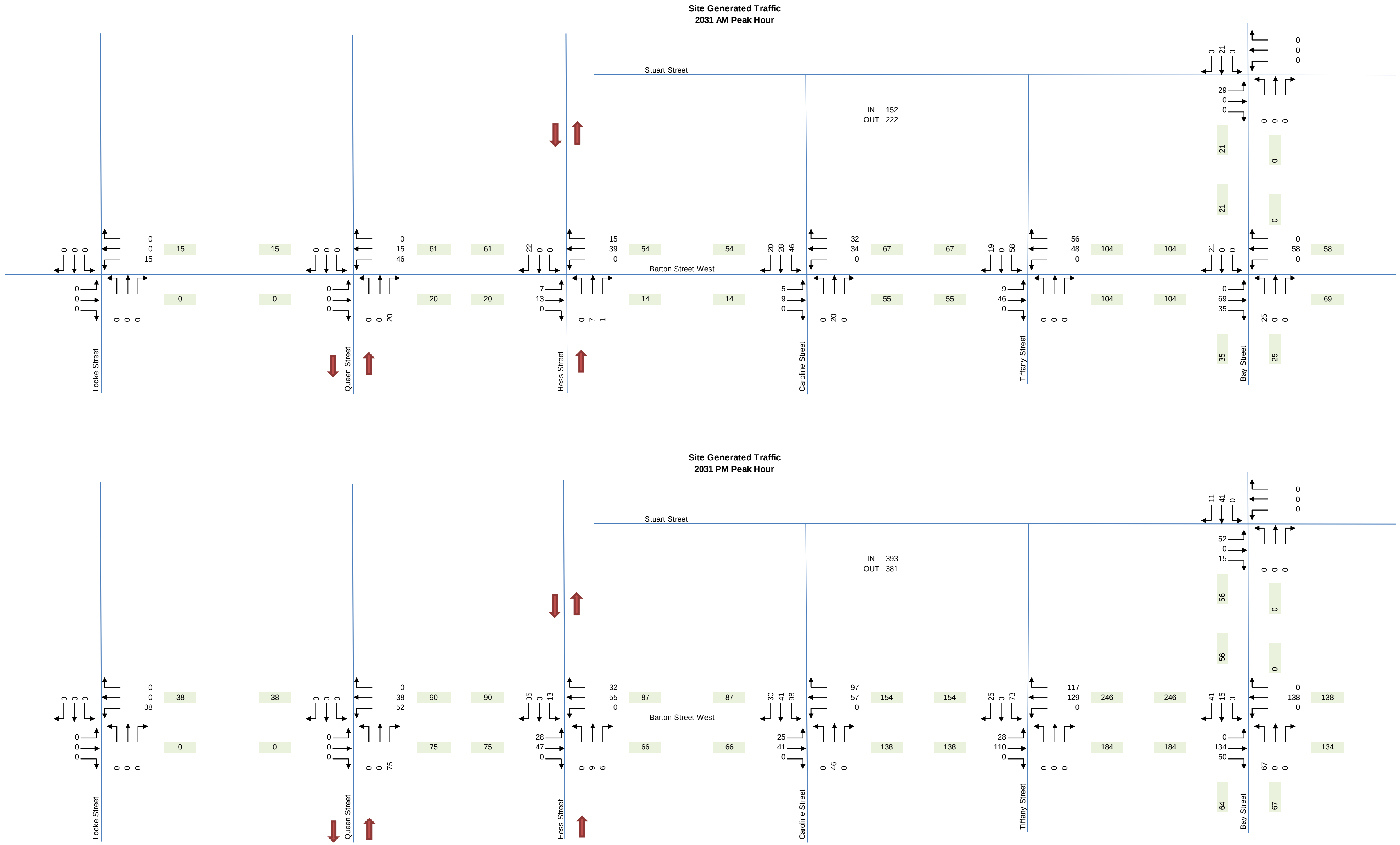
# Figure 5.3

## Site-Generated (2021) Peak Hour Traffic Volumes

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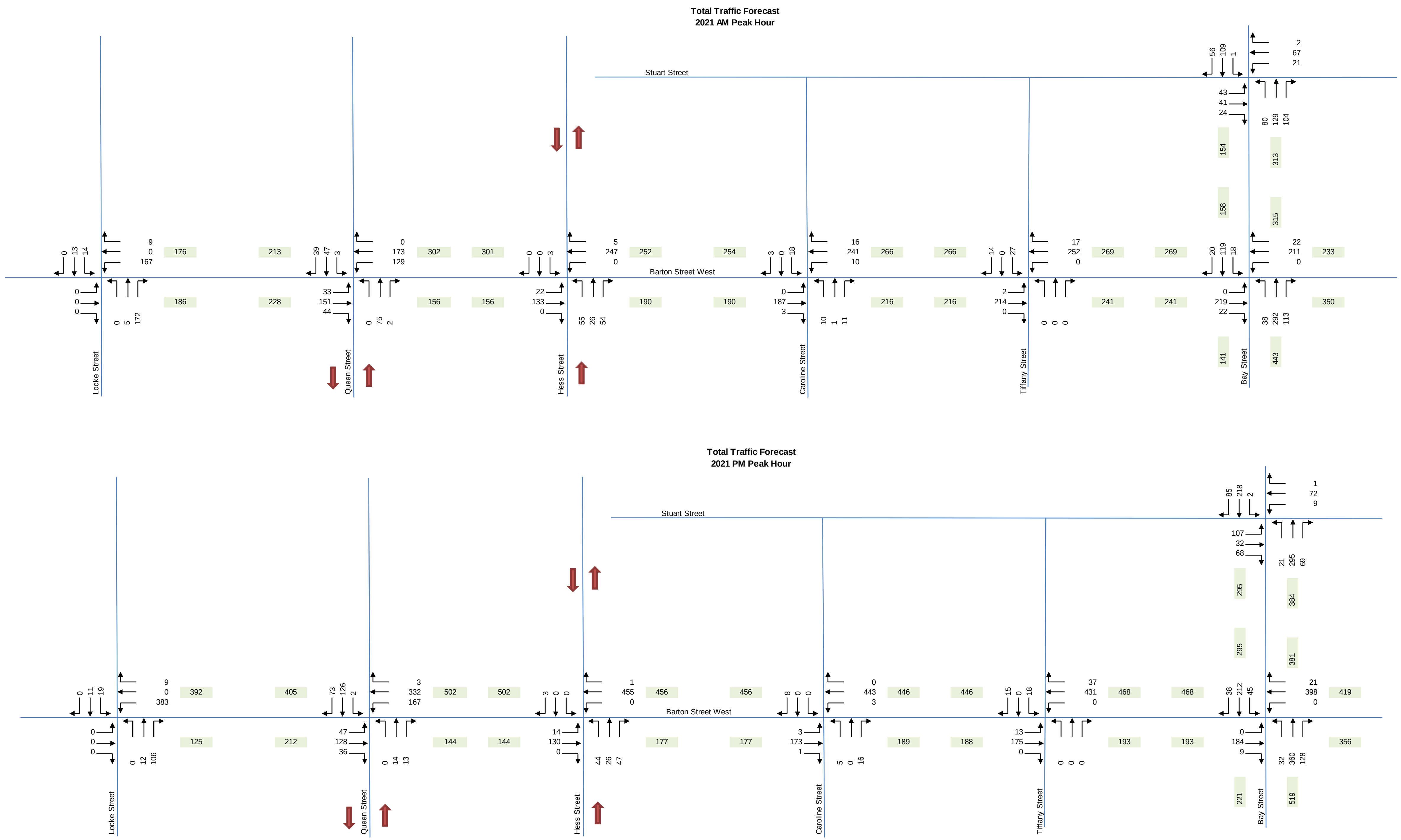
# Figure 5.4

## Site-Generated (2031) Peak Hour Traffic Volumes

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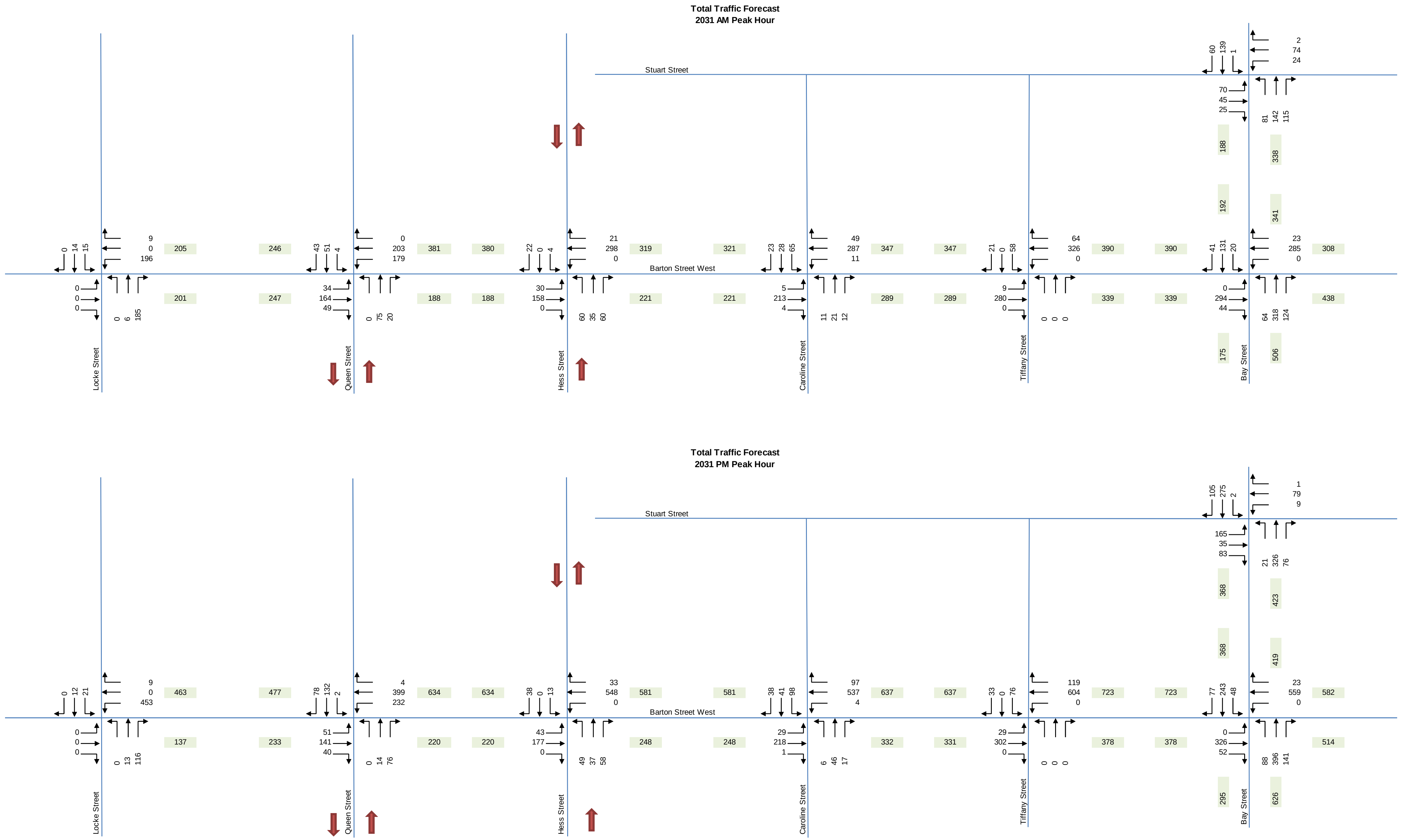
# Figure 5.5

## Total Traffic (2021) Peak Hour Traffic Volumes

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# Figure 5.6

## Total Traffic (2031) Peak Hour Traffic Volumes

# 6.0 Future Traffic Operations

Intersection capacity analyses were completed for the key Study Area intersections in order to confirm future operating conditions, assess traffic impacts to the adjacent transportation system, and identify the need for future roadway and intersection improvements required as a result of future development. Analysis of future total traffic conditions was undertaken using the same methodology described in **Section 1.4** and utilized existing signal timings, where appropriate.

A review of the forecast 2021and 2031 total traffic link volumes along both Barton Street West and Stuart Street indicate that the existing four-lane cross-section provides more than enough capacity when compared to existing and future forecast traffic volumes. It is recognized that the existing roadway infrastructure was planned/constructed at a time when the adjacent land uses were predominantly industrial in nature and adjacent traffic volumes consisted of a high percentage of heavy trucks. In the past, a widened right-of-way with a four-lane cross-section may have been adequate, or even required, in order to accommodate traffic demands associated with the previous land uses. However, the proposed redevelopment of the subject Brownfield sites encourage higher density residential uses that are both transit-supportive and pedestrian oriented in nature. As such, the requirement for a four-lane cross-section is no longer considered needed given the forecasted traffic volumes and anticipated shift from predominately auto-oriented traffic to a greater reliance on active transportation and public transit.

Analysis of future traffic conditions has been based on the following network assumptions:

**Barton Street West** – A three-lane cross section (two travel lanes and a centre two-way left-turn lane / landscaped median island) has been assumed from Bay Street North to Queen Street North, reducing to a two-lane cross section from Queen Street North to Locke Street;

**Stuart Street** – A three-lane cross section (two travel lanes and a centre two-way left-turn lane / landscaped median island) has been assumed from Bay Street North to Hess Street which will tie into the existing cross section east of Queen Street. Utilizing a three-lane cross section protects for future left-turn lanes at key intersections which will serve as access points to the surface parking areas associated with the proposed Mobility Hub.

**Queen Street North** – Consistent with the assumptions and recommendations made as part of the James Street North GO Station TIS, the operation of Queen Street North (between York Boulevard and Barton Street West) has been assumed to be converted from its current one-way southbound operation to two-way operation, consisting of a single northbound and two southbound lanes. The ultimate design of Queen Street North, including provision of on-street parking and/or parking restrictions, is assumed to be determined through further study as part of the 5-year Transportation Master Plan review;

**Tiffany Street** – Through discussions with City staff, it has been noted that the current traffic signals located at Tiffany Street (eastbound direction) were installed in the 1960's in order to minimize the occurrence of vehicles and heavy trucks stopping on the relatively steep grade on Barton Street on the west approach at Bay Street North. The signal operates by turning amber eight seconds prior to the signal at Bay Street North. Staff have indicated that given the limited remaining industrial uses and subsequent reduction in truck traffic, the need for these signals has since been reduced and as such, the City would not object to the removal of the signal display at this location;

**Caroline Street** – The preferred land use concept illustrates the future extension of Caroline Street North, from Cannon Street West to Stuart Street. As such, the extension of this roadway and associated impact to trip assignment has been included as part of the analyses. It has been assumed that Caroline

Street North will consist of a two-lane urban cross-section with provision of enhanced pedestrian treatments at Barton Street West.

## 6.1 2021 Horizon Year

Operational conditions and performance measures for each of the study area intersections under 2021 future total traffic conditions are summarized in **Table 6.1** and the projected 95$^{th}$ percentile queue lengths for critical movements are summarized in **Table 6.2**. The analyses have been based on the assumption that Barton Street West will be reduced to a three-lane cross-section between Bay Street North and Queen Street North. Detailed Synchro 7.0 and SimTraffic Queuing and Blocking summary reports are contained in **Appendix E** for further reference.

### TABLE 6.1: FUTURE (2021) TOTAL TRAFFIC OPERATIONS

| | Intersection | Traffic Control | Analysis Period | Movement | Measure of Effectiveness | | |
|---|---|---|---|---|---|---|---|
| | | | | | LOS | Delay (sec) | V/C |
| 1 | Barton Street at Bay Street | Signalized | AM | Overall | B | 16.4 | 0.39 |
| | | | PM | | B | 18.4 | 0.55 |
| 2 | Barton Street at Tiffany Street | Minor Street Stop Control | AM | Overall | B | 10.4 | - |
| | | | PM | | B | 11.4 | - |
| 3 | Barton Street at Caroline Street | Minor Street Stop Control | AM | Overall | B | 10.8 | - |
| | | | PM | | B | 10.9 | - |
| 4 | Barton Street at Hess Street | Minor Street Stop Control | AM | Overall | B | 11.4 | - |
| | | | PM | | B | 11.5 | - |
| 5 | Barton Street at Queen Street | All Way Stop | AM | Overall | A | 9.2 | - |
| | | | PM | | B | 11.6 | - |
| 6 | Barton Street at Locke Street | All Way Stop | AM | Overall | A | 8.1 | - |
| | | | PM | | A | 9.7 | - |
| 7 | Bay Street at Stuart Street | All Way Stop | AM | Overall | B | 10.0 | - |
| | | | PM | | B | 14.0 | - |

Analyses findings are summarized as follows:

**AM Peak Hour**

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS B or better and no movements were flagged as having a critical v/c ratio or poor level-of-service.

**PM Peak Hour**

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS B or better and no movements were flagged as having a critical v/c ratio or poor level-of-service.

### TABLE 6.2: FUTURE (2021) TOTAL TRAFFIC QUEUING CONDITIONS

| | Intersection | Traffic Control | Critical Movement | Storage Length (metres) | 95th %ile Queue (m) | |
|---|---|---|---|---|---|---|
| | | | | | AM | PM |
| 1 | Barton Street at Bay Street | Signalized | EB T | 85 m | 38 m | 49 m |
| | | | EB R | 85 m | 8 m | 8 m |
| 2 | Barton Street at Tiffany Street | Stop Control | EB L | 45 m | - | 7 m |
| | | | SB LR | 65 m | 15 m | 15 m |
| 3 | Barton Street at Caroline Street | Stop Control | EB L | 50 m | - | - |
| | | | WB L | 45 m | - | - |
| | | | NB LTR | 50 m | 12 m | 12 m |
| | | | SB LTR | 50 m | 13 m | 8 m |
| 4 | Barton Street at Hess Street | Stop Control | EB L | 50 m | 4 m | 7 m |
| | | | NB L | 50 m | 17 m | 16 m |
| | | | SB L | 50 m | 6 m | 6 m |
| 5 | Barton Street at Queen Street | All Way Stop | EB L | 35 m | 14 m | 18 m |
| | | | WB L | 50 m | 17 m | 21 m |
| 6 | Barton Street at Locke Street | All Way Stop | WB L | 50 m | 13 m | 15 m |
| | | | WB LR | 30 m | 14 m | 13 m |
| 7 | Bay Street at Stuart Street | All Way Stop | EB L | 110 m | 15 m | 18 m |

The queuing analysis indicates that the proposed two-way left-turn lane on Barton Street West will be sufficient to accommodate projected mainline left-turn queues. No movements were flagged as potential locations where anticipated vehicle queues may exceed available storage and/or block downstream intersections.

The resulting analyses conclude that the proposed transportation network can satisfactorily accommodate future 2021 traffic conditions. No additional improvements, aside from the assumptions summarized in **Section 6.1**, are required in order to accommodate site traffic.

## 6.2 2031 Horizon Year

Operational conditions and performance measures for each of the study area intersections under 2031 future total traffic conditions are summarized in **Table 6.3** and the projected 95$^{th}$ percentile queue lengths for critical movements are summarized in **Table 6.4**. The analyses have been based on the road network assumptions used to undertake the 2021 total traffic analysis. Detailed Synchro 7.0 and SimTraffic Queuing and Blocking summary reports are contained in **Appendix F** for further reference.

## TABLE 6.3: FUTURE (2031) TOTAL TRAFFIC OPERATIONS

| | Intersection | Traffic Control | Analysis Period | Movement | Measure of Effectiveness | | |
|---|---|---|---|---|---|---|---|
| | | | | | LOS | Delay (sec) | V/C |
| 1 | Barton Street at Bay Street | Signalized | AM | Overall | B | 17.5 | 0.49 |
| | | | PM | | C | 23.3 | 0.77 |
| 2 | Barton Street at Tiffany Street | Minor Street Stop Control | AM | Overall | B | 12.0 | - |
| | | | PM | | C | 16.7 | - |
| 3 | Barton Street at Caroline Street | Minor Street Stop Control | AM | Overall | B | 13.1 | - |
| | | | PM | | C | 20.8 | - |
| 4 | Barton Street at Hess Street | Minor Street Stop Control | AM | Overall | B | 11.7 | - |
| | | | PM | | B | 14.2 | - |
| 5 | Barton Street at Queen Street | All Way Stop | AM | Overall | B | 10.1 | - |
| | | | PM | | C | 15.5 | - |
| 6 | Barton Street at Locke Street | All Way Stop | AM | Overall | A | 8.4 | - |
| | | | PM | | B | 10.7 | - |
| 7 | Bay Street at Stuart Street | All Way Stop | AM | Overall | B | 11.0 | - |
| | | | PM | | C | 21.1 | - |

Analyses findings are summarized as follows:

### AM Peak Hour

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS B or better and no movements were flagged as having a critical v/c ratio or poor level-of-service.

### PM Peak Hour

- All Study Area intersections were found to be operating at acceptable levels-of-service with measurable reserve capacity and acceptable levels of delay. All intersections perform at LOS C or better and no movements were flagged as having a critical v/c ratio or poor level-of-service.

**TABLE 6.4: FUTURE (2031) TOTAL TRAFFIC QUEUING CONDITIONS**

| Intersection | | Traffic Control | Critical Movement | Storage Length (metres) | 95th %ile Queue (m) | |
|---|---|---|---|---|---|---|
| | | | | | AM | PM |
| 1 | Barton Street at Bay Street | Signalized | EB T | 85 m | 66 m | 65 m |
| | | | EB R | 85 m | 22 m | 23 m |
| 2 | Barton Street at Tiffany Street | Stop Control | EB L | 45 m | 6 m | 20 m |
| | | | SB LR | 65 m | 17 m | 24 m |
| 3 | Barton Street at Caroline Street | Stop Control | EB L | 50 m | 4 m | 9 m |
| | | | WB L | 45 m | 5 m | 6 m |
| | | | NB LTR | 50 m | 15 m | 17 m |
| | | | SB LTR | 50 m | 21 m | 35 m |
| 4 | Barton Street at Hess Street | Stop Control | EB L | 50 m | 7 m | 12 m |
| | | | NB L | 50 m | 15 m | 17 m |
| | | | SB L | 50 m | 14 m | 14 m |
| 5 | Barton Street at Queen Street | All Way Stop | EB L | 35 m | 17 m | 17 m |
| | | | WB L | 50 m | 19 m | 22 m |
| 6 | Barton Street at Locke Street | All Way Stop | WB L | 50 m | 14 m | 17 m |
| | | | WB LR | 30 m | 14 m | 16 m |
| 7 | Bay Street at Stuart Street | All Way Stop | EB L | 110 m | 15 m | 22 m |

The queuing analysis indicates that the proposed two-way left-turn lane on Barton Street West will be sufficient to accommodate projected mainline left-turn queues. No movements were flagged as potential locations where anticipated vehicle queues may exceed available storage and/or block downstream intersections.

## 6.3 Summary of Findings

The transportation analyses has been based on the proposed road network and land uses illustrated in **Figure 3.1**, and concludes that the proposed transportation network can satisfactorily accommodate future total traffic conditions. Overall, the transportation network is anticipated to operate satisfactory with the proposed lane reductions throughout Barton Street West and along Stuart Street. Based on the analyses findings, it is anticipated that there is surplus roadway capacity available to support the ultimate build-out of the Barton-Tiffany Urban Design Study Area (inclusive of Areas 6 through 11). The need for auxiliary turn lanes and the ultimate location of centre median islands will be subject to further study as part of the development approval process.

# 7.0 Accommodating Transit, Cyclists and Pedestrians

## 7.1 Transit

### 7.1.1 Proposed Future Service

It is noted in the James Street North GO Station Transportation Impact Study[15] that the Station Access Strategy will take a comprehensive multi-modal approach in order to reflect its unique needs as an urban station and mobility hub. As a result, the prioritization of travel modes and access needs will differ from those of a "conventional" GO Station. In particular, modes of access are prioritized with walking and cycling taking a predominant role, with public transit supporting access to the Mobility Hub.

Currently, the Barton-Tiffany Urban Design Study Area is not well serviced by public transit; however, regular (year-round) service is generally provided within a 400-metre walking distance of the centre of the Study Area (i.e. *Route 8 – York* service is provided at the intersection of York Boulevard and Hess Street North, which is a distance of approximately 400 metres from the intersection of Barton Street West and Hess Street North, representative of the "centre" of the Study Area).

Discussions with Hamilton Street Railway (HSR) have confirmed that by 2021, there will be increased service along James Street North (between LIUNA Station and the MacNab Transit Terminal) through the future extension of the A Line express. The enhanced service throughout this corridor is in response to the need for better connections to the Waterfront as well as the need to adequately service the James Street North Mobility Hub. With appropriate funding, the HSR is anticipating 10-minute weekday frequency during peak periods, with off-peak frequency being dependant on future GO rail service schedules.

In addition, the HSR is presently studying *Route 8 - York* and examining the possibility of extending the route southerly on Dundurn Street, from York Boulevard to the Hillcrest Loop. Frequency may increase in order to provide feeder service to the B Line station at Dundurn. There is also potential to enhance service by extending a route to the Aldershot GO Station via York Boulevard, which is anticipated to occur by 2021.

The HSR anticipates continued enhancement of the A Line through the 2031 horizon. Depending on the operation of Queen Street (one-way or two-way operation), as well as the amount of future development within the Barton-Tiffany Urban Design Study Area, there may be an opportunity to provide service along Queen Street between the James Street North Mobility Hub and Main Street, connecting with the B Line service on King Street and Main Street. Potential east-west linkages connecting Queen Street to the James Street North Mobility Hub may include Barton Street West or Stuart Street.

Ultimately, all future transit routing will be determined by the HSR in conjunction with the City of Hamilton. As such, all potential routes (i.e. neighbourhood mobility streets) are to be appropriately designed in order to accommodate transit vehicles.

### 7.1.2 Right-of-Way Requirements and Turning Radii

A minimum 3.5 metre curb lane is recommended on all roads where future transit routes are anticipated. As discussed in **Section 7.1.1**, there may be potential to expand future routes to include transit on Queen Street North, as well as potential for future service within the Study Area, most likely throughout the

[15] James Street North GO Station – Transportation Impact Study (Draft Report), Chapter 7; IBI Group, July 2013.

Barton Street West and Stuart Street corridors. Curb radii at all arterial and collector intersections should meet industry standards to accommodate 12 metre urban buses (15 metre radii).

### 7.1.3 Stop Location and Design

In general terms, bus stop spacing is largely dependent on the pattern of intersections and other roadway features. Stops located within the community should be spaced at a distance of approximately 400-metres which is considered "typical". As per current HSR practice, nearside stops are preferred over farside stops. Nearside stops result in the bus stopping before crossing the intersection thereby accommodating the transit patron near an adjacent crosswalk and facilitating the crossing with the assistance of traffic signals, where provided. Provision of nearside bus stops also result in operators entering the intersections from a complete stop, allowing for a wider-angle view of the intersection and potential conflicts, thereby reducing collision potential with both pedestrians and cyclists.

Parking should be prohibited approximately 45 metres from the upstream intersection when accommodating a nearside bus stop with an additional 6 metre area provided for the bus to merge back into traffic (measured downstream from the bus stop marker). This distance allows for an adequate bus area which can accommodate manoeuvring and bus parking without being impeded by parked cars.

## 7.2 Cycling Facilities

### 7.2.1 On-Street Bike Routes

Dedicated cycling facilities are preferred over shared on-street bike routes and as such, the redevelopment of the Barton-Tiffany Urban Design Study Area includes provision of dedicated on-road bike lanes throughout the neighbourhood mobility street network. Currently, Barton Street West and Tiffany Street (within the limits of the Study Area) are designated as signed routes (shared on-street), as per the Cycling Master Plan.[16]

The Cycling Master Plan identifies that on-street bike lanes are proposed for York Boulevard (from Queen Street to Dundurn Street), Locke Street (from Barton Street West to York Boulevard), and Bay Street (from Strachan Street to Cannon Street) once bridge reconstruction activities are completed.

On-street bike lanes are recommended at the following locations as part of the planned redevelopment, and as such, complement the existing and planned cycling network:

- Barton Street West (Locke Street to Bay Street North); and
- Queen Street North (York Boulevard to Stuart Street).

The proposed cycling facilities are to consist of 1.8 metre delineated on-street bike lanes which will tie into the City's current cycling infrastructure plans which include a proposed pedestrian and cyclist bridge which is planned to cross the CN Rail corridor and connect with the waterfront. Signage and pavement markings are to be implemented as per Transportation Association of Canada (TAC) Guidelines and the preferred width of an on-street bike lane is ideally 1.5 metres to 1.8 metres, with an absolute minimum width of 1.2 metres. It is noted that the dimensions are measured from the edge of pavement, and in the case of no gutter pan, can be measured to the face of curb.

[16] Shifting Gears 2009, Hamilton's Cycling Master Plan (Ecoplans Limited), June 2009 (as revised in 2011).

Provision of on-street bike lanes on key neighbourhood mobility streets achieves the goal of creating an interconnected multi-modal transportation network which provides strong linkages to the future Mobility Hub, the Downtown Core, and other key destinations such as the Waterfront Trail and Dundurn Park.

### 7.2.2 Off-Road Multi-Use Recreational Trails

Off-road multi-use recreational trails are proposed to complement the comprehensive network of on-street cycling facilities throughout the Study Area and facilitate key linkages between community open spaces, recreational uses, and key destinations such at the James Street North Mobility Hub.

Off-road multi-use recreational trails are recommended at the following locations:

- Barton Street West (north side of the roadway, west of Queen Street North);
- Stuart Street (south side of the roadway from Queen Street North to Bay Street North);
- Queen Street North (east side of the roadway from Barton Street West to Stuart Street); and
- Caroline Street North (east side of the roadway from Cannon Street to Stuart Street).

Off-road multi-use recreational trails are typically shared by pedestrians and other non-motorized users and an asphalt surface is desirable. As summarized in the Hamilton Recreational Trails Master Plan[17], the preferred minimum width is 4.0 metres, but on heavy traffic trails (i.e. the Waterfront Trail), a width of up to 6.0 metres should be considered. It is further recommended that the proposed off-road multi-use recreational trails be designated by the use of appropriate signage and may also incorporate delineation through the use of pavement markings (i.e. application of a yellow centre line) in order to separate opposing flows of traffic and reduce potential conflicts between users.

## 7.3 Pedestrian Facilities

### 7.3.1 Sidewalks

In addition to the extensive network of on-street cycling facilities and an interconnected off-road multi-use trail system, a fully connected network of sidewalks is planned throughout the Barton-Tiffany Urban Design Study Area which follows the fine grid network of existing and planned streets throughout the community.

All road rights-of-way are to include continuous, hard surfaced linear facilities on both sides of the roadway, dedicated for the use of pedestrians with a minimum width of 2.0 metres. In accordance with the City's accessibility plan, any new transportation infrastructure is to consider barrier-free urban design. Elements include barrier-free sidewalks, wheelchair let-downs at all intersections and planned crossings, inclusion of the Urban Braille system and implementation of audible pedestrian crossing signals (where appropriate).

---

[17] Hamilton Recreational Trails Master Plan (G. O'Connor Consultants Inc.), December 2007.

An enhanced sidewalk is recommended at the following locations:

| Roadway | Limits | Sidewalk Facility Provided | Notes |
|---|---|---|---|
| Barton Street West | Bay Street North to Queen Street North | 3.0 metre sidewalk provided on north side | "Commercial" width sidewalk is recommended in order to serve high-density residential lands. |
| Barton Street West | Queen Street North to Locke Street | 4.0 metre Multi-use Trail on north side | Multi-use Trail to provide seamless transition from on-road bike lanes east of Queen Street North |
| Stuart Street & Queen Street | Barton Street West to Bay Street North | 4.0 metre Multi-use Trail provided on the north & west sides of the roadway | Enhanced pedestrian facilities provided in order to encourage active travel to/from Stuart Street Commercial Development and future GO Station. |
| Caroline Street | Limits | 4.0 metre Multi-use Trail provided on east side of the roadway, adjacent to park. | Enhanced pedestrian facilities to promote active travel to/from the park and surrounding uses. |

The sidewalk network, as proposed, provides effective connections between the various land uses (including community open spaces and retail developments), as well as facilitates pedestrian access to the planned James Street North Mobility Hub.

In combination, the network of on-street cycling facilities, off-road multi-use trails and sidewalks achieve a complete system of non-motorized travel facilities which connect all areas of the community and provide opportunity to interconnect with existing infrastructure in order to access key destinations within and adjacent to the Barton-Tiffany community.

### 7.3.2 Enhanced Pedestrian Crossing

The potential for an enhanced pedestrian crossing location has been identified at the intersection of Barton Street West and Caroline Street North. From a transportation operations perspective, the intersection is anticipated to operate satisfactorily under the 2031 horizon based on the current minor street stop control. However, given the adjacent land uses and close proximity to community open spaces, a higher volume of pedestrian activity is anticipated at this intersection.

Opportunity exists to design the intersection in a manner that reduces vehicle-pedestrian conflict potential through the installation of an Intersection Pedestrian Signal (IPS), complimented with enhanced pedestrian crossing treatments.

Based on provincial guidance contained in the Ontario Traffic Manual[18] (OTM), Intersection Pedestrian Signals (IPS) may be installed at intersection locations that are characterized by very light traffic on the side road but have considerable pedestrian volumes crossing the mainline. In particular, vulnerable pedestrians such as school children and seniors can benefit significantly when protected crossings are provided.

[18] Ontario Traffic Manual (OTM) Book 12: Traffic Signals, November 2007.

The purpose of an IPS is to provide a high level of service and quick response to pedestrians waiting at an intersection. At IPS locations, the minor road is controlled with stop signs while the control of the pedestrian signal is facilitated by pedestrian actuated operation. Pedestrian signal indications are used for the crosswalk crossing the main line and regular traffic control signals are provided on the mainline approaches. The mainline signal rests in green until a pedestrian actuation is received. The signal indicators then cycle to red in order to stop mainline traffic and facilitate a protected pedestrian crossing. Minor street traffic continues to be controlled via two-way stop control.

Protecting for future installation of an IPS on the east leg of the intersection of Barton Street West at Caroline Street would result in the intersection retaining its current two-way stop control (Caroline Street North operating with northbound and southbound stop control) while Barton Street West operates free flow (resting in the green phase), and the east side crosswalk controlled via an IPS (pedestrian movements would be prohibited on the west side crosswalk).

A future IPS at this location is desirable from a pedestrian perspective as it would provide for a protected crossing of Barton Street West within the vicinity of the community open space, provide gaps in mainline traffic to facilitate crossings, and serve to minimize conflicts involving vulnerable road users. Furthermore, a signal protected crossing is likely to serve to consolidate the potential of numerous midblock crossings of Barton Street West into a single location. Preliminary discussions with City Staff have indicated that an IPS at the intersection of Barton Street West and Caroline Street North would be supported as it achieves minimum spacing requirements from the upstream signal at Bay Street North and is not anticipated to negatively impact traffic operations, specifically westbound traffic on Barton Street West and the grades associated with the section of roadway between Bay Street North and Tiffany Street.

Justification for the future installation of an IPS at this location would be based upon the warrants contained in OTM Book 12, specifically Justification 6 – Pedestrian Volume and Delay, which is intended for application where traffic volume on the mainline is high and pedestrians experience excessive delay or hazard in crossing the main road unassisted, or where high pedestrian crossing volumes produce the likelihood of delay. The need for an IPS can be considered if both the minimum pedestrian volume and delay criteria, as outlined in Justification 6, are met. The ultimate determination of the installation of an IPS is at the discretion of the City of Hamilton and will be based on future vehicle and pedestrian demands. As such it is not feasible to definitively recommend that an IPS be installed; however it is recommended that a future IPS be protected for at the intersection of Barton Street West and Caroline Street North.

In addition to protecting for a future IPS at the intersection of Barton Street West and Caroline Street North, a number of alternative measures can be employed which alone, or in combination, can serve to enhance the design of the intersection and alert motorists to the high likelihood that pedestrians may be crossing. Some potential intersection and crosswalk treatments include:

- **Curb Extension** – also referred to as "bump outs", horizontal intrusion of the curb into the roadway which results in a narrower section of roadway. Beneficial in reducing crossing distances and improving pedestrian visibility;

- **Curb Radius Reduction** – designing the intersection using a smaller radius, generally in the range of 3.0 metres to 5.0 metres. Beneficial in reducing speed of right-turning vehicles, reducing crossing distance for pedestrians and improving pedestrian visibility;

- **Raised Crosswalk** – a marked pedestrian crosswalk that is constructed at a higher elevation than the adjacent roadway. Beneficial in reducing vehicle speeds, reducing pedestrian-vehicle conflicts and improving pedestrian visibility;

- **Raised Intersection** – similar to a raised crosswalk, a raised intersection is an intersection area (including crosswalks) that is constructed at a higher elevation than the adjacent roadways. Beneficial in reducing vehicle speeds, defining crosswalk areas and reducing pedestrian-vehicle conflicts;

- **Sidewalk Extension** – continuation of the sidewalk across a local street intersection. For a "raised" sidewalk extension, the sidewalk is continued at its original elevation with the adjacent roadway raised to the level of the sidewalk at the intersection. For an "un-raised" sidewalk extension, the sidewalk is lowered to the elevation of the adjacent roadway. Beneficial in emphasizing pedestrian priority; and

- **Textured Crosswalk** – construction of a crosswalk which incorporates textured or patterned surfaces which contrast with the adjacent roadway (i.e. interlocking paving stones, stamped concrete, coloured pavement treatments, etc.). Used to better define the crossing location for pedestrians, emphasize pedestrian priority, and reduce pedestrian-vehicle conflicts.

These measures, either applied in isolation or in combination, including the future installation of an IPS, are recommended at the intersection of Barton Street West and Caroline Street North in order to encourage and delineate a consolidated pedestrian crossing location which serves to facilitate movement to and from the community open space, while complimenting the proposed multi-use trail network through the creation of an enhanced pedestrian crossing location. Enhanced intersection design with a focus on emphasizing pedestrian movements achieves the benefit of increasing vulnerable road user safety through the reduction of pedestrian-vehicle collisions.

It is noted that an IPS facilitates pedestrian crossings only as cyclists are prohibited from riding through a crosswalk. The expectation is that cyclists will dismount and walk their bicycle through the crosswalk as a pedestrian. If the City wishes to allow cyclists to ride across Barton Street West, the need for full traffic signalization would be required and would be subject to further study.

# 8.0 Findings and Recommendations

## 8.1 Study Findings

The results of the traffic analyses for the proposed residential and commercial development within the Barton-Tiffany Urban Design Study Area conclude that sufficient transportation capacity exists within the existing road right-of-way and furthermore, implementing a "road diet" which would effectively reduce the current four-lane cross section of Barton Street West to a three-lane cross section, as well as reduce the existing four-lane cross section of Stuart Street to a two-lane cross section with auxiliary turn lanes where required. The results of this study have determined that no additional infrastructure is required to satisfactorily accommodate forecasted traffic demands as a result of the proposed redevelopment.

The following summarizes the key findings of this study:

- **Proposed Development:** The Barton-Tiffany Study Area is located within the West Harbour Secondary Planning Area and spans two municipal Wards (Ward 1 and Ward 2). The developable area is approximately 11.72 hectares (28.96 acres) in size and has been planned to ultimately accommodate approximately 1,161 residential units (population yield of 2,025 persons) and 58,367 $m^2$ of commercial space (employment yield of 1,630 jobs).

  The preferred design concept consists of 11 distinct development areas. Four primary categories of development have been proposed:

  - **Low Density Residential** – approximately 133 low-density residential units (single, semi-detached and stacked townhouse units);
  - **Medium Density Residential** – approximately 868 medium-density residential units (range of 4-storey to 8-storey apartment buildings);
  - **High Density Residential** – approximately 160 high-density residential units located within the 12 and 16-storey Point Towers; and
  - **Commercial** – proposed uses consist of retail and general office, totaling 628,257 $ft^2$ (58,367 $m^2$) of gross floor area (GFA).

  The proposed development is anticipated to be built-out in three distinct phases:

  - **Phase 1** – the first phase of development is anticipated to be built-out and occupied by the 2021 horizon year and includes the residential component of the proposed White Star development (Area 1) which consists of an 8-storey apartment for a total of 168 residential units;
  - **Phase 2** – the second phase of development is anticipated to be built-out and occupied by the 2031 horizon year and includes the development and occupancy of the remainder of Area 1, as well as the development of occupancy of Areas 2 through 5. Phase 2 development is to include approximately 40 low-density residential units, 486 medium-density residential units (4 to 8-storey apartments), 160 high-density residential units (12 and 16 Point Towers), and approximately 44,076 $m^2$ of commercial uses; and
  - **Phase 3** – the remaining development is anticipated to be built-out and occupied post 2031 and as such, has not been included in the analysis of traffic impacts. The final phase of development includes Areas 6 through 11 and includes approximately 93 low-density residential units, 214 medium-density residential units (4-storey apartments), and approximately 14,291 $m^2$ of commercial uses. Traffic impacts associated with Phase 3 of development were not analyzed due

to the fact that industry standard practice generally only examines future forecasts in the 5 – 10 year horizon. Given the significance of planned development and change in land use, as well as shift from predominately auto-modes of travel to include higher transit and active transportation shares within the next 10 years, it is difficult to accurately estimate traffic impacts beyond a 2031 horizon.

- **Existing Traffic Conditions:** Weekday 8-hour AM and PM peak hour turning movement counts were collected on Wednesday February 12, 2014 and Thursday February 13, 2014 in order to capture "typical" weekday AM and PM peak hour conditions.

  A challenge in determining existing traffic volumes was the fact that the Bay Street bridge is currently under construction and as a result, traffic demands that would have presumably used Bay Street North are now required to divert to adjacent north-south arterials such as MacNab Street or James Street North. In attempts to accurately model "existing" traffic conditions under a scenario where the Bay Street Bridge is open and all traffic movements are permitted, a review of historical TMC data and existing traffic demands on adjacent arterials was undertaken. For the purposes of reviewing historical TMC data, the 2013 traffic volumes illustrated in the James Street North GO Station Traffic Impact Study were used.

  Capacity and queuing analyses were undertaken in order to provide a "benchmark" of existing traffic operations. The findings of the analyses indicate that all Study Area intersections are operating at acceptable levels of service with measurable reserve capacity and acceptable levels of vehicle delay. All Study Area intersections perform at a LOS B or better. No movements were identified as experiencing excessive queuing or blocking.

- **Study Area Strengths, Weaknesses, Opportunities and Threats:** An analysis of Study Area Strengths, Weaknesses, Opportunities and Threats (S.W.O.T.) was undertaken in order to identify opportunities for improvement which will be used to guide the future urban design of the Barton-Tiffany Study Area. A number of significant opportunities to enhance the Study Area were identified including:

  - Provision of dedicated cycling facilities;
  - Provision of dedicated pedestrian facilities:
  - Creating of key linkages to both the Waterfront Trail and Bayfront Park;
  - Provision of future transit service within the community; and
  - Incorporation of traffic demand management measures and traffic calming elements as part of the urban design strategy.

The resulting S.W.O.T. analyses illustrates that overall, there are ample opportunities throughout the development of the urban design guidelines in which to improve upon the strengths of the Study Area, keeping with the overriding study goals and objectives. Any identified potential threats are anticipated to be mitigated through future roadway and intersection design, providing a special emphasis on accommodating all modes of transportation, inclusive of vulnerable road users.

- **Future Background Traffic Conditions:** Both a 2021 and 2031 planning horizon were assessed in order to evaluate impacts of background traffic growth and planned area development. For the purposes of estimating background traffic growth, an annual growth rate of 1% was applied (as endorsed by the City of Hamilton) in order to reflect generalized growth.

  In addition, traffic contributions associated with planned developments within the Study Area, notably the James Street North Mobility Hub, were included as part of the future background traffic forecasts. It has been noted that ultimately, vehicular (auto) trips within the Study Area may be expected to decline upon completion and establishment of the future Mobility Hub given that many people living within the immediate area will be able to utilize alternate modes of travel.

The resultant future background traffic conditions were not included as part of this analyses, however; the James Street North GO Station Traffic Impact Study analyzed a 2020 total traffic condition which considered a 1% growth rate and full build-out of the proposed Mobility Hub, which identified that the overall transportation network is anticipated to operate satisfactorily under future 2020 traffic conditions and will be able to satisfactorily accommodate future traffic demands.

- **Demand Forecasting:** Peak hour trip generation estimates were based on anticipated development phasing and occupancy. Under Phase 1 (2021), the proposed development is estimated to generate approximately 56 two-way vehicle trips during the AM peak hour and 72 two-way trips during the PM peak hour. Phase 1 trip generation estimates assumed an active transportation modal reduction of 15% (consistent with the targets set out in the City's transportation policies) and a transit mode reduction of 20%, consistent with existing transit share and anticipated future increased reliance on transit as a result of the construction of the James Street North Mobility Hub.

  Under Phase 2 (2031), the proposed development is estimated to generate an additional 374 two-way vehicle trips during the AM peak hour, and 774 two-way trips during the PM Peak Hour. Phase 2 trip generation estimates assumed an active transportation modal reduction of 15%, a transit mode reduction of 25% (an increase of 5% over the previous horizon due to increased reliance on public transit in the 2031 horizon), as well as a pass-by / multi-purpose trip reduction of 30% which was applied to commercial (retail and office) trip estimates.

  Under Phase 3 (post 2031), the proposed development is estimated to generate an additional 162 two-way vehicle trips during the AM peak hour and 315 two-way vehicle trips during the PM peak hour. Traffic impacts associated with development occurring post 2031 have not been examined as part of this study given the study horizon.

- **Trip Distribution:** Distribution of the site-generated trips was based on a review of current Transportation Tomorrow Survey (TTS) data which summarized origin / destination patterns for internal and external trips made within the Downtown Core area. A review of the TTS data indicated that a considerable amount of peak hour trips remain internal to the City of Hamilton, while the majority of external trips are oriented to and from the GTA. Site-generated trips were assigned to the local transportation network based on overall directness of travel, accessibility to adjacent freeway facilities, and knowledge of local Study Area patterns. Consideration was also given to planned and programmed roadway improvements within and adjacent to the Study Area including the future reopening of the Bay Street Bridge (anticipated completion date of Summer 2014), as well as the potential future conversion of Queen Street from one-way to two-way (from York Boulevard to Barton Street West).

- **Total Traffic Conditions:** Capacity and queuing analyses were undertaken for both the 2021 and 2031 total traffic conditions. Analyses results indicate that overall, the transportation network is anticipated to operate satisfactory with the proposed lane reduction throughout the Barton Street West and Stuart Street corridors, assuming a three-lane cross-section with a two-way left-turn lane / raised median islands.

  Based on the analyses findings, it is anticipated that there is surplus roadway capacity available to support the ultimate build-out of the Barton-Tiffany Urban Design Study Area (inclusive of Areas 6 through 11). As such, no additional network improvements are anticipated in order to accommodate future total traffic growth.

It is noted that future studies may be required in order to confirm the need for left-turn lanes and/or ultimate placement of raised median islands within the centre two-way left-turn lane. Confirmation of ultimate traffic impacts and subsequent requirements for auxiliary turn lanes and/or changes in traffic control are to be confirmed through the undertaking of detailed Traffic Impact Studies, as required through the site plan approval process.

- **Future Transit Needs:** Through discussions with the HSR, the agency anticipates continued enhancement of the A Line BRT. Dependent upon future roadway operations, i.e. conversion of Queen Street North from one-way to two-way operation, and the extent of development within the Barton-Tiffany neighbourhood, there may be opportunities to provide additional transit service within the Study Area. The HSR has previously indicated that Queen Street North may be considered as a potential candidate route, providing a key linkage between the James Street North Mobility Hub and B Line BRT via King Street and Main Street.

  Recognizing the potential for future enhancements to transit service within the Study Area, a minimum 3.5 metre curb lane has been recommended on all roads where transit service may be anticipated (i.e. Neighbourhood Mobility Streets) inclusive of Barton Street West and Stuart Street. Key arterial and collector intersections shall be designed in a manner that protects for future transit service.

- **Accommodating Cyclists:** Keeping with the study goals of promoting and accommodating active, sustainable transportation, 1.8 metre on-street bike lanes have been proposed along a number of key corridors. The proposed cycling network consists of both on-street dedicated cycling lanes and off-road multi-use trails and is anticipated to complement the City's current cycling infrastructure and achieves the goal of creating an interconnected, multi-modal transportation network which provides strong linkages to the future Mobility Hub, the Downtown Core, and other key destinations such as the Waterfront Trail and Dundurn Park.

- **Accommodating Pedestrians:** In addition to the extensive network of on-street cycling facilities and an interconnected off-road multi-use trail system, a fully connected network of sidewalks is planned throughout the Study Area which follows the fine grid network of existing and planned streets throughout the community. All proposed road rights-of-way are to include at least one continuous, hard surfaced linear facility dedicated for the use of pedestrians. Provision of an accessible and interconnected pedestrian network supports the study goals of promoting active and sustainable transportation.

  Combined, the proposed network of on-street cycling facilities, off-road multi-use trails and sidewalks achieve a complete system of non-motorized travel facilities which connect all areas of the community and provide opportunity to interconnect with existing infrastructure in order to access key destinations within and adjacent to the community.

- **Opportunity to Enhance Pedestrian Crossings:** Further to the provision of an accessible and interconnected cycling and pedestrian network, opportunity exists to further enhance the transportation network through the design and implementation of enhanced pedestrian crossings.

  A future Intersection Pedestrian Signal (IPS) at the intersection of Barton Street West and Caroline Street is desirable from a pedestrian perspective as it would provide for a protected crossing of Barton Street West within the vicinity of pedestrian generating lands uses.

Preliminary discussions with City Staff have indicated that an IPS at the intersection of Barton Street West and Caroline Street North would be supported as it achieves minimum spacing requirements from the upstream signal at Bay Street North and is not anticipated to negatively impact traffic operations.

In addition to, or as an interim measure, a number of pedestrian enhancement elements can be implemented in order to enhance intersection design and alert motorists to the potential presence of vulnerable road users. Intersection and crosswalk treatments that may be considered include curb extensions, curb radius reductions, raised crosswalks, sidewalk extensions and textured crosswalks.

These measures, either applied in isolation or in combination with a future IPS, can be used to encourage and delineate a consolidated pedestrian crossing which aims to achieve the benefit of increasing vulnerable road user safety through the reduction of conflict potential.

## 8.2 Recommendations

Based on the findings of the transportation analyses, it is recommended that the City of Hamilton support the preferred development concept on the basis that the build-out and occupancy of the proposed development will not negatively impact the adjacent transportation network, but rather that the redevelopment of these lands will serve to improve upon and enhance the adjacent transportation network, and the overall Study Area.

# Part B

# Transportation Demand Management Guidelines

# Transportation Demand Management

Transportation Demand Management (TDM) strategies need to be incorporated as part of future development and should be considered though the development approval process. The resulting TDM strategies form the basis for future development with the intention of guiding the design and layout of all portions of the Barton-Tiffany Urban Design Study Area in a manner that supports alternate modes of travel and reduces the reliance on auto-oriented transportation.

Designing the lands in a comprehensive manner which takes into account sustainable mobility and transportation demand management principles, policies and strategies can lead to the ability to choose sustainable transportation options while not negatively impacting the efficiencies of other travel modes. Factors affecting commuters' decisions include: cost, time, safety, comfort and stress of traveling, all of which can be impacted through site design.

General TDM guidelines are comprised of four categories of strategies that can be used at the site design stage to promote walking, cycling, transit, car sharing and carpooling. The four key TDM categories include:

- **Site Organization:** Designing the site in a way that gives higher priority to sustainable modes of transportation over single occupant vehicles. Design options include building placement, building entrance locations, location of parking facilities, and parking supply. These key strategies are typically considered at the beginning of the site design process.

- **Site Layout:** Includes the internal transportation network, parking facility layout, location of transit facilities and pick-up / drop-off areas. All efforts should be made to reduce conflict areas in order to ensure safety for all road users. Factors to consider include size, type, capacity and orientation of parking and facilities.

- **Site Infrastructure:** Sites should be designed in a manner which places a higher priority on alternative and/or sustainable modes of transportation over single occupant vehicles. These aspects can be altered after the site is completed (i.e. inclusion of bicycle parking facilities); however, emphasis should be placed on site infrastructure during the design phase.

- **Site Amenities:** Available amenities can also impact a commuter's decision regarding sustainable transportation. Provision of bicycle racks, showers, change rooms, transit shelters and street furniture can make a commuter feel safe and comfortable and often results in a significant impact when choosing one mode of travel over another. Many amenities can be added after site completion or during a retrofit, if necessary.

In addition to the four key TDM categories, a number of "soft" strategies also exist; reduced parking requirements for car share, bike share and transit pass programs, as well as Smart Commute Programs which are generally recommended for businesses with 50 employees or greater as an incentive to encourage carpooling, transit use and/or active transportation.

Using the strategies outlined above and additional information provided by the City of Hamilton, TDM measures for each proposed type of development (residential, commercial and employment) have been developed. The measures are outlined in **Table 9.1** and are summarized by type of development.

## TABLE 9.1: TRANSPORTATION DEMAND MANAGEMENT

| Design Element | TDM Measure | Land Use | | |
|---|---|---|---|---|
| | | Residential | Commercial / Retail | Employment |
| Exterior Design | Provide a clearly visible "way-finding system" which provides direction to everyone including persons with impairment of one or more senses. Features may include textured surfaces, coloured lines and patters, lights raised letters, large lettering and other clearly understandable directional cues. | ✔ | ✔ | ✔ |
| | Locate signage indicating entrances, amenities (i.e. showers, lockers, transit stations, etc.) and transportation information kiosks strategically throughout the site. In general, every time an individual must make a directional decision, a sign should indicate available choices. | | ✔ | ✔ |
| | Provide signage indicating clear direction from transit to public facilities and service centres. | ✔ | ✔ | ✔ |
| Walking | Provide the most direct, convenient and shortest connections from buildings to public sidewalks, off-site pedestrian paths, and transit stops; as well as direct connections between buildings on-site. Ensure sidewalks are paved and maintained in winter. | ✔ | ✔ | ✔ |
| | Ensure main entrances of new buildings front directly on-street and are clearly visible. | ✔ | ✔ | ✔ |
| | Ensure pedestrian circulation is well-defined with safe and convenient connections to parking areas (car and bike) and off-site pedestrian facilities. Ensure that pedestrian specific lighting is provided adjacent to sidewalks and pathways. | ✔ | ✔ | ✔ |
| | Ensure sidewalks are continuous and depressed where they intersect with a driveway to emphasize pedestrian priority. Ensure sidewalks are barrier-free with at least 2 metres width to accommodate simultaneous passage of a pedestrian and a wheelchair. | ✔ | ✔ | ✔ |
| | Construct asphalt multi-use pathways 3.0 to 4.5 metres in width with 1.0 metre "clear zones" on either side. Consider delineation to assist with bi-directional circulation. | ✔ | ✔ | ✔ |
| | Design sidewalks and pathways to ensure personal security and safety through general practices such as sufficient lighting, unobstructed sign lines and at-grade facilities. | ✔ | ✔ | ✔ |

| Design Element | TDM Measure | Land Use | | |
|---|---|---|---|---|
| | | Residential | Commercial / Retail | Employment |
| Cycling | Ensure connectivity between the on-site transportation network, the pathways adjacent to the site and the bicycle parking facilities. | ✔ | ✔ | ✔ |
| | Ensure that bicycle parking is visible, accessible, easy to use and conveniently located. Locate parking facilities adjacent to entrances or in a special area within the building to ensure that bicycle parking does not interfere with pedestrian movement. | ✔ | ✔ | ✔ |
| | Provide bicycle parking in required amounts, designed to meet or exceed minimum depth, width and height requirements. | ✔ | ✔ | ✔ |
| | Provide sheltered cages for all-day bicycle parking with hooks or racks within the cage. | ✔ | ✔ | ✔ |
| | Provide short-term bicycle parking that meet minimum criteria to ensure spaces can be used conveniently, are easy to use, install and maintain. | ✔ | ✔ | ✔ |
| Transit | Provide shelters at key locations with seating areas, lighting, scheduling information and security at all transit stations and key bus stops (i.e. transfer locations). | ✔ | ✔ | ✔ |
| Carpool | Locate carpool parking stalls near the main entrance of the building. | | ✔ | ✔ |
| | Provide ample carpool stalls to meet or exceed minimum parking requirements. | | ✔ | ✔ |
| | Clearly mark stalls as being reserved for carpool vehicles. | | ✔ | ✔ |
| | Direct carpoolers to reserved parking stalls with clear and adequate signage throughout the facility. | | ✔ | ✔ |
| General Interior Design | Provide adequate signage and way-finding at main entrances to all facilities or amenities such as showers, lockers, information / transit ticket purchase service. | | ✔ | ✔ |
| | Provide a permanent TDM booth at main entrances of all buildings and facilities to display transportation information including a monitor with transit schedules for the nearest transit station/stop. | ✔ | ✔ | ✔ |
| | Provide for direct access to transit facilities from the lobby of major buildings located along a transit route. | ✔ | ✔ | ✔ |

| Design Element | TDM Measure | Land Use | | |
|---|---|---|---|---|
| | | Residential | Commercial / Retail | Employment |
| Active Transportation Facilities | Provide functional and secure change rooms that are well-lit, ventilated and equipped with showers, sinks, toilets lockers, benches, hooks mirrors and shelves. | | ✔ | ✔ |
| | Where possible, connect change room, shower and locker facilities with washrooms, exercise and bicycle facilities. | | ✔ | ✔ |
| | Provide separate change/shower facilities for males and females. In buildings with <300 employees, provide a single lockable shower/change room for both genders. | | ✔ | ✔ |
| | Provide ample shower facilities to avoid waits at peak times and to accommodate future demand. | | | ✔ |
| | Provide the minimum required number of showers based on employee counts. Typically, 2 showers (one per gender) up to 300 employees and for each additional 300 employees, one additional shower per gender. | | | ✔ |
| | Provide one locker for each all-day bicycle parking stall plus 10 additional lockers. | | ✔ | ✔ |
| | Provide full-length lockers to allow for storage of clothing, towels and toiletries. | | ✔ | ✔ |

## Summary

- The TDM measures identified in this report should guide the future design and site layout throughout the Barton-Tiffany Urban Design Study Area. It is recommended that design phase activities should aim to incorporate as many measures as appropriate in order to achieve the goals of the TDM strategy; and

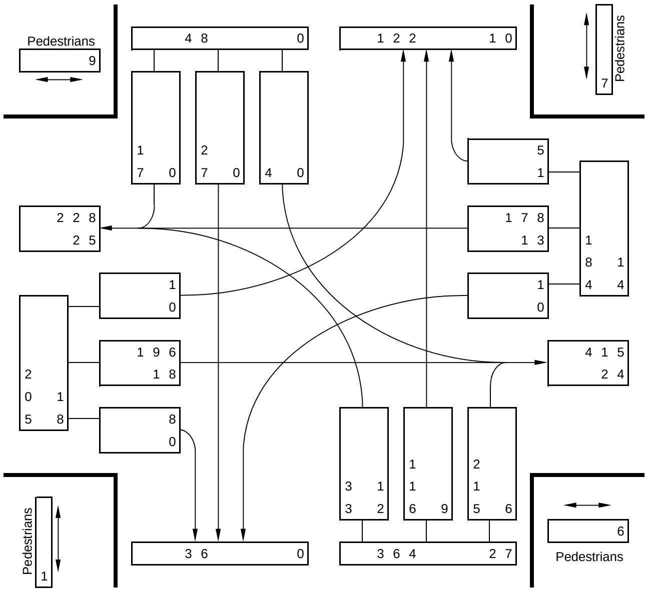
- The implementation of the bulk of the TDM measure outlined herein should assist with saving commuters time and money and allow flexibility in choosing alternative modes of transportation. In turn, this is believed to positively impact mode share and result in a reduction of auto-trips over the long term.

# Appendix A

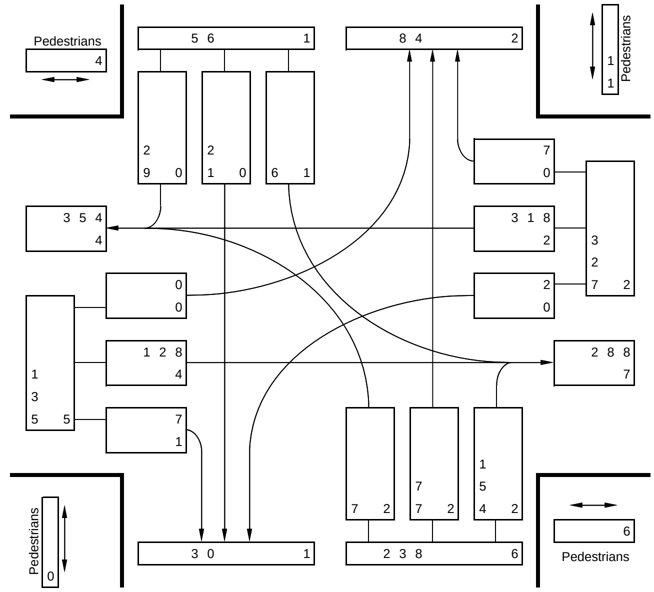
# TMC Data

**City of Hamilton** **T U R N I N G  M O V E M E N T  F L O W  C H A R T** Loc. Code: 2

| | | | | | |
|---|---|---|---|---|---|
| Intersection: | **Bay St** | **at** | **Barton St** | Total Vehicles: 4,498 | Date: Wednesday |
| Direction: | (North/South) | | (East/West) | M.V.E./Year: 3.517 | Feb 12, 2014 |
| Road Condition: Dry | | Weather: Clear | | AWDT Factor: 2.3 | Period: 7 hours |
| Comments: | | | | | |

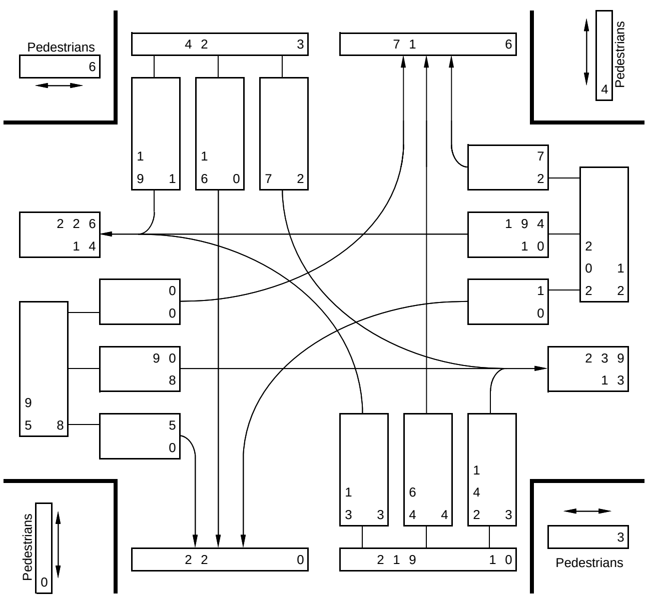



A.M. PEAK HOUR = 8:15 AM - 9:15 AM

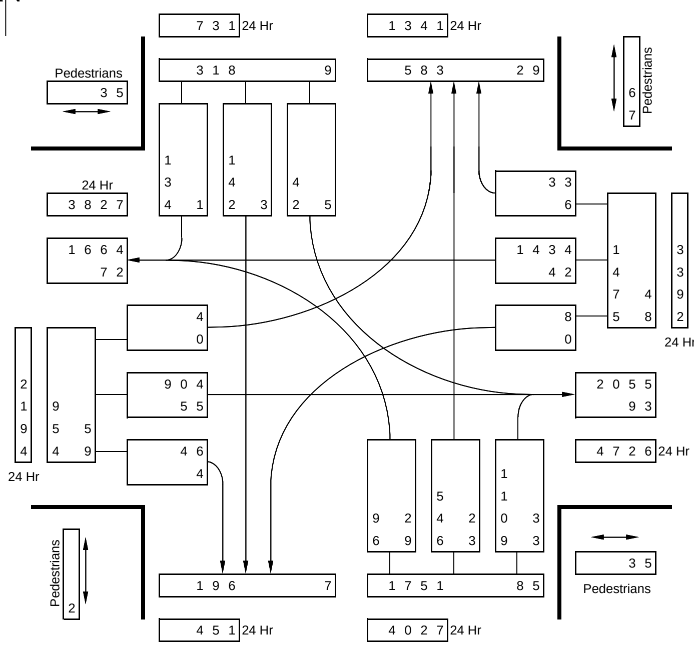



P.M. PEAK HOUR = 4:15 PM - 5:15 PM

N



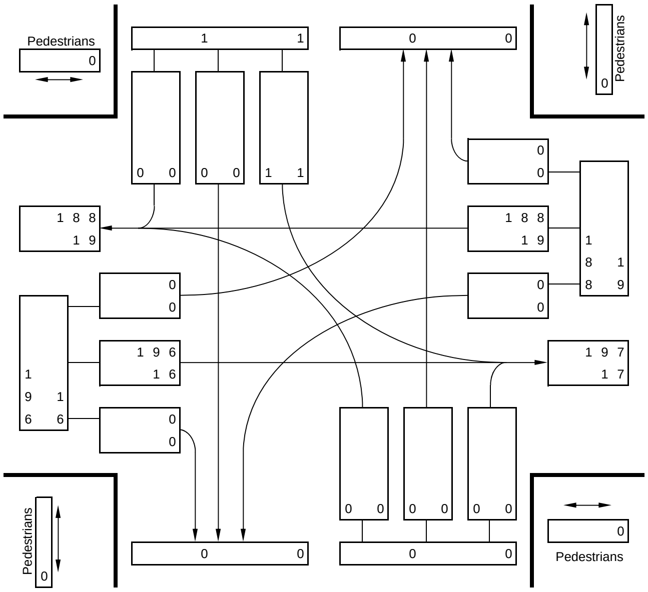

NORMAL HOUR = 2:00 PM - 3:00 PM



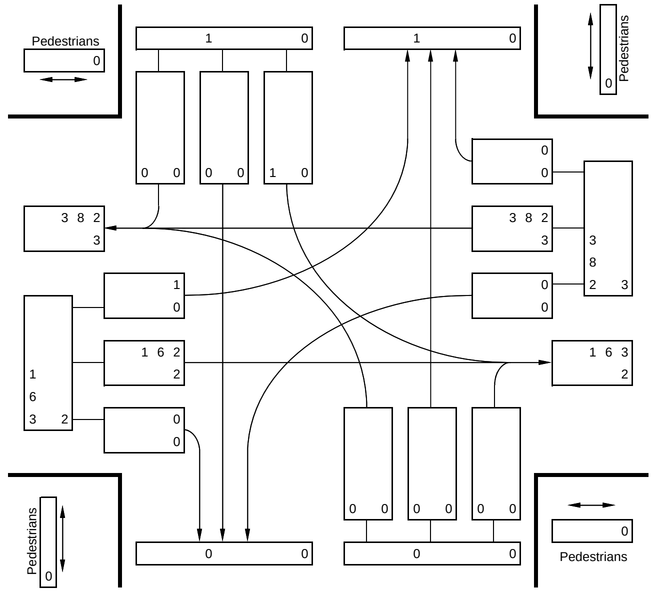

7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** **TURNING MOVEMENT FLOW CHART** Loc. Code: 5

Intersection: **Tiffany St** **at** **Barton St** Total Vehicles: 2,573 Date: Thursday
Direction: (North/South) (East/West) M.V.E./Year: 1.933 Feb 13, 2014
Road Condition: Dry Weather: Clear AWDT Factor: 2.21 Period: 7 hours
Comments:

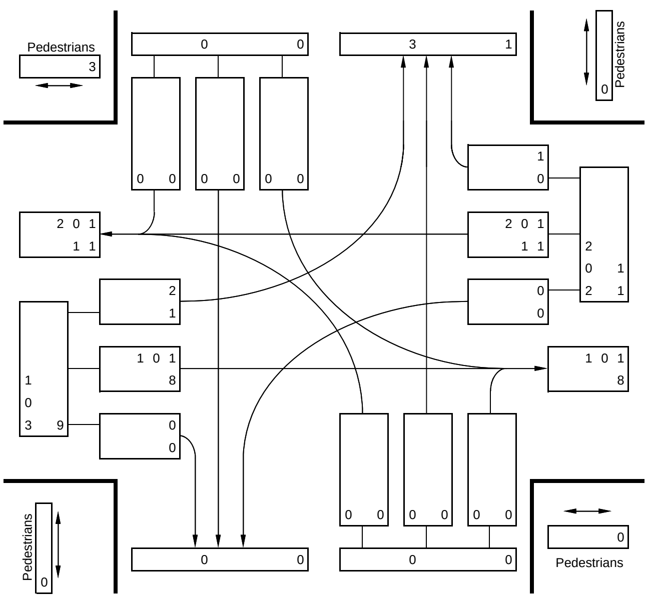



A.M. PEAK HOUR = 8:30 AM - 9:30 AM

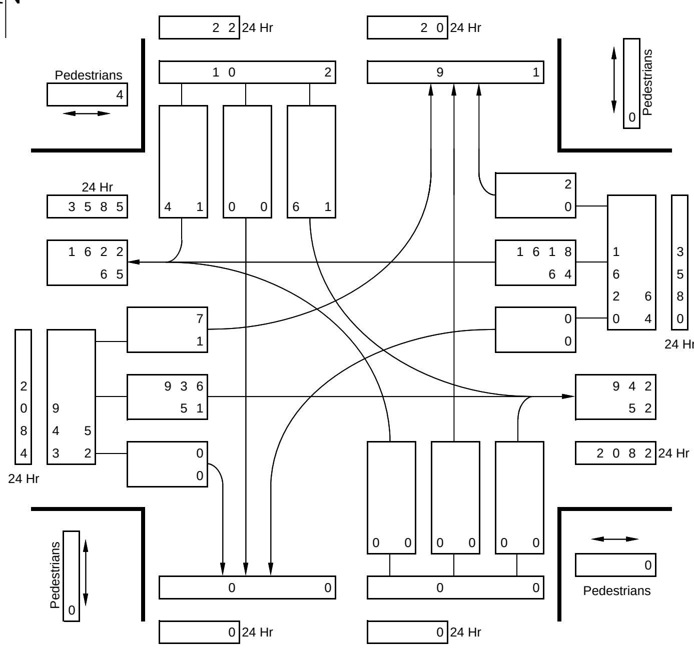



P.M. PEAK HOUR = 4:30 PM - 5:30 PM

N



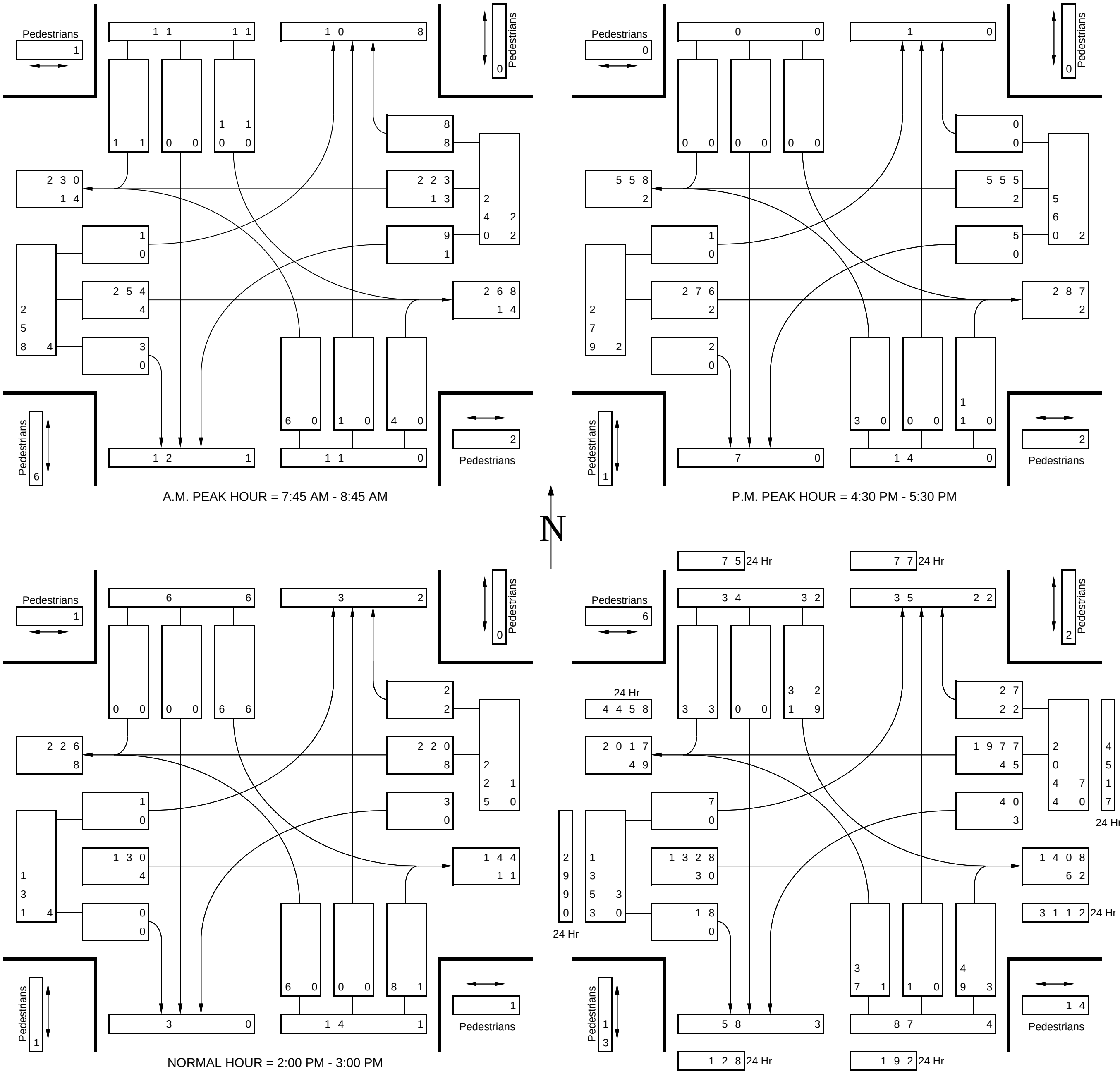

NORMAL HOUR = 2:00 PM - 3:00 PM




7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** **T U R N I N G   M O V E M E N T   F L O W   C H A R T** Loc. Code: 6

| | | | | | |
|---|---|---|---|---|---|
| Intersection: | **Caroline St** | **at** | **Barton St** | Total Vehicles: 3,518 | Date: Thursday |
| Direction: | (North/South) | | (East/West) | M.V.E./Year: 2.643 | Feb 13, 2014 |
| Road Condition: Dry | | Weather: Clear | | AWDT Factor: 2.21 | Period: 7 hours |
| Comments: | | | | | |




A.M. PEAK HOUR = 7:45 AM - 8:45 AM

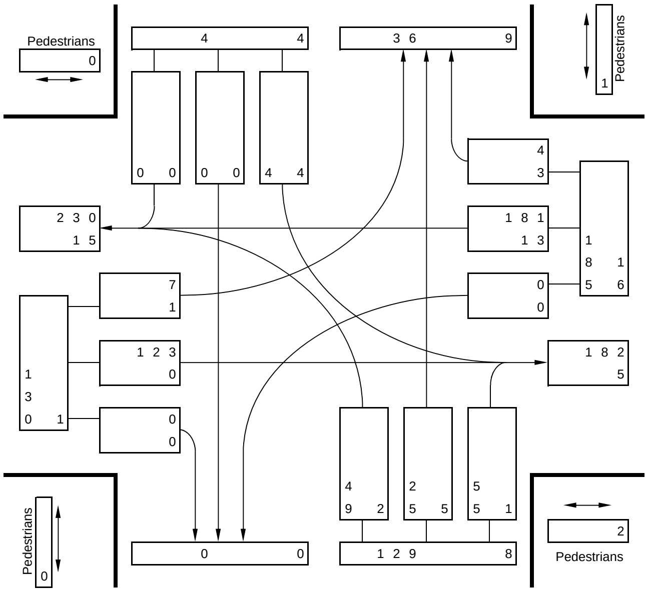
P.M. PEAK HOUR = 4:30 PM - 5:30 PM

NORMAL HOUR = 2:00 PM - 3:00 PM

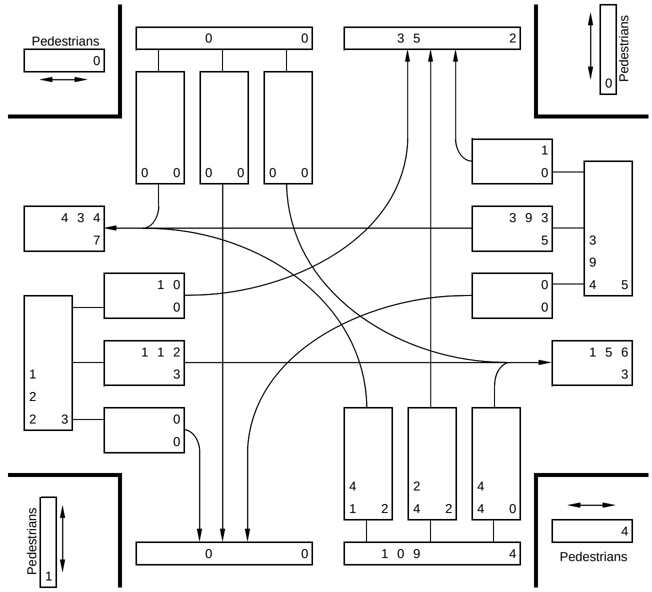
7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** **TURNING MOVEMENT FLOW CHART** Loc. Code: 5

| | | | | | |
|---|---|---|---|---|---|
| Intersection: | **Hess St** | **at** | **Barton St** | Total Vehicles: 3,016 | Date: Thursday |
| Direction: | (North/South) | | (East/West) | M.V.E./Year: 2.266 | Feb 13, 2014 |
| Road Condition: Dry | | Weather: Clear | | AWDT Factor: 2.21 | Period: 7 hours |
| Comments: | | | | | |

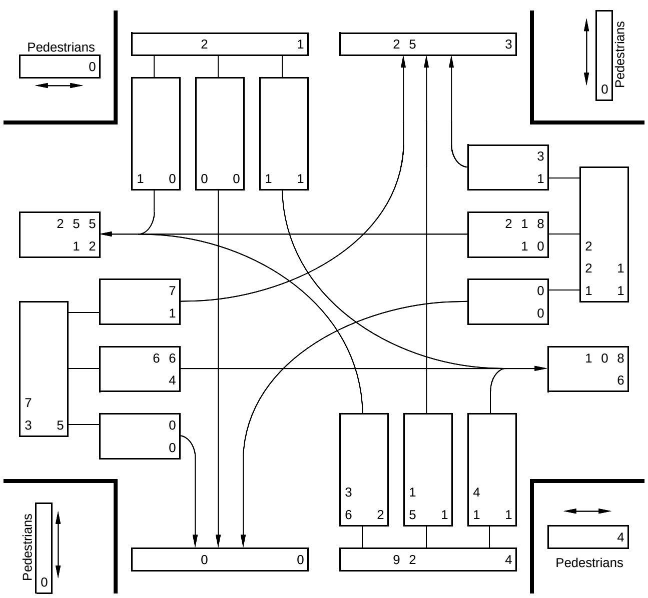



A.M. PEAK HOUR = 8:30 AM - 9:30 AM

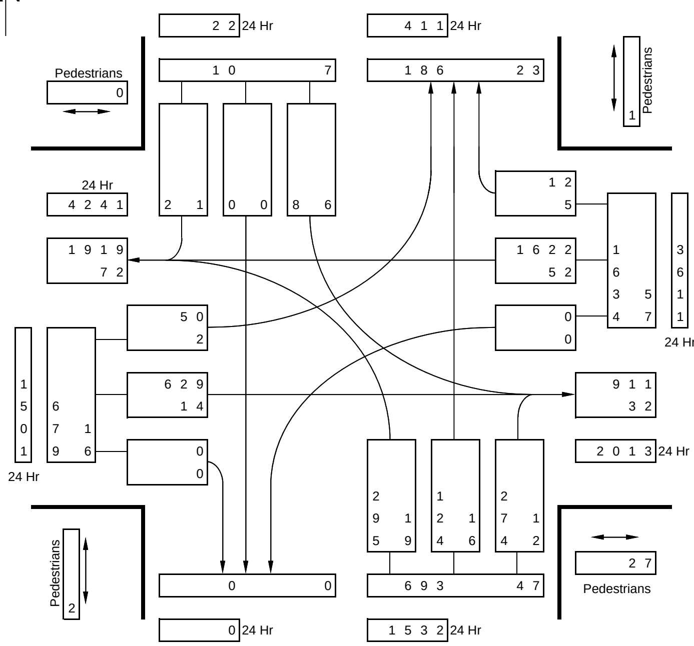



P.M. PEAK HOUR = 4:15 PM - 5:15 PM

N




NORMAL HOUR = 2:00 PM - 3:00 PM



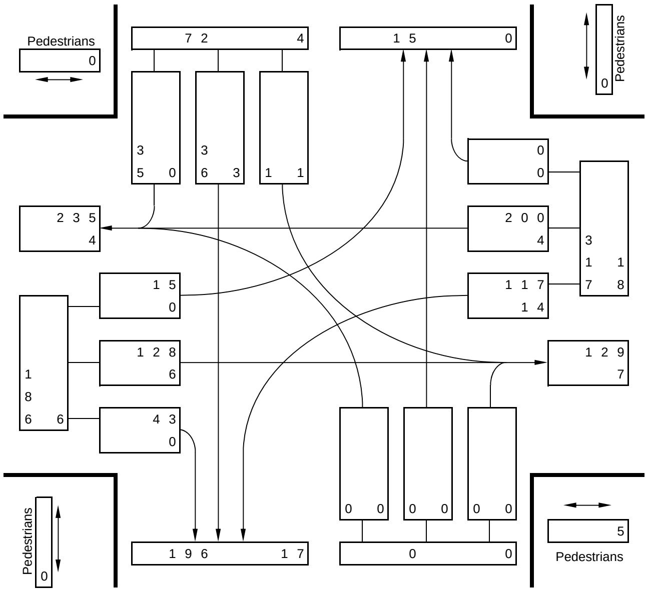

7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** | **TURNING MOVEMENT FLOW CHART** | Loc. Code: 4

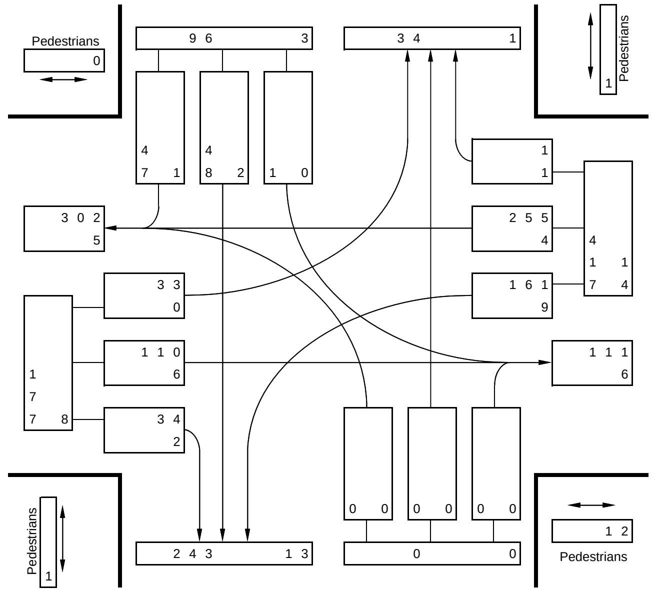
Intersection: **Queen St** at **Barton St**
Direction: (North/South) (East/West)
Road Condition: Dry Weather: Clear
Comments:

Total Vehicles: 3,666
M.V.E./Year: 2.867
AWDT Factor: 2.3

Date: Wednesday
Feb 12, 2014
Period: 7 hours

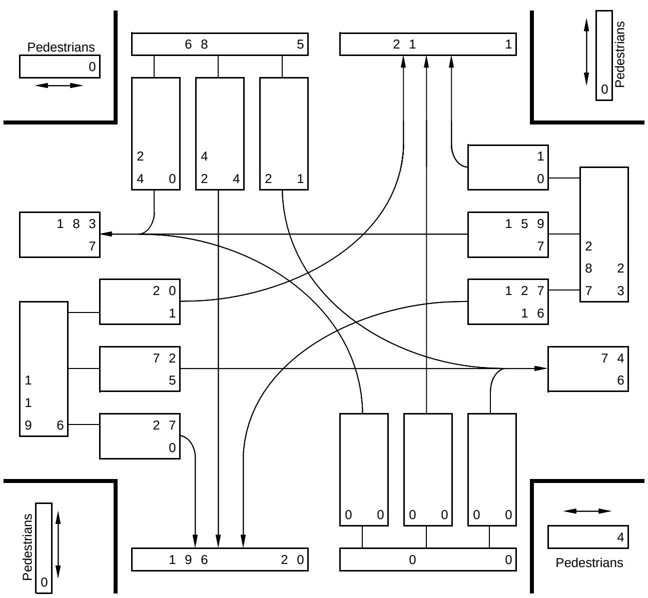



A.M. PEAK HOUR = 8:00 AM - 9:00 AM

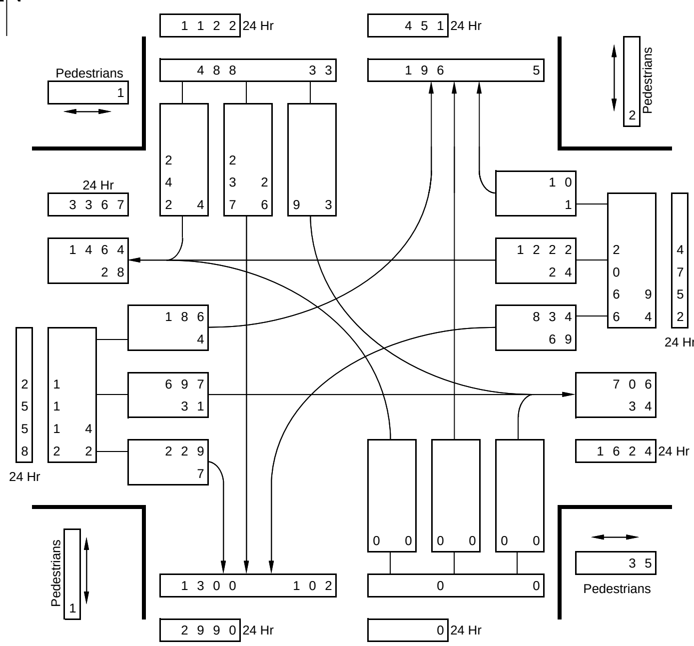



P.M. PEAK HOUR = 4:00 PM - 5:00 PM

N




NORMAL HOUR = 2:00 PM - 3:00 PM



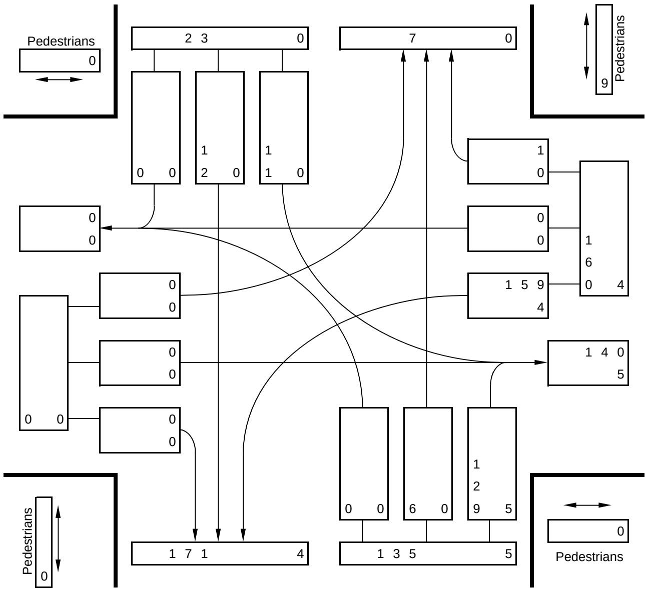

7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** | **T U R N I N G   M O V E M E N T   F L O W   C H A R T** | Loc. Code: 8

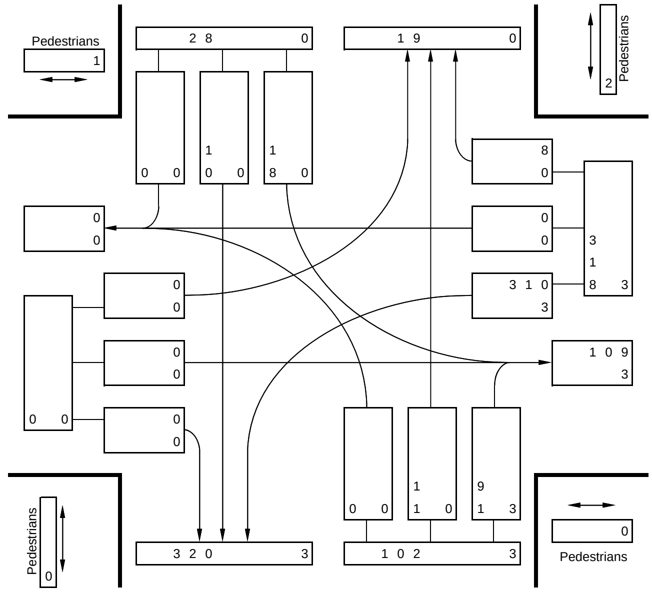
Intersection: **Locke St** (North/South) **at** **Barton St** (East/West)
Direction: (North/South) (East/West)
Road Condition: Dry
Weather: Clear
Comments:

Total Vehicles: 2,078
M.V.E./Year: 1.561
AWDT Factor: 2.21

Date: Thursday
Feb 13, 2014
Period: 7 hours

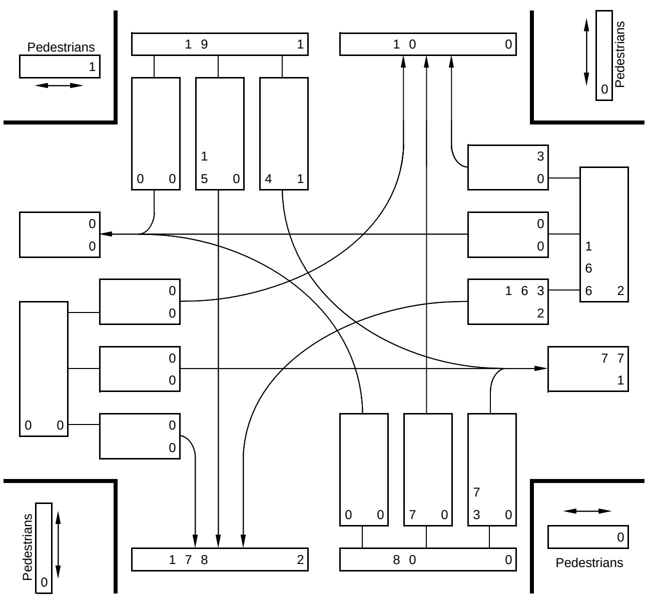



A.M. PEAK HOUR = 8:00 AM - 9:00 AM

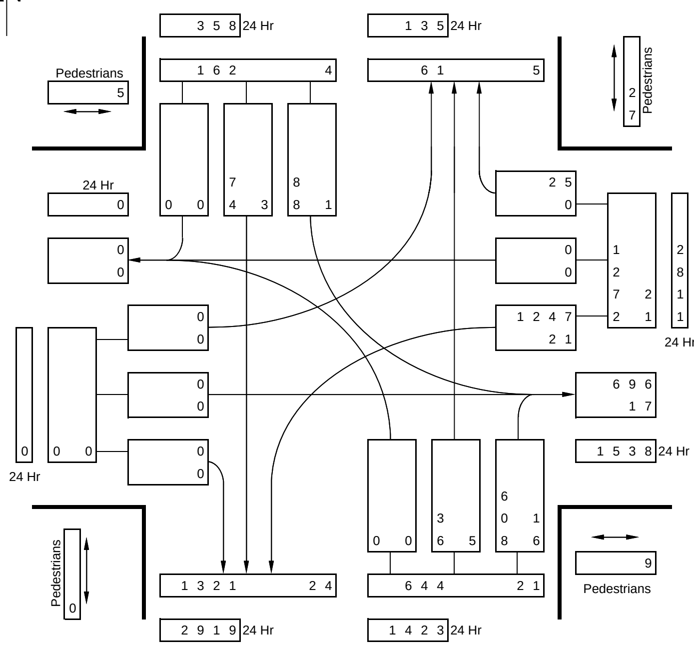



P.M. PEAK HOUR = 4:15 PM - 5:15 PM

N



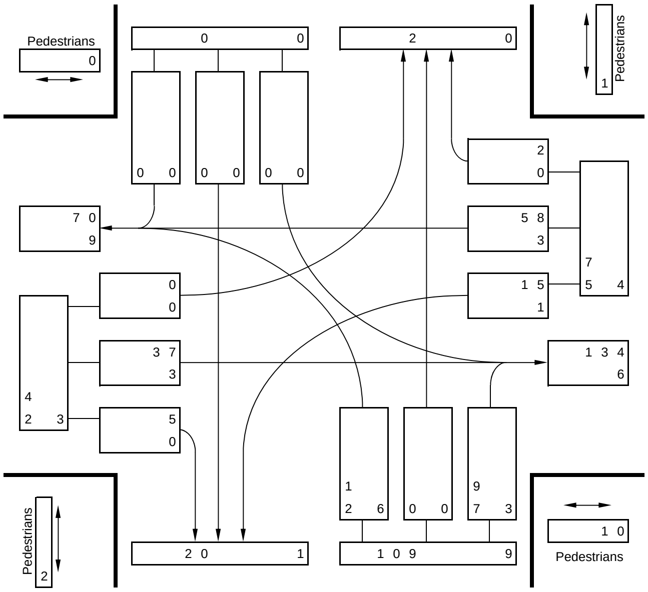

NORMAL HOUR = 2:00 PM - 3:00 PM



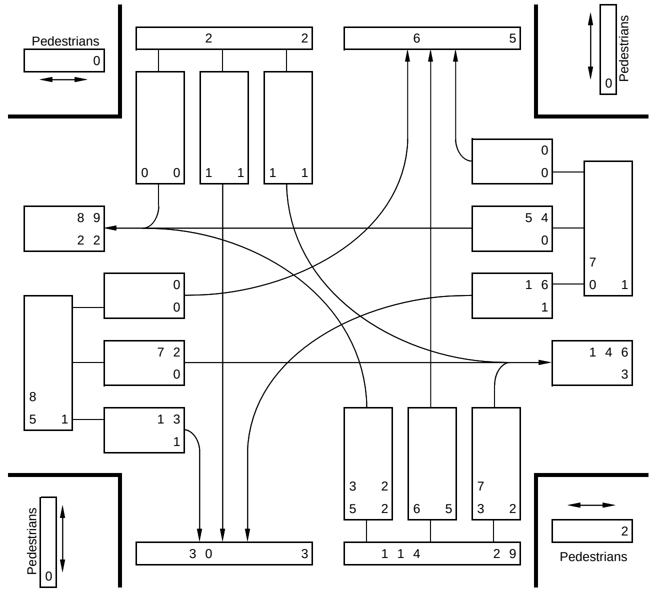

7 Hr & 24 Hr TOTAL VOLUMES

**City of Hamilton** **TURNING MOVEMENT FLOW CHART** Loc. Code: 1

| | | | | | |
|---|---|---|---|---|---|
| Intersection: | **Bay St** | **at** | **Stuart St** | Total Vehicles: 1,404 | Date: Wednesday |
| Direction: | (North/South) | | (East/West) | M.V.E./Year: 1.098 | Feb 12, 2014 |
| Road Condition: Dry | | Weather: Clear | | AWDT Factor: 2.3 | Period: 7 hours |
| Comments: | | | | | |

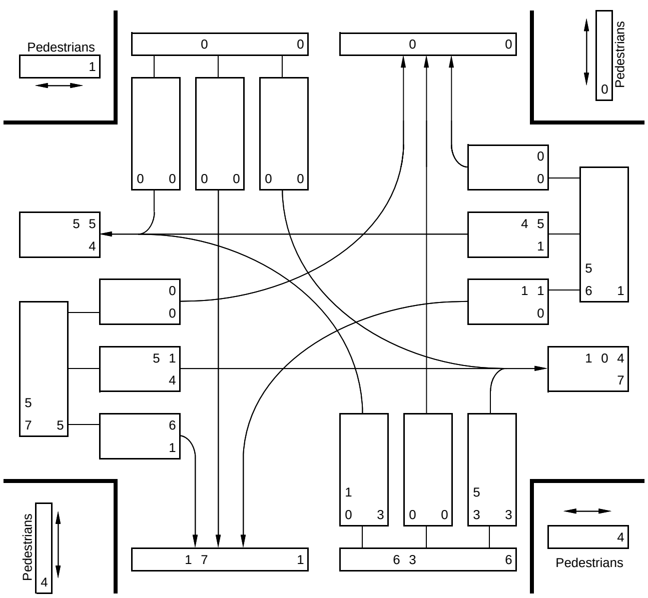



A.M. PEAK HOUR = 8:15 AM - 9:15 AM

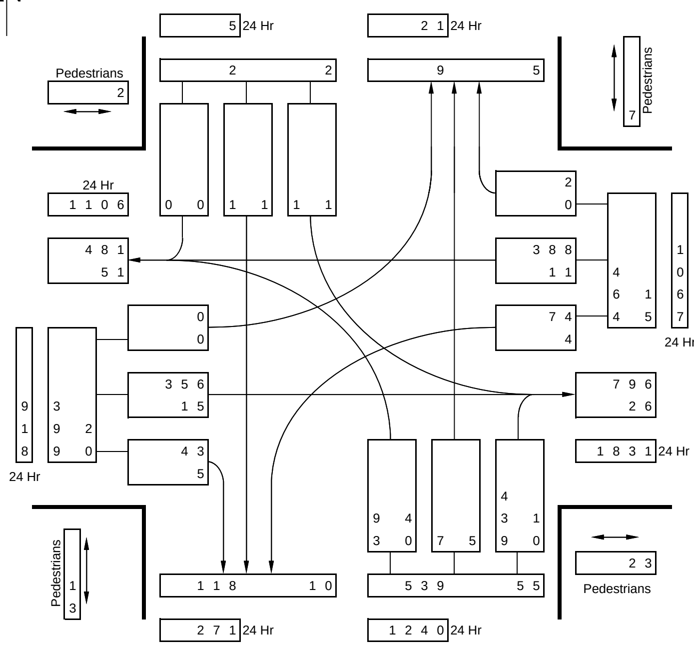



P.M. PEAK HOUR = 5:00 PM - 6:00 PM

N




NORMAL HOUR = 2:00 PM - 3:00 PM




7 Hr & 24 Hr TOTAL VOLUMES

# Appendix B

# Collision Analyses

| DATE | STREET 1 | DISTANCE | DIR FROM INT | STREET 2 | COLL CLASS | INITIAL IMPACT | TRAF CONT | ROAD 1 SURF COND | WEATHER | LIGHTING |
|---|---|---|---|---|---|---|---|---|---|---|
| 10/22/2008 | BARTON H | 0 | 0 | QUEEN H | Non fatal injury | Intersection 90 degrees | Stop sign | Dry | Clear | Daylight |
| 11/02/2008 | BARTON H | 0 | 0 | QUEEN H | Non fatal injury | Rear end | Stop sign | Dry | Clear | Daylight |
| 09/24/2009 | BARTON H | 0 | 0 | QUEEN H | Non fatal injury | Intersection 90 degrees | Stop sign | Dry | Clear | Daylight |
| 06/13/2013 | BARTON H | 0 | 0 | QUEEN H | Non fatal injury | Rear end | Stop sign | Dry | Clear | Daylight |
| 11/24/2008 | LOCKE | 0 | 0 | BARTON H | Non fatal injury | Ped/Vehicle | Stop sign | Wet | Rain | Dark artificial |
| 11/11/2010 | BARTON H | 0 | 0 | LOCKE | Non fatal injury | Ped/Vehicle | Stop sign | Dry | Clear | Daylight |
| 01/21/2010 | STUART | 0 | 0 | BAY | Non fatal injury | Left turn (oncoming) | Stop sign | Dry | Clear | Daylight |
| 04/20/2010 | STUART | 0 | 0 | BAY | PD only | SMV other | Stop sign | Dry | Clear | Daylight |
| 02/03/2011 | BAY | 0 | 0 | STUART | Non fatal injury | Left turn (oncoming) | Stop sign | Wet | Clear | Daylight |
| 03/13/2009 | BARTON H | 0 | 0 | HESS | Non fatal injury | Intersection 90 degrees | Stop sign | Dry | Clear | Daylight |
| 10/07/2010 | HESS | 0 | 0 | BARTON H | Non fatal injury | Intersection 90 degrees | Traffic signal | Dry | Clear | Daylight artificial |
| 11/23/2011 | BARTON H | 0 | 0 | HESS | PD only | Intersection 90 degrees | Stop sign | Dry | Clear | Daylight |
| 12/29/2012 | HESS | 0 | 0 | BARTON H | PD only | SMV other | Stop sign | Loose snow | Snow | Dark artificial |
| 08/24/2013 | HESS | 0 | 0 | BARTON H | PD only | Intersection 90 degrees | Stop sign | Dry | Clear | Daylight |
| 05/16/2013 | BARTON H | 0 | 0 | BAY | Non fatal injury | Left turn (opposite thru) | Traffic signal | Dry | Clear | Daylight |
| 02/24/2009 | BAY | 0 | 0 | BARTON H | Non fatal injury | Rear end | Traffic signal | Dry | Clear | Dark |
| 04/25/2009 | BARTON H | 0 | 0 | BAY | Non fatal injury | Left turn (opposite thru) | Traffic signal | Dry | Clear | Daylight |
| 03/12/2011 | BAY | 0 | 0 | BARTON H | PD only | Right turn (oncoming) | Traffic signal | Dry | Clear | Daylight |

# Appendix C

## Existing (2014) Traffic Analyses

### Synchro and SimTraffic Summary Reports

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 180 | 8 | 1 | 178 | 5 | 33 | 226 | 105 | 14 | 102 | 17 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.97 | | 1.00 | | | 1.00 | 0.97 | | 1.00 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | | | 1.00 | 0.85 | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 0.99 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1685 | 1486 | | 1735 | | | 1687 | 1473 | | 1718 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.95 | 1.00 | | 0.96 | |
| Satd. Flow (perm) | | 1685 | 1486 | | 1735 | | | 1616 | 1473 | | 1658 | |
| 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) | 0 | 196 | 9 | 1 | 193 | 5 | 36 | 246 | 114 | 15 | 111 | 18 |
| RTOR Reduction (vph) | 0 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Lane Group Flow (vph) | 0 | 196 | 4 | 0 | 198 | 0 | 0 | 282 | 114 | 0 | 138 | 0 |
| Confl. Peds. (#/hr) | 9 | | 6 | 6 | | 9 | 1 | | 7 | 7 | | 1 |
| Heavy Vehicles (%) | 2% | 9% | 2% | 2% | 5% | 20% | 30% | 5% | 3% | 2% | 5% | 2% |
| Turn Type | | | Perm | Perm | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | 2 | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 40.5 | 40.5 | | 40.5 | | | 39.0 | 39.0 | | 39.0 | |
| Effective Green, g (s) | | 41.5 | 41.5 | | 41.5 | | | 40.0 | 40.0 | | 40.0 | |
| Actuated g/C Ratio | | 0.46 | 0.46 | | 0.46 | | | 0.44 | 0.44 | | 0.44 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 777 | 685 | | 800 | | | 718 | 655 | | 737 | |
| v/s Ratio Prot | | c0.12 | | | | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | 0.11 | | | c0.17 | 0.08 | | 0.08 | |
| v/c Ratio | | 0.25 | 0.01 | | 0.25 | | | 0.39 | 0.17 | | 0.19 | |
| Uniform Delay, d1 | | 14.8 | 13.1 | | 14.8 | | | 16.8 | 15.1 | | 15.1 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 0.8 | 0.0 | | 0.7 | | | 0.4 | 0.1 | | 0.1 | |
| Delay (s) | | 15.6 | 13.1 | | 15.5 | | | 17.2 | 15.2 | | 15.3 | |
| Level of Service | | B | B | | B | | | B | B | | B | |
| Approach Delay (s) | | 15.5 | | | 15.5 | | | 16.6 | | | 15.3 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.32 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 188 | 228 | 0 | 0 | 0 |
| 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) | 0 | 204 | 248 | 0 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 248 | | | | 350 | 124 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 248 | | | | 350 | 124 |
| tC, single (s) | 4.1 | | | | 6.8 | 6.9 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1315 | | | | 621 | 904 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | SB 1 |
|---|---|---|---|---|---|
| Volume Total | 68 | 136 | 165 | 83 | 0 |
| Volume Left | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 0 | 0 |
| cSH | 1315 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.08 | 0.10 | 0.05 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | | | A |
| Approach Delay (s) | 0.0 | | 0.0 | | 0.0 |
| Approach LOS | | | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 9.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 0 | 167 | 3 | 9 | 212 | 7 | 9 | 1 | 10 | 11 | 0 | 1 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 182 | 3 | 10 | 230 | 8 | 10 | 1 | 11 | 12 | 0 | 1 |
| Pedestrians | | 1 | | | 1 | | | 1 | | | 1 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 239 | | | 186 | | | 321 | 443 | 94 | 358 | 441 | 121 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 239 | | | 186 | | | 321 | 443 | 94 | 358 | 441 | 121 |
| tC, single (s) | 4.1 | | | 4.3 | | | 7.7 | 6.5 | 7.1 | 7.9 | 6.5 | 7.3 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.3 | | | 3.6 | 4.0 | 3.4 | 3.7 | 4.0 | 3.5 |
| p0 queue free % | 100 | | | 99 | | | 98 | 100 | 99 | 98 | 100 | 100 |
| cM capacity (veh/h) | 1324 | | | 1329 | | | 580 | 503 | 917 | 519 | 505 | 852 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 91 | 94 | 125 | 123 | 22 | 13 |
| Volume Left | 0 | 0 | 10 | 0 | 10 | 12 |
| Volume Right | 0 | 3 | 0 | 8 | 11 | 1 |
| cSH | 1324 | 1700 | 1329 | 1700 | 704 | 536 |
| Volume to Capacity | 0.00 | 0.06 | 0.01 | 0.07 | 0.03 | 0.02 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.2 | 0.0 | 0.7 | 0.6 |
| Control Delay (s) | 0.0 | 0.0 | 0.7 | 0.0 | 10.3 | 11.9 |
| Lane LOS | | | A | | B | B |
| Approach Delay (s) | 0.0 | | 0.3 | | 10.3 | 11.9 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.0 | | |
| Intersection Capacity Utilization | 23.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 6 | 117 | 0 | 0 | 215 | 5 | 51 | 24 | 50 | 3 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 127 | 0 | 0 | 234 | 5 | 55 | 26 | 54 | 3 | 0 | 0 |
| Pedestrians | | 1 | | | 1 | | | 1 | | | 1 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 240 | | | 128 | | | 259 | 381 | 66 | 382 | 379 | 122 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 240 | | | 128 | | | 259 | 381 | 66 | 382 | 379 | 122 |
| tC, single (s) | 4.3 | | | 4.1 | | | 7.6 | 6.8 | 6.9 | 7.9 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.3 | | | 2.2 | | | 3.6 | 4.2 | 3.3 | 3.7 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 92 | 95 | 94 | 99 | 100 | 100 |
| cM capacity (veh/h) | 1266 | | | 1454 | | | 658 | 514 | 983 | 459 | 548 | 905 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total | 49 | 85 | 156 | 83 | 55 | 80 | 3 |
| Volume Left | 7 | 0 | 0 | 0 | 55 | 0 | 3 |
| Volume Right | 0 | 0 | 0 | 5 | 0 | 54 | 0 |
| cSH | 1266 | 1700 | 1700 | 1700 | 658 | 759 | 459 |
| Volume to Capacity | 0.01 | 0.05 | 0.09 | 0.05 | 0.08 | 0.11 | 0.01 |
| Queue Length 95th (m) | 0.1 | 0.0 | 0.0 | 0.0 | 2.1 | 2.7 | 0.2 |
| Control Delay (s) | 1.1 | 0.0 | 0.0 | 0.0 | 11.0 | 10.3 | 12.9 |
| Lane LOS | A | | | | B | B | B |
| Approach Delay (s) | 0.4 | | 0.0 | | 10.6 | | 12.9 |
| Approach LOS | | | | | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.0 | | |
| Intersection Capacity Utilization | 19.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 13 | 120 | 41 | 112 | 155 | 0 | 0 | 0 | 0 | 1 | 31 | 33 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 14 | 130 | 45 | 122 | 168 | 0 | 0 | 0 | 0 | 1 | 34 | 36 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 79 | 110 | 206 | 84 | 0 | 18 | 53 |
| Volume Left (vph) | 14 | 0 | 122 | 0 | 0 | 1 | 0 |
| Volume Right (vph) | 0 | 45 | 0 | 0 | 0 | 0 | 36 |
| Hadj (s) | 0.18 | -0.22 | 0.40 | 0.09 | 0.00 | 0.23 | -0.39 |
| Departure Headway (s) | 5.1 | 4.7 | 5.3 | 4.9 | 5.7 | 5.8 | 5.2 |
| Degree Utilization, x | 0.11 | 0.14 | 0.30 | 0.12 | 0.00 | 0.03 | 0.08 |
| Capacity (veh/h) | 684 | 738 | 668 | 709 | 594 | 570 | 637 |
| Control Delay (s) | 7.6 | 7.3 | 9.3 | 7.4 | 8.7 | 7.8 | 7.4 |
| Approach Delay (s) | 7.4 | | 8.7 | | 0.0 | 7.5 | |
| Approach LOS | A | | A | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.1 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 26.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 153 | 1 | 5 | 122 | 13 | 12 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 166 | 1 | 5 | 133 | 14 | 13 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 111 | 57 | 138 | 27 |
| Volume Left (vph) | 111 | 55 | 0 | 14 |
| Volume Right (vph) | 0 | 1 | 133 | 0 |
| Hadj (s) | 0.53 | 0.51 | -0.54 | 0.14 |
| Departure Headway (s) | 5.4 | 5.4 | 3.8 | 4.6 |
| Degree Utilization, x | 0.17 | 0.08 | 0.15 | 0.03 |
| Capacity (veh/h) | 651 | 648 | 898 | 736 |
| Control Delay (s) | 8.2 | 7.7 | 7.5 | 7.8 |
| Approach Delay (s) | 8.0 | | 7.5 | 7.8 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 7.8 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 23.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 30 | 37 | 10 | 20 | 58 | 2 | 12 | 120 | 97 | 1 | 100 | 30 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 33 | 40 | 11 | 22 | 63 | 2 | 13 | 130 | 105 | 1 | 109 | 33 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 73 | 11 | 87 | 249 | 142 |
| Volume Left (vph) | 33 | 0 | 22 | 13 | 1 |
| Volume Right (vph) | 0 | 11 | 2 | 105 | 33 |
| Hadj (s) | 0.39 | -0.53 | 0.17 | -0.18 | -0.06 |
| Departure Headway (s) | 5.9 | 5.0 | 5.2 | 4.4 | 4.6 |
| Degree Utilization, x | 0.12 | 0.02 | 0.13 | 0.30 | 0.18 |
| Capacity (veh/h) | 563 | 664 | 634 | 791 | 738 |
| Control Delay (s) | 8.5 | 6.9 | 9.0 | 9.2 | 8.6 |
| Approach Delay (s) | 8.3 | | 9.0 | 9.2 | 8.6 |
| Approach LOS | A | | A | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.9 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 38.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | LTR | LT | R | LTR |
| Maximum Queue (m) | 46.0 | 8.6 | 45.6 | 101.0 | 37.7 | 33.6 |
| Average Queue (m) | 22.5 | 0.8 | 20.6 | 32.5 | 9.7 | 15.3 |
| 95th Queue (m) | 37.7 | 4.9 | 37.2 | 64.1 | 22.5 | 31.4 |
| Link Distance (m) | 99.7 | 99.7 |  | 238.8 | 238.8 | 200.7 |
| Upstream Blk Time (%) |  |  |  |  |  |  |
| Queuing Penalty (veh) |  |  |  |  |  |  |
| Storage Bay Dist (m) |  |  |  |  |  |  |
| Storage Blk Time (%) |  |  |  |  |  |  |
| Queuing Penalty (veh) |  |  |  |  |  |  |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement |
|---|
| Directions Served |
| Maximum Queue (m) |
| Average Queue (m) |
| 95th Queue (m) |
| Link Distance (m) |
| Upstream Blk Time (%) |
| Queuing Penalty (veh) |
| Storage Bay Dist (m) |
| Storage Blk Time (%) |
| Queuing Penalty (veh) |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | WB | NB | SB |
|---|---|---|---|
| Directions Served | LT | LTR | LR |
| Maximum Queue (m) | 9.2 | 15.4 | 14.8 |
| Average Queue (m) | 0.9 | 5.0 | 3.9 |
| 95th Queue (m) | 5.3 | 13.8 | 12.3 |
| Link Distance (m) | 97.7 | 252.4 |  |
| Upstream Blk Time (%) |  |  |  |
| Queuing Penalty (veh) |  |  |  |
| Storage Bay Dist (m) |  |  |  |
| Storage Blk Time (%) |  |  |  |
| Queuing Penalty (veh) |  |  |  |

## Intersection: 4: Barton Street W & Hess Street

| Movement | NB | NB | SB |
|---|---|---|---|
| Directions Served | L | TR | LR |
| Maximum Queue (m) | 16.1 | 19.6 | 16.5 |
| Average Queue (m) | 7.8 | 9.9 | 1.4 |
| 95th Queue (m) | 14.9 | 16.7 | 7.8 |
| Link Distance (m) | 258.3 | 258.3 | |
| Upstream Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |
| Storage Bay Dist (m) | | | |
| Storage Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | SB | SB |
|---|---|---|---|---|---|
| Directions Served | LT | TR | LT | LT | TR |
| Maximum Queue (m) | 32.2 | 23.7 | 27.3 | 9.2 | 16.6 |
| Average Queue (m) | 12.1 | 10.0 | 15.8 | 2.4 | 7.6 |
| 95th Queue (m) | 22.0 | 19.3 | 23.2 | 9.0 | 14.3 |
| Link Distance (m) | 51.1 | 51.1 | 120.1 | | |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 14.5 | 15.0 | 16.4 | 9.2 |
| Average Queue (m) | 8.5 | 9.4 | 9.7 | 4.8 |
| 95th Queue (m) | 12.5 | 13.4 | 12.7 | 12.3 |
| Link Distance (m) | 50.9 | 50.9 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | LT | R | LTR | LTR | LTR |
| Maximum Queue (m) | 22.0 | 14.8 | 23.7 | 53.4 | 22.1 |
| Average Queue (m) | 9.8 | 2.9 | 9.9 | 15.4 | 10.6 |
| 95th Queue (m) | 17.8 | 10.2 | 16.9 | 29.8 | 16.9 |
| Link Distance (m) | | | 185.4 | 200.7 | 177.9 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 0

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 150 | 2 | 0 | 345 | 17 | 18 | 327 | 119 | 26 | 151 | 30 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.97 | | 1.00 | | | 1.00 | 0.97 | | 1.00 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.99 | | | 1.00 | 0.85 | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1801 | 1318 | | 1787 | | | 1788 | 1481 | | 1753 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.98 | 1.00 | | 0.93 | |
| Satd. Flow (perm) | | 1801 | 1318 | | 1787 | | | 1756 | 1481 | | 1640 | |
| 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) | 0 | 163 | 2 | 0 | 375 | 18 | 20 | 355 | 129 | 28 | 164 | 33 |
| RTOR Reduction (vph) | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Lane Group Flow (vph) | 0 | 163 | 1 | 0 | 391 | 0 | 0 | 375 | 129 | 0 | 218 | 0 |
| Confl. Peds. (#/hr) | 4 | | 6 | 6 | | 4 | | | 11 | 11 | | |
| Heavy Vehicles (%) | 0% | 2% | 15% | 2% | 2% | 2% | 10% | 2% | 2% | 2% | 2% | 2% |
| Turn Type | | | Perm | | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 40.5 | 40.5 | | 40.5 | | | 39.0 | 39.0 | | 39.0 | |
| Effective Green, g (s) | | 41.5 | 41.5 | | 41.5 | | | 40.0 | 40.0 | | 40.0 | |
| Actuated g/C Ratio | | 0.46 | 0.46 | | 0.46 | | | 0.44 | 0.44 | | 0.44 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 830 | 608 | | 824 | | | 780 | 658 | | 729 | |
| v/s Ratio Prot | | 0.09 | | | c0.22 | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | | | | c0.21 | 0.09 | | 0.13 | |
| v/c Ratio | | 0.20 | 0.00 | | 0.47 | | | 0.48 | 0.20 | | 0.30 | |
| Uniform Delay, d1 | | 14.4 | 13.1 | | 16.7 | | | 17.7 | 15.2 | | 16.0 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 0.5 | 0.0 | | 2.0 | | | 0.5 | 0.1 | | 0.2 | |
| Delay (s) | | 14.9 | 13.1 | | 18.7 | | | 18.1 | 15.4 | | 16.2 | |
| Level of Service | | B | B | | B | | | B | B | | B | |
| Approach Delay (s) | | 14.9 | | | 18.7 | | | 17.4 | | | 16.2 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 78.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 1 | 150 | 393 | 0 | 2 | 0 |
| 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) | 1 | 163 | 427 | 0 | 2 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 427 | | | | 511 | 214 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 427 | | | | 511 | 214 |
| tC, single (s) | 4.1 | | | | 6.8 | 6.9 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1129 | | | | 492 | 791 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | SB 1 |
|---|---|---|---|---|---|
| Volume Total | 55 | 109 | 285 | 142 | 2 |
| Volume Left | 1 | 0 | 0 | 0 | 2 |
| Volume Right | 0 | 0 | 0 | 0 | 0 |
| cSH | 1129 | 1700 | 1700 | 1700 | 492 |
| Volume to Capacity | 0.00 | 0.06 | 0.17 | 0.08 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Control Delay (s) | 0.2 | 0.0 | 0.0 | 0.0 | 12.4 |
| Lane LOS | A | | | | B |
| Approach Delay (s) | 0.1 | | 0.0 | | 12.4 |
| Approach LOS | | | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 20.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 3 | 148 | 1 | 3 | 390 | 0 | 5 | 0 | 4 | 0 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 161 | 1 | 3 | 424 | 0 | 5 | 0 | 4 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | 2 | | | | |
| Lane Width (m) | | | | | | | | 3.3 | | | | |
| Walking Speed (m/s) | | | | | | | | 1.2 | | | | |
| Percent Blockage | | | | | | | | 0 | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 424 | | | 164 | | | 388 | 600 | 83 | 522 | 601 | 212 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 424 | | | 164 | | | 388 | 600 | 83 | 522 | 601 | 212 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 99 | 100 | 100 | 100 | 100 | 100 |
| cM capacity (veh/h) | 1132 | | | 1410 | | | 541 | 410 | 958 | 434 | 410 | 793 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 84 | 82 | 215 | 212 | 10 | 0 |
| Volume Left | 3 | 0 | 3 | 0 | 5 | 0 |
| Volume Right | 0 | 1 | 0 | 0 | 4 | 0 |
| cSH | 1132 | 1700 | 1410 | 1700 | 671 | 1700 |
| Volume to Capacity | 0.00 | 0.05 | 0.00 | 0.12 | 0.01 | 0.00 |
| Queue Length 95th (m) | 0.1 | 0.0 | 0.1 | 0.0 | 0.3 | 0.0 |
| Control Delay (s) | 0.3 | 0.0 | 0.1 | 0.0 | 10.4 | 0.0 |
| Lane LOS | A | | A | | B | A |
| Approach Delay (s) | 0.2 | | 0.1 | | 10.4 | 0.0 |
| Approach LOS | | | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.3 | | |
| Intersection Capacity Utilization | 22.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 10 | 108 | 0 | 0 | 394 | 1 | 41 | 24 | 44 | 0 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 11 | 117 | 0 | 0 | 428 | 1 | 45 | 26 | 48 | 0 | 0 | 0 |
| Pedestrians | | 1 | | | 1 | | | 4 | | | 1 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 430 | | | 121 | | | 358 | 573 | 64 | 572 | 573 | 217 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 430 | | | 121 | | | 358 | 573 | 64 | 572 | 573 | 217 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.6 | 6.7 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.1 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 92 | 94 | 95 | 100 | 100 | 100 |
| cM capacity (veh/h) | 1125 | | | 1459 | | | 557 | 406 | 984 | 360 | 422 | 787 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total | 50 | 78 | 286 | 144 | 45 | 74 | 0 |
| Volume Left | 11 | 0 | 0 | 0 | 45 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 1 | 0 | 48 | 0 |
| cSH | 1125 | 1700 | 1700 | 1700 | 557 | 655 | 1700 |
| Volume to Capacity | 0.01 | 0.05 | 0.17 | 0.08 | 0.08 | 0.11 | 0.00 |
| Queue Length 95th (m) | 0.2 | 0.0 | 0.0 | 0.0 | 2.0 | 2.9 | 0.0 |
| Control Delay (s) | 1.9 | 0.0 | 0.0 | 0.0 | 12.0 | 11.2 | 0.0 |
| Lane LOS | A | | | | B | B | A |
| Approach Delay (s) | 0.7 | | 0.0 | | 11.5 | | 0.0 |
| Approach LOS | | | | | B | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.2 | | |
| Intersection Capacity Utilization | 22.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 40 | 116 | 34 | 152 | 280 | 3 | 0 | 0 | 0 | 2 | 48 | 50 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 43 | 126 | 37 | 165 | 304 | 3 | 0 | 0 | 0 | 2 | 52 | 54 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 107 | 100 | 317 | 155 | 0 | 28 | 80 |
| Volume Left (vph) | 43 | 0 | 165 | 0 | 0 | 2 | 0 |
| Volume Right (vph) | 0 | 37 | 0 | 3 | 0 | 0 | 54 |
| Hadj (s) | 0.25 | -0.21 | 0.31 | 0.02 | 0.00 | 0.07 | -0.44 |
| Departure Headway (s) | 5.5 | 5.1 | 5.3 | 5.0 | 6.2 | 6.1 | 5.6 |
| Degree Utilization, x | 0.16 | 0.14 | 0.47 | 0.22 | 0.00 | 0.05 | 0.13 |
| Capacity (veh/h) | 630 | 680 | 659 | 693 | 541 | 537 | 587 |
| Control Delay (s) | 8.4 | 7.7 | 11.8 | 8.2 | 9.2 | 8.2 | 8.2 |
| Approach Delay (s) | 8.1 | | 10.6 | | 0.0 | 8.2 | |
| Approach LOS | A | | B | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 9.6 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 34.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

# 6: Barton Street W & Locke Street

PM Peak Hour (4:15 - 5:15 PM)

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 310 | 8 | 11 | 91 | 18 | 10 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 337 | 9 | 12 | 99 | 20 | 11 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 225 | 121 | 111 | 30 |
| Volume Left (vph) | 225 | 112 | 0 | 20 |
| Volume Right (vph) | 0 | 9 | 99 | 0 |
| Hadj (s) | 0.53 | 0.45 | -0.50 | 0.16 |
| Departure Headway (s) | 5.4 | 5.3 | 4.3 | 5.1 |
| Degree Utilization, x | 0.33 | 0.18 | 0.13 | 0.04 |
| Capacity (veh/h) | 649 | 664 | 788 | 663 |
| Control Delay (s) | 9.8 | 8.2 | 8.0 | 8.3 |
| Approach Delay (s) | 9.3 | | 8.0 | 8.3 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.9 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 24.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 75 | 25 | 1 | 8 | 66 | 1 | 8 | 275 | 64 | 2 | 197 | 75 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 82 | 27 | 1 | 9 | 72 | 1 | 9 | 299 | 70 | 2 | 214 | 82 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 109 | 1 | 82 | 377 | 298 |
| Volume Left (vph) | 82 | 0 | 9 | 9 | 2 |
| Volume Right (vph) | 0 | 1 | 1 | 70 | 82 |
| Hadj (s) | 0.42 | -0.67 | 0.05 | -0.07 | -0.13 |
| Departure Headway (s) | 6.7 | 5.6 | 6.0 | 4.9 | 4.9 |
| Degree Utilization, x | 0.20 | 0.00 | 0.14 | 0.51 | 0.41 |
| Capacity (veh/h) | 481 | 565 | 525 | 716 | 698 |
| Control Delay (s) | 10.2 | 7.4 | 9.9 | 12.8 | 11.2 |
| Approach Delay (s) | 10.2 | | 9.9 | 12.8 | 11.2 |
| Approach LOS | B | | A | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.6 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 42.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | TR | LT | R | LTR |
| Maximum Queue (m) | 34.6 | 8.6 | 77.8 | 84.1 | 33.0 | 66.2 |
| Average Queue (m) | 15.8 | 0.3 | 38.3 | 47.7 | 15.0 | 30.2 |
| 95th Queue (m) | 29.8 | 2.8 | 63.3 | 74.3 | 29.4 | 54.8 |
| Link Distance (m) | 99.7 | 99.7 | | 238.8 | 238.8 | 200.7 |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | | | | | |
| Storage Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement | SB |
|---|---|
| Directions Served | LR |
| Maximum Queue (m) | 9.2 |
| Average Queue (m) | 0.9 |
| 95th Queue (m) | 5.4 |
| Link Distance (m) | |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (m) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | NB |
|---|---|
| Directions Served | LR |
| Maximum Queue (m) | 9.3 |
| Average Queue (m) | 2.6 |
| 95th Queue (m) | 9.2 |
| Link Distance (m) | 252.4 |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (m) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

## Intersection: 4: Barton Street W & Hess Street

| Movement | EB | WB | WB | NB | NB |
|---|---|---|---|---|---|
| Directions Served | LT | T | TR | L | TR |
| Maximum Queue (m) | 7.0 | 6.0 | 8.4 | 9.3 | 23.6 |
| Average Queue (m) | 1.0 | 0.2 | 0.3 | 7.9 | 10.1 |
| 95th Queue (m) | 4.9 | 2.0 | 2.8 | 12.5 | 17.0 |
| Link Distance (m) | 120.1 | 136.8 | 136.8 | 258.3 | 258.3 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | WB | SB | SB |
|---|---|---|---|---|---|---|
| Directions Served | LT | TR | LT | TR | LT | TR |
| Maximum Queue (m) | 17.6 | 17.2 | 53.3 | 9.0 | 9.2 | 20.4 |
| Average Queue (m) | 11.3 | 9.4 | 28.2 | 0.9 | 3.1 | 9.5 |
| 95th Queue (m) | 17.1 | 14.4 | 47.9 | 5.3 | 10.2 | 14.4 |
| Link Distance (m) | 51.1 | 51.1 | 120.1 | 120.1 | | |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | | | | | |
| Storage Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 16.1 | 20.3 | 16.4 | 9.2 |
| Average Queue (m) | 10.0 | 11.1 | 9.3 | 4.5 |
| 95th Queue (m) | 14.1 | 16.5 | 11.5 | 11.9 |
| Link Distance (m) | 60.7 | 60.7 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | LT | R | LTR | LTR | LTR |
| Maximum Queue (m) | 20.3 | 9.1 | 23.7 | 52.1 | 26.8 |
| Average Queue (m) | 10.1 | 0.3 | 10.3 | 26.9 | 13.7 |
| 95th Queue (m) | 15.9 | 3.0 | 15.5 | 44.9 | 21.8 |
| Link Distance (m) | | | 185.4 | 200.7 | 177.9 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 0

# Appendix D

## Trip Generation Estimates (Detailed)

***Assumptions:***

| | |
|---|---|
| Single Family Residential | 210 Single Family Detached |
| Semi-Detached Residential | 210 Single Family Detached |
| Townhouses | 230 Residential Condominimum / Townhouse |
| Apartments (4 Storey - 16 Storey) | 220 Apartment |
| Commercial | 820 Shopping Centre |
| Office | 710 General Office |

Based on BTUDS Urban Design Concept
30-Jul-14

1 sq. m = 10.763910 sq. ft
10.76391

BTUDS Trip Generation Estimates - ITE Trip Generation 9th Edition

| | | ITE LUC | Description of Land Use Type | Variable | Units | AM Peak Hour In | AM Peak Hour Out | AM Peak Hour Total | PM Peak Hour In | PM Peak Hour Out | PM Peak Hour Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 Build Out | **Area 1** | | | | | | | | | |
| Trip Equ'n | | 220 | White Star (8 storey apartments) | Dwelling Units | 168 | 17 | 69 | 86 | 72 | 39 | 111 |
| | | *Area 1 Modal Split - Active Transportation 15%* | | | | 3 | 10 | 13 | 11 | 6 | 17 |
| | | *Area 1 Modal Split- Transit 20%* | | | | 3 | 14 | 17 | 14 | 8 | 22 |
| | | ***Area 1 New Trips*** | | | | **11** | **45** | **56** | **47** | **25** | **72** |
| | 2031 Build Out | **Area 1** | | | | | | | | | |
| Trip Equ'n | | 220 | NE Tiffany/Barton (8 storey apartments) | Dwelling Units | 160 | 16 | 66 | 82 | 69 | 37 | 106 |
| Trip Equ'n | | 220 | NW Bay/Barton (4 storey apartments) | Dwelling Units | 70 | 8 | 30 | 38 | 36 | 20 | 56 |
| | | *Area 1 Modal Split - Active Transportation 15%* | | | | 4 | 14 | 18 | 16 | 9 | 24 |
| | | *Area 1 Modal Split - Transit 25%* | | | | 6 | 24 | 30 | 26 | 14 | 41 |
| | | *Area 1 New Residential Trips* | | | | 14 | 58 | 72 | 63 | 34 | 97 |
| Trip Equ'n | | 710 | White Start Office | 1000 ft$^2$ GFA | 17,405 | 41 | 6 | 47 | 17 | 81 | 98 |
| Avg Rate | | 820 | White Star Commercial | 1000 ft$^2$ GLA | 83,835 | 50 | 31 | 81 | 149 | 162 | 311 |
| | | *Area 1 Modal Split - Active Transportation 15%* | | | | 14 | 6 | 19 | 25 | 36 | 61 |
| | | *Area 1 Modal Split - Trasit 25%* | | | | 23 | 9 | 32 | 42 | 61 | 102 |
| | | *Area 1 Pass-By / Multi-Purpose Trip Reduction 30%* | | | | 27 | 11 | 38 | 50 | 73 | 123 |
| | | *Area 1 New Office & Commercial Trips* | | | | 27 | 11 | 38 | 50 | 73 | 123 |
| | | ***Area 1 New Trips*** | | | | **42** | **69** | **110** | **113** | **107** | **220** |
| | | **Area 2** | | | | | | | | | |
| Trip Equ'n | | 220 | North Side (4 storey apartments) | Dwelling Units | 96 | 10 | 41 | 51 | 46 | 24 | 70 |
| Trip Equ'n | | 220 | North Side (16 Storey Point Tower) | Dwelling Units | 96 | 10 | 41 | 51 | 46 | 27 | 73 |
| Trip Equ'n | | 230 | Stacked Townhouse | Dwelling Units | 20 | 2 | 12 | 14 | 11 | 5 | 16 |
| | | *Area 2 Modal Split - Active Transportation 15%* | | | | 3 | 14 | 17 | 15 | 8 | 24 |
| | | *Area 2 Modal Split - Transit 25%* | | | | 6 | 24 | 29 | 26 | 14 | 40 |
| | | ***Area 2 New Trips*** | | | | **13** | **56** | **70** | **62** | **34** | **95** |
| | | **Area 3** | | | | | | | | | |
| Trip Equ'n | | 710 | Office | 1000 ft$^2$ GFA | 24,552 | 56 | 7 | 63 | 18 | 88 | 106 |
| Avg Rate | | 820 | Other Commercial | 1000 ft$^2$ GLA | 118,237 | 70 | 43 | 113 | 211 | 228 | 439 |
| | | *Area 3 Modal Split - Active Transportation 15%* | | | | 19 | 8 | 26 | 34 | 47 | 82 |
| | | *Area 3 Modal Split - Transit 25%* | | | | 32 | 13 | 44 | 57 | 79 | 136 |
| | | *Area 3 Pass-By / Multi-Purpose Trip Reduction 30%* | | | | 38 | 15 | 53 | 69 | 95 | 164 |
| | | ***Area 3 New Trips*** | | | | **38** | **15** | **53** | **69** | **95** | **164** |
| | | **Area 4** | | | | | | | | | |
| Trip Equ'n | | 220 | North Side (4 storey apartments) | Dwelling Units | 160 | 16 | 66 | 82 | 69 | 37 | 106 |
| Trip Equ'n | | 220 | South Side (12 storey Point Tower) | Dwelling Units | 64 | 7 | 28 | 35 | 34 | 19 | 53 |
| | | 230 | Stacked Townhouse | Dwelling Units | 20 | 2 | 12 | 14 | 11 | 5 | 16 |
| | | *Area 4 Modal Split - Active Transportation 15%* | | | | 4 | 16 | 20 | 17 | 9 | 26 |
| | | *Area 4 Modal Split - Transit 25%* | | | | 6 | 27 | 33 | 29 | 15 | 44 |
| | | ***Area 4 New Trips*** | | | | **15** | **64** | **79** | **68** | **37** | **105** |
| | | **Area 5** | | | | | | | | | |
| Trip Equ'n | | 710 | Office | 1000 ft$^2$ GFA | 29,213 | 63 | 9 | 72 | 19 | 92 | 111 |
| Avg Rate | | 820 | Other Commercial | 1000 ft$^2$ GLA | 140,698 | 84 | 51 | 135 | 251 | 271 | 522 |
| | | *Area 5 Modal Split - Active Transportation 15%* | | | | 22 | 9 | 31 | 41 | 54 | 95 |
| | | *Area 5 Modal Split - Transit 25%* | | | | 37 | 15 | 52 | 68 | 91 | 158 |
| | | *Area 5 Pass-By / Multi-Purpose Trip Reduction 30%* | | | | 44 | 18 | 62 | 81 | 109 | 190 |
| | | ***Area 5 New Trips*** | | | | **44** | **18** | **62** | **81** | **109** | **190** |
| | Post 2031 Build Out | **Area 6** | | | | | | | | | |
| Trip Equ'n | | 220 | North Side (4 storey apartments) | Dwelling Units | 134 | 14 | 55 | 69 | 59 | 32 | 91 |
| Trip Equ'n | | 230 | Stacked Townhouse | Dwelling Units | 22 | 3 | 13 | 16 | 12 | 6 | 18 |
| | | *Area 6 Modal Split - Active Transportation 15%* | | | | 3 | 10 | 13 | 11 | 6 | 16 |
| | | *Area 6 Modal Split - Transit 25%* | | | | 4 | 17 | 21 | 18 | 10 | 27 |
| | | ***Area 6 New Trips*** | | | | **10** | **41** | **51** | **43** | **23** | **65** |
| | | **Area 7** | | | | | | | | | |
| Trip Equ'n | | 710 | Office | 1000 ft$^2$ GFA | 9,623 | 26 | 4 | 30 | 15 | 74 | 89 |
| Avg Rate | | 820 | Other Commercial | 1000 ft$^2$ GLA | 46,350 | 28 | 17 | 45 | 83 | 89 | 172 |
| | | *Area 7 Modal Split - Active Transportation 15%* | | | | 8 | 3 | 11 | 15 | 24 | 39 |
| | | *Area 7 Modal Split - Transit 25%* | | | | 14 | 5 | 19 | 25 | 41 | 65 |
| | | *Area 7 Pass-By / Multi-Purpose Trip Reduction 30%* | | | | 16 | 6 | 23 | 29 | 49 | 78 |
| | | ***Area 7 New Trips*** | | | | **16** | **6** | **23** | **29** | **49** | **78** |
| | | **Area 8** | | | | | | | | | |
| Avg Rate | | 710 | Office | 1000 ft$^2$ GFA | 13,455 | 34 | 5 | 39 | 16 | 78 | 94 |
| | | 820 | Other Commercial | 1000 ft$^2$ GLA | 64,786 | 39 | 24 | 63 | 115 | 125 | 240 |
| | | *Area 8 Modal Split - Active Transportation 15%* | | | | 11 | 4 | 15 | 20 | 30 | 50 |
| | | *Area 8 Modal Split - Transit 25%* | | | | 18 | 7 | 26 | 33 | 51 | 84 |
| | | *Area 8 Pass-By / Multi-Purpose Trip Reduction 30%* | | | | 22 | 9 | 31 | 39 | 61 | 100 |
| | | ***Area 8 New Trips*** | | | | **22** | **9** | **31** | **39** | **61** | **100** |
| | | **Area 9** | | | | | | | | | |
| Trip Equ'n | | 230 | Townhouses | Dwelling Units | 23 | 3 | 13 | 16 | 12 | 6 | 18 |
| | | *Area 9 Modal Split - Active Transportation 15%* | | | | 0 | 2 | 2 | 2 | 1 | 3 |
| | | *Area 9 Modal Split - Transit 25%* | | | | 1 | 3 | 4 | 3 | 2 | 5 |
| | | ***Area 9 New Trips*** | | | | **2** | **8** | **10** | **7** | **4** | **11** |
| | | **Area 10** | | | | | | | | | |
| Trip Equ'n | | 220 | Apartment (4 storey apartments) | Dwelling Units | 80 | 9 | 34 | 43 | 40 | 22 | 62 |
| | | *Area 10 Modal Split - Active Transportation 15%* | | | | 1 | 5 | 6 | 6 | 3 | 9 |
| | | *Area 10 Modal Split - Transit 25%* | | | | 2 | 9 | 11 | 10 | 6 | 16 |
| | | ***Area 10 New Trips*** | | | | **5** | **20** | **26** | **24** | **13** | **37** |
| | | **Area 11** | | | | | | | | | |
| Trip Equ'n | | 230 | Townhouses | Dwelling Units | 42 | 4 | 21 | 25 | 20 | 10 | 30 |
| Trip Equ'n | | 210 | Single and Semi-Detached | Dwelling Units | 6 | 3 | 10 | 13 | 5 | 3 | 8 |
| | | *Area 11 Modal Split - Active Transportation 15%* | | | | 1 | 5 | 6 | 4 | 2 | 6 |
| | | *Area 11 Modal Split - Transit 25%* | | | | 2 | 8 | 10 | 6 | 3 | 10 |
| | | ***Area 11 New Trips*** | | | | **4** | **19** | **23** | **15** | **8** | **23** |

# Appendix E

# Future (2021) Total Traffic Analyses

## Synchro and SimTraffic Summary Reports

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 219 | 22 | 0 | 211 | 22 | 38 | 292 | 113 | 18 | 119 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.96 | | 1.00 | | | 1.00 | 0.96 | | 1.00 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.99 | | | 1.00 | 0.85 | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 0.99 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1801 | 1471 | | 1771 | | | 1789 | 1468 | | 1749 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.95 | 1.00 | | 0.94 | |
| Satd. Flow (perm) | | 1801 | 1471 | | 1771 | | | 1712 | 1468 | | 1659 | |
| 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) | 0 | 238 | 24 | 0 | 229 | 24 | 41 | 317 | 123 | 20 | 129 | 22 |
| RTOR Reduction (vph) | 0 | 0 | 13 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Lane Group Flow (vph) | 0 | 238 | 11 | 0 | 249 | 0 | 0 | 358 | 123 | 0 | 165 | 0 |
| Confl. Peds. (#/hr) | 10 | | 10 | 10 | | 10 | 10 | | 15 | 15 | | 10 |
| Confl. Bikes (#/hr) | | | 5 | | | 5 | | | 5 | | | 5 |
| Turn Type | | | Perm | | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 40.5 | 40.5 | | 40.5 | | | 39.0 | 39.0 | | 39.0 | |
| Effective Green, g (s) | | 41.5 | 41.5 | | 41.5 | | | 40.0 | 40.0 | | 40.0 | |
| Actuated g/C Ratio | | 0.46 | 0.46 | | 0.46 | | | 0.44 | 0.44 | | 0.44 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 830 | 678 | | 817 | | | 761 | 652 | | 737 | |
| v/s Ratio Prot | | 0.13 | | | c0.14 | | | | | | | |
| v/s Ratio Perm | | | 0.01 | | | | | c0.21 | 0.08 | | 0.10 | |
| v/c Ratio | | 0.29 | 0.02 | | 0.31 | | | 0.47 | 0.19 | | 0.22 | |
| Uniform Delay, d1 | | 15.1 | 13.2 | | 15.2 | | | 17.6 | 15.2 | | 15.4 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 0.9 | 0.0 | | 1.0 | | | 0.5 | 0.1 | | 0.2 | |
| Delay (s) | | 15.9 | 13.2 | | 16.2 | | | 18.0 | 15.3 | | 15.6 | |
| Level of Service | | B | B | | B | | | B | B | | B | |
| Approach Delay (s) | | 15.7 | | | 16.2 | | | 17.3 | | | 15.6 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 2 | 214 | 252 | 17 | 27 | 14 |
| 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) | 2 | 233 | 274 | 18 | 29 | 15 |
| Pedestrians | | 5 | 5 | | 5 | |
| Lane Width (m) | | 3.3 | 3.3 | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | 1.2 | | 1.2 | |
| Percent Blockage | | 0 | 0 | | 0 | |
| Right turn flare (veh) | | | | | | |
| Median type | | TWLTL | TWLTL | | | |
| Median storage veh) | | 2 | 2 | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | 0.92 | | | | 0.92 | 0.92 |
| vC, conflicting volume | 297 | | | | 530 | 293 |
| vC1, stage 1 conf vol | | | | | 288 | |
| vC2, stage 2 conf vol | | | | | 242 | |
| vCu, unblocked vol | 199 | | | | 451 | 194 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | 5.4 | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 96 | 98 |
| cM capacity (veh/h) | 1265 | | | | 679 | 777 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 2 | 233 | 292 | 45 |
| Volume Left | 2 | 0 | 0 | 29 |
| Volume Right | 0 | 0 | 18 | 15 |
| cSH | 1265 | 1700 | 1700 | 710 |
| Volume to Capacity | 0.00 | 0.14 | 0.17 | 0.06 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 | 1.5 |
| Control Delay (s) | 7.9 | 0.0 | 0.0 | 10.4 |
| Lane LOS | A | | | B |
| Approach Delay (s) | 0.1 | | 0.0 | 10.4 |
| Approach LOS | | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.8 | | |
| Intersection Capacity Utilization | 25.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 0 | 187 | 3 | 10 | 241 | 16 | 10 | 1 | 11 | 18 | 0 | 3 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 203 | 3 | 11 | 262 | 17 | 11 | 1 | 12 | 20 | 0 | 3 |
| Pedestrians | | 5 | | | 5 | | | 5 | | | 5 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | 0.96 | | | | | | 0.96 | 0.96 | | 0.96 | 0.96 | 0.96 |
| vC, conflicting volume | 284 | | | 212 | | | 502 | 516 | 215 | 518 | 509 | 281 |
| vC1, stage 1 conf vol | | | | | | | 210 | 210 | | 297 | 297 | |
| vC2, stage 2 conf vol | | | | | | | 292 | 306 | | 221 | 212 | |
| vCu, unblocked vol | 239 | | | 212 | | | 465 | 480 | 215 | 482 | 472 | 235 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 99 | | | 98 | 100 | 99 | 97 | 100 | 100 |
| cM capacity (veh/h) | 1275 | | | 1354 | | | 642 | 596 | 819 | 627 | 598 | 769 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 207 | 11 | 279 | 24 | 23 |
| Volume Left | 0 | 0 | 11 | 0 | 11 | 20 |
| Volume Right | 0 | 3 | 0 | 17 | 12 | 3 |
| cSH | 1700 | 1700 | 1354 | 1700 | 717 | 644 |
| Volume to Capacity | 0.00 | 0.12 | 0.01 | 0.16 | 0.03 | 0.04 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.2 | 0.0 | 0.8 | 0.8 |
| Control Delay (s) | 0.0 | 0.0 | 7.7 | 0.0 | 10.2 | 10.8 |
| Lane LOS | | | A | | B | B |
| Approach Delay (s) | 0.0 | | 0.3 | | 10.2 | 10.8 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.1 | | |
| Intersection Capacity Utilization | 25.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 22 | 133 | 0 | 0 | 247 | 5 | 55 | 26 | 54 | 3 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 24 | 145 | 0 | 0 | 268 | 5 | 60 | 28 | 59 | 3 | 0 | 0 |
| Pedestrians | | 5 | | | 5 | | | 5 | | | 5 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 279 | | | 150 | | | 474 | 476 | 155 | 546 | 474 | 281 |
| vC1, stage 1 conf vol | | | | | | | 197 | 197 | | 276 | 276 | |
| vC2, stage 2 conf vol | | | | | | | 276 | 279 | | 270 | 197 | |
| vCu, unblocked vol | 279 | | | 150 | | | 474 | 476 | 155 | 546 | 474 | 281 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 98 | | | 100 | | | 91 | 95 | 93 | 99 | 100 | 100 |
| cM capacity (veh/h) | 1279 | | | 1426 | | | 638 | 597 | 884 | 569 | 609 | 752 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 24 | 145 | 274 | 60 | 87 | 3 |
| Volume Left | 24 | 0 | 0 | 60 | 0 | 3 |
| Volume Right | 0 | 0 | 5 | 0 | 59 | 0 |
| cSH | 1279 | 1700 | 1700 | 638 | 765 | 569 |
| Volume to Capacity | 0.02 | 0.09 | 0.16 | 0.09 | 0.11 | 0.01 |
| Queue Length 95th (m) | 0.4 | 0.0 | 0.0 | 2.3 | 2.9 | 0.1 |
| Control Delay (s) | 7.9 | 0.0 | 0.0 | 11.2 | 10.3 | 11.4 |
| Lane LOS | A | | | B | B | B |
| Approach Delay (s) | 1.1 | | 0.0 | 10.7 | | 11.4 |
| Approach LOS | | | | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.0 | | |
| Intersection Capacity Utilization | 31.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 33 | 151 | 44 | 129 | 173 | 0 | 0 | 75 | 2 | 3 | 47 | 39 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 36 | 164 | 48 | 140 | 188 | 0 | 0 | 82 | 2 | 3 | 51 | 42 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 36 | 212 | 140 | 188 | 84 | 29 | 68 |
| Volume Left (vph) | 36 | 0 | 140 | 0 | 0 | 3 | 0 |
| Volume Right (vph) | 0 | 48 | 0 | 0 | 2 | 0 | 42 |
| Hadj (s) | 0.53 | -0.12 | 0.53 | 0.03 | 0.02 | 0.09 | -0.40 |
| Departure Headway (s) | 5.9 | 5.3 | 5.8 | 5.3 | 6.0 | 6.1 | 5.6 |
| Degree Utilization, x | 0.06 | 0.31 | 0.23 | 0.28 | 0.14 | 0.05 | 0.11 |
| Capacity (veh/h) | 575 | 656 | 594 | 651 | 551 | 536 | 582 |
| Control Delay (s) | 8.1 | 9.4 | 9.3 | 9.2 | 10.0 | 8.2 | 8.1 |
| Approach Delay (s) | 9.2 | | 9.2 | | 10.0 | 8.1 | |
| Approach LOS | A | | A | | B | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 9.2 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 36.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 167 | 9 | 5 | 172 | 14 | 13 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 182 | 10 | 5 | 187 | 15 | 14 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 121 | 70 | 192 | 29 |
| Volume Left (vph) | 121 | 61 | 0 | 15 |
| Volume Right (vph) | 0 | 10 | 187 | 0 |
| Hadj (s) | 0.53 | 0.37 | -0.55 | 0.14 |
| Departure Headway (s) | 5.5 | 5.3 | 3.9 | 4.8 |
| Degree Utilization, x | 0.19 | 0.10 | 0.21 | 0.04 |
| Capacity (veh/h) | 624 | 648 | 884 | 713 |
| Control Delay (s) | 8.6 | 7.8 | 7.9 | 7.9 |
| Approach Delay (s) | 8.3 | | 7.9 | 7.9 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.1 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 26.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 43 | 41 | 24 | 21 | 67 | 2 | 80 | 129 | 104 | 1 | 109 | 56 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 47 | 45 | 26 | 23 | 73 | 2 | 87 | 140 | 113 | 1 | 118 | 61 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 47 | 71 | 98 | 340 | 180 |
| Volume Left (vph) | 47 | 0 | 23 | 87 | 1 |
| Volume Right (vph) | 0 | 26 | 2 | 113 | 61 |
| Hadj (s) | 0.53 | -0.22 | 0.07 | -0.11 | -0.17 |
| Departure Headway (s) | 6.4 | 5.7 | 5.5 | 4.6 | 4.8 |
| Degree Utilization, x | 0.08 | 0.11 | 0.15 | 0.44 | 0.24 |
| Capacity (veh/h) | 510 | 576 | 584 | 747 | 706 |
| Control Delay (s) | 8.8 | 8.2 | 9.5 | 11.2 | 9.3 |
| Approach Delay (s) | 8.4 | | 9.5 | 11.2 | 9.3 |
| Approach LOS | A | | A | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.0 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 49.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | TR | LT | R | LTR |
| Maximum Queue (m) | 45.6 | 9.2 | 39.2 | 97.8 | 36.4 | 47.4 |
| Average Queue (m) | 21.8 | 1.8 | 16.8 | 42.1 | 10.1 | 16.4 |
| 95th Queue (m) | 38.1 | 7.7 | 35.9 | 75.4 | 23.4 | 31.6 |
| Link Distance (m) | 99.5 | | | 238.6 | 238.6 | 205.9 |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | 50.0 | | | | |
| Storage Blk Time (%) | 0 | | | | | |
| Queuing Penalty (veh) | 0 | | | | | |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement | SB |
|---|---|
| Directions Served | LR |
| Maximum Queue (m) | 16.4 |
| Average Queue (m) | 7.9 |
| 95th Queue (m) | 15.4 |
| Link Distance (m) | |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (m) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | NB | SB |
|---|---|---|
| Directions Served | LTR | LR |
| Maximum Queue (m) | 9.2 | 15.7 |
| Average Queue (m) | 5.2 | 4.7 |
| 95th Queue (m) | 12.3 | 12.7 |
| Link Distance (m) | 254.0 | |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (m) | | |
| Storage Blk Time (%) | | |
| Queuing Penalty (veh) | | |

## Intersection: 4: Barton Street W & Hess Street

| Movement | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LR |
| Maximum Queue (m) | 7.4 | 6.6 | 22.2 | 20.3 | 9.1 |
| Average Queue (m) | 0.5 | 0.2 | 9.3 | 9.8 | 1.2 |
| 95th Queue (m) | 3.5 | 2.2 | 17.4 | 14.7 | 6.1 |
| Link Distance (m) | | 136.9 | 260.0 | 260.0 | |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 50.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | WB | NB | SB | SB |
|---|---|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LTR | LT | TR |
| Maximum Queue (m) | 14.8 | 25.5 | 22.1 | 22.9 | 15.7 | 16.4 | 20.5 |
| Average Queue (m) | 6.8 | 14.3 | 11.4 | 11.7 | 9.6 | 3.1 | 9.6 |
| 95th Queue (m) | 13.9 | 22.2 | 17.2 | 17.9 | 12.0 | 11.4 | 16.2 |
| Link Distance (m) | | 51.1 | | 120.1 | 262.6 | | |
| Upstream Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |
| Storage Bay Dist (m) | 50.0 | | 50.0 | | | | |
| Storage Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 15.5 | 20.4 | 16.8 | 9.2 |
| Average Queue (m) | 8.4 | 9.9 | 10.8 | 5.1 |
| 95th Queue (m) | 12.6 | 14.1 | 15.6 | 12.5 |
| Link Distance (m) | 61.0 | 61.0 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | LTR | LTR | LTR |
| Maximum Queue (m) | 16.8 | 23.7 | 27.7 | 59.2 | 20.1 |
| Average Queue (m) | 8.6 | 10.3 | 10.0 | 25.1 | 10.9 |
| 95th Queue (m) | 15.4 | 18.2 | 17.1 | 43.2 | 16.0 |
| Link Distance (m) | | | 185.4 | 205.9 | 179.8 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 70.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 0

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 184 | 9 | 0 | 398 | 21 | 32 | 360 | 128 | 45 | 212 | 38 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.96 | | 1.00 | | | 1.00 | 0.96 | | 1.00 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.99 | | | 1.00 | 0.85 | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1801 | 1471 | | 1785 | | | 1792 | 1468 | | 1746 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.95 | 1.00 | | 0.88 | |
| Satd. Flow (perm) | | 1801 | 1471 | | 1785 | | | 1716 | 1468 | | 1547 | |
| 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) | 0 | 200 | 10 | 0 | 433 | 23 | 35 | 391 | 139 | 49 | 230 | 41 |
| RTOR Reduction (vph) | 0 | 0 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| Lane Group Flow (vph) | 0 | 200 | 5 | 0 | 454 | 0 | 0 | 426 | 139 | 0 | 314 | 0 |
| Confl. Peds. (#/hr) | 10 | | 10 | 10 | | 10 | 10 | | 15 | 15 | | 10 |
| Confl. Bikes (#/hr) | | | 5 | | | 5 | | | 5 | | | 5 |
| Turn Type | | | Perm | | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 40.1 | 40.1 | | 40.1 | | | 39.4 | 39.4 | | 39.4 | |
| Effective Green, g (s) | | 41.1 | 41.1 | | 41.1 | | | 40.4 | 40.4 | | 40.4 | |
| Actuated g/C Ratio | | 0.46 | 0.46 | | 0.46 | | | 0.45 | 0.45 | | 0.45 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 822 | 672 | | 815 | | | 770 | 659 | | 694 | |
| v/s Ratio Prot | | 0.11 | | | c0.25 | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | | | | c0.25 | 0.09 | | 0.20 | |
| v/c Ratio | | 0.24 | 0.01 | | 0.56 | | | 0.55 | 0.21 | | 0.45 | |
| Uniform Delay, d1 | | 14.9 | 13.3 | | 17.8 | | | 18.2 | 15.1 | | 17.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 0.7 | 0.0 | | 2.7 | | | 0.9 | 0.2 | | 0.5 | |
| Delay (s) | | 15.6 | 13.3 | | 20.6 | | | 19.0 | 15.3 | | 17.6 | |
| Level of Service | | B | B | | C | | | B | B | | B | |
| Approach Delay (s) | | 15.5 | | | 20.6 | | | 18.1 | | | 17.6 | |
| Approach LOS | | B | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.55 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 13 | 175 | 431 | 37 | 18 | 15 |
| 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) | 14 | 190 | 468 | 40 | 20 | 16 |
| Pedestrians | | 5 | 5 | | 5 | |
| Lane Width (m) | | 3.3 | 3.3 | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | 1.2 | | 1.2 | |
| Percent Blockage | | 0 | 0 | | 0 | |
| Right turn flare (veh) | | | | | | |
| Median type | | TWLTL | TWLTL | | | |
| Median storage veh) | | 2 | 2 | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | 0.82 | | | | 0.82 | 0.82 |
| vC, conflicting volume | 514 | | | | 717 | 499 |
| vC1, stage 1 conf vol | | | | | 494 | |
| vC2, stage 2 conf vol | | | | | 223 | |
| vCu, unblocked vol | 292 | | | | 541 | 274 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | 5.4 | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 97 | 97 |
| cM capacity (veh/h) | 1033 | | | | 578 | 620 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 14 | 190 | 509 | 36 |
| Volume Left | 14 | 0 | 0 | 20 |
| Volume Right | 0 | 0 | 40 | 16 |
| cSH | 1033 | 1700 | 1700 | 596 |
| Volume to Capacity | 0.01 | 0.11 | 0.30 | 0.06 |
| Queue Length 95th (m) | 0.3 | 0.0 | 0.0 | 1.5 |
| Control Delay (s) | 8.5 | 0.0 | 0.0 | 11.4 |
| Lane LOS | A | | | B |
| Approach Delay (s) | 0.6 | | 0.0 | 11.4 |
| Approach LOS | | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 36.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 3 | 173 | 1 | 3 | 443 | 0 | 5 | 0 | 16 | 0 | 0 | 8 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 188 | 1 | 3 | 482 | 0 | 5 | 0 | 17 | 0 | 0 | 9 |
| Pedestrians | | 5 | | | 5 | | | 5 | | | 5 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | 0.84 | | | | | | 0.84 | 0.84 | | 0.84 | 0.84 | 0.84 |
| vC, conflicting volume | 487 | | | 194 | | | 702 | 693 | 199 | 710 | 694 | 492 |
| vC1, stage 1 conf vol | | | | | | | 200 | 200 | | 493 | 493 | |
| vC2, stage 2 conf vol | | | | | | | 502 | 493 | | 217 | 201 | |
| vCu, unblocked vol | 290 | | | 194 | | | 547 | 537 | 199 | 557 | 537 | 296 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 99 | 100 | 98 | 100 | 100 | 99 |
| cM capacity (veh/h) | 1061 | | | 1374 | | | 531 | 514 | 836 | 537 | 515 | 618 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 3 | 189 | 3 | 482 | 23 | 9 |
| Volume Left | 3 | 0 | 3 | 0 | 5 | 0 |
| Volume Right | 0 | 1 | 0 | 0 | 17 | 9 |
| cSH | 1061 | 1700 | 1374 | 1700 | 736 | 618 |
| Volume to Capacity | 0.00 | 0.11 | 0.00 | 0.28 | 0.03 | 0.01 |
| Queue Length 95th (m) | 0.1 | 0.0 | 0.1 | 0.0 | 0.7 | 0.3 |
| Control Delay (s) | 8.4 | 0.0 | 7.6 | 0.0 | 10.1 | 10.9 |
| Lane LOS | A | | A | | B | B |
| Approach Delay (s) | 0.1 | | 0.1 | | 10.1 | 10.9 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 37.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 14 | 130 | 0 | 0 | 455 | 1 | 44 | 26 | 47 | 0 | 0 | 3 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 15 | 141 | 0 | 0 | 495 | 1 | 48 | 28 | 51 | 0 | 0 | 3 |
| Pedestrians | | 5 | | | 5 | | | 5 | | | 5 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 0 | | | 0 | | | 0 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | 0.86 | | | | | | 0.86 | 0.86 | | 0.86 | 0.86 | 0.86 |
| vC, conflicting volume | 501 | | | 146 | | | 680 | 677 | 151 | 742 | 677 | 505 |
| vC1, stage 1 conf vol | | | | | | | 177 | 177 | | 500 | 500 | |
| vC2, stage 2 conf vol | | | | | | | 503 | 501 | | 242 | 177 | |
| vCu, unblocked vol | 344 | | | 146 | | | 552 | 548 | 151 | 623 | 548 | 349 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 91 | 94 | 94 | 100 | 100 | 99 |
| cM capacity (veh/h) | 1046 | | | 1430 | | | 524 | 503 | 888 | 501 | 513 | 596 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 15 | 141 | 496 | 48 | 79 | 3 |
| Volume Left | 15 | 0 | 0 | 48 | 0 | 0 |
| Volume Right | 0 | 0 | 1 | 0 | 51 | 3 |
| cSH | 1046 | 1700 | 1700 | 524 | 698 | 596 |
| Volume to Capacity | 0.01 | 0.08 | 0.29 | 0.09 | 0.11 | 0.01 |
| Queue Length 95th (m) | 0.3 | 0.0 | 0.0 | 2.3 | 2.9 | 0.1 |
| Control Delay (s) | 8.5 | 0.0 | 0.0 | 12.6 | 10.8 | 11.1 |
| Lane LOS | A | | | B | B | B |
| Approach Delay (s) | 0.8 | | 0.0 | 11.5 | | 11.1 |
| Approach LOS | | | | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.1 | | |
| Intersection Capacity Utilization | 40.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 47 | 128 | 36 | 167 | 332 | 3 | 0 | 14 | 13 | 2 | 126 | 73 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 51 | 139 | 39 | 182 | 361 | 3 | 0 | 15 | 14 | 2 | 137 | 79 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 51 | 178 | 182 | 364 | 29 | 71 | 148 |
| Volume Left (vph) | 51 | 0 | 182 | 0 | 0 | 2 | 0 |
| Volume Right (vph) | 0 | 39 | 0 | 3 | 14 | 0 | 79 |
| Hadj (s) | 0.53 | -0.12 | 0.53 | 0.03 | -0.25 | 0.05 | -0.34 |
| Departure Headway (s) | 6.5 | 5.8 | 6.1 | 5.6 | 6.5 | 6.5 | 6.1 |
| Degree Utilization, x | 0.09 | 0.29 | 0.31 | 0.57 | 0.05 | 0.13 | 0.25 |
| Capacity (veh/h) | 525 | 590 | 571 | 630 | 504 | 513 | 549 |
| Control Delay (s) | 8.9 | 10.0 | 10.6 | 14.4 | 9.8 | 9.2 | 9.9 |
| Approach Delay (s) | 9.7 | | 13.1 | | 9.8 | 9.7 | |
| Approach LOS | A | | B | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.6 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 40.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 383 | 9 | 12 | 106 | 19 | 11 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 416 | 10 | 13 | 115 | 21 | 12 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 278 | 149 | 128 | 33 |
| Volume Left (vph) | 278 | 139 | 0 | 21 |
| Volume Right (vph) | 0 | 10 | 115 | 0 |
| Hadj (s) | 0.53 | 0.45 | -0.50 | 0.16 |
| Departure Headway (s) | 5.4 | 5.3 | 4.5 | 5.3 |
| Degree Utilization, x | 0.42 | 0.22 | 0.16 | 0.05 |
| Capacity (veh/h) | 643 | 657 | 755 | 633 |
| Control Delay (s) | 11.1 | 8.7 | 8.3 | 8.5 |
| Approach Delay (s) | 10.2 | | 8.3 | 8.5 |
| Approach LOS | B | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 9.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 26.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 107 | 32 | 68 | 9 | 72 | 1 | 21 | 295 | 69 | 2 | 218 | 85 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 116 | 35 | 74 | 10 | 78 | 1 | 23 | 321 | 75 | 2 | 237 | 92 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 116 | 109 | 89 | 418 | 332 |
| Volume Left (vph) | 116 | 0 | 10 | 23 | 2 |
| Volume Right (vph) | 0 | 74 | 1 | 75 | 92 |
| Hadj (s) | 0.53 | -0.44 | 0.05 | -0.06 | -0.13 |
| Departure Headway (s) | 7.2 | 6.2 | 6.6 | 5.4 | 5.4 |
| Degree Utilization, x | 0.23 | 0.19 | 0.16 | 0.62 | 0.50 |
| Capacity (veh/h) | 452 | 518 | 451 | 639 | 626 |
| Control Delay (s) | 11.2 | 9.5 | 10.9 | 16.9 | 13.8 |
| Approach Delay (s) | 10.4 | | 10.9 | 16.9 | 13.8 |
| Approach LOS | B | | B | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 14.0 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 54.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | TR | LT | R | LTR |
| Maximum Queue (m) | 45.6 | 9.2 | 39.2 | 97.8 | 36.4 | 47.4 |
| Average Queue (m) | 21.8 | 1.8 | 16.8 | 42.1 | 10.1 | 16.4 |
| 95th Queue (m) | 38.1 | 7.7 | 35.9 | 75.4 | 23.4 | 31.6 |
| Link Distance (m) | 99.5 | | | 238.6 | 238.6 | 205.9 |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | 50.0 | | | | |
| Storage Blk Time (%) | 0 | | | | | |
| Queuing Penalty (veh) | 0 | | | | | |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement | SB |
|---|---|
| Directions Served | LR |
| Maximum Queue (m) | 16.4 |
| Average Queue (m) | 7.9 |
| 95th Queue (m) | 15.4 |
| Link Distance (m) | |
| Upstream Blk Time (%) | |
| Queuing Penalty (veh) | |
| Storage Bay Dist (m) | |
| Storage Blk Time (%) | |
| Queuing Penalty (veh) | |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | NB | SB |
|---|---|---|
| Directions Served | LTR | LR |
| Maximum Queue (m) | 9.2 | 15.7 |
| Average Queue (m) | 5.2 | 4.7 |
| 95th Queue (m) | 12.3 | 12.7 |
| Link Distance (m) | 254.0 | |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (m) | | |
| Storage Blk Time (%) | | |
| Queuing Penalty (veh) | | |

## Intersection: 4: Barton Street W & Hess Street

| Movement | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LR |
| Maximum Queue (m) | 7.4 | 6.6 | 22.2 | 20.3 | 9.1 |
| Average Queue (m) | 0.5 | 0.2 | 9.3 | 9.8 | 1.2 |
| 95th Queue (m) | 3.5 | 2.2 | 17.4 | 14.7 | 6.1 |
| Link Distance (m) | | 136.9 | 260.0 | 260.0 | |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 50.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | WB | NB | SB | SB |
|---|---|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LTR | LT | TR |
| Maximum Queue (m) | 14.8 | 25.5 | 22.1 | 22.9 | 15.7 | 16.4 | 20.5 |
| Average Queue (m) | 6.8 | 14.3 | 11.4 | 11.7 | 9.6 | 3.1 | 9.6 |
| 95th Queue (m) | 13.9 | 22.2 | 17.2 | 17.9 | 12.0 | 11.4 | 16.2 |
| Link Distance (m) | | 51.1 | | 120.1 | 262.6 | | |
| Upstream Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |
| Storage Bay Dist (m) | 50.0 | | 50.0 | | | | |
| Storage Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 15.5 | 20.4 | 16.8 | 9.2 |
| Average Queue (m) | 8.4 | 9.9 | 10.8 | 5.1 |
| 95th Queue (m) | 12.6 | 14.1 | 15.6 | 12.5 |
| Link Distance (m) | 61.0 | 61.0 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | LTR | LTR | LTR |
| Maximum Queue (m) | 16.8 | 23.7 | 27.7 | 59.2 | 20.1 |
| Average Queue (m) | 8.6 | 10.3 | 10.0 | 25.1 | 10.9 |
| 95th Queue (m) | 15.4 | 18.2 | 17.1 | 43.2 | 16.0 |
| Link Distance (m) | | | 185.4 | 205.9 | 179.8 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 70.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 0

# Appendix F

# Future (2031) Total Traffic Analyses

## Synchro and SimTraffic Summary Reports

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 294 | 44 | 0 | 285 | 23 | 64 | 318 | 124 | 20 | 131 | 41 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.96 | | 1.00 | | | 1.00 | 0.95 | | 0.99 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.99 | | | 1.00 | 0.85 | | 0.97 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 0.99 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1801 | 1464 | | 1777 | | | 1783 | 1462 | | 1723 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.91 | 1.00 | | 0.94 | |
| Satd. Flow (perm) | | 1801 | 1464 | | 1777 | | | 1641 | 1462 | | 1629 | |
| 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) | 0 | 320 | 48 | 0 | 310 | 25 | 70 | 346 | 135 | 22 | 142 | 45 |
| RTOR Reduction (vph) | 0 | 0 | 26 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| Lane Group Flow (vph) | 0 | 320 | 22 | 0 | 332 | 0 | 0 | 416 | 135 | 0 | 197 | 0 |
| Confl. Peds. (#/hr) | 10 | | 10 | 10 | | 10 | 10 | | 15 | 15 | | 10 |
| Confl. Bikes (#/hr) | | | 10 | | | 10 | | | 10 | | | 10 |
| Turn Type | | | Perm | | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 40.2 | 40.2 | | 40.2 | | | 39.3 | 39.3 | | 39.3 | |
| Effective Green, g (s) | | 41.2 | 41.2 | | 41.2 | | | 40.3 | 40.3 | | 40.3 | |
| Actuated g/C Ratio | | 0.46 | 0.46 | | 0.46 | | | 0.45 | 0.45 | | 0.45 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 824 | 670 | | 813 | | | 735 | 655 | | 729 | |
| v/s Ratio Prot | | 0.18 | | | c0.19 | | | | | | | |
| v/s Ratio Perm | | | 0.02 | | | | | c0.25 | 0.09 | | 0.12 | |
| v/c Ratio | | 0.39 | 0.03 | | 0.41 | | | 0.57 | 0.21 | | 0.27 | |
| Uniform Delay, d1 | | 16.1 | 13.4 | | 16.3 | | | 18.4 | 15.1 | | 15.6 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.4 | 0.1 | | 1.5 | | | 1.0 | 0.2 | | 0.2 | |
| Delay (s) | | 17.5 | 13.5 | | 17.8 | | | 19.4 | 15.3 | | 15.8 | |
| Level of Service | | B | B | | B | | | B | B | | B | |
| Approach Delay (s) | | 17.0 | | | 17.8 | | | 18.4 | | | 15.8 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 9 | 280 | 326 | 64 | 58 | 21 |
| 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) | 10 | 304 | 354 | 70 | 63 | 23 |
| Pedestrians | | 10 | 10 | | 10 | |
| Lane Width (m) | | 3.3 | 3.3 | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | 1.2 | | 1.2 | |
| Percent Blockage | | 1 | 1 | | 1 | |
| Right turn flare (veh) | | | | | | |
| Median type | | TWLTL | TWLTL | | | |
| Median storage veh) | | 2 | 2 | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | 0.88 | | | | 0.88 | 0.88 |
| vC, conflicting volume | 434 | | | | 733 | 409 |
| vC1, stage 1 conf vol | | | | | 399 | |
| vC2, stage 2 conf vol | | | | | 334 | |
| vCu, unblocked vol | 293 | | | | 632 | 265 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | 5.4 | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 89 | 97 |
| cM capacity (veh/h) | 1112 | | | | 582 | 673 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 10 | 304 | 424 | 86 |
| Volume Left | 10 | 0 | 0 | 63 |
| Volume Right | 0 | 0 | 70 | 23 |
| cSH | 1112 | 1700 | 1700 | 603 |
| Volume to Capacity | 0.01 | 0.18 | 0.25 | 0.14 |
| Queue Length 95th (m) | 0.2 | 0.0 | 0.0 | 3.8 |
| Control Delay (s) | 8.3 | 0.0 | 0.0 | 12.0 |
| Lane LOS | A | | | B |
| Approach Delay (s) | 0.3 | | 0.0 | 12.0 |
| Approach LOS | | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.3 | | |
| Intersection Capacity Utilization | 35.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 5 | 213 | 4 | 11 | 287 | 49 | 11 | 21 | 12 | 65 | 28 | 23 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 232 | 4 | 12 | 312 | 53 | 12 | 23 | 13 | 71 | 30 | 25 |
| Pedestrians | | 10 | | | 10 | | | 10 | | | 10 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 1 | | | 1 | | | 1 | | | 1 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | 0.94 | | | | | | 0.94 | 0.94 | | 0.94 | 0.94 | 0.94 |
| vC, conflicting volume | 375 | | | 246 | | | 641 | 654 | 254 | 649 | 629 | 359 |
| vC1, stage 1 conf vol | | | | | | | 255 | 255 | | 372 | 372 | |
| vC2, stage 2 conf vol | | | | | | | 386 | 399 | | 277 | 257 | |
| vCu, unblocked vol | 302 | | | 246 | | | 584 | 598 | 254 | 594 | 572 | 284 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 99 | | | 98 | 96 | 98 | 87 | 94 | 96 |
| cM capacity (veh/h) | 1173 | | | 1310 | | | 529 | 532 | 773 | 549 | 544 | 698 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 5 | 236 | 12 | 365 | 48 | 126 |
| Volume Left | 5 | 0 | 12 | 0 | 12 | 71 |
| Volume Right | 0 | 4 | 0 | 53 | 13 | 25 |
| cSH | 1173 | 1700 | 1310 | 1700 | 581 | 572 |
| Volume to Capacity | 0.00 | 0.14 | 0.01 | 0.21 | 0.08 | 0.22 |
| Queue Length 95th (m) | 0.1 | 0.0 | 0.2 | 0.0 | 2.0 | 6.4 |
| Control Delay (s) | 8.1 | 0.0 | 7.8 | 0.0 | 11.8 | 13.1 |
| Lane LOS | A | | A | | B | B |
| Approach Delay (s) | 0.2 | | 0.2 | | 11.8 | 13.1 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.0 | | |
| Intersection Capacity Utilization | 38.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 30 | 158 | 0 | 0 | 298 | 21 | 60 | 35 | 60 | 4 | 0 | 22 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 33 | 172 | 0 | 0 | 324 | 23 | 65 | 38 | 65 | 4 | 0 | 24 |
| Pedestrians | | 10 | | | 10 | | | 10 | | | 10 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 1 | | | 1 | | | 1 | | | 1 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 357 | | | 182 | | | 616 | 604 | 192 | 677 | 592 | 355 |
| vC1, stage 1 conf vol | | | | | | | 247 | 247 | | 345 | 345 | |
| vC2, stage 2 conf vol | | | | | | | 369 | 357 | | 331 | 247 | |
| vCu, unblocked vol | 357 | | | 182 | | | 616 | 604 | 192 | 677 | 592 | 355 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 97 | | | 100 | | | 88 | 93 | 92 | 99 | 100 | 96 |
| cM capacity (veh/h) | 1193 | | | 1383 | | | 536 | 535 | 837 | 496 | 555 | 678 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 172 | 347 | 65 | 103 | 28 |
| Volume Left | 33 | 0 | 0 | 65 | 0 | 4 |
| Volume Right | 0 | 0 | 23 | 0 | 65 | 24 |
| cSH | 1193 | 1700 | 1700 | 536 | 693 | 642 |
| Volume to Capacity | 0.03 | 0.10 | 0.20 | 0.12 | 0.15 | 0.04 |
| Queue Length 95th (m) | 0.6 | 0.0 | 0.0 | 3.1 | 4.0 | 1.0 |
| Control Delay (s) | 8.1 | 0.0 | 0.0 | 12.6 | 11.1 | 10.9 |
| Lane LOS | A | | | B | B | B |
| Approach Delay (s) | 1.3 | | 0.0 | 11.7 | | 10.9 |
| Approach LOS | | | | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.4 | | |
| Intersection Capacity Utilization | 41.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 34 | 164 | 49 | 179 | 203 | 0 | 0 | 75 | 20 | 4 | 51 | 43 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 37 | 178 | 53 | 195 | 221 | 0 | 0 | 82 | 22 | 4 | 55 | 47 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 37 | 232 | 195 | 221 | 103 | 32 | 74 |
| Volume Left (vph) | 37 | 0 | 195 | 0 | 0 | 4 | 0 |
| Volume Right (vph) | 0 | 53 | 0 | 0 | 22 | 0 | 47 |
| Hadj (s) | 0.53 | -0.13 | 0.53 | 0.03 | -0.09 | 0.10 | -0.41 |
| Departure Headway (s) | 6.2 | 5.5 | 6.0 | 5.5 | 6.2 | 6.5 | 6.0 |
| Degree Utilization, x | 0.06 | 0.36 | 0.32 | 0.34 | 0.18 | 0.06 | 0.12 |
| Capacity (veh/h) | 550 | 626 | 579 | 633 | 535 | 505 | 548 |
| Control Delay (s) | 8.4 | 10.4 | 10.7 | 10.1 | 10.6 | 8.7 | 8.6 |
| Approach Delay (s) | 10.1 | | 10.4 | | 10.6 | 8.6 | |
| Approach LOS | B | | B | | B | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.1 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 40.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 196 | 9 | 6 | 185 | 15 | 14 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 213 | 10 | 7 | 201 | 16 | 15 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 142 | 81 | 208 | 32 |
| Volume Left (vph) | 142 | 71 | 0 | 16 |
| Volume Right (vph) | 0 | 10 | 201 | 0 |
| Hadj (s) | 0.53 | 0.39 | -0.55 | 0.14 |
| Departure Headway (s) | 5.6 | 5.4 | 4.0 | 4.9 |
| Degree Utilization, x | 0.22 | 0.12 | 0.23 | 0.04 |
| Capacity (veh/h) | 619 | 639 | 863 | 695 |
| Control Delay (s) | 8.9 | 8.0 | 8.2 | 8.1 |
| Approach Delay (s) | 8.6 | | 8.2 | 8.1 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.4 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 28.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 70 | 45 | 25 | 24 | 74 | 2 | 81 | 142 | 115 | 1 | 139 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 76 | 49 | 27 | 26 | 80 | 2 | 88 | 154 | 125 | 1 | 151 | 65 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 76 | 76 | 109 | 367 | 217 |
| Volume Left (vph) | 76 | 0 | 26 | 88 | 1 |
| Volume Right (vph) | 0 | 27 | 2 | 125 | 65 |
| Hadj (s) | 0.53 | -0.22 | 0.07 | -0.12 | -0.15 |
| Departure Headway (s) | 6.7 | 5.9 | 5.9 | 4.9 | 5.1 |
| Degree Utilization, x | 0.14 | 0.13 | 0.18 | 0.50 | 0.31 |
| Capacity (veh/h) | 489 | 549 | 545 | 711 | 666 |
| Control Delay (s) | 9.6 | 8.6 | 10.1 | 12.6 | 10.3 |
| Approach Delay (s) | 9.1 | | 10.1 | 12.6 | 10.3 |
| Approach LOS | A | | B | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.0 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 53.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | TR | LT | R | LTR |
| Maximum Queue (m) | 78.3 | 52.3 | 57.1 | 69.3 | 31.6 | 59.7 |
| Average Queue (m) | 36.5 | 6.0 | 26.8 | 37.8 | 14.0 | 22.3 |
| 95th Queue (m) | 66.1 | 22.2 | 52.3 | 61.5 | 26.8 | 40.9 |
| Link Distance (m) | 99.5 | | | 238.6 | 238.6 | 205.9 |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | 50.0 | | | | |
| Storage Blk Time (%) | 3 | 0 | | | | |
| Queuing Penalty (veh) | 1 | 0 | | | | |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement | EB | EB | WB | SB |
|---|---|---|---|---|
| Directions Served | L | T | TR | LR |
| Maximum Queue (m) | 9.2 | 14.8 | 9.3 | 23.6 |
| Average Queue (m) | 1.2 | 0.8 | 0.3 | 10.4 |
| 95th Queue (m) | 6.3 | 5.7 | 3.1 | 16.9 |
| Link Distance (m) | | 97.7 | 99.5 | |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | 50.0 | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | EB | EB | WB | WB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LTR | LTR |
| Maximum Queue (m) | 9.1 | 9.1 | 9.2 | 6.6 | 15.7 | 27.8 |
| Average Queue (m) | 0.6 | 0.5 | 0.9 | 0.2 | 8.0 | 12.8 |
| 95th Queue (m) | 4.2 | 3.8 | 5.3 | 2.2 | 14.6 | 21.2 |
| Link Distance (m) | | 136.9 | | 97.7 | 254.0 | |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | 50.0 | | 50.0 | | | |
| Storage Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |

## Intersection: 4: Barton Street W & Hess Street

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | L | T | TR | L | TR | LR |
| Maximum Queue (m) | 7.5 | 6.4 | 9.0 | 16.3 | 16.4 | 15.7 |
| Average Queue (m) | 2.0 | 0.6 | 0.3 | 9.5 | 9.4 | 5.6 |
| 95th Queue (m) | 7.3 | 3.7 | 3.0 | 15.4 | 13.8 | 13.4 |
| Link Distance (m) | | 120.1 | 136.9 | 260.0 | 260.0 | |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | 50.0 | | | | | |
| Storage Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | WB | NB | SB | SB |
|---|---|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LTR | LT | TR |
| Maximum Queue (m) | 23.7 | 24.7 | 22.4 | 21.0 | 16.4 | 9.3 | 20.5 |
| Average Queue (m) | 6.6 | 15.1 | 12.9 | 13.7 | 9.2 | 4.9 | 8.5 |
| 95th Queue (m) | 17.0 | 23.1 | 19.2 | 19.5 | 14.5 | 12.4 | 15.9 |
| Link Distance (m) | | 51.1 | | 120.1 | 262.6 | | |
| Upstream Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |
| Storage Bay Dist (m) | 50.0 | | 50.0 | | | | |
| Storage Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 15.5 | 20.5 | 20.4 | 9.2 |
| Average Queue (m) | 8.9 | 9.4 | 11.9 | 5.2 |
| 95th Queue (m) | 13.9 | 14.3 | 18.3 | 12.6 |
| Link Distance (m) | 61.0 | 61.0 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | LTR | LTR | LTR |
| Maximum Queue (m) | 15.7 | 16.3 | 16.8 | 51.0 | 22.4 |
| Average Queue (m) | 7.3 | 10.6 | 10.3 | 25.4 | 12.1 |
| 95th Queue (m) | 14.5 | 15.1 | 14.5 | 43.5 | 19.2 |
| Link Distance (m) | | | 185.4 | 205.9 | 179.8 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 70.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 1

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 326 | 52 | 0 | 559 | 23 | 88 | 396 | 141 | 48 | 243 | 77 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.3 | 4.3 | | 4.3 | | | 4.2 | 4.2 | | 4.2 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frpb, ped/bikes | | 1.00 | 0.96 | | 1.00 | | | 1.00 | 0.96 | | 0.99 | |
| Flpb, ped/bikes | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.99 | | | 1.00 | 0.85 | | 0.97 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | | 0.99 | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1801 | 1464 | | 1788 | | | 1783 | 1462 | | 1722 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | | 0.85 | 1.00 | | 0.77 | |
| Satd. Flow (perm) | | 1801 | 1464 | | 1788 | | | 1521 | 1462 | | 1336 | |
| 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) | 0 | 354 | 57 | 0 | 608 | 25 | 96 | 430 | 153 | 52 | 264 | 84 |
| RTOR Reduction (vph) | 0 | 0 | 31 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 11 | 0 |
| Lane Group Flow (vph) | 0 | 354 | 26 | 0 | 631 | 0 | 0 | 526 | 153 | 0 | 389 | 0 |
| Confl. Peds. (#/hr) | 10 | | 10 | 10 | | 10 | 10 | | 15 | 15 | | 10 |
| Confl. Bikes (#/hr) | | | 10 | | | 10 | | | 10 | | | 10 |
| Turn Type | | | Perm | | | | Perm | | Perm | Perm | | |
| Protected Phases | | 2 | | | 2 | | | 4 | | | 4 | |
| Permitted Phases | | | 2 | | | | 4 | | 4 | 4 | | |
| Actuated Green, G (s) | | 39.4 | 39.4 | | 39.4 | | | 40.1 | 40.1 | | 40.1 | |
| Effective Green, g (s) | | 40.4 | 40.4 | | 40.4 | | | 41.1 | 41.1 | | 41.1 | |
| Actuated g/C Ratio | | 0.45 | 0.45 | | 0.45 | | | 0.46 | 0.46 | | 0.46 | |
| Clearance Time (s) | | 5.3 | 5.3 | | 5.3 | | | 5.2 | 5.2 | | 5.2 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 808 | 657 | | 803 | | | 695 | 668 | | 610 | |
| v/s Ratio Prot | | 0.20 | | | c0.35 | | | | | | | |
| v/s Ratio Perm | | | 0.02 | | | | | c0.35 | 0.10 | | 0.29 | |
| v/c Ratio | | 0.44 | 0.04 | | 0.79 | | | 0.76 | 0.23 | | 0.64 | |
| Uniform Delay, d1 | | 17.0 | 13.9 | | 21.1 | | | 20.3 | 14.8 | | 18.7 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.7 | 0.1 | | 7.6 | | | 4.7 | 0.2 | | 2.2 | |
| Delay (s) | | 18.7 | 14.0 | | 28.8 | | | 25.0 | 15.0 | | 20.9 | |
| Level of Service | | B | B | | C | | | C | B | | C | |
| Approach Delay (s) | | 18.1 | | | 28.8 | | | 22.8 | | | 20.9 | |
| Approach LOS | | B | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 23.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 8.5 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 29 | 302 | 604 | 119 | 76 | 22 |
| 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) | 32 | 328 | 657 | 129 | 83 | 24 |
| Pedestrians | | 10 | 10 | | 10 | |
| Lane Width (m) | | 3.3 | 3.3 | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | 1.2 | | 1.2 | |
| Percent Blockage | | 1 | 1 | | 1 | |
| Right turn flare (veh) | | | | | | |
| Median type | | TWLTL | TWLTL | | | |
| Median storage veh) | | 2 | 2 | | | |
| Upstream signal (m) | | | 111 | | | |
| pX, platoon unblocked | 0.69 | | | | 0.69 | 0.69 |
| vC, conflicting volume | 796 | | | | 1132 | 741 |
| vC1, stage 1 conf vol | | | | | 731 | |
| vC2, stage 2 conf vol | | | | | 401 | |
| vCu, unblocked vol | 484 | | | | 970 | 406 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | 5.4 | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 96 | | | | 80 | 95 |
| cM capacity (veh/h) | 742 | | | | 405 | 441 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 32 | 328 | 786 | 107 |
| Volume Left | 32 | 0 | 0 | 83 |
| Volume Right | 0 | 0 | 129 | 24 |
| cSH | 742 | 1700 | 1700 | 412 |
| Volume to Capacity | 0.04 | 0.19 | 0.46 | 0.26 |
| Queue Length 95th (m) | 1.0 | 0.0 | 0.0 | 7.7 |
| Control Delay (s) | 10.1 | 0.0 | 0.0 | 16.7 |
| Lane LOS | B | | | C |
| Approach Delay (s) | 0.9 | | 0.0 | 16.7 |
| Approach LOS | | | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.7 | | |
| Intersection Capacity Utilization | 53.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 29 | 218 | 1 | 4 | 537 | 97 | 6 | 46 | 17 | 98 | 41 | 38 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 32 | 237 | 1 | 4 | 584 | 105 | 7 | 50 | 18 | 107 | 45 | 41 |
| Pedestrians | | 10 | | | 10 | | | 10 | | | 10 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 1 | | | 1 | | | 1 | | | 1 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 217 | | | | | | | |
| pX, platoon unblocked | 0.73 | | | | | | 0.73 | 0.73 | | 0.73 | 0.73 | 0.73 |
| vC, conflicting volume | 699 | | | 248 | | | 977 | 1018 | 258 | 1009 | 966 | 656 |
| vC1, stage 1 conf vol | | | | | | | 311 | 311 | | 655 | 655 | |
| vC2, stage 2 conf vol | | | | | | | 666 | 708 | | 353 | 311 | |
| vCu, unblocked vol | 405 | | | 248 | | | 784 | 841 | 258 | 828 | 770 | 346 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 96 | | | 100 | | | 98 | 86 | 98 | 73 | 89 | 92 |
| cM capacity (veh/h) | 837 | | | 1308 | | | 338 | 364 | 769 | 395 | 409 | 502 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 32 | 238 | 4 | 689 | 75 | 192 |
| Volume Left | 32 | 0 | 4 | 0 | 7 | 107 |
| Volume Right | 0 | 1 | 0 | 105 | 18 | 41 |
| cSH | 837 | 1700 | 1308 | 1700 | 416 | 417 |
| Volume to Capacity | 0.04 | 0.14 | 0.00 | 0.41 | 0.18 | 0.46 |
| Queue Length 95th (m) | 0.9 | 0.0 | 0.1 | 0.0 | 4.9 | 18.0 |
| Control Delay (s) | 9.5 | 0.0 | 7.8 | 0.0 | 15.6 | 20.8 |
| Lane LOS | A | | A | | C | C |
| Approach Delay (s) | 1.1 | | 0.0 | | 15.6 | 20.8 |
| Approach LOS | | | | | C | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.5 | | |
| Intersection Capacity Utilization | 57.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 43 | 177 | 0 | 0 | 548 | 33 | 49 | 37 | 58 | 13 | 0 | 38 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 47 | 192 | 0 | 0 | 596 | 36 | 53 | 40 | 63 | 14 | 0 | 41 |
| Pedestrians | | 10 | | | 10 | | | 10 | | | 10 | |
| Lane Width (m) | | 3.3 | | | 3.3 | | | 3.3 | | | 3.3 | |
| Walking Speed (m/s) | | 1.2 | | | 1.2 | | | 1.2 | | | 1.2 | |
| Percent Blockage | | 1 | | | 1 | | | 1 | | | 1 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | TWLTL | | | TWLTL | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | 366 | | | | | | | |
| pX, platoon unblocked | 0.83 | | | | | | 0.83 | 0.83 | | 0.83 | 0.83 | 0.83 |
| vC, conflicting volume | 642 | | | 202 | | | 961 | 937 | 212 | 1003 | 919 | 634 |
| vC1, stage 1 conf vol | | | | | | | 296 | 296 | | 624 | 624 | |
| vC2, stage 2 conf vol | | | | | | | 665 | 642 | | 379 | 296 | |
| vCu, unblocked vol | 468 | | | 202 | | | 852 | 824 | 212 | 902 | 802 | 459 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | 6.1 | 5.5 | | 6.1 | 5.5 | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 95 | | | 100 | | | 85 | 90 | 92 | 96 | 100 | 92 |
| cM capacity (veh/h) | 903 | | | 1359 | | | 349 | 385 | 815 | 384 | 422 | 493 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 47 | 192 | 632 | 53 | 103 | 55 |
| Volume Left | 47 | 0 | 0 | 53 | 0 | 14 |
| Volume Right | 0 | 0 | 36 | 0 | 63 | 41 |
| cSH | 903 | 1700 | 1700 | 349 | 568 | 460 |
| Volume to Capacity | 0.05 | 0.11 | 0.37 | 0.15 | 0.18 | 0.12 |
| Queue Length 95th (m) | 1.2 | 0.0 | 0.0 | 4.0 | 5.0 | 3.1 |
| Control Delay (s) | 9.2 | 0.0 | 0.0 | 17.2 | 12.7 | 13.9 |
| Lane LOS | A | | | C | B | B |
| Approach Delay (s) | 1.8 | | 0.0 | 14.2 | | 13.9 |
| Approach LOS | | | | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.2 | | |
| Intersection Capacity Utilization | 53.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 51 | 141 | 40 | 232 | 399 | 4 | 0 | 14 | 76 | 2 | 132 | 78 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 55 | 153 | 43 | 252 | 434 | 4 | 0 | 15 | 83 | 2 | 143 | 85 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 55 | 197 | 252 | 438 | 98 | 74 | 157 |
| Volume Left (vph) | 55 | 0 | 252 | 0 | 0 | 2 | 0 |
| Volume Right (vph) | 0 | 43 | 0 | 4 | 83 | 0 | 85 |
| Hadj (s) | 0.53 | -0.12 | 0.53 | 0.03 | -0.47 | 0.05 | -0.35 |
| Departure Headway (s) | 7.1 | 6.5 | 6.5 | 6.0 | 6.7 | 7.1 | 6.7 |
| Degree Utilization, x | 0.11 | 0.35 | 0.46 | 0.73 | 0.18 | 0.15 | 0.29 |
| Capacity (veh/h) | 475 | 530 | 538 | 584 | 494 | 469 | 500 |
| Control Delay (s) | 9.8 | 11.7 | 13.7 | 22.4 | 11.2 | 10.1 | 11.2 |
| Approach Delay (s) | 11.3 | | 19.2 | | 11.2 | 10.9 | |
| Approach LOS | B | | C | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 15.5 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 44.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Stop | | | Stop |
| Volume (vph) | 453 | 9 | 13 | 116 | 21 | 12 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 492 | 10 | 14 | 126 | 23 | 13 |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 328 | 174 | 140 | 36 |
| Volume Left (vph) | 328 | 164 | 0 | 23 |
| Volume Right (vph) | 0 | 10 | 126 | 0 |
| Hadj (s) | 0.53 | 0.47 | -0.51 | 0.16 |
| Departure Headway (s) | 5.5 | 5.4 | 4.6 | 5.5 |
| Degree Utilization, x | 0.50 | 0.26 | 0.18 | 0.05 |
| Capacity (veh/h) | 639 | 650 | 727 | 610 |
| Control Delay (s) | 12.6 | 9.1 | 8.7 | 8.8 |
| Approach Delay (s) | 11.4 | | 8.7 | 8.8 |
| Approach LOS | B | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.7 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 36.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 165 | 35 | 83 | 9 | 79 | 1 | 21 | 326 | 76 | 2 | 279 | 105 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 179 | 38 | 90 | 10 | 86 | 1 | 23 | 354 | 83 | 2 | 303 | 114 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 179 | 128 | 97 | 460 | 420 |
| Volume Left (vph) | 179 | 0 | 10 | 23 | 2 |
| Volume Right (vph) | 0 | 90 | 1 | 83 | 114 |
| Hadj (s) | 0.53 | -0.46 | 0.05 | -0.06 | -0.13 |
| Departure Headway (s) | 7.9 | 6.9 | 7.7 | 6.1 | 6.1 |
| Degree Utilization, x | 0.39 | 0.25 | 0.21 | 0.77 | 0.71 |
| Capacity (veh/h) | 412 | 474 | 407 | 574 | 563 |
| Control Delay (s) | 14.8 | 10.9 | 12.6 | 26.8 | 22.5 |
| Approach Delay (s) | 13.2 | | 12.6 | 26.8 | 22.5 |
| Approach LOS | B | | B | D | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.1 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 59.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

## Intersection: 1: Barton Street W & Bay Street N

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | T | R | TR | LT | R | LTR |
| Maximum Queue (m) | 71.9 | 50.3 | 121.8 | 172.3 | 51.0 | 192.9 |
| Average Queue (m) | 39.0 | 7.6 | 69.9 | 77.7 | 18.3 | 76.8 |
| 95th Queue (m) | 64.6 | 22.7 | 105.8 | 128.6 | 37.2 | 140.8 |
| Link Distance (m) | 99.5 | | | 238.6 | 238.6 | 205.9 |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | | 50.0 | | | | |
| Storage Blk Time (%) | 2 | 0 | | | | |
| Queuing Penalty (veh) | 1 | 0 | | | | |

## Intersection: 2: Barton Street W & Tiffany Street

| Movement | EB | EB | WB | SB |
|---|---|---|---|---|
| Directions Served | L | T | TR | LR |
| Maximum Queue (m) | 33.4 | 15.0 | 65.6 | 28.2 |
| Average Queue (m) | 7.0 | 0.5 | 4.5 | 12.8 |
| 95th Queue (m) | 19.9 | 5.0 | 25.9 | 24.0 |
| Link Distance (m) | | 97.7 | 99.5 | |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | 50.0 | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 3: Barton Street W & Caroline Street

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | TR | LTR | LTR |
| Maximum Queue (m) | 9.2 | 8.4 | 21.4 | 21.6 | 46.1 |
| Average Queue (m) | 2.4 | 0.5 | 5.3 | 9.7 | 19.4 |
| 95th Queue (m) | 9.0 | 3.6 | 17.1 | 17.1 | 35.1 |
| Link Distance (m) | | 136.9 | 97.7 | 254.0 | |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 50.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Intersection: 4: Barton Street W & Hess Street

| Movement | EB | EB | WB | NB | NB | SB |
|---|---|---|---|---|---|---|
| Directions Served | L | T | TR | L | TR | LR |
| Maximum Queue (m) | 18.6 | 6.3 | 14.7 | 21.9 | 22.7 | 16.5 |
| Average Queue (m) | 4.7 | 0.2 | 1.5 | 9.1 | 10.6 | 7.7 |
| 95th Queue (m) | 12.0 | 2.1 | 7.5 | 16.8 | 18.4 | 13.9 |
| Link Distance (m) | | 120.1 | 136.9 | 260.0 | 260.0 | |
| Upstream Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |
| Storage Bay Dist (m) | 50.0 | | | | | |
| Storage Blk Time (%) | | | | | | |
| Queuing Penalty (veh) | | | | | | |

## Intersection: 5: Barton Street W & Queen Street

| Movement | EB | EB | WB | WB | NB | SB | SB |
|---|---|---|---|---|---|---|---|
| Directions Served | L | TR | L | TR | LTR | LT | TR |
| Maximum Queue (m) | 17.3 | 30.1 | 22.6 | 45.5 | 26.4 | 16.4 | 17.0 |
| Average Queue (m) | 9.6 | 15.9 | 14.9 | 20.6 | 9.9 | 8.9 | 11.8 |
| 95th Queue (m) | 16.8 | 25.6 | 21.9 | 33.5 | 18.0 | 14.7 | 16.9 |
| Link Distance (m) | | 51.1 | | 120.1 | 262.6 | | |
| Upstream Blk Time (%) | | | | | | | |
| Queuing Penalty (veh) | | | | | | | |
| Storage Bay Dist (m) | 50.0 | | 50.0 | | | | |
| Storage Blk Time (%) | | | | 0 | | | |
| Queuing Penalty (veh) | | | | 0 | | | |

## Intersection: 6: Barton Street W & Locke Street

| Movement | WB | WB | NB | SB |
|---|---|---|---|---|
| Directions Served | L | LR | TR | LT |
| Maximum Queue (m) | 20.0 | 21.4 | 22.5 | 9.3 |
| Average Queue (m) | 11.7 | 10.7 | 10.8 | 5.5 |
| 95th Queue (m) | 17.4 | 15.9 | 18.0 | 12.9 |
| Link Distance (m) | 61.0 | 61.0 | 262.9 | 136.4 |
| Upstream Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |
| Storage Bay Dist (m) | | | | |
| Storage Blk Time (%) | | | | |
| Queuing Penalty (veh) | | | | |

## Intersection: 7: Stuart Street & Bay Street N

| Movement | EB | EB | WB | NB | SB |
|---|---|---|---|---|---|
| Directions Served | L | TR | LTR | LTR | LTR |
| Maximum Queue (m) | 24.3 | 20.3 | 22.9 | 79.7 | 34.4 |
| Average Queue (m) | 13.7 | 11.1 | 10.3 | 38.3 | 20.1 |
| 95th Queue (m) | 22.1 | 16.7 | 16.9 | 64.7 | 30.1 |
| Link Distance (m) | | | 185.4 | 205.9 | 179.8 |
| Upstream Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |
| Storage Bay Dist (m) | 70.0 | | | | |
| Storage Blk Time (%) | | | | | |
| Queuing Penalty (veh) | | | | | |

## Zone Summary

Zone wide Queuing Penalty: 1

# BARTON- TIFFANY STUDY AREA

# Functional

# Servicing Report

**Project Location:**
Hamilton, ON

**Prepared for:**
GSP Group Inc.
29 Rebecca Street, Suite 200
Hamilton, ON

**August 2014**

**MTE File No.: 38514-100**

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## TABLES



## FIGURES WITHIN REPORT



## FIGURES

# 1.0 INTRODUCTION

MTE Consultants Inc. was retained by GSP Group Inc. to complete a Functional Servicing Report in support of an Urban Design Study commissioned by the City of Hamilton for the Barton-Tiffany Study Area. The Urban Design Study will serve as the benchmark for form and functional design and as an implementation tool for future development applications within the Study Area.

The Study Area is located in the City of Hamilton and consists of approximately 22.8 ha of land. The north portion of the site is generally bounded by Bay Street to the east, Barton Street to the south, Crooks Street to the west and Stuart Street and a CN Rail shunting yard to the north. The south portion of the site is generally bounded by Bay Street to the east, the south boundary of Central Park to the south, Caroline Street to the west and Barton Street to the north, as shown on **Figure 1.0**.

The site is proposed to be developed as an area of mixed-use intensification composed of a multi-functional neighbourhood which will include residential, commercial/industrial and recreational/public spaces.

# 2.0 EXISTING SITE CONDITIONS

## 2.1 Existing Zoning

The Study Area is located within the larger West Harbour area of Hamilton and has traditionally been an area of concentrated industrial activity, dating back to the 1800s. The large CN Rail shunting yard separating the Study Area from the waterfront remains in use and speaks to the area's industrial past. **Figure 2.0** shows the existing land-uses within the Study Area.

With the migration of industry from the area in recent years, large parcels of land stand either underutilized or vacant altogether. The City of Hamilton currently owns a number of these vacant properties within the Study Area, including:

- The former Rheem factory site bounded by Stuart Street, Tiffany Street, Barton Street and Caroline Street. The former factory has been demolished and the site is currently undergoing environmental remediation.
- The property bounded by Stuart Street, Caroline Street, Barton Street and Hess Street. The buildings previously occupying this site, including a gasoline filling station, detached residential buildings and various industrial buildings have been demolished, though the building foundations remain.
- The property west of Bay Street bounded by Barton Street, Sheaffe Street and Caroline Street currently occupied by the City of Hamilton Central Services Building.

- A large industrial parcel adjacent to the CN Rail shunting yard west of the intersection of Stuart Street and Hess Street and north of the existing AVL Manufacturing Inc. property.
- The City also owns a number of smaller, interspersed properties adjacent to the east side of Tiffany Street, north of Barton Street.

Aside from City-owned lands, other properties within the Study Area include:

- Parcels of vacant land at the southeast corner of the intersection of Tiffany and Stuart Streets;
- The parcel of land bounded by Hess Street, Barton Street, Queen Street and Stuart Street which contains an abandoned industrial building site at the northeast corner surrounded by vegetated land;
- Two undeveloped properties adjacent to the north side of Barton Street west of Queen Street;
- Low density residential properties adjacent to the west side of Bay Street and east side of Tiffany Street between Barton and Stuart Streets; and
- The industrial property west of Queen Street currently occupied by AVL Manufacturing Inc.

Central Park is located within the Study Area and forms its south boundary.

## 2.2 Existing Easements

Central Park is a prominent feature of the Study Area at which a number of the surrounding streets terminate, including: Mill and Harriet Streets at the west park boundary; Caroline and Railway Streets at the south boundary; Sheaffe Street at the east boundary; and Caroline Street at the north boundary (refer to **Figure 6.0**).

In order to maintain continuity of the services located in the surrounding adjacent streets, a number of existing services currently extend through the park. These include: a combined (storm/sanitary) sewer and water main running north-south from Caroline Street at the south park boundary to Caroline Street at the north boundary; a combined sewer running roughly diagonally from Railway Street at the south park boundary to Harriet Street at the west park boundary; a combined sewer running from Mill Street at the west boundary to connect to the aforementioned Caroline Street sewer within the park; and separated storm and sanitary sewers running from Sheaffe Street at the east boundary to the Caroline Street main north of the park.

North of the Study Area there are three outlets in the CN Rail yard which extend under the railway tracks (refer to **Figure 6.0**). These include: a 1200 mm diameter combined sewer crossing the rail yard north of the intersection of Stuart Street and Queen Street; 900 mm and 1350 mm diameter storm sewers crossing the rail yard between Hess and Caroline Streets; and an 800 mm x 1200 mm sanitary sewer crossing the rail yard between Tiffany and Bay Streets.

Any future development or road network will need to contemplate easements placed over the existing services such that they remain accessible for future maintenance. Alternatively, these services may be relocated within new road networks or pedestrian links so as not to restrict or hinder options for future development blocks.

Constructing new sewer crossings beneath the active rails will be expensive and have the added complexity of requiring new legal agreements with CN Rail; therefore, the sewer concept for the Study Area will look to take advantage of these existing connections rather than construct new sewers across the rail yard.

## 2.3 Topographic Conditions

The Study Area is characterized by a large, low-lying, relatively flat area bounded by higher-elevation ground to the east, south and west, as shown on **Figure 3.0**.

Barton Street between Tiffany and Queen Streets is relatively flat; ranging in elevation from 84.0 m to 85.0 m. West of Queen Street, Barton Street rises up at approximately 5% to an elevation of 95.0 m at Magill Street. Barton Street is again relatively flat west of Magill Street. East of Tiffany Street, Barton Street again rises steeply at a grade of approximately 9% to an elevation of 94.0 m at Bay Street.

Roads north of Barton Street slope gradually down to Stuart Street, which is relatively flat, ranging in elevation between 77.0 m and 78.0 m along most of its length. Like Barton Street, Stuart Street rises sharply east of Tiffany Street to meet Bay Street at an elevation 87.0 m.

Caroline Street south of Barton Street slopes up gradually from an elevation of 84.0 m at Barton Street to an elevation of 89.0 m where it meets Central Park. Central Park also generally slopes up to the south with the north edge of the park at an approximate elevation of 89.0 m and the south edge of the park at an elevation of 95.0 m.

Two significant slopes are located on properties within the Study Area which warrant discussion. There is an existing retaining wall and along the east and south boundaries of the City of Hamilton Central Services property. From the top of the retaining wall the ground slopes up steeply to meet the backs of the adjacent properties. The slope rises from an approximate elevation of ± 89.0 m on top of the wall to an elevation of 94.0 m at the rear of the surrounding residential properties. The other significant slope is located at the north edge of the properties adjacent to Barton Street west of Queen Street. The top of this approximate 50% slope has an elevation of 95.0 m and slopes down to the north to an elevation of 80.0 m at the AVL Manufacturing Inc. property. These elevation changes will provide both constraints and opportunities within the future development scenarios.

## 3.0 PROPOSED DEVELOPMENT

The Preferred Urban Design Concept for the Study Area was provided by GSP Group Inc. (see **Figure 4.0**). For ease of discussion the Study Area will be broken into the following three sub-areas (**Figure 5.0**):

> **Sub-Area 1** includes the area south of Barton Street and comprises Parcels 10 and 11a to 11e, Central Park, Barton Street between Queen and Bay Streets and the proposed extensions of Harriet, Mill, Caroline, Mulberry and Railway Streets;
>
> **Sub-Area 2** includes the area north of Barton Street between Queen Street and Bay Street and comprises Parcels 1 to 7, the proposed GO Transit parking lot north of Stuart Street and Hess, Caroline, Tiffany and Stuart Streets.
>
> **Sub-Area 3** includes the area west of Queen Street and contains Parcels 8 and 9, and Queen Street north of Barton Street and Barton Street west of Queen Street.

### 3.1 Proposed Zoning

#### *3.1.1 Sub-Area 1*

Sub-Area 1 is located on the sites currently occupied by Central Park and the existing Hamilton Central Services building.

The proposed development of Sub-Area 1 includes extending the existing streets which currently terminate at Central Park in order to improve connectivity through the site. This includes constructing Caroline Street through the park to connect the existing Caroline Street terminuses at the north and south park boundaries. Mill and Harriet Streets are proposed to be extended to connect to the west side of Caroline Street and Mulberry Street is proposed to be extended to connect to the east side of Caroline Street. Railway Street is proposed to be extended north to connect to Mulberry Street.

Five residential parcels (Parcels 11a to 11e) comprised mostly of townhomes with some single detached homes are proposed at the south end of the sub-area which currently comprises part of Central Park. A residential parcel (Parcel 10) fronting Central Park and accessed from Barton Street is proposed at the northeast corner of the sub-area which currently comprises part of the Hamilton Central Services site.

Central Park is proposed to be reconfigured such that it forms an ‘L’ shape bounded by Barton Street, Caroline Street, Mulberry Street, Bay Street, Sheaffe Street and by the west boundary of the residential parcels located between Barton and Sheaffe Streets. A community facility is proposed for the north end of the park.

Table 1 summarizes the existing and proposed land-uses for Sub-Area 1.

**TABLE 3.1.1 – SUB-AREA 1 LAND-USE SUMMARY**

| | Green Space / Park | Residential | Industrial/ Commercial | Road Right-of-Way | Total |
|---|---|---|---|---|---|
| **Pre-Development Area (ha)** | 2.79 | 0 | 2.47 | 1.36 | 6.62 |
| **Post-Development Area (ha)** | 1.80 | 1.47 | 0.52 | 2.83 | 6.62 |

### *3.1.2 Sub-Area 2*

Sub-Area 2 consists of properties north of Barton Street between Bay and Queen Streets and includes Stuart Street. The existing properties in this area are largely former industrial properties, with the exception of some low-density residential properties fronting the east side of Tiffany Street and west side of Bay Street.

The buildings on the properties between Hess Street and Tiffany Street have been demolished, along with the buildings on the property at the southeast corner of the Stuart Street/Tiffany Street intersection. An abandoned industrial building remains at the northeast corner of the property located between Queen Street and Hess Street; the remainder of this property is undeveloped and overgrown with vegetation.

The proposed development of Sub-Area 2 includes commercial properties fronting Stuart Street along its entire length from Queen Street to Bay Street with medium- to high-density residential properties consisting mostly of townhomes fronting Barton and Bay Streets with two proposed residential towers located on Parcels 2 and 4 at the intersection of Barton and Caroline Streets. A parking lot for a GO Transit facility is proposed to run adjacent to the north side of Stuart Street from Queen Street to Bay Street.

Table 3.1.2 summarizes the existing and proposed land-uses for Sub-Area 2.

**TABLE 3.1.2 – SUB-AREA 2 LAND-USE SUMMARY**

| | Green Space / Park | Residential | Industrial/ Commercial | Road Right-of-Way | Total |
|---|---|---|---|---|---|
| **Pre-Development Area (ha)** | 1.01 | 1.26 | 5.86 | 2.16 | 10.27 |
| **Post-Development Area (ha)** | 0 | 2.90 | 3.55 | 3.82 | 10.27 |

### *3.1.3 Sub-Area 3*

Sub-Area 3 consists of properties within the Study Area north of Barton Street and west of Queen Street and includes Queen Street north of Barton Street and Barton Street west of Queen Street. AVL Manufacturing Inc. operates an industrial manufacturing facility adjacent to Queen Street. Vacant, vegetated properties are located south of the AVL site, adjacent to Barton Street.

The proposed development of Sub-Area 3 includes a residential parcel (Parcel 9) adjacent to Barton Street on land that is currently vacant and vegetated and the re-development of the AVL site (Parcel 8) as a commercial development.

A path located between Parcel 8 and the City-owned industrial property is proposed to connect Stuart Street to the north end of Locke Street North.

The vegetated tract of land between proposed developments on Parcel 8 and Parcel 9 is currently zoned as Conservation/Hazard Land (P5) and is characterized by a steep, 2H:1V slope. For the purpose of this report it is assumed that no development will take place on this steep slope and that it will remain vegetated.

Table 3.1.3 summarizes the existing and proposed land-uses for Sub-Area 3.

**TABLE 3.1.3 – SUB-AREA 3 LAND-USE SUMMARY**

| | Green Space / Park | Residential | Industrial/ Commercial | Road Right-of-Way | Total |
|---|---|---|---|---|---|
| **Pre-Development Area (ha)** | 2.11 | 0 | 2.80 | 0.97 | 6.62 |
| **Post-Development Area (ha)** | 2.11 | 0.62 | 1.99 | 1.15 | 6.62 |

## 3.2 Proposed Servicing Easements / Realignments

A number of existing services (sewers and watermain) currently cross through Central Park to connect sewers from the adjacent streets to the existing Caroline Street sewer. As mentioned in the previous section, the proposed development in Sub-Area 1 includes a reconfiguration of Central Park which will affect these existing services (refer to **Figure 6.1**).

An existing 300 mm diameter storm sewer and 250 mm diameter sanitary sewer run east-west within the reconfigured Central Park from where Sheaffe Street intersects with the park to Caroline Street. If these sewers were to remain in their current location it is recommended that an easement would be provided over the services to ensure access for maintenance. These services and easements would need to be considered during future use planning of the park (e.g. incorporation of play fields, etc.). Alternatively, there may be a benefit to re-aligning the Sheaffe Street storm and sanitary sewers to flow north to Barton Street along the east park boundary and to remove the existing east-west sewers within Central Park. Though the re-aligned sewers would also require an easement, this alternate alignment may be less restrictive to future park planning.

An existing 300 mm diameter combined sewer currently flows from Harriet Street to the existing 450 mm diameter combined sewer running south to north through Central Park in line with Caroline Street on either side of the park. The existing Harriet Street sewer cuts across the northeast corner of the proposed development parcel at the corner of Caroline and Harriet Streets. Rather than register an easement over the development parcel to allow the existing sewer to remain in its current location, it is recommended the sewer be realigned to run within the Harriet Street road allowance. In addition, given the opportunity within the proposed development, the combined sewer should be separated into storm and sanitary sewers and connected to the appropriate system.

Combined sewer flow from Railway Street currently enters Central Park where Railway Street intersects the park and then flows west to connect to the aforementioned north-south combined sewer in the park. Similar to the existing configuration at Harriet Street, the existing sewer cuts across the corner of a proposed development parcel. It is recommended that the Railway Street sewer be re-aligned to remain within the right-of-way of the proposed Railway Street extension. It is also recommended the existing Railway Street combined sewer be separated into storm and sanitary sewers through the park and connected to the appropriate system.

From the Study Area there are outlets at three locations within the CN Rail yard which extend under the railway tracks. These include: a 1200 mm diameter combined sewer crossing the rail yard north of the intersection of Stuart Street and Queen Street; 900 mm and 1350 mm diameter storm sewers crossing the rail yard between Hess and Caroline Streets; and a 800 mm x 1200 mm sanitary sewer crossing the rail yard between Tiffany and Bay Streets.

As previously discussed, constructing new sewer crossings beneath the active rails will be expensive and have the added complexity of requiring new legal agreements with CN Rail; therefore, the sewer concept for the Study Area will look to take advantage of these existing connections rather than construct new sewers across the rail yard.

Note that the existing 1200 mm diameter sewer north of Queen Street crosses the northeast corner of proposed Parcel 8. An easement will be required over the sewer where it crosses through the development parcel. Furthermore, the current design concept shows a building located on top of the existing sewer. The existing sewer, therefore, will need to be re-aligned to avoid the building.

## 3.3 Proposed Grading

### *3.3.1 Proposed Roads*

The proposed development in Sub-Area 1 includes extending a number of existing streets to improve connectivity. On the west side of Central Park an extension of Caroline Street is proposed to connect existing Caroline Street north of the park to Caroline Street south of the park. Extensions of Harriet Street, Mill Street and Mulberry Street are proposed to connect to the Caroline Street extension (refer to **Figure 3.0**).

The existing elevation of Caroline Street is approximately 88.0 m where it terminates north of Central Park and approximately 94.5 m where it terminates south of the park. The proposed Caroline Street connection between these two points can be constructed with a minimum longitudinal grade of approximately 3.5%, which is well within City of Hamilton design standards. Because the grades of existing Caroline Street at either end of the park are in the range of 3% to 4%, no vertical curves will be necessary to construct the proposed connecting road. The proposed intersecting roads (Harriet, Mill and Mulberry Streets) will have similarly flat grades.

The Caroline Street connection would require some amount of through-cut, as existing Caroline Street north of the park terminates at the base of a moderate slope. There is no opportunity to alter the profile of the existing road north of the park due to the presence of existing residences with minimal setbacks adjacent to the west side of the street.

### *3.3.2 Proposed Development Parcels*

Although the majority of the Study Area is relatively flat with gentle slopes, there are three locations where special consideration with respect to site grading will need to be given during the detailed design of the building sites:

**Parcel 1** is located north of Barton Street and South of Stuart Street, between Tiffany and Bay Streets. Currently, there are existing residential buildings fronting Bay Street on the east side of this parcel; the west side of the parcel is composed of both residential properties and vacant lots. There is a significant (± 8.0 m) elevation difference east-west across this parcel. Most of the elevation change takes place in the middle of the parcel, with the portions of land adjacent to Tiffany and Bay Streets being relatively flat. Stuart and Barton Streets, adjacent to the north and south parcel boundaries, are constructed at a more or less constant slope between Tiffany and Bay Streets.

Special consideration with respect to grading will be required in the detailed design of this parcel. Much of the elevation difference across the site can be made up by designing the buildings to be stepped, with two or more Finished Floor Elevations (FFE's). A retaining wall may be required at the northeast corner of the site adjacent to any existing buildings fronting Stuart Street which are to remain. Furthermore, landscaping for the site may also require terracing and/or additional retaining walls to make up the grade difference across the site.

**Parcel 9** is located on the north side of Barton Street between Ray Street and Crook Street on a parcel of land that sits roughly 10 m higher than other proposed development parcel located on Queen Street (Parcel 8). The majority of the parcel is relatively flat at an elevation of ± 95.0 m, however, there is an existing steep (2H:1V) slope starting approximately 20 m south of the north parcel boundary which drops 15.0 m in elevation to the back of the AVL site (Parcel 8). A retaining wall will be required to be constructed at the north boundary of Parcel 9 in order to develop the site as proposed in the Demonstration Concept without encroaching onto the adjacent properties to the north.

The proposed path connecting Stuart Street to the north end of Locke Street North is located on this slope. From where Locke Street North ends to the bottom of the slope there is an elevation difference of ± 19 m. The path will require stairs in order to accommodate the grade change. Significant meanders/switchbacks would be required to be added to the current configuration in order for the path to be considered fully accessible.

**Parcel 10** is located on the existing Hamilton Central Services site, south of Barton Street between Central Park and the existing residential properties on Bay and Sheaffe Streets, which are proposed to remain. The existing Central Services site sits approximately 7.0 m to 8.0 m lower than the adjacent residential properties to the east and south. To accommodate the elevation difference there is an existing 2.5 m to 3.0 m high retaining wall located east and south of the Central Services building. This retaining wall is offset from the property boundary, with the remaining elevation difference made up by a steep slope rising from the top of the retaining wall to the backs of the adjacent properties.

Depending on the final site plan for this parcel, the existing retaining wall may need to be replaced with a new, higher retaining wall located along the east and south parcel boundaries.

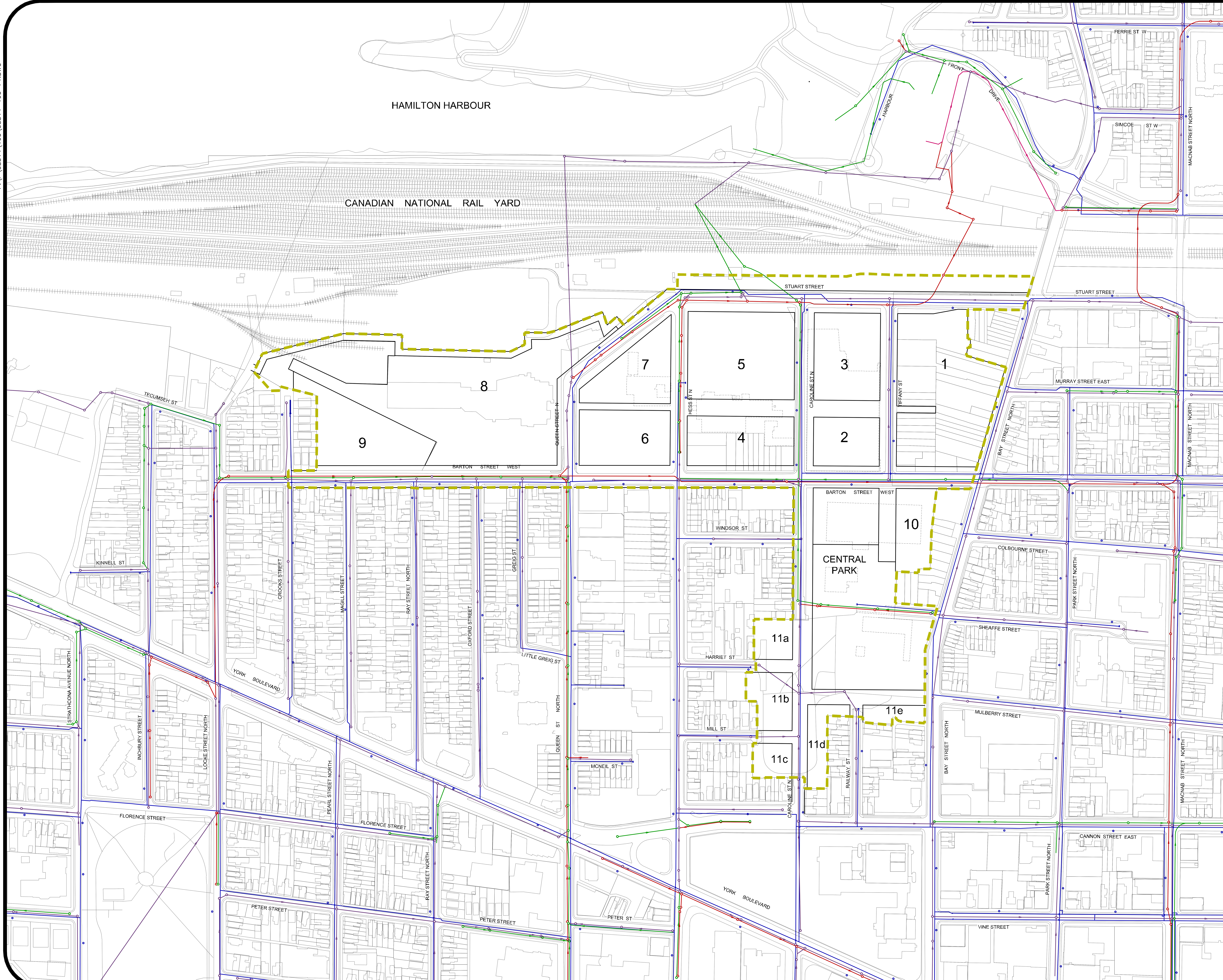
## 4.0 EXISTING SERVICING REVIEW

The Study Area is located in an old part of the City. The following discussion regarding the existing servicing capacity assumes that the existing services all function as they were intended, with no degradation of functionality due to age or any other effects. Prior to development, it is strongly recommended that the existing services be video-inspected or otherwise tested to determine whether any replacement or upgrading of services is required. It is anticipated that planned replacement of underground services is a component of the City's capital planning and overall infrastructure management plans. This document will assist in sizing and guiding potential new connections, alignments and/or potential separations.

A review of the existing sewer system identified many cross connections, flow splitting manholes and sewer overflows upstream and downstream of the Study Area (see **Figures 6.0 to 6.4**). Due to the complexity of the sewer system, both upstream and downstream of the Study Area, the following discussion does not attempt to analyze the affects of proposed development within the Study Area on the greater external sewer system; rather, assumptions will be made to estimate the servicing capacity immediately up and downstream of the Study Area.

## 4.1 Water Servicing

The Study Area is well serviced by an existing water distribution network, with watermains located in all roads within the Study Area, ranging in size from 100 mm diameter to 300 mm diameter. This existing layout provides excellent looping and redundancy in the water supply. Although the domestic water demands for the site will not likely increase with development, as the Study Area formerly housed heavy industry, it is likely that 100 mm diameter watermains will not be sufficient to meet fire flow requirements. The existing system will be required to be modeled, taking into account the pressure zone boundaries located within the Study Area, in order to confirm any upgrades once a detailed land-use plan has been developed for the Study Area. It is anticipated that 150 mm diameter watermains will be required at minimum to achieve appropriate fire protection.




LEGEND

- LIMIT OF STUDY AREA
- EXISTING COMBINED SEWER
- EXISTING SANITARY SEWER
- EXISTING WATERMAIN
- EXISTING STORM SEWER
- EXISTING FORCEMAIN

Scale: 1:2000 AUG. 2014

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**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

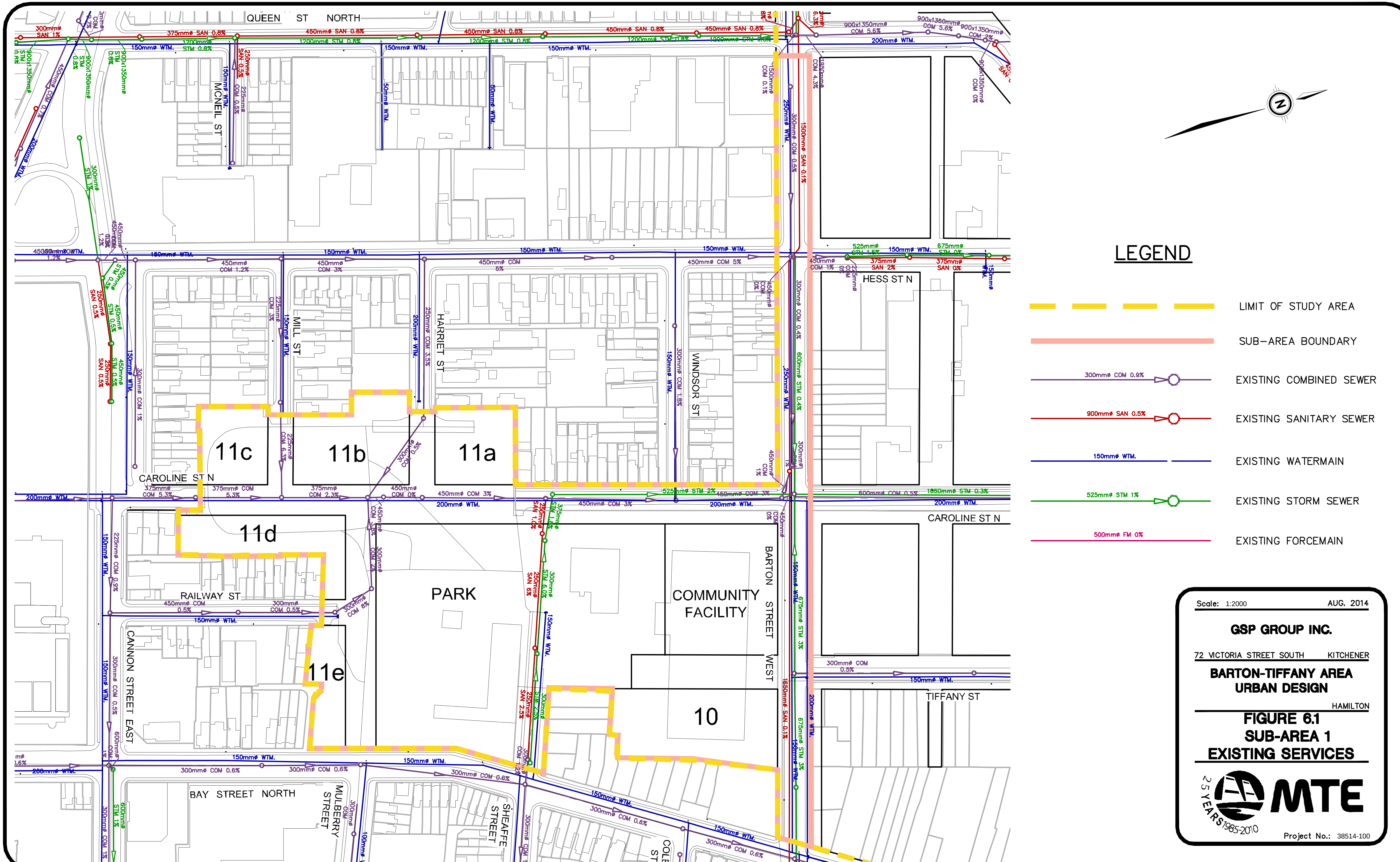
**FIGURE 6.0**
**EXISTING SERVICES**

25 YEARS 1985-2010 MTE

Project No.: 38514-100

38514-100-F6.0
EXISTING SERVICES
MTE FILE No: P:\P\38514\100\38514-100-F1.DWG

August 13, 2014 — 3:42 p.m. — Plotted By: pralmboult




August 13, 2014 4:24 p.m. Plotted By: praimbault

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August 13, 2014 4:24 p.m. Plotted By: praimbault

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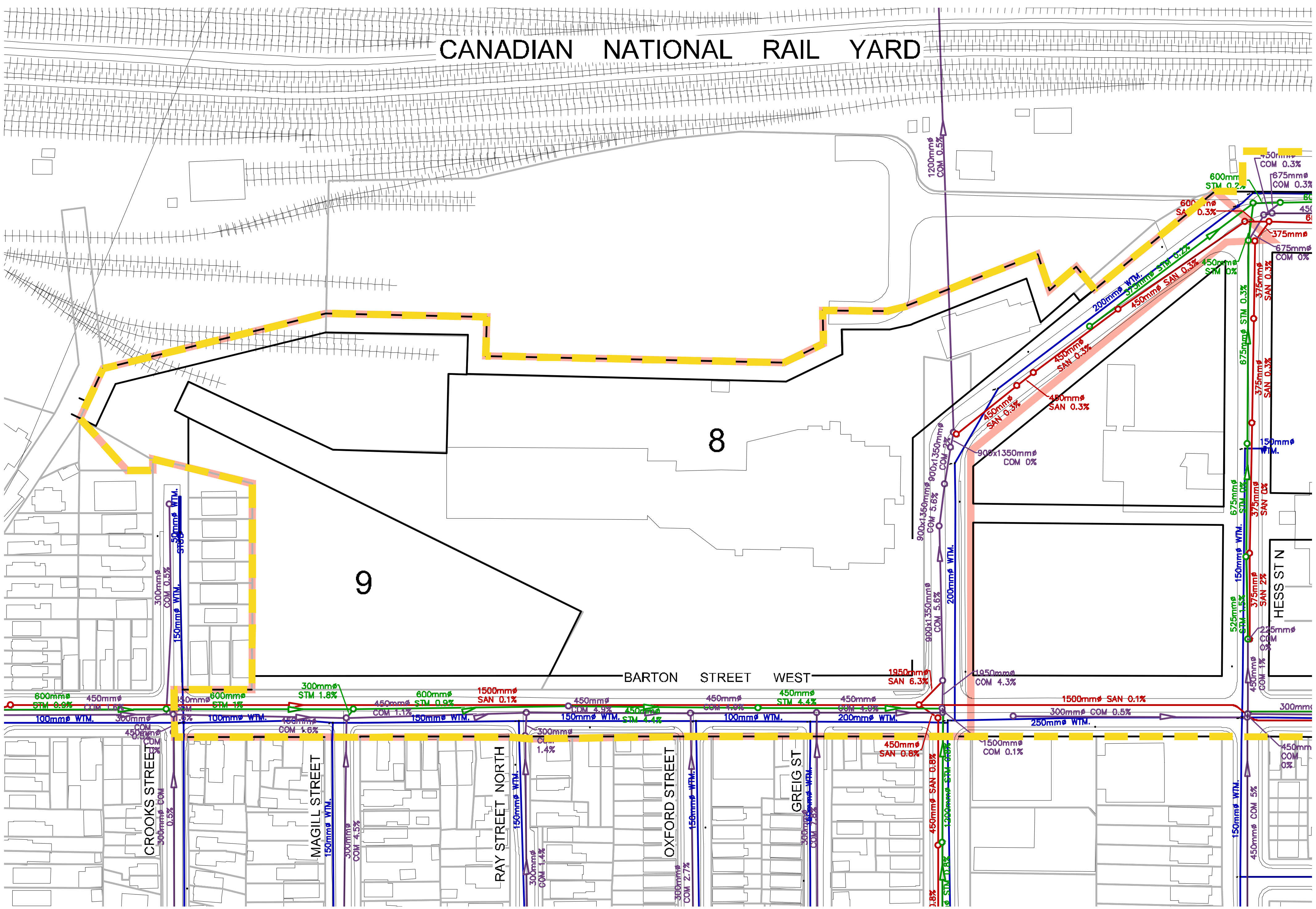


## LEGEND

- LIMIT OF STUDY AREA
- SUB-AREA BOUNDARY
- 300mmø COM 0.9% — EXISTING COMBINED SEWER
- 900mmø SAN 0.5% — EXISTING SANITARY SEWER
- 150mmø WTM. — EXISTING WATERMAIN
- 525mmø STM 1% — EXISTING STORM SEWER
- 500mmø FM 0% — EXISTING FORCEMAIN

Scale: 1:2000 AUG. 2014

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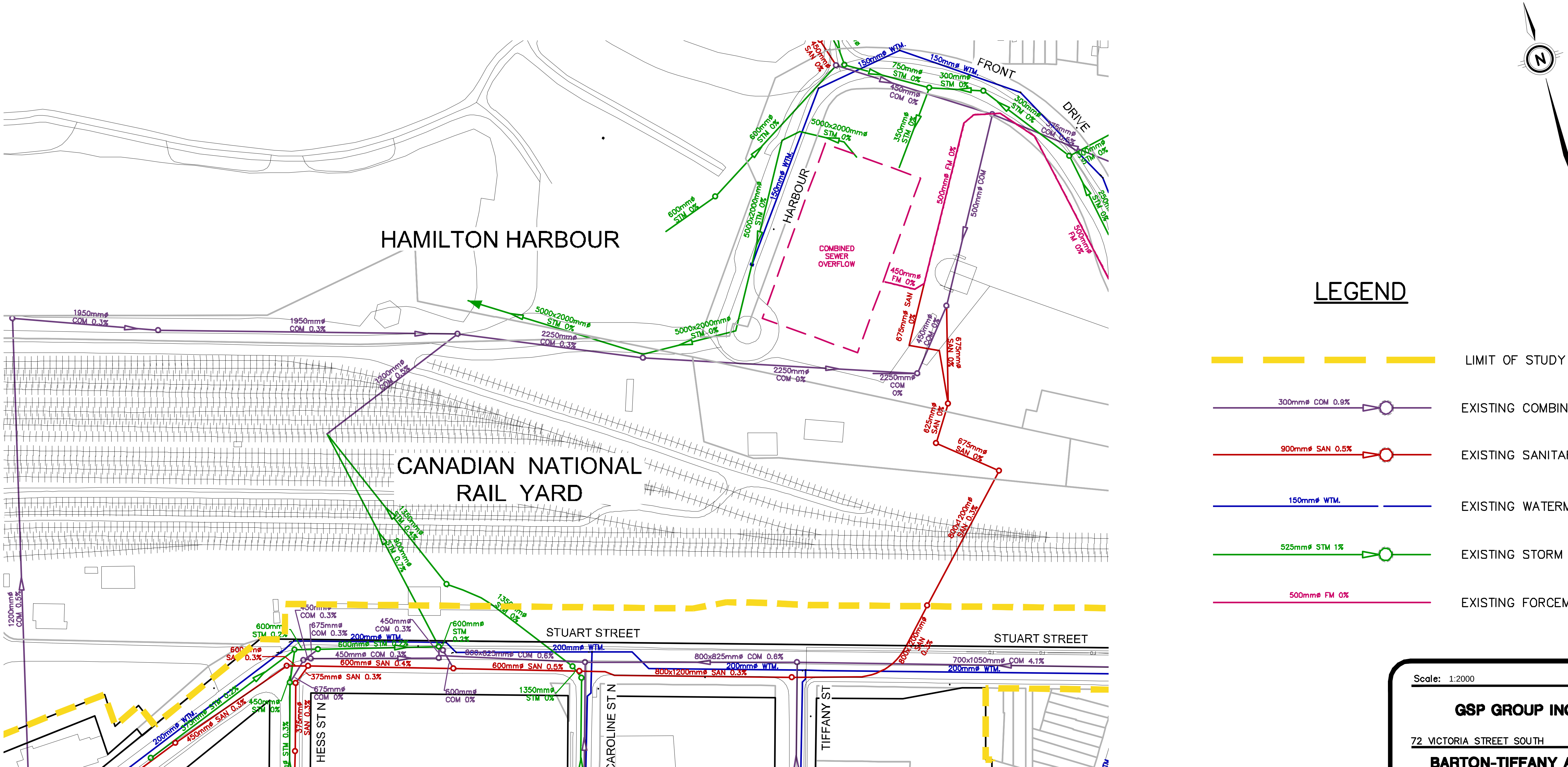
**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

**FIGURE 6.3 SUB-AREA 3 EXISTING SERVICES**

MTE 25 YEARS 1985-2010

Project No.: 38514-100




## LEGEND

| | |
|---|---|
| | LIMIT OF STUDY AREA |
| 300mmø COM 0.9% | EXISTING COMBINED SEWER |
| 900mmø SAN 0.5% | EXISTING SANITARY SEWER |
| 150mmø WTM. | EXISTING WATERMAIN |
| 525mmø STM 1% | EXISTING STORM SEWER |
| 500mmø FM 0% | EXISTING FORCEMAIN |

Scale: 1:2000 AUG. 2014

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**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

**FIGURE 6.4**
**STUDY AREA OUTFALLS EXISTING SERVICES**

25 YEARS 1985-2010 MTE

Project No.: 38514-100

### *4.1.1 Sub-Area 1*

An existing 200 mm diameter watermain runs north-south in Caroline Street and through Central Park within this Sub-Area. There are 150 mm and 200 mm diameter watermains located in Barton Street east of Caroline Street and a 250 mm diameter watermain in Barton Street west of Caroline Street. The Caroline Street main is connected to the Barton Street watermains.

A 150 mm diameter watermain connects to the Caroline Street main at Windsor Street. There are also existing stubbed watermains located in the dead-end streets surrounding Central Park (200 mm diameter at Harriet Street and 150 mm diameter at Mill and Railway Streets).

### *4.1.2 Sub-Area 2*

A continuous existing 200 mm diameter watermain is located within Stuart Street which connects to the existing mains in Barton and Queen Streets. 150 mm and 200 mm diameter watermains located in Tiffany and Caroline Street, respectively, connect to the Stuart and Barton Street mains.

There is a “hanging” watermain located in Hess Street which is connected to the Barton Street main but dead-ends midblock between Barton and Stuart Streets.

### *4.1.3 Sub-Area 3*

An existing 200 mm diameter watermain is located in Queen Street which connects to the existing Stuart Street and Barton Street mains. An existing watermain in Barton Street varies in size though this sub-area, ranging from 100 mm diameter between Grieg and Oxford Streets, 150 mm diameter between Oxford and Magill Streets and 200 mm diameter west of Magill Street and east of Grieg Street.

## 4.2 Existing Storm & Sanitary Sewer Servicing

As noted above, the Study Area was originally serviced by combined sewers, which convey both storm and sanitary sewer flow, and require treatment prior to discharge to the environment. The City of Hamilton has begun the process of separating the combined sewer system into separate storm and sanitary systems and has mandated that all new sewers in the City shall be separated, with provision made to connect to existing up- or downstream combined sewers where required.

Because full separation of the upstream sewer system has not taken place, all sewer flow entering the Study Area is assumed to be combined for the purposes of this report unless a definite separated (storm or sanitary) flow can be determined.

Storm sewer flows in the following sections are calculated using the Rational Method, based on the 5-Year Mount Hope rainfall intensity and a 10 minute inlet time, in accordance with current City of Hamilton design standards. A velocity of 2 m/s within sewer pipes is used to estimate the travel time within a sewer in order to determine time of concentration.

Sanitary sewer flows are calculated based on average per-capita daily flows of 360 l/day, in accordance with City of Hamilton design standards. Peaking factors are based on the Babbitt Formula and an infiltration allowance of 0.2 l/s/ha has been made.

### *4.2.1 Upstream Sewer Catchments*

For simplification, upstream catchments were assigned one of three land uses with corresponding stormwater runoff coefficients (i.e. ‘c’ values) - park (c = 0.25), residential (c = 0.60) or commercial (c = 0.80). Unlike for the internal Study Area sub-areas, road rights-of-way were not considered as a separate land-use for the external catchments. Note that a lower ‘c’ value was used for residential areas outside of the Study area than for the proposed development within the Study Area owing the larger proportion of single-family and semi-detached homes as opposed to townhomes and apartments.

Contributing sanitary populations are estimated on a persons-per-hectare (ppha) basis, with assumed values of 25 ppha for parks, 75 ppha for residential areas and 450 ppha for commercial areas.

Catchment boundaries were provided in CAD format by the City of Hamilton GIS Department. Examination of the sewer networks within each catchment shows that not all flow generated within a catchment will necessarily find its way to the catchment outlet, as there are several cross-connections and overflow structures located upstream of the Study Area.

Due to the complexity of the upstream sewer network, this report does not endeavor to determine how or where upstream external sewer flows are split out of the upstream catchments and, rather, assumes that all flow generated within a catchment will reach the catchment outlet.

Upstream catchment boundaries and assumed land-uses are shown on **Figure 7.0**.

**Catchment A** is generally the area north of York Boulevard between Inchbury and Ray Streets, but also includes drainage from nearby Dundurn Castle. Flow from this catchment enters Sub-Area 3 in sanitary and combined sewers located in Barton Street. Tables 4.2.1a and 4.2.1b describe the flow parameters of this catchment.

**TABLE 4.2.1A – CATCHMENT A STORM RUNOFF PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|
| Park (c = 0.25) | Residential (c = 0.60) | Commercial (c = 0.80) | | |
| 1.03 | 11.50 | 0 | 12.53 | 0.57 |

**TABLE 4.2.1B – CATCHMENT A SANITARY FLOW PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|
| Park (25 ppha) | Residential (75 ppha) | Commercial (450 ppha) | | |
| 1.03 | 11.50 | 0 | 12.53 | 888 |

**Catchment B -** is generally defined as the area south of York Boulevard between Dundurn and Queen Streets and the area north of York Boulevard and south of Barton Street between Ray and Queen Streets. The majority of sewer flow from this catchment enters Sub-Area 3 from sewers in Queen Street. Tables 4.2.2a and 4.2.2b describe the flow parameters of this catchment.

**TABLE 4.2.2A – CATCHMENT B STORM RUNOFF PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|
| Park (c = 0.25) | Residential (c = 0.60) | Commercial (c = 0.80) | | |
| 3.06 | 25.40 | 11.23 | 39.69 | 0.63 |

**TABLE 4.2.2B – CATCHMENT B SANITARY FLOW PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|
| Park (25 ppha) | Residential (75 ppha) | Commercial (450 ppha) | | |
| 3.06 | 25.40 | 11.23 | 39.69 | 7035 |

**Catchment C -** is the area defined by the properties south of Barton Street and north of York Avenue adjacent to Hess Street. Sewer flow from this catchment enters Sub-Area 2 at the intersection of Barton and Hess Streets. Tables 4.2.3a and 4.2.3b describe the flow parameters of this catchment.

**TABLE 4.2.3A – CATCHMENT C STORM RUNOFF PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|
| Park (c = 0.25) | Residential (c = 0.60) | Commercial (c = 0.80) | | |
| 0.59 | 1.93 | 2.66 | 5.18 | 0.66 |

**TABLE 4.2.3B – CATCHMENT C SANITARY FLOW PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|
| Park (25 ppha) | Residential (75 ppha) | Commercial (450 ppha) | | |
| 0.59 | 1.93 | 2.66 | 5.18 | 1357 |

**Catchment D -** is the area defined by the area north of York Boulevard and south of Barton Street between Bay and Caroline Streets, including properties adjacent to the west sides of Caroline Street and Central Park. Sewer flow from this catchment enters Sub-Area 1 via a combined sewer in Caroline Street. Tables 4.2.4a and 4.2.4b describe the flow parameters of this catchment.

**TABLE 4.2.4A – CATCHMENT D STORM RUNOFF PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|
| Park (c = 0.25) | Residential (c = 0.60) | Commercial (c = 0.80) | | |
| 1.67 | 4.04 | 0.16 | 5.87 | 0.51 |

**TABLE 4.2.4B – CATCHMENT D SANITARY FLOW PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|
| Park (25 ppha) | Residential (75 ppha) | Commercial (450 ppha) | | |
| 1.67 | 4.04 | 0.16 | 5.87 | 417 |

**Catchment E -** is the area north of York Boulevard and south of Barton Street between Bay Street to the west and James Street to the east and the area north of Barton Street and south of Stuart Street between Bay Street and Murray Street. Combined sewer flow from this catchment enters Sub-Area 2 via a combined sewer in Stuart Street. A large (1200 mm x 1314 mm) storm sewer diverts a portion of the combined flow from the intersection of Park Street North and Barton Street and conveys it into the Study Area at the intersection of Barton and Bay Streets. The storm sewer flow from Catchment E, therefore, requires that Catchment E be broken into two parts (Catchment E1 and Catchment E2). Tables 4.2.5a and 4.2.5b describe the flow parameters of this catchment.

**TABLE 4.2.5A – CATCHMENT E STORM RUNOFF PARAMETERS**

| | Land Use (ha) | | | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|---|
| | Park (c = 0.25) | Residential (c = 0.60) | Commercial (c = 0.80) | | |
| Catchment E1 | 0.48 | 7.81 | 6.97 | 15.26 | 0.68 |
| Catchment E2 | 0 | 4.69 | 9.51 | 14.20 | 0.73 |

**TABLE 4.2.5B – CATCHMENT E SANITARY FLOW PARAMETERS**

| Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|
| Park (25 ppha) | Residential (75 ppha) | Commercial (450 ppha) | | |
| 0.48 | 12.17 | 16.82 | 16.82 | 8493 |

### *4.2.2 Existing Sewers*

**Sub-Area 1**

There are existing 525 mm diameter storm and 450 mm diameter combined sewers located in Caroline Street between Barton Street and Sheaffe Street. A separated storm sewer from Sheaffe Street connects to the terminal manhole of the Caroline Street storm sewer and a separated sanitary sewer from Sheaffe Street connects to the Caroline Street combined sewer. South of Sheaffe Street the existing Caroline Street sewer (through Central Park) consists of an existing combined sewer only.

A large, 1500 mm diameter sanitary trunk sewer enters Sub-Area 1 from Sub-Area 3 and continues through Sub-Area 1 along Barton Street where it exits at Bay Street. There is an existing 300 mm diameter combined sewer in Barton Street between Queen Street and Hess Street which flows to a manhole located at the intersection of Hess Street and Barton Street. From this manhole flow is split to three separate sewers: a 450 mm diameter combined sewer flowing north to Hess Street in Sub-Area 2 and 600 mm diameter storm and 300 mm diameter combined sewers flowing east in Barton Street to Caroline Street. An existing 675 mm diameter storm sewer flowing from Bay Street to Caroline Street is also located in Barton Street within Sub-Area 1.

At Caroline Street the 300 mm diameter Barton Street combined sewer connects to the aforementioned sanitary trunk sewer. A portion of the combined flow from Caroline Street south of Barton Street also connects to the trunk sewer, with the remainder connecting to an existing combined sewer manhole at the intersection of Barton and Caroline Streets. The existing Barton Street and Caroline Street storm sewers also converge at this manhole. Flow from this manhole flows north to Sub-Area 2 in existing 1050 mm diameter storm and 600 mm diameter combined sewers.

External combined sewer flow enters Sub-Area 1 from Catchment C at Hess Street and from Catchment D in several locations, including Caroline Street south of Central Park, Mill Street, Harriet Street, Railway Street and Windsor Street. External storm sewer flow enters Sub-Area 1 from Catchment E2 in a 1200 mm x 1350 mm storm sewer at the intersection of Barton and Bay Streets.

**Sub-Area 2**

Existing separated storm (525 mm diameter) and sanitary (375 mm diameter) sewers are located within Hess Street. These sewers are split from an existing 450 mm diameter combined sewer connected to Barton Street in Sub-Area 1. Flow in the existing storm sewer splits from a manhole located at the intersection of Hess and Stuart Streets and flows to existing 450 mm diameter combined and 600 mm diameter storm sewers in Stuart Street.

Existing Caroline Street sewers include a 1050 mm diameter storm sewer and 600 mm diameter combined sewer. Flow in these sewers is split from an existing combined sewer manhole located at the intersection of Barton and Caroline Streets in Sub-Area 1. The Caroline Street storm sewer flows to one of the outlets in the Study Area, a 1350 mm diameter pipe which crosses the CN Rail tracks towards the West Harbour. The combined sewer connects to an existing 800 mm x 825 mm brick sewer in Stuart Street which flows west towards Hess Street.

The sole existing sewer in Tiffany Street is a 300 mm diameter combined sewer, which flows to the existing combined sewer in Stuart Street.

An existing sanitary sewer is located in Stuart Street which flows from the intersection of Queen and Stuart Streets to just east of the intersection with Tiffany Street, at which point it turns north and flows across the CN Rail yard and onto the Strachan Street Pumping Station.

An existing combined sewer in Stuart Street enters the Study Area from Catchment E at Bay Street and flows west to a combined sewer manhole located approximately half way between Hess and Caroline Streets, collecting combined flow from Tiffany and Caroline Streets en route. A combined sewer flowing east from the intersection with Hess also flows to this manhole.

An existing storm sewer is located in Stuart Street west of Hess Street and flows to a storm sewer manhole midway between Hess and Caroline Streets. There is a cross-connection between the existing combined and storm sewers at the intersection of Hess and Stuart Streets, as well as a cross-connection between the storm and combined manholes located midway between Hess and Caroline Streets. Combined and storm sewer flow exits the Study Area from the mid-block storm manhole via a 900 mm diameter storm sewer which flows north across the CN Rail tracks. There is an overflow connection from this manhole which connects to the Stuart Street sanitary sewer.

**Sub-Area 3**

There are existing storm and combined sewers located in Barton Street west of Queen Street. The storm sewer ranges between 450 mm and 600 mm in diameter; the combined sewer is 450 mm diameter. Both sewers convey flow entering the Study Area from Catchment A. There is a cross-connection between the storm and combined sewers at Magill Street. Both the storm and combined sewers flow to the same manhole at the intersection of Barton and Queen Streets, at which point flow is conveyed north down Queen Street in a 900 mm x 1350 mm combined sewer. The 900 mm x 1350 mm sewer changes to a 1200 mm diameter sewer at the intersection of Queen and Stuart Streets and continues to flow north from this location across the CN Rail tracks. Storm sewer flow from Catchment B is also collected and conveyed to the across the CN Rail yard by the Queen Street combined sewer.

## Outlets

A total of five sewer outlets from the Study Area were identified – two storm sewer outlets, two sanitary outlets and a combined sewer outlet.

The combined sewer outlet is a 1200 mm diameter sewer which collects combined sewer flow from Queen Street and conveys it across the CN Rail yard to an existing 2250 mm diameter combined sewer which flows from west to east along the harbour shoreline.

The 900 mm and 1350 mm diameter storm sewer outlets north of Stuart Street flow to a common manhole located within the CN Rail Yard. This manhole is connected to the existing 2250 mm diameter shoreline sewer by a 1200 mm diameter sewer. The 2250 mm diameter shoreline sewer in turn flows to the Strachan Street Pumping Station.

The sanitary sewer outlet at Stuart Street east of Tiffany Street also flows across the CN Rail yard to the Strachan Street Pumping Station. All flow from the Strachan Street Pumping Station is pumped into a gravity sewer which in turn connects to the aforementioned sanitary trunk sewer at the intersection of MacNab and Strachan Streets.

The sanitary trunk sewer represents the last outlet from the Study Area, exiting the Study Area at the intersection of Barton Street and Bay Street. From here it flows east and north, crossing the CN Rail tracks at MacNab Street and continuing on to the Woodward Wastewater Treatment Facility, approximately 7 km to the east.

Surplus sewer flow which cannot be pumped by the Strachan Street station during peak events is collected in Combined Sewer Overflow (CSO) chambers where it can be stored until such time that it can be pumped to the Woodward facility. In cases where sewer flow exceeds the capacity of the CSO chambers, excess flow is diverted to a 5000 mm x 2000 m storm sewer which outlets in Hamilton Harbour. There is an existing direct connection from the 2250 mm diameter shoreline sewer to this outlet sewer, located upstream of where the shoreline sewer enters the Strachan Street Pump Station.

# 5.0 PROPOSED SERVICING CONCEPT

Given the age of the majority of the underground infrastructure within the Study Area, available as-constructed information does not fully encompass the extents of the Study Area. The following recommendations are based on available record drawings and GIS information provided by the City of Hamilton; however, invert elevations were not available for all sewers within the Study Area. It is recommended that during detailed design the existing manholes be “dipped” so as to confirm the existing sewer inverts, as these will impact the feasibility of the proposed concepts.

## 5.1 Sub-Area 1

See **Figure 8.1** for the recommended servicing concept for Sub-Area 1.

### South of Barton Street

The preferred urban design concept for Sub-Area 2 contemplates a re-configuration of Central Park and the Hamilton Central Services site. Caroline Street is proposed to be extended through the existing Central Park to connect Caroline Street north and south of the park. Five residential parcels at the south end of Central Park are to be created by extending existing Mill, Harriet and Mulberry Streets to intersect with the new Caroline Street extension and by extending existing Railway Street to intersect with the new Mulberry Street extension. A new residential parcel will be created at the north end of the reconfigured Central Park on the existing Central Services site.

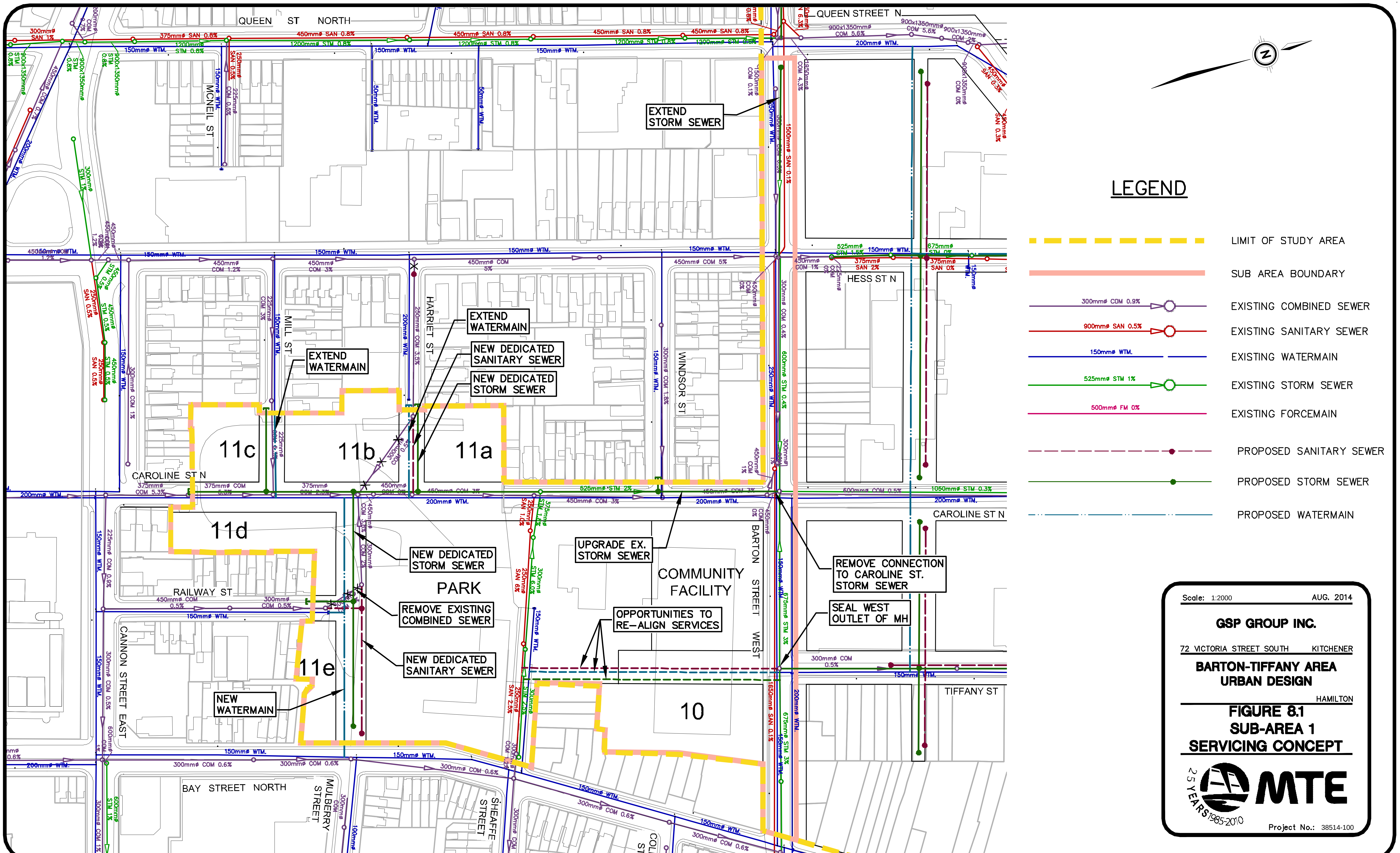
Recommended modifications to the water distribution network in Sub-Area 1 include extending the dead-end watermains in Mill Street and Harriet Street to connect to the existing Caroline Street main in order to provide increased system looping and redundancy. Likewise, it is recommended to provide a new watermain in the Mulberry Street extension to connect between Bay Street and Caroline Street. It is also recommended that the existing Railway Street dead-end connection be extended to connect to the new Mulberry Street main.

The existing storm sewer within Caroline Street is recommended to be extended south to the south boundary of the Study Area such that the upstream sewer system can connect to it once it has been separated. Lateral storm sewer connections are also recommended to be installed at Mill Street, Harriet Street and Windsor Street such that these streets can connect to the dedicated storm sewer once the sewers in those streets have been separated.

A new dedicated storm sewer will be required to be installed within the new Mulberry Street extension to collect roadway drainage and to service the new residential properties on the south side of the street. A lateral storm sewer connection to collect future separated storm flows from Railway Street should be provided from this main.

Parcels 11a to 11e will be serviced by separated sanitary and storm sewers located in Caroline and Mulberry Streets. The existing 525 mm diameter storm sewer within Caroline Street has adequate capacity to accommodate the 5-year storm flow from within the Study Area; however, it does not have capacity to accommodate additional flow from areas external to the Study Area. It is recommended that the existing 525 mm diameter storm sewer be replaced with a larger pipe capable of conveying storm sewer runoff from both Sub-Area 1 and the upstream catchment.

There is an existing combined sewer located within Caroline Street along the entire length of the Sub-Area which collects combined sewer flow from the upstream areas, as well as from Mill Street, Harriet Street, Windsor Street and Railway Street. A dedicated sanitary sewer connects to the combined main from Central Park.

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As mentioned in previous sections, the existing combined sewer laterals from Harriet and Railway Streets cut across the proposed development parcels. It is recommended that these sewers be replaced with new sewers located within the rights-of-way of the new road extensions.

The approximate combined sewer flow (5-year storm + sanitary) generated from external Catchment D is 0.59 $m^3$/s, which exceeds the capacity of the existing 450 mm diameter combined sewer; however, once separation of the upstream sewer system has taken place and all storm sewer flow is routed to the upgraded Caroline Street storm sewer the existing 450 mm diameter combined sewer will have more than adequate capacity to convey all (internal and external) sanitary sewer flow and may operate as a dedicated sanitary sewer.

Until such time as upstream sewer separation has taken place, it is recommended that combined flow from external areas continue to be directed to the existing Caroline Street combined sewer, under the expectation the combined sewer may surcharge from time to time. If no surcharge can be tolerated, one or more overflow connections may be made between the combined sewer and the proposed dedicated storm sewer. The connections should be designed such that they can be removed once upstream sewer separation is complete.

Flow from the combined sewer manhole at the intersection of Caroline and Barton Streets is currently split, with outlets from the manhole flowing to the Barton Street sanitary trunk sewer and to the storm sewer located in Caroline Street north of Barton Street. As the ultimate goal of the servicing design is to have the existing Caroline Street combined sewer function as a dedicated sanitary sewer, it is recommended to remove the connection from this manhole to the storm sewer such that all flow is directed to the trunk sanitary sewer.

The existing services running east-west through Central Park from the intersection of Sheaffe and Bay Streets may limit the available options when planning the park layout facilities. Should it be required to re-align the existing services in order to un-encumber the park, the option is available to re-align the existing Sheaffe Street watermain and sewers to the north such that they run parallel to the east boundary of the park and connect to existing services in Barton Street. Note that there is a significant grade difference immediately north of Sheaffe Street that would have to be considered in adopting this option.

**Barton Street**

Barton Street between Queen and Bay Streets falls within Sub-Area 1. There is an existing continuous watermain located within Barton Street between Queen and Bay Streets ranging in size from 150 mm to 250 mm diameter. No upgrades to the Barton Street watermain between Queen and Bay Streets are anticipated.

Existing storm sewers in Barton Street between Queen and Bay Streets consist of a 600 mm diameter sewer extending west from Caroline Street to Hess Street and a 675 mm diameter sewer extending east from Caroline Street to a manhole approximately 30 m west of Bay Street; east of this manhole the pipe changes to a 1200 mm x 1350 mm sewer.

The existing Barton Street storm sewer west of Caroline Street is connected to a combined sewer manhole at Hess Street such that a portion of the combined flow from Catchment C can flow to the sewer. The storm sewer east of Caroline Street collects storm sewer flow from external Catchment E2. Both these sewer runs flow to an existing 1050 mm diameter storm sewer located within Caroline Street north of Barton Street, as will the proposed upgraded storm sewer located within Caroline Street south of Barton Street. The cumulative storm sewer flow in these three sewer runs exceeds the capacity of the existing 1050 mm diameter storm sewer; therefore, it is recommended that the storm sewers within Barton Street be re-configured to reduce the amount of flow entering the Caroline Street storm sewer.

The existing storm sewer within Barton Street east of Caroline Street has capacity to accommodate the external flow from Catchment E2, as well as flow from development Parcel 10 and roadway drainage. Rather than allow this flow to continue to flow to the over-capacity Caroline Street sewer, it is recommended that the above-noted flows be directed to a new storm sewer located within Tiffany Street and that the connection between the Barton Street storm sewer east and west of Tiffany Street be eliminated.

To further reduce the flow to Caroline Street sewer it is recommended that the connection between the Hess Street combined sewer south of Barton Street and the Barton Street storm sewer be removed, such that the flow within the storm sewer is limited to road drainage and storm runoff from developments adjacent to Barton Street which are directly connected to this sewer. Combined sewer flow from Hess Street south of Barton Street could then flow entirely to an upgraded sewer within Hess Street north of Barton Street. The existing Barton Street storm sewer west of Caroline Street is recommended to be extended to east of Queen Street in order to provide a fully separated sewer system within the block between Queen and Hess Streets.

Between Queen Street and Bay Street (in Sub-Area 1) there is an existing sanitary trunk sewer located within Barton Street. An existing 300 mm diameter combined sewer is also located between Queen Street and Caroline Street; the existing combined sewer connects to the trunk sanitary sewer at Caroline Street. It is recommended that the existing combined sewer function as a dedicated sanitary sewer once separation of any contributing flows is complete. It is also recommended that a sanitary sewer stub from this sewer be provided at Hess Street to collect upstream sanitary sewer flows once upstream sewer separation has taken place.

## 5.2 Sub-Area 2

See **Figure 8.2** for the recommended servicing concept for Sub-Area 2.

### Hess, Caroline, Tiffany Streets

Existing watermains are located within Hess, Caroline, Tiffany and Stuart Streets in Sub-Area 2. The watermains in Caroline and Tiffany Streets are connected to mains in both Barton Street and Stuart Street, whereas the existing main in Hess Street is "hanging" with a connection to Barton Street but no connection to Stuart Street.

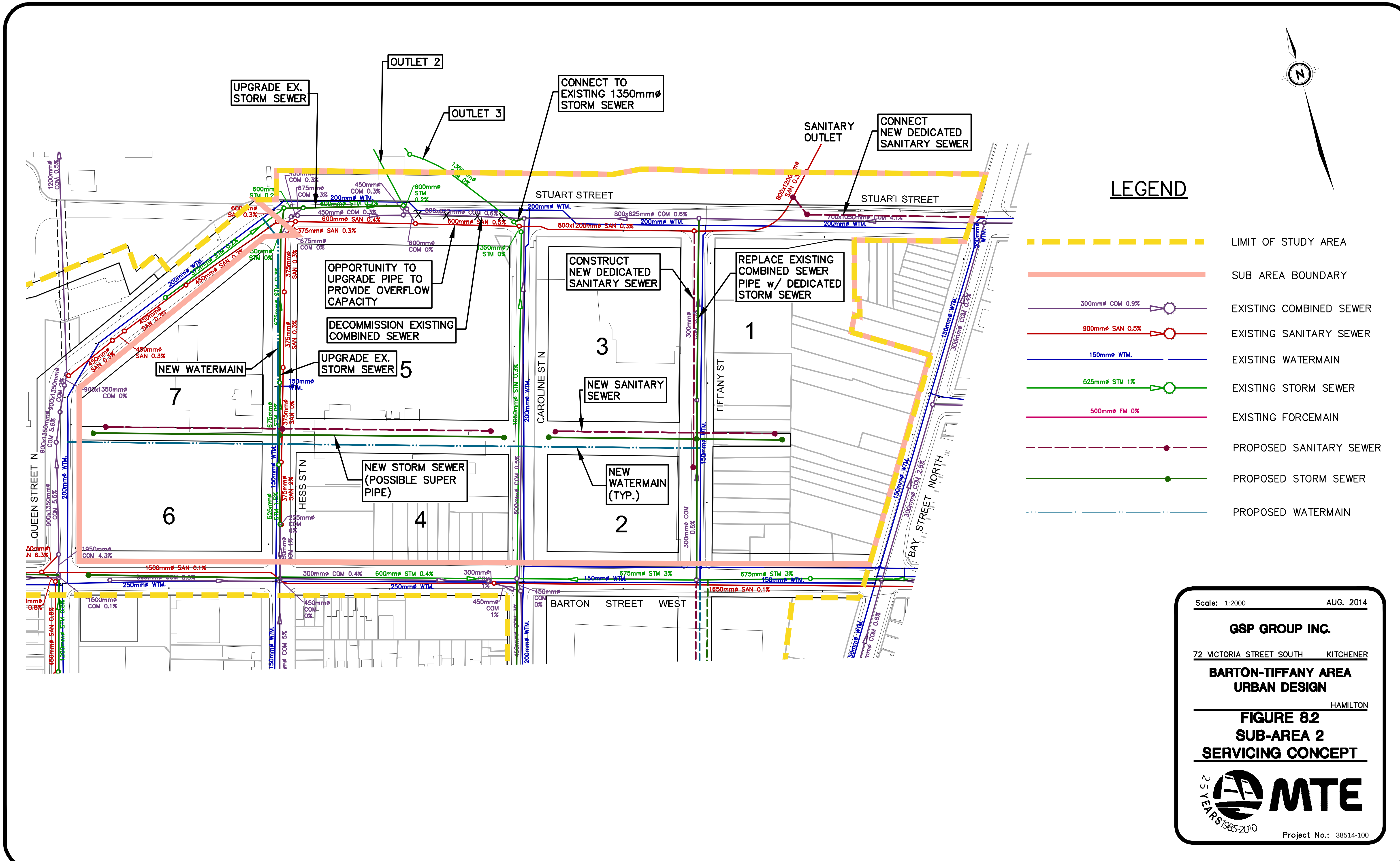
To improve water distribution looping and redundancy it is recommended that the Hess Street watermain be extended north to connect to Stuart Street. Furthermore, it is recommended that a new watermain be constructed within the proposed east-west street between Stuart and Barton Streets to provide inter-connection between the Queen Street and Tiffany Street mains and provide service to buildings fronting the new street. Provision of this main will depend, in part, on whether the proposed road is to be a public or private facility.

The existing storm sewer in Caroline Street has adequate capacity to accommodate flows from the Caroline Street storm sewer south of Barton Street and roadway drainage from Barton Street between Hess Street and Tiffany Street and Caroline Street north of Barton Street. It does not, however, have adequate capacity to service any of the Sub-Area 2 parcels; therefore, it is recommended that storm sewer flow from the development parcels be directed to storm sewers within Hess and Tiffany Streets.

New storm and sanitary sewers will be required to be constructed within the proposed east-west road located between Barton and Stuart Streets in order to collect roadway drainage and to service any buildings which front onto this street, with portions of the road east of Caroline Street flowing to Tiffany Street and portions of the road west of Caroline Street flowing to Hess Street.

An existing combined sewer conveys combined sewer flow from Hess Street south of Barton Street to a manhole located within Hess Street approximately 30 m north of the Hess Street/Barton Street intersection. From this manhole flow is split to the existing storm sewer and an existing sanitary sewer manhole located within Hess Street. It is recommended that the connection between the storm and sanitary manholes be removed such that the existing sanitary sewer within Hess Street functions as a dedicated sanitary sewer and only conveys sanitary flows from within the Study Area north of Barton Street.

The Hess Street storm sewer must be able to convey flow from the proposed development parcels adjacent to Hess Street (Parcels 4 to 7) as well as Hess Street roadway drainage and flow from external Catchment C. The existing storm sewer in Hess Street does not have the capacity to convey this flow; therefore, it will be required to be upgraded. Because flow from external Catchment C is combined storm and sanitary flow, the Hess Street storm sewer will operate as a combined sewer until such time that upstream flows are fully separated.

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In order to have the Hess Street storm sewer function as such in the interim would require either intercepting the combined sewer flow from Hess Street south of Barton Street and directing it to the Barton Street sanitary trunk sewer which, given the depth of the trunk sewer, would require a very deep and expensive drop manhole structure or upgrading the existing sanitary sewers in Hess Street and Stuart Street to accommodate the combined flow until such time that the upstream flows are separated and upstream storm flow can be re-directed into the Hess Street storm sewer.

**Stuart Street**

Combined sewer flow from Catchment E1 currently enters the Study Area from the east at Bay Street in an existing 700 mm x 1050 mm brick sewer and continues west along Stuart Street to the existing 900 mm diameter storm sewer outlet located midway between Hess and Caroline Streets. It is recommended that this combined sewer be retained to function as a dedicated storm sewer upon separation of the upstream sewers. It is recommended that a new sanitary sewer be constructed to convey future separated sanitary sewer flow to the existing sanitary sewer outlet located approximately 55 m east of Tiffany Street.

To reduce the amount of flow directed to the relatively small 900 mm diameter storm sewer outlet, it is recommended that the Stuart Street combined sewer be decommissioned west of Caroline Street and east of the 900 mm diameter storm sewer outlet and that a new connection be made from the existing combined sewer manhole to the existing storm sewer manhole located at Caroline Street such that storm sewer flow east of Caroline Street flows to the larger existing 1350 mm diameter storm sewer outlet located at Caroline Street.

The existing 600 mm diameter storm sewer east of Hess Street will collect drainage from parcels north of Barton Street and adjacent to Hess Street (Parcels 4 to 7), from external Catchment C and from Queen Street in Sub-Area 3. As noted above, the flow to this sewer will consist of combined (sanitary and storm) flow until such time that the upstream sewer system in Catchment C is separated. The sewer is cross-connected to a parallel 450 mm diameter combined sewer. Both sewers are connected to the existing 900 mm diameter storm sewer outlet located midway between Hess and Caroline Streets.

The existing tandem of the 600 mm diameter storm and 450 mm diameter combined sewer does not have capacity to accommodate the contributing flow; therefore, it is recommended that one or both of the sewers be upgraded.

There is an overflow connection from the existing 900 mm diameter storm sewer outlet to the existing 600 mm diameter sanitary sewer in Stuart Street which acts as an overflow connection if the storm sewer outlet becomes surcharged. It is recommended that the overflow connection remain in place. There may be a benefit to upgrading the size of the 600 mm diameter sanitary sewer between the outlet and Caroline Street (approximately 60 m of sewer) in order to provide additional overflow capacity.

## 5.3 Sub-Area 3

See **Figure 8.3** for the recommended servicing concept for Sub-Area 3.

### Barton Street

Existing services within Barton Street between Crooks Street and Queen Street include: storm sewer; combined sewer; sanitary trunk sewer; and watermain. It should be noted that the existing storm sewer in Barton Street collects combined sewer flow upstream of the Study Area and, therefore, currently functions as a combined sewer.

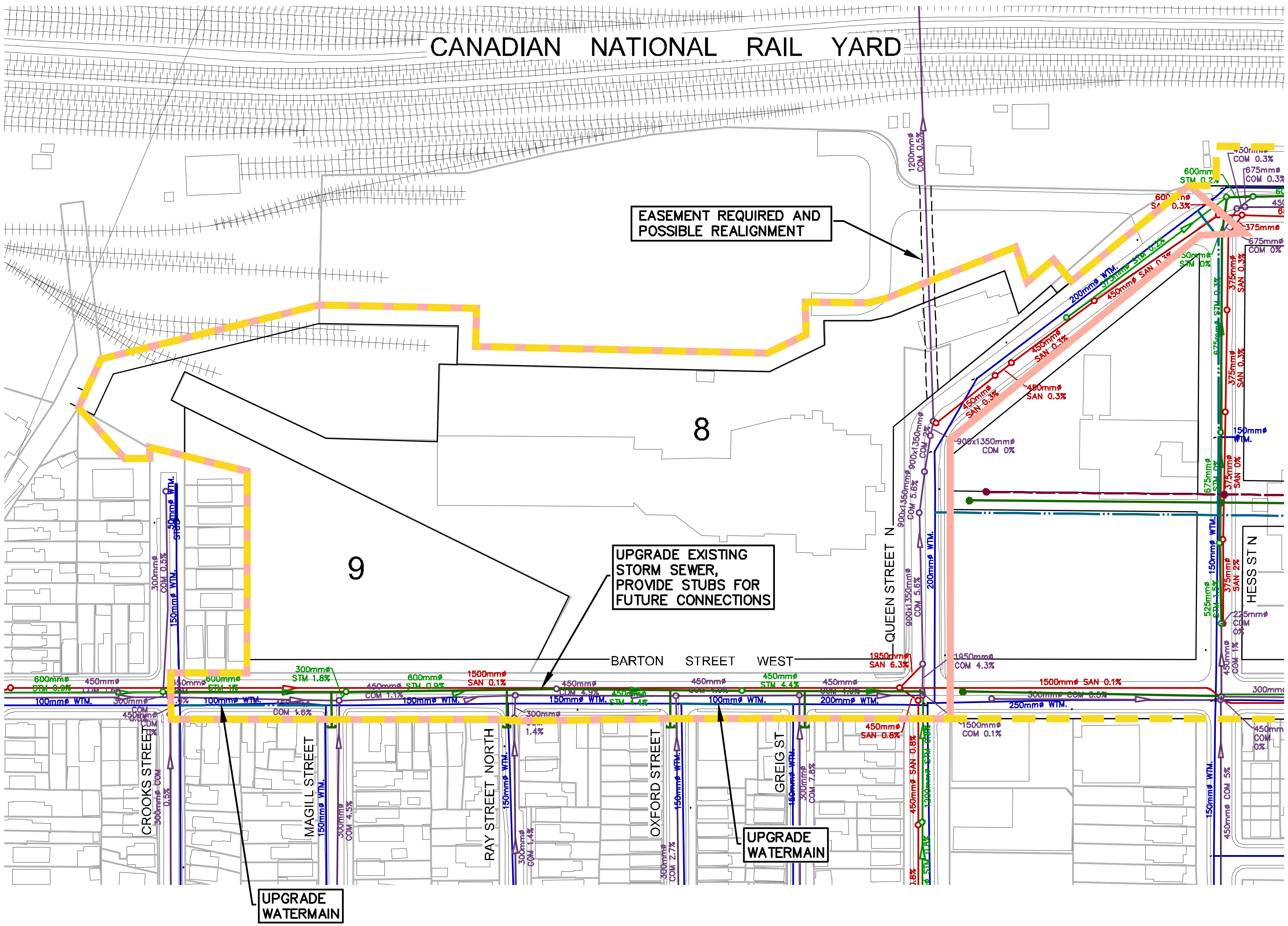
The existing watermain in this stretch of Barton Street ranges in size from 100 mm diameter to 200 mm diameter. It is recommended that, at minimum, the existing 100 mm diameter watermains be upsized.

The majority of combined sewer flow from Catchment A enters the sub-area from the west at Barton Street while some combined flow enters from the south at Magill, Ray, Oxford and Greig Streets. Neither of the existing sewers (combined or storm) in Barton Street west of Queen Street have adequate capacity to accommodate the external flow from upstream of the Study Area; therefore, it is recommended that the existing storm sewer be upgraded to accommodate all upstream storm sewer flow. Lateral sewer stubs should be provided from the upgraded storm sewer to provide connections to future separated storm sewers located in Magill, Ray, Oxford and Greig Streets.

Once upstream sewer separation has occurred and all upstream storm sewer flow is conveyed within the new dedicated storm sewer, the existing combined sewer will function as a dedicated sanitary sewer. It is recommended that a connection be made from the existing combined sewer into the existing 1500 mm diameter trunk sanitary sewer at the intersection of Barton and Queen Streets, similar to the existing connection from the Queen Street sanitary sewer into the trunk sewer.

### Queen Street

Existing combined and storm sewers within Barton Street west of Queen Street and the existing storm sewer from Queen Street south of Barton Street currently flow to the existing 900 mm x 1350 mm combined sewer within Barton Street. The existing sewer has adequate capacity to accommodate flow from these sewers as well as from Parcel 8 west of Queen Street, however, the pipe size changes to a 1200 mm diameter sewer where Queen Street meets Stuart Street; the 1200 mm diameter sewer does not have adequate capacity to accommodate these flows. The 1200 mm diameter sewer continues north from Queen Street, through proposed Parcel 8 and across the CN Rail yard; unless the pipe were to be upgraded beneath the rail tracks, there is no opportunity to upgrade the size of this pipe. Depending on the final site plan for Parcel 8, the existing 1200 mm diameter sewer may need to be re-routed through the development parcel to avoid conflicting with proposed buildings.




## LEGEND

- LIMIT OF STUDY AREA
- SUB AREA BOUNDARY
- EXISTING COMBINED SEWER (300mmø COM 0.9%)
- EXISTING SANITARY SEWER (900mmø SAN 0.5%)
- EXISTING WATERMAIN (150mmø WTM.)
- EXISTING STORM SEWER (525mmø STM 1%)
- EXISTING FORCEMAIN (500mmø FM 0%)
- PROPOSED SANITARY SEWER
- PROPOSED STORM SEWER
- PROPOSED WATERMAIN

Scale: 1:2000 AUG. 2014

**GSP GROUP INC.**

72 VICTORIA STREET SOUTH KITCHENER

**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

**FIGURE 8.3**
**SUB-AREA 3**
**SERVICING CONCEPT**

25 YEARS 1985-2010 MTE

Project No.: 38514-100

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### Stuart Street

The existing 450 mm diameter sanitary sewer in Stuart Street between Queen and Hess Streets will service only proposed development Parcel 8. The existing 375 mm diameter storm sewer in Stuart Street between Queen and Hess Streets will only be required to collect roadway drainage from this portion of Stuart Street. It is recommended that these sewers remain in service and that no upgrades in this location be made.

# 6.0 OUTLET CAPACITY ANALYSIS

As noted, the City of Hamilton's ultimate goal is to separate the City's sewer system into dedicated storm and sanitary sewers. To this end, sewers within the Study Area will be designed as a separated system and will look to take advantage of existing sewer outlets, if capacity allows.

Storm runoff calculations are based on Mount Hope 5-Year Storm values.

In analyzing the capacity of the existing outlets, the ultimate (separated) sewer flows will be considered rather than the existing combined flows.

## 6.1 Storm/Combined Sewer Outlets

### *6.1.1 Outlet 1 (Queen Street)*

There is an existing combined sewer flowing north from the intersection of Queen and Stuart Streets. Once the upstream sewer system has been separated, it is assumed all sanitary flow from south of Barton Street will be directed to the Barton Street sanitary trunk sewer. This will leave the Queen Street sewer as a dedicated storm sewer outlet.

Storm sewer runoff contributing to this outlet includes runoff from external Catchments A and B, as well as internal runoff from Sub-Area 3. The approximate time of concentration to the intersection of Stuart and Queen Streets is 22.5 minutes (10 minute inlet time + 12.5 minute travel time @ 2 m/s), with a corresponding 5-year rainfall intensity of 67.47 mm/hr.

The approximate storm sewer flow to Outlet 1 is 6.75 $m^3/s$, as summarized in Table 6.1.1 below.

**TABLE 6.1.1 – OUTLET 1 FLOW ($M^3/S$)**

| | Park (c=0.25) | Residential (c=0.60) | Industrial/ Commercial (c=0.80) | Road Right-of-Way (c=0.90) | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|---|---|
| **External Catchment A** | 1.03 | 11.50 | 0 | N/A | 12.53 | 0.57 |
| **External Catchment B** | 3.06 | 25.40 | 11.23 | N/A | 39.69 | 0.63 |
| **Sub-total (External Flow)** | 4.09 | 36.90 | 11.23 | N/A | 52.22 | 0.62 |
| **External Flow to Outlet = 0.00278ciA** | | | | | **6.07 $m^3/s$** | |
| | **Park (c=0.25)** | **Residential (c=0.75)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area (ha)** | **Weighted 'c' Value** |
| **Sub-Area 3** | 2.11 | 0.63 | 1.99 | 1.15 | 5.88 | 0.62 |
| **Study Area Flow to Outlet = 0.00278ciA** | | | | | **0.68 $m^3/s$** | |
| **Cumulative Flow to Outlet = 0.00278ciA** | | | | | **6.75 $m^3/s$** | |

The existing Outlet 1 is composed of a 1200 mm diameter sewer at a slope of 0.5%. This sewer has a full-flow capacity of 2.76 $m^3/s$ and 85% flow capacity of 2.35 $m^3/s$ (based on Manning's equation), which is much less than the contributing flow. Assuming an upgraded outlet would be constructed at a similar slope to the existing sewer, an 1800 mm diameter or larger sewer would be required at this location to adequately service the catchment area and meet the City's 85% capacity criterion.

### *6.1.2 Outlet 2 (Stuart Street between Hess and Caroline Streets)*

There is an existing storm sewer flowing north from Stuart Street located approximately midblock between the intersections of Queen and Caroline Streets. Areas currently draining to this sewer outlet include external Catchment E1, which enters the Study Area at the intersection of Stuart and Bay Streets and is conveyed to the outlet via an old brick sewer in Stuart Street, external Catchments C, D and E2 which are conveyed to the outlet through existing sewers in Hess, Caroline and Tiffany Streets, respectively, as well as internal drainage from those streets.

The proposed servicing arrangement will reduce the total area flowing to Outlet 2, such that the only external flow to the outlet will be from Catchment C and the contributing area within the Study Area will be limited to Sub-Area 2 west of Caroline Street.

The approximate time of concentration to this outlet is 16.3 minutes (10 minute inlet time + 6.3 minute travel time @ 2 m/s), with a corresponding 5-year rainfall intensity of 80.97 mm/hr.

The approximate storm sewer flow to Outlet 2 is 1.66 $m^3/s$, as summarized in Table 6.1.2 below.

**TABLE 6.1.2 – OUTLET 2 FLOW ($M^3/S$)**

| | Park (c=0.25) | Residential (c=0.60) | Industrial/ Commercial (c=0.80) | Road Right-of-Way (c=0.90) | Total Area (ha) | Weighted 'c' Value |
|---|---|---|---|---|---|---|
| **External Catchment C** | 0.59 | 1.93 | 2.66 | N/A | 5.18 | 0.66 |
| **External Flow to Outlet = 0.00278ciA** | | | | | **0.77 $m^3/s$** | |
| | **Park (c=0.25)** | **Residential (c=0.75)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area (ha)** | **Weighted 'c' Value** |
| **Sub-Area 2 (W. of Caroline)** | 0 | 1.42 | 1.94 | 1.44 | 4.80 | 0.82 |
| **Study Area Flow to Outlet = 0.00278ciA** | | | | | **0.89 $m^3/s$** | |
| **Total Flow to Outlet = 0.00278ciA** | | | | | **1.66 $m^3/s$** | |

The existing Outlet 2 is composed of a 900 mm diameter sewer at a slope of 0.7%. This sewer has a maximum discharge capacity of 1.63 $m^3/s$ and 85% capacity of 1.39 $m^3/s$ (based on Manning's equation), which is only slightly less than the contributing flow to this outlet. Assuming an upgraded outlet would be constructed at a similar slope to the existing sewer, a 1050 mm diameter or larger sewer would be required at this location to meet the City's 85% capacity criterion.

### *6.1.3 Outlet 3 (Stuart Street between Hess and Caroline Streets)*

A second existing storm sewer flowing north from Stuart Street is located east of Outlet 2, l approximately at the intersection with Caroline Street. Areas draining to this sewer outlet include external Catchment D, which enters the Study Area at the south end of Central Park and is conveyed down Caroline Street through Sub-Areas 1 and 2 and external Catchment E, which enters the Study Area at two locations; at the intersection of Stuart and Bay Streets (Catchment E1) and at the intersection of Barton and Bay Streets (Catchment E2). Within the Study Area, Sub-Area 1 drains to this outlet, as well as the portion of Sub-Area 2 east of and including Caroline Street.

The approximate time of concentration to this outlet is 21.5 minutes (10 minute inlet time + 11.5 minute travel time @ 2 m/s), with a corresponding 5-year rainfall intensity of 69.30 mm/hr.

The approximate storm sewer flow to Outlet 3 is 6.24 $m^3/s$, as summarized in Table 6.1.3 below.

**TABLE 6.1.3 – OUTLET 3 FLOW ($M^3/S$)**

| | Park (c=0.25) | Residential (c=0.60) | Industrial/ Commercial (c=0.80) | Road Right-of-Way (c=0.90) | Total Area | Weighted 'c' Value |
|---|---|---|---|---|---|---|
| **External Catchment D** | 1.67 | 4.04 | 0.16 | N/A | 5.87 | 0.51 |
| **External Catchment E1** | 0.48 | 7.81 | 6.97 | N/A | 15.26 | 0.68 |
| **External Catchment E2** | 0 | 4.69 | 9.51 | N/A | 14.20 | 0.73 |
| **Sub-total (External Flow)** | 2.15 | 16.54 | 16.64 | N/A | 35.33 | 0.67 |
| **External Flow to Outlet = 0.00278ciA** | | | | | **4.56 $m^3/s$** | |
| | **Park (c=0.25)** | **Residential (c=0.75)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area (ha)** | **Weighted 'c' Value** |
| **Sub-Area 1** | 2.44 | 1.50 | 0 | 2.68 | 6.62 | 0.63 |
| **Sub-Area 2 (E. of Caroline)** | 0 | 1.48 | 1.61 | 2.38 | 5.47 | 0.83 |
| **Sub-total (Study Area Flow)** | 2.44 | 2.98 | 1.61 | 5.06 | 12.09 | 0.72 |
| **Study Area Flow to Outlet = 0.00278ciA** | | | | | **1.68 $m^3/s$** | |
| **Total Flow to Outlet = 0.00278ciA** | | | | | **6.24 $m^3/s$** | |

The existing Outlet 3 is composed of a 1350 mm diameter sewer at a slope of 0.4%. This sewer has a maximum discharge capacity of 3.63 $m^3/s$ and 85% capacity of 3.09 $m^3/s$ (based on Manning's equation), which is less than the contributing flow to this outlet. Assuming an upgraded outlet would be constructed at a similar slope to the existing sewer, an 1800 mm diameter or larger sewer would be required.

### *6.1.4 Downstream Storm/Combined Sewer Outlets*

Downstream of Outlets 2 and 3 the discharge from these two sewers is combined to flow in a single 1200 mm diameter sewer. The contributing areas in this sewer, therefore, are the combined contributing areas to Outlets 2 and 3: External Catchments C, D and E and Sub-Areas 1 and 2.

The approximate time of concentration to this outlet is 22.1 minutes (10 minute inlet time + 12.1 minute travel time @ 2m/s), with a corresponding 5-year rainfall intensity of 68.19 mm/hr.

The approximate storm sewer flow to this downstream outlet is 7.60 $m^3/s$, as summarized in Table 6.1.4a below.

**TABLE 6.1.4A FLOW TO 1200 MM DIAMETER DOWNSTREAM OUTLET ($M^3/S$)**

| | **Park (c=0.25)** | **Residential (c=0.60)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area** | **Weighted 'c' Value** |
|---|---|---|---|---|---|---|
| **External Catchment C** | 0.59 | 1.93 | 2.66 | N/A | 5.18 | 0.68 |
| **External Catchment D** | 1.67 | 4.04 | 0.16 | N/A | 5.87 | 0.54 |
| **External Catchment E** | 0.48 | 12.17 | 16.82 | N/A | 29.47 | 0.73 |
| **Sub-total (External Flow)** | 2.74 | 18.14 | 19.64 | N/A | 40.52 | 0.70 |
| **External Flow to Outlet = 0.00278ciA** | | | | | **5.14 $m^3/s$** | |
| | **Park (c=0.25)** | **Residential (c=0.75)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area (ha)** | **Weighted 'c' Value** |
| **Sub-Area 1** | 1.80 | 1.47 | 0.52 | 2.83 | 6.62 | 0.68 |
| **Sub-Area 2** | 0 | 2.90 | 3.55 | 3.82 | 10.27 | 0.82 |
| **Sub-total (Study Area Flow)** | 1.80 | 4.37 | 4.07 | 6.65 | 16.89 | 0.77 |
| **Study Area Flow to Outlet = 0.00278ciA** | | | | | **2.46 $m^3/s$** | |
| **Total Flow to Outlet = 0.00278ciA** | | | | | **7.60 $m^3/s$** | |

The existing Outlet at this location is composed of a 1200 mm diameter sewer at a slope of 0.5%. This sewer has a maximum discharge capacity of 2.97 $m^3$/s and 85% capacity of 2.52 $m^3$/s (based on Manning's equation), which is less than the contributing flow to this outlet. Assuming an upgraded outlet would be constructed at a similar slope to the existing sewer, an 1800 mm diameter or larger sewer would be required at this location to meet the City's 85% capacity criterion.

As noted previously, outlets 1, 2, and 3 eventually discharge to a large 2250 mm diameter sewer located along the shoreline of Hamilton Harbour north of the CN Rail yard. External Catchments A to E and Sub-Areas 1 to 4 all drain to this sewer.

The approximate time of concentration to the point in this sewer where all the above-noted areas are captured is 26.5 minutes (10 minute inlet time + 16.5 minute travel time @ 2m/s), with a corresponding 5-year rainfall intensity of 61.11 mm/hr.

The approximate storm sewer flow to this downstream outlet is 12.90 $m^3$/s, as summarized in Table 6.1.4b on the following page.

### TABLE 6.1.4B FLOW TO 2250 MM DIAMETER DOWNSTREAM OUTLET ($M^3/S$)

| | Park (c=0.25) | Residential (c=0.60) | Industrial/ Commercial (c=0.80) | Road Right-of-Way (c=0.90) | Total Area | Weighted 'c' Value |
|---|---|---|---|---|---|---|
| **External Catchment A** | 1.03 | 11.50 | 0 | N/A | 12.53 | 0.57 |
| **External Catchment B** | 3.06 | 25.40 | 11.23 | N/A | 39.69 | 0.63 |
| **External Catchment C** | 0.59 | 1.93 | 2.66 | N/A | 5.18 | 0.66 |
| **External Catchment D** | 1.67 | 4.04 | 0.16 | N/A | 5.87 | 0.51 |
| **External Catchment E** | 0.48 | 12.17 | 16.82 | N/A | 29.47 | 0.71 |
| **Sub-total (External Flow)** | 6.83 | 55.04 | 30.87 | N/A | 92.74 | 0.64 |
| | | | | **External Flow to Outlet = 0.00278ciA** | **10.08 $m^3/s$** | |
| | **Park (c=0.25)** | **Residential (c=0.75)** | **Industrial/ Commercial (c=0.80)** | **Road Right-of-Way (c=0.90)** | **Total Area (ha)** | **Weighted 'c' Value** |
| **Sub-Area 1** | 2.44 | 1.50 | 0 | 2.68 | 6.62 | 0.68 |
| **Sub-Area 2** | 0 | 2.90 | 3.56 | 3.81 | 10.27 | 0.82 |
| **Sub-Area 3** | 2.12 | 0.62 | 1.99 | 1.15 | 5.88 | 0.62 |
| **Sub-total (Study Area Flow)** | 4.56 | 5.02 | 5.55 | 7.64 | 22.77 | 0.73 |
| | | | | **Study Area Flow to Outlet = 0.00278ciA** | **2.82 $m^3/s$** | |
| | | | | **Total Flow to Outlet = 0.00278ciA** | **12.90 $m^3/s$** | |

The existing Outlet at this location is composed of a 2250 mm diameter sewer at a slope of 0.3%. This sewer has a full-flow capacity of 12.28 $m^3/s$ and 85% capacity of 10.44 $m^3/s$ (based on Manning's equation), which is less than the contributing flow to this outlet. Assuming an upgrade outlet would be constructed at a similar slope to the existing sewer, a 2500 mm diameter or larger sewer would be required at this location to meet the City's 85% capacity criterion.

Table 6.1.5 summarizes the flow to each of the existing storm/combined sewer outlets from the Study Area:

**TABLE 6.1.5 EXISTING STORM/COMBINED SEWER SUMMARY**

| Outlet | External Flow | | Study Area Flow | | Total Flow ($m^3/s$) | 85% Capacity ($m^3/s$) |
|---|---|---|---|---|---|---|
| | Contributing Catchment(s) | External Flow ($m^3/s$) | Contributing Sub-Area(s) | Study Area Flow ($m^3/s$) | | |
| 1 | A, B | 6.07 | 3 | 0.68 | 6.75 | 2.52 |
| 2 | C | 0.77 | 2 (W. of Caroline) | 0.89 | 1.66 | 1.39 |
| 3 | C,D | 4.56 | 1, 2 (E. of Caroline) | 1.68 | 6.24 | 3.09 |
| 1200 mm Dia | C,D,E | 5.14 | 1,2 | 2.46 | 7.60 | 2.52 |
| 2250 mm Dia | A to E | 10.08 | 1,2,3 | 2.82 | 12.90 | 10.44 |

The existing combined sewer outlets represent a significant “bottleneck” for the storm/combined sewer system. As shown in the table above, the contributing flow to each of the five outlet locations identified for the Study Area exceeds the 85% capacity of the outlets in all cases.

The existing downstream outlets should be upgraded to provide adequate capacity to service the contributing catchment areas and should be included in the City of Hamilton’s capital planning if they are not already. With Outlets 2 and 3 located within the future GO Station site, in may be beneficial to upgrade these sewers prior to construction of the station.

Upgrades to the existing outlets will be expensive and complicated by the fact that the outlets all cross the CN Rail tracks. Consideration should also be given to how increasing capacity of the existing outlets will affect flows to the Strachan Street Pump Station and the functionality of any Combined Sewer Overflow tanks and the Woodward Wastewater Treatment Facility.

The broader plan for the upstream sewer system will also impact the expected outlet flows in the future. The City of Hamilton has the authority to require all new developments to provide stormwater management in order to attenuate the amount of runoff generated from the site. As sites upstream are re-developed and stormwater management is expanded within upstream catchment areas the outlet flow can be expected to be reduced. Furthermore, as the sewer system gradually shifts to a fully separated system, flow that was previously directed to the combined sewer outlets will instead be routed to a dedicated sanitary sewer outlet.

## 6.2 Stormwater Management

Further to Sections 3.1 and 5.1 above, the pre- and post development land-uses and corresponding weighted runoff coefficients within the Study Area are summarized below in Table 6.2:

**TABLE 6.2 PRE- AND POST-DEVELOPMENT CONDITIONS**

| | Park (c=0.25) | Residential | | Industrial/ Commercial (c=0.80) | Road Right-of-Way (c=0.90) | Total Area | Weighted 'c' Value |
|---|---|---|---|---|---|---|---|
| | | Pre-Development (C=0.60) | Post-Development (c=0.75) | | | | |
| **Sub-Area 1** | | | | | | | |
| **Pre-Development** | 2.79 | 0 | 0 | 2.47 | 1.36 | 6.62 | 0.59 |
| **Post-Development** | 1.80 | 0 | 1.47 | 0.52 | 2.83 | 6.62 | 0.68 |
| **Sub-Area 2** | | | | | | | |
| **Pre-Development** | 1.01 | 1.26 | 0 | 5.86 | 2.14 | 10.27 | 0.67 |
| **Post-Development** | 0 | 0 | 2.83 | 3.59 | 3.05 | 9.47 | 0.82 |
| **Sub-Area 3** | | | | | | | |
| **Pre-Development** | 2.11 | 0 | 0 | 2.80 | 0.97 | 5.88 | 0.62 |
| **Post-Development** | 2.11 | 0 | 0.63 | 1.99 | 1.15 | 5.88 | 0.62 |
| **Cumulative** | | | | | | | |
| **Pre-Development** | 5.97 | 1.26 | 0 | 11.13 | 4.47 | 22.77 | 0.63 |
| **Post-Development** | 3.91 | 0 | 5.00 | 6.06 | 7.80 | 22.77 | 0.66 |
| **Cumulative Pre-Development 'c' Value** | | | | | | **0.63** | |
| **Cumulative Post-Development 'c' Value** | | | | | | **0.73** | |

The post-development runoff generated within the Study Area is approximately 15% greater than the pre-development condition. Intuitively, this would be expected given the pre-development condition of the Study Area is mostly industrial in nature.

Though the post-development uncontrolled runoff generated from the Study Area is only slightly more than the pre-development condition, it is still desirable to provide a level of quantity control, both to reduce the flow to the over-capacity combined sewer outlets and as part of a "best practices" approach. Note that, as summarized in Table 6.1.5, the majority of flow to the combined sewer outlets from the Study Area is generated from upstream catchments external to the Study Area and in all cases except Outlet 2 the capacity of each of the outlets is exceeded by the runoff generated by upstream catchments external to the Study Area; therefore, flow to the outlets will continue to exceed capacity regardless of any measures taken to attenuate the runoff generated within the Study Area.

The City of Hamilton Stormwater Master Plan – Class Environmental Report describes three stormwater management measures to be considered as means to reduce the amount of runoff; End of Pipe Measures, Conveyance Control Measures, and Source Control Measures:

**End of Pipe Measures** include stormwater ponds, wetlands or infiltration basins used to treat stormwater prior to discharge to a receiving body of water. It is not recommended that End of Pipe Measures be implemented within the Study Area for the following reasons:

1. **Soil Contamination**
   The Study Area was historically an area of varied industrial activity dating from the early 1800s. Given the past land uses within the Study Area, the underlying soils are suspected to be contaminated. It would not be recommended to construct a stormwater management pond or other such facility in an area containing contaminated soil, both due to the amount of contaminated excess soil the excavation of such a facility would produce (which would require specialized treatment and disposal) and the risk for any contaminants contained in soil adjacent to the pond to migrate into the pond itself and in turn be discharged to the environment;

2. **Combined Sewer Flow**
   As discussed in previous sections, the large portion of the sewer system upstream of the Study Area is a combined system whereby both storm and sanitary flows are carried in a single pipe. Although the City of Hamilton has begun the process of separating the sewer system, it will take many years to achieve full separation. Until such time as the sewer system is separated, it is not recommended to discharge sewer effluent containing raw (untreated) sewage to an above-ground End of Pipe facility such as a stormwater management pond.

3. **Space/Grading Limitations**
   The Study Area has been identified as an area of intensification and, therefore, the preferred concept does not provide many open spaces on which to locate a stormwater pond. The two potential locations on which to locate a pond are within Central Park and on the parcel located west of Queen Street between Parcels 8 and 9. In both cases the ground elevation is higher relative to the adjacent parcels within the Study Area such that it would be challenging to route stormwater flow from within the Study Area to either location by gravity. Similarly, a review of the existing sewers also shows that the existing sewers adjacent to these parcels are deep, such that is would be challenging to outlet these sewers into a pond located on these parcels.

**Conveyance Control Measures** are measures typically located within the road right-of-way and may include surface features such as vegetated swales and raingardens or sub-surface features such as perforated pipes and underground infiltration trenches.

Surface control measures could be considered for use within the Study Area, however, the impact of such features will be limited given the relatively small area such features will occupy in relation to the area of the Sub Area rights-of-way.

Sub-surface conveyance control measures can be very effective, depending on the surrounding soil and groundwater conditions, in providing a means for sewer flow to infiltrate into the ground, thereby reducing the amount of flow discharged to the environment. The implementation of sub-surface control conveyance measures within the Study Area may prove difficult for the same reasons relating to contaminated soil and combined sewage described above.

One sub-surface control measure that may be effective in alleviating peak flows at the outlets and should be considered is the upsizing of storm sewers within road rights-of-way to act as temporary storage (i.e. “superpipes”). As oversized pipes would not be perforated, there would not be the same concern with contamination as with infiltration pipes.

**Source Control Measures** are located at the beginning of the drainage system, most often on private property. Source controls can include green roofs/roof gardens, planted swales or soakaway pits, among others, designed to reduce the amount of runoff from a site making its way to the storm sewer system. Other means of attenuating the volume of runoff discharged to the sewer would include provision of on-site storage such as parking lot or rooftop ponding or underground stormwater retention tanks.

Though the uncontrolled post-development stormwater volume generated from within the Study Area is only 15% greater than the volume generated in the existing condition it is recommended that stormwater quantity controls be implemented within the Study Area to further reduce (i.e. over-control) the stormwater flows entering the sewer system to help alleviate the bottleneck condition at the existing combined sewer outlets.

Given that proposed development parcels represent the majority of land within the Study Area (in relation to municipal rights-of-way), on-site source control measures represent the greatest opportunity to reduce the amount of stormwater runoff discharged to the sewer system and should be used to reduce the 5-year post-development discharge to the 2-year pre-development runoff.

Conveyance control measures may be utilized as an effective means of helping to attenuate the runoff within the Study Area, however, the potential for contaminants from the surrounding soil entering the sewer system should be considered as part of the decision process. Likewise, any conveyance control measures should be designed in such a way that only stormwater flow is allowed to infiltrate into the surrounding soil (soil conditions permitting). Combined sewer flow should be contained within the sewer system and not be permitted to infiltrate into the surrounding soil.

## 6.3 Sanitary Sewer Outlets

There are two sanitary sewer outlets within the study area; the large trunk sewer that runs west-to-east along Barton Street and exits the Study Area at Bay Street and the sanitary sewer that runs in Stuart Street and exits the Study Area across the CN Rail yard east of Tiffany Street.

Sanitary sewer flows are calculated based on an equivalent population and an average per-capita sewer flow of 360 l/day/person. For the external catchments the populations must be estimated using population densities based on land use provided in the City of Hamilton design guidelines.

The equivalent populations for External Catchments A to E are summarized in Table 5.2.1 below.

**TABLE 6.3.1 – EXTERNAL SANITARY FLOW CHARACTERISTICS**

| | Land Use (ha) | | | Total Area (ha) | Equivalent Population |
|---|---|---|---|---|---|
| | **Park (25 ppha)** | **Residential (75 ppha)** | **Commercial (450 ppha)** | | |
| Catchment A | 1.03 | 11.56 | 0 | 12.59 | 893 |
| Catchment B | 3.06 | 25.40 | 11.23 | 39.69 | 7035 |
| Catchment C | 0.59 | 1.93 | 2.66 | 5.18 | 1357 |
| Catchment D | 1.67 | 4.04 | 0.16 | 5.87 | 417 |
| Catchment E | 0.48 | 11.57 | 16.64 | 28.69 | 8368 |
| | | | | **Total External Equivalent Population** | **18,070** |

For the development parcels within the Study Area, the number and types of units and projected populations in each parcel are based on a planning assessment completed as part of this study and prior documents. A summary of the proposed development metrics was provided by GSP Group and is summarized in Table 6.3.2

### TABLE 6.3.2 – INTERNAL SANITARY FLOW CHARACTERISTICS

| Development Area | Residential | | Commercial | | Equivalent Population |
|---|---|---|---|---|---|
| | Units | People | Floor Space ($m^2$) | Employees | |
| 1 | 398 | 677 | 10,780 | 287 | 964 |
| 2 | 212 | 360 | 0 | 0 | 360 |
| 3 | 0 | 0 | 15,204 | 405 | 405 |
| 4 | 244 | 415 | 0 | 0 | 415 |
| 5 | 0 | 0 | 18,092 | 549 | 549 |
| 6 | 156 | 265 | 0 | 0 | 265 |
| 7 | 0 | 0 | 5,960 | 181 | 181 |
| 8 | 0 | 0 | 8,331 | 208 | 208 |
| 9 | 23 | 58 | 0 | 0 | 58 |
| 10 | 80 | 136 | 0 | 0 | 136 |
| 11 | 48 | 122 | 0 | 0 | 122 |
| **Total Internal Equivalent Population** | | | | | **3,663** |

Although a portion of sanitary flow from the both the study area and upstream catchments is routed to the Barton Street trunk sewer, it is conceivable that with separation of the combined sewer system most if not all of the sanitary sewer flow could be routed to the Stuart Street outlet in the future. As such, the sum total of the internal and external sanitary sewer flows has been calculated to determine if there is sufficient capacity in the existing Stuart Street outlet.

According to City of Hamilton design guidelines, sanitary sewers are to be designed for daily flows of 360 litres per day per capita. The total contributing population to the Stuart Street outlet is approximately 22,000, which corresponds to a sanitary flow of 7,823,900 litres/day.

A peaking factor based on population is applied to the flow calculated above using the Babbitt Formula ($M = 5 \div P^{0.2}$, where P=population in thousands). The peaking factor based on a population of 22,000 is 2.69, yielding a peak sanitary flow of 21,046,300 litres per day, or 256 litres/second.

The City also requires that an allowance of 0.2 litres/second/hectare be made for infiltration into the sanitary sewer system. This would add an additional 22 litres/second for a total of 244 litres/second or 0.244 $m^3$/s.

The Stuart Street sanitary outlet is a 800 mm x 1200 mm oval brick sewer at a slope of 0.3% with a corresponding capacity of 1.06 $m^3$/s. This sewer can accommodate the expected sanitary flow from both the Study Area as well as the upstream catchments.

## 7.0 SUMMARY OF RECOMMENDATIONS

Below is a summary of the recommendations made within this servicing report.

### 7.1 Sub-Area 1

**Servicing Easements/Realignments**

- Re-align existing Harriet Street combined sewer to be located within the right-of-way of the new Harriet Street extension;
- Re-align existing Railway Street combined sewer to be located within the right-of-way of the new Railway Street extension; and
- Consider re-aligning Stuart Street storm, sanitary and watermains to the north in a new easement along the west boundary of Parcel 10 in order to un-encumber Central Park.

**Grading**

- The proposed road network within Sub-Area 1 can be constructed; and
- A retaining structure will be required along the east and south boundaries of Parcel 10.

**Sewers**

- Upgrade the existing Caroline Street storm sewer and extend it south to the south boundary of the Study Area.
- Construct a new dedicated storm sewer in Mulberry Street and connect to Caroline Street storm sewer.
- Provide dedicated storm sewer connections for future connections at Mill, Harriet, Windsor and Railway Streets.
- Extend Barton Street storm sewer from west of Caroline Street to east of Queen Street to provide dedicated storm sewer to the block between Queen and Hess Streets.
- Decommission west outlet of storm manhole at intersection of Tiffany and Barton Streets, such that storm sewer flow east of Tiffany Street is conveyed down Tiffany Street and does not continue west along Barton Street.
- Existing Caroline Street combined sewer to remain. Sewer to convey combined sewer flow from areas external to Study Area and separated sanitary flow from within the Study Area. Remove connection to storm sewer at Barton Street, direct all flow to Barton Street trunk sanitary sewer.
- Provide new dedicated sanitary sewer within new Mulberry Street right-of-way.

**Watermain**

- Extend existing watermains in Mill and Harriet Streets to connect to existing Caroline Street main;
- Provide new watermain within new Mulberry Street right-of-way and connect to existing Caroline and Bay Street watermains; and
- Extend existing Railway Street watermain to connect to new Mulberry Street main.

## 7.2 Sub-Area 2

**Servicing Easements/Realignments**

- None.

**Grading**

- Buildings on Parcel 1 may require multiple Finished Floor Elevations; and
- Landscaping on Parcel 1 may require retaining walls and/or terracing.

**Sewers**

- Replace existing Tiffany Street combined sewer with upgraded dedicated storm sewer;
- Existing Caroline Street storm sewer to remain;
- Upgrade existing Hess Street storm sewer;
- Upgrade existing Stuart Street sewer west of Outlet 2;
- Decommission existing Stuart Street combined sewer between Caroline Street and Outlet 2; connect combined sewer to Outlet 3;
- Provide new storm sewers in proposed east-west road. No new sewers to be connected to Caroline Street storm sewer;
- Provide new dedicated sanitary sewer in Stuart Street west of sanitary outlet and connect to sanitary outlet;
- Provide new sanitary sewers within proposed new east-west road; and
- Consideration should be given to upgrading the existing storm sewer outlets at Stuart Street. Will require a study of the impacts to the functionality of the downstream pumping station and combined sewer overflow tanks.

**Watermain**

- Extend existing Hess Street watermain to Stuart Street; and
- Provide new watermain in proposed new east-west road to interconnect Queen, Hess, Caroline, and Tiffany Street mains.

## 7.3 Sub-Area 3

### Servicing Easements/Realignments

- Easement will be required over the existing 1200 mm diameter combined sewer outlet where it crosses through Parcel 8, the proposed path and the City-owned lands adjacent to the rail yard. Sewer may need to be re-aligned in order to be compatible with proposed Parcel 8 buildings.

### Grading

- The back of Parcel 9 is located on a steep (2H:1V) slope; a retaining structure will be required in order to construct the parcel as proposed.
- The path connecting Locke Street North to Queen Street will require stairs in order to accommodate the significant grade change at the west end of the path. Alternatively, the path could be reconfigured to incorporate meandering/switchbacks to make the path accessible.

### Sewers

- Existing combined and sanitary trunk sewer to remain;
- Upgrade existing storm sewer; provide storm sewer stubs to Magill, Ray, Oxford and Greig Streets for future connections;
- Existing Queen and Stuart Street sewers to remain;
- Existing 1200 mm diameter outlet is undersized; consider upgrading.

### Watermain

- Upgrade existing 100 mm diameter watermains.

## 7.4 Stormwater Management

Although the post-development runoff generated within the Study Area is only 15% greater than the pre-development condition, it is still desirable to provide a level of quantity control, both to reduce the flow to the over-capacity combined sewer outlets and as part of a “best practices” approach.

The majority of flow to the combined sewer outlets from the Study Area is generated from upstream catchments external to the Study Area and in all cases except Outlet 2 the capacity of each of the outlets is exceeded by the runoff generated by upstream catchments external to the Study Area; therefore, flow to the outlets will continue to exceed capacity regardless of any measures taken to attenuate the runoff generated within the Study Area.

It is recommended that source controls, including parking lot/rooftop storage, soak pits, detention tanks, etc. be the primary method of SWM within the Study Area, with the possibility of exploring the use of conveyance measures within the municipal rights-of-way (including the use of pipe storage, or “superpipes”). End of pipe measures area not recommended to be implemented within the Study Area due to the concerns listed in Section 6.2 relating to grading, contaminated soil and combined sewer flow.

## 8.0 SUMMARY

The main findings of the functional servicing report for the proposed development within the Barton-Tiffany Study Area are:

1. Special consideration to site grading will be required during detailed design of Parcels 1, 9 and 10. The proposed pedestrian path connecting Locke Street North to Stuart Street will require a significant staircase.

2. Water supply for the Study Area will be provided by the existing water distribution network. Existing 100 mm diameter mains that are not anticipated to provide sufficient fire flow should be upgraded to meet fire flow demands. Boundary conditions have been requested from the City; once received, the existing system will be modeled with the proposed development concept to confirm sufficient capacity and the need for watermain upgrades.

3. It is recommended to construct new watermains in the following locations:

    - Mulberry Street between Caroline and Bay Streets;
    - The new proposed east-west road between Tiffany and Queen Streets north of Barton Street;
    - Hess Street between the new proposed east-west street and Stuart Street; and
    - The proposed extensions of Mill, Harriet and Railway Streets.

4. A separated sewer system can be established within the Study Area. All sanitary sewer flow from the Study Area can be directed to the dedicated sanitary sewer outlet located north of Stuart Street between Tiffany and Bay Streets. A number of storm sewers within the Study Area will be required to convey combined sewer flow until such time as the upstream sewer systems are separated.

5. The Study Area can be adequately serviced by existing sanitary outlet connections.

6. The existing storm sewer outlets from the Study Area do not have sufficient capacity to meet the City’s design criteria. The capacity of each of the storm sewer outlets (with the exception of Outlet 2) is exceeded by the contributing flow from the upstream catchments external to the Study Area; therefore, some surcharge of the storm sewers within the Study Area can be expected until such time as the outlets are upgraded.

7. The anticipated runoff from the Study Area will increase slightly (±15%) from the existing condition. It is recommended that stormwater management (SWM) control measures be implemented extensively within the Study Area, with the goal of not only reducing post-development discharge to pre-existing conditions, but to "overcontol" stormwater flows to help alleviate the capacity issues at the storm sewer outlets. It is recommended that source controls, including parking lot/rooftop storage, soak pits, detention tanks, etc. be the primary method of SWM within the Study Area, with the possibility of exploring the use of conveyance measures within the municipal rights-of-way (including the use of pipe storage, or "superpipes"). End of pipe measures area not recommended to be implemented within the Study Area due to concerns related to suspected contaminated soils within the Study Area and the fact that the majority of sewers which convey storm runoff to the Study Area are combined sewers.

All of which is respectfully submitted,

**MTE CONSULTANTS INC.**

Jason Rosevear, B.A.Sc.
Designer

Kayam Ramsewak, P.Eng.
Manager, Site Development Division

JBR:clt

MTE
More Than Engineering
25 YEARS 1985-2010

# FIGURES


LEGEND

LIMIT OF STUDY AREA

Scale: 1:2000 AUG. 2014

GSP GROUP INC.

72 VICTORIA STREET SOUTH KITCHENER

BARTON-TIFFANY AREA URBAN DESIGN

HAMILTON

FIGURE 1.0
LOCATION PLAN

25 YEARS 1985-2010 MTE

Project No.: 38514-100

MTE FILE No: 38514-100-F1.0
LOCATION PLAN
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August 13, 2014 — 3:42 p.m. — Plotted By: pralmbault

MTE FILE No: 38514-100-F2.0
EXISTING LAND USE
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August 13, 2014 — 2:48 p.m. — Plotted By: pralmbault

MTE FILE No: 38514-100-F3.0
EXISTING CONTOUR PLAN
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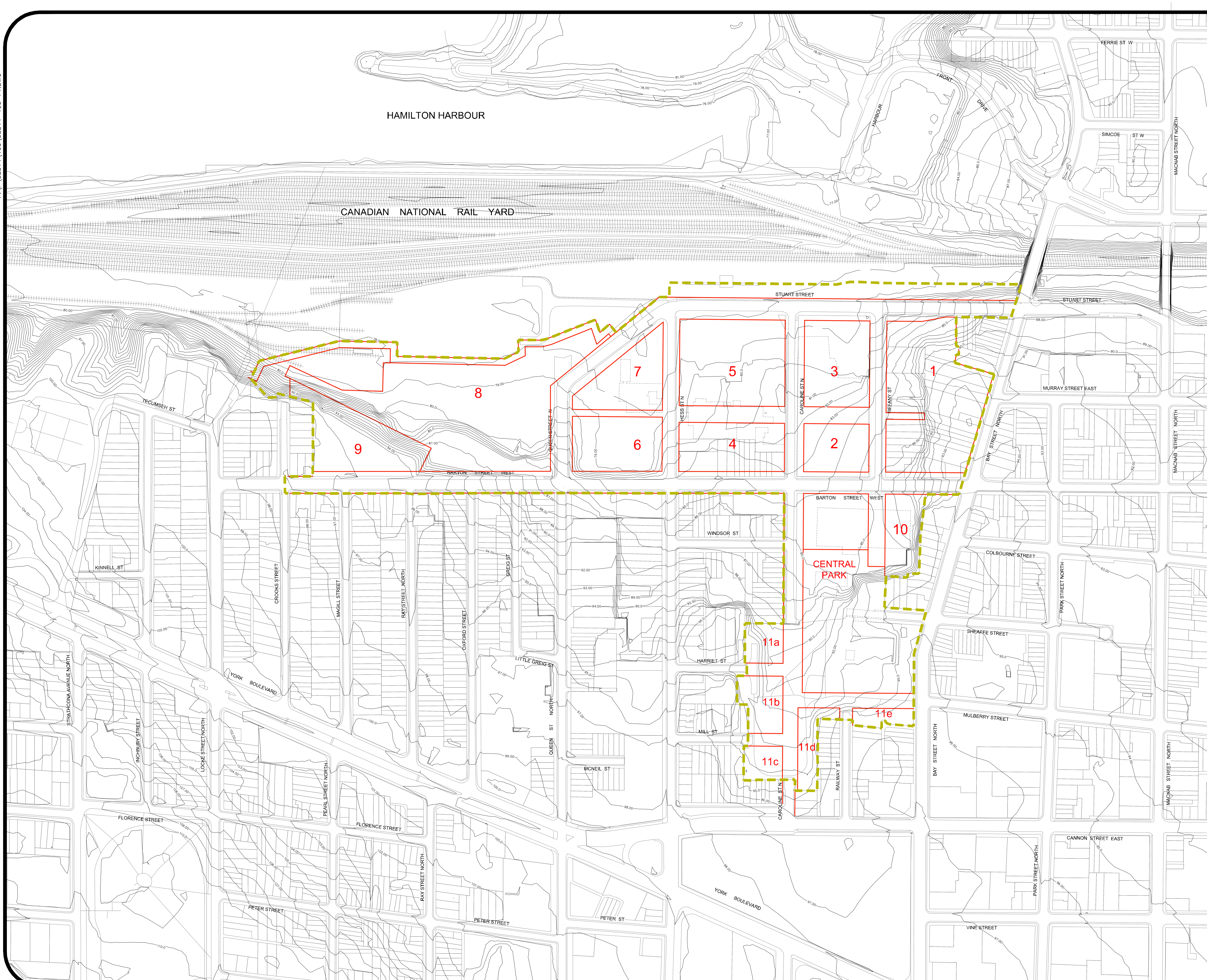


## LEGEND

LIMIT OF STUDY AREA

EXISTING CONTOURS

Scale: 1:2000 AUG. 2014

**GSP GROUP INC.**

72 VICTORIA STREET SOUTH KITCHENER

**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

**FIGURE 3.0 EXISTING CONTOUR PLAN**

MTE 25 YEARS 1985-2010

Project No.: 38514-100

August 13, 2014 — 3:42 p.m. — Plotted By: pralmboult

MTE FILE No: 38514-100-F4.0
PREFERED URBAN DESIGN CONCEPT
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August 13, 2014 — 3:42 p.m. — Plotted By: praimbault

MTE FILE No: 38514-100-F5.0
INTERNAL SUB-AREAS
P:\P\38514\100\38514-100-F1.DWG


August 13, 2014 — 3:42 p.m. — Plotted By: prolmbault

MTE FILE No: 38514-100-F7.0
EXTERNAL CATCHMENT AREAS
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Scale: 1:2000 AUG. 2014

**GSP GROUP INC.**

72 VICTORIA STREET SOUTH KITCHENER

**BARTON-TIFFANY AREA URBAN DESIGN**

HAMILTON

**FIGURE 7.0 EXTERNAL CATCHMENT AREAS**

MTE 25 YEARS 1985-2010

Project No.: 38514-100

August 13, 2014 — 3:42 p.m. — Plotted By:

HGC ENGINEERING

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# Noise and Vibration Feasibility Study for the Barton-Tiffany Area of Hamilton, Ontario

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And

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August 25, 2014

# Table of Contents

# 1 Introduction and Summary

HGC Engineering was retained by the City of Hamilton to assess the potential impact of noise from the CN Stuart Street Rail Yard, nearby roadways, and through rail traffic upon the lands known as the "Barton-Tiffany Study Area", in the City of Hamilton, Ontario. The lands are bounded by Stuart Street, Bay Street North, Barton Street West and a Municipal park area. The lands within the Barton-Tiffany Study Area are currently designated and zoned for a variety of downtown commercial and residential land uses as the result of a recent Ontario Municipal Board Hearing.

This report incorporates the preliminary comments dated May 8, 2014 from the City of Hamilton (provided in Appendix F) based on a review of our draft noise report dated November 15, 2013. The current report includes reference to the preferred urban design concept plan.

This report investigates potential noise and vibration impact from the Stuart Street Yard and road and rail traffic on the Barton-Tiffany lands to develop an understanding of the constraints and opportunities of development in the area and to inform future building designs. This report is based on the latest guidelines of the Ontario Ministry of Environment (MOE), NPC-300.

Traffic on Barton Street West, Bay Street North and Queen Street, rail traffic on the railway corridor (Canadian National (CN), Southern Ontario Railway (SOR) and GO Transit) were determined to be the dominant transportation sources of sound affecting the study area. The Stuart Street Rail Yard was found to be a significant stationary noise source. The concept plan has beneficially located less noise sensitive commercial uses as a buffer between the rail lands and the proposed residential uses from a planning perspective in terms of Land Use Compatibility.

Traffic volume data for the roadways was obtained from the City of Hamilton. Data for the railway was obtained from HGC Engineering project files, originally from the GO Transit personnel, Canadian National (CN) and SOR personnel and was verified by personnel to be valid. The data was used in conjunction with the zoning map of the study area to predict future traffic sound levels at the proposed building facades. The predictions were evaluated with respect to the guidelines of the Ministry of Environment (MOE) and the City of Hamilton, and used to develop noise control recommendations with regard to traffic noise.

Sound levels of the rail yard activities were measured by HGC Engineering and used to conduct predictive acoustical modeling of the rail yard facility. Acoustic assessment criteria were developed, based on the guidelines of the Ontario Ministry of Environment.

In summary, the results of this study indicate that both traffic and stationary (Barton Street Yard) noise levels significantly exceed MOE sound level guidelines on the subject lands. With suitable noise control measures integrated into the design of the buildings, MOE sound level limits can be met.

The recommended noise control measures for the residential units to address traffic sources include appropriate wall and window glazing assemblies, the use of air-conditioning so that windows can be kept closed, acoustical shielding of ground level outdoor amenity space and parapets around large above grade or rooftop outdoor amenity areas.

The recommended noise control measures for the stationary sources include enclosed noise buffers and architectural design features to protect the windows of noise sensitive spaces such as bedrooms, living/dining and family rooms, particularly at upper storey units which have clear exposure to the rail yard.

Warning clauses should be included in the property and tenancy agreements and offers of purchase and sale to warn occupants of potentially audible transportation and stationary noise.

Detailed noise studies are recommended for each proposed residential building in the study area to ensure conformance with the recommendations in this report. Those studies would provide detailed recommendations for building facade constructions, ventilation requirements, noise barriers or parapets and architectural features or enclosed noise buffers for noise mitigation purposes to address both traffic and stationary noise.

Detailed noise studies are also required for individual proposed commercial buildings with regard to any potential noise sources at those facilities such as loading bays or rooftop mechanical equipment with the potential to impact residential units in the study area.

Ground-borne vibration from rail traffic through the Stuart Rail Yard was measured at representative locations at the future commercial lands. Those vibration levels are within the CN/GO Transit guidelines for commercial uses, but more detailed analysis should be conducted for individual commercial buildings if particular vibration sensitive activities or equipment such as may be associated with laboratories or vision clinics are proposed. Vibration mitigation measures are not required for the proposed residential uses.

# 2 Terms of Reference

The Terms of Reference for this study are taken from the following sections of an RFP from the City of Hamilton dated July 16, 2013 entitled *"Contract Number: C3-11-13 Contract Title: Professional Consultant Services Required for Urban Design Study for the Barton-Tiffany Area of Hamilton"*.

***1.0 SCOPE OF WORK***

> *"The City of Hamilton is soliciting Proposals from qualified and experienced Urban Design consultants to provide professional and technical services for the undertaking of an Urban Design Study for the lands located within the Barton-Tiffany Study Area. To further assist in the development of the Urban Design Concept and Guidelines, the study also includes the preparation of a Functional Servicing Report, a Traffic Impact Study, Transportation Demand Management Report and reviews of existing studies (for example: Noise and Vibration Impacts, and Geotechnical). In addition, a Noise Feasibility Study will be required to support the preferred design concept."*

***3.03 Additional Study Objectives***

> *"The study must address noise and vibration impacts in conjunction with the active rail yard which abuts the study area to the north (i.e. CN Rail lands). This will require the use of innovative building techniques and building typologies that reduce noise and promote sustainability. The acoustic impacts will also determine the location and conceptual design for landscape buffers."*

***A.2.e) iv} Noise Feasibility Study Guidelines***

> "(Source: MOE – Ministry of the Environment, Document Title: Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning, Publication: NPC-300, release date October 21, 2013, Document #: std01_079357[1] )"

Also, in 2003, the City of Hamilton commissioned an environmental noise and vibration assessment [Ref. 1] which considered in broad terms the entire West Harbour Planning Area. That study did not focus on any one particular development site, but investigated the potential area of influence surrounding the Stuart Street Yard. Given the age of that study and its broad nature, the City has requested that an updated site-specific acoustical study be undertaken for the Barton Tiffany Study Area. That study was reviewed by HGC Engineering to inform the current study.

# 3 The Planning Context

## 3.1 Barton-Tiffany Study Area Description

The subject site is bounded by Stuart Street and the Stuart Street Rail Yard to the north, Bay Street North to the east, an existing park to the south and Barton Street West and municipal park lands to the west, as shown in Figures 1 and 2. Much of the subject site was zoned for industrial uses and many of the formerly industrial lands are vacant or are currently being demolished to make way for redevelopment. There are existing residences along Bay Street North and Barton Street West, many of which will be retained. Several parcels are owned by the Municipality and are anticipated to change ownership and use as the lands are redeveloped.

Figure 2 shows an aerial photo of the Barton-Tiffany Lands with the surrounding land uses.

## 3.2 Zoning of Barton-Tiffany Study Area

**Background Information**

The Barton-Tiffany lands are a former Industrial Area with some existing residential lands. The lands are located within the West Harbour Secondary Planning Area and are bounded by Stuart Street to the north, Bay Street North to the east, Barton Street West to the south and Conservation Authority regulated lands to the west. Schedule K and L Amendment No. 198 to the Official Plan for the former City of Hamilton are provided in Appendix A.

City Council has adopted Official Plan Amendment No. 23 to the former Region of Hamilton-Wentworth Official Plan and Official Plan Amendment No. 198 to the former City of Hamilton Official Plan for the West Harbour. An OMB decision now allows a mixture of medium density residential uses along Barton Street West and Bay Street North and commercial uses on the lands within 150 metres of the rail yard. There are also some existing lands at the southwest corner of Stuart Street and Bay Street which are to remain as low density residential. The lands have been rezoned according to the OMB decision. Appendix A shows the current zoning for the lands within the Barton-Tiffany Study Area. Map 868 shows the majority of the Barton Tiffany Study Area. Maps 867, 825, 910 and 826 show the surrounding areas.

The City of Hamilton Zoning Information is provided in Appendix A. A brief description of the relevant lands in the Barton Tiffany Study Area is provided below.

**D2 (Downtown Prime Retail Streets)**

D2 zoning refers to Downtown Prime Retail Streets as identified on Maps 867 and 868. A variety of commercial uses are permitted on these lands: commercial entertainment, commercial parking facility, commercial recreation, commercial school, conference or convention centre, craftsperson shop, financial establishment, medical clinic, office personal services, recreation, repair service, restaurant, retail, studio, tradesperson's shop and veterinary service. The maximum height of a commercial building is 15 m or 5 storeys (if each storey is 3 m in height).

**D6 (Downtown Multiple Residential)**

D6 zoning refers to Downtown Multiple Residential as identified on Maps 867 and 868. Only two uses are allowed on these lands: multiple dwelling and home business in accordance with the City of Hamilton by-law. The building may be a mixed use building with commercial on the ground floor only. The permitted commercial uses are commercial entertainment, commercial recreation, commercial school, conference or convention centre, day nursery, financial establishment, medical clinic, office, personal services, recreation, repair service, restaurant, retail, studio, tradesperson's shop and veterinary service. The minimum building height is required to be 7.5 m in height or 2 storeys. The maximum height of a mixed use building is 15 m or 5 storeys (if each storey is 3 m in height).

**D5 (Downtown Residential)**

D5 zoning refers to Downtown Residential as identified on Map 868. The permitted uses are single detached dwellings, semi-detached dwellings and street townhouse dwellings. The maximum height of single, semi- or street townhouse dwellings is 11.25 m or 3.5 storeys (if each storey is 3 m in height).

A variety of commercial uses are permitted on these lands: commercial entertainment, commercial parking facility, commercial recreation, commercial school, conference or convention centre, craftsperson shop, financial establishment, medical clinic, office personal services, recreation, repair service, restaurant, retail, studio, tradesperson's shop and veterinary service. The maximum height of a commercial building is 15 m or 5 storeys (if each storey is 3 m in height).

Outdoor amenity areas are not permitted in rear yards or northerly side yards

## 3.3 CN Rail Lands and Associated Activities

The rail yard lands to the north of the subject site are owned by CN Rail, but the majority is leased and operated by Southern Ontario Railway (SOR). The southwest portion of the rail yard hosts a CN CargoFlo facility, where bulk materials (flour and PVC powder) are transferred between rail cars and tanker trucks. The Grimsby Subdivision of the CN Rail system, which is a Principal Main Line thoroughfare, runs through the middle of the rail yard lands, at a distance of about 130 metres from the nearest proposed buildings on the subject lands.

The extents of the rail yard are shown in Figure 2. HGC Engineering personnel visited the yard on May 5, May 22 and May 29, 2009 and October/November 2013, to discuss the rail yard operations with representatives of SOR and CN CargoFlo, and to make observations and sound level measurements of the rail yard activities. These activities were verified to be current by discussions with the relevant operators and during the site visit. The majority of the yard is used for sorting and classification of rail cars, which is accomplished using one or both of two yard locomotives that are resident on site. The sorting of rail cars and building up of train segments for outbound shipping involves the coupling and decoupling of rail cars. Drop-off and pickup of rail cars by freight trains, as well as classification and sorting by the yard locomotives can occur during both daytime and nighttime hours.

At the southwest corner of the SOR portion of the yard, there is a locomotive maintenance facility. Although the maintenance work itself is conducted inside the building, there is load testing of a locomotive that can occur from time to time, whereby the locomotive is operated at a high idle condition for a period up to or exceeding an hour, typically during daytime hours only.

As noted in Figure 2, the southwest portion of the yard is operated by CN CargoFlo. The activities in this area include the offloading of flour and PVC powder from tank cars into tank trucks using truck-mounted pneumatic blowers. Discussions with CargoFlo personnel indicate that operations are normally scheduled only during daytime hours, and that on a busy day, two to five flour trucks and two to three PVC trucks could visit the site to be loaded. Loading of one truck typically requires 90 minutes to two hours. On occasion, two trucks could visit the site at one time (e.g., one flour truck and one PVC truck).

AVL, a metal fabrication industry is located at the west of the study area on lands proposed for commercial uses. A drive by inspection of that facility indicated that noise emissions are primarily from open doors and yard activity which is directed to the north away from existing residential and the future residential uses.

# 4 Sound and Vibration Assessment Guidelines

## 4.1 Relevant Acoustic Terminology

A variety of specialized acoustical terms are used throughout this report. The following provides a basic summary of the terms and the underlying concepts.

**Class 1 area:**

Means an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the activities of people, usually road traffic, often referred to as “urban hum”.

**Class 2 area:**

Means an area with an acoustical environment that has qualities representative of Both Class 1 and Class 3 area:

- Sound levels characteristic of Class 1 during daytime (07:00 to 19:00 or to 23:00 hours); and
- Low evening and night background sound level defined by natural environmental and infrequent human activity starting as early as 19:00 hours (19:00 or 23:00 to 07:00 hours).

**Class 3 area:**

Means a rural area with an acoustical environment that is dominated by natural sounds having little or no road traffic, such as:

- A small community;
- Agricultural area;
- A rural recreational area such as a cottage or a resort area; or
- A wilderness area.

**Class 4 area:**

Means an area or specific site that would otherwise be defined as class 1 or 2 and which:

- Is an area intended for development with new noise sensitive land use(s) that are not yet built;
- Is in proximity to existing, lawfully established stationary sources(s); and
- Has formal confirmation from the land use planning authority with the Class 4 area classification which is determined during the land use planning process.

The exclusionary limits for each Class area are summarized in Table I and II.

**Table I: Exclusion Limit Values of One-Hour Equivalent Sound Level ($L_{EQ}$, dBA) Outdoor Points of Reception**

| Time of Day | Class 1 Area | Class 2 Area | Class 3 Area | Class 4 Area |
|---|---|---|---|---|
| 07:00 – 19:00 | 50 | 50 | 45 | 55 |
| 19:00 – 23:00 | 50 | 45 | 40 | 55 |

**Table II: Exclusion Limit Values of One-Hour Equivalent Sound Level ($L_{EQ}$, dBA) Plane of Window of Noise Sensitive Spaces**

| Time of Day | Class 1 Area | Class 2 Area | Class 3 Area | Class 4 Area |
|---|---|---|---|---|
| 07:00 – 19:00 | 50 | 50 | 45 | 60 |
| 19:00 – 23:00 | 50 | 45 | 40 | 60 |
| 23:00 – 07:00 | 45 | 45 | 40 | 55 |

## Enclosed Noise Buffer

An enclosed noise buffer means an enclosed area outside the exterior wall of a building such as an enclosed balcony specifically intended to buffer one or more windows of noise sensitive spaces. In order for the concept of enclosed noise buffer to be acceptable within the context of an MOE approval of stationary sources, it can only apply to high-rise multi-unit buildings in a Class 4 area. Since the Stuart Street yard is Federally regulated it does not require MOE approvals and enclosed noise buffers could be considered with regard to noise mitigation for the subject lands without Class 4 designation. The characteristics of an enclosed noise buffer are listed below:

- not less than one metre and not more than two metres deep;
- fully enclosed with floor to ceiling glazing or a combination of solid parapet plus glazing above – glazing can potentially be operable to the maximum permitted by the Ontario Building Code;
- separated from interior space with a weatherproof boundary of exterior grade wall, exterior grade window, exterior grade door, or any combination, in compliance with exterior envelope requirements of the Ontario Building Code;
- of sufficient horizontal extent to protect windows of noise sensitive spaces; and
- the architectural design is not amenable to converting the enclosed space to being noise sensitive.

## Magnitude and Frequency of Sound

The human ear perceives oscillations in air pressure as sound. The magnitude of the oscillations determines the loudness of the sound, and is typically measured logarithmically, in terms of sound pressure level, in units of decibels [dB]. A faint whisper might produce only a few decibels, while a loud shout can exceed 100 dB at close range.

In addition to differences in magnitude, the human ear perceives differences in the frequency or "pitch" of sounds, which corresponds to the number of pressure oscillations occurring per second, measured in units of Hertz [Hz]. 1.0 Hz is equal to one oscillation per second. A low frequency sound (in the bass range), such as a tuba or rolling thunder, exhibits a relatively small number of oscillations per second, while a high frequency sound (in the treble range), such as a piccolo or a hissing air leak, consists of thousands of oscillations per second. The audible frequency range for human hearing extends from about 20 Hz to 20 kHz.

Most general noises, such as traffic, industry, or wind, contain many different frequencies simultaneously. The human ear varies in its sensitivity to sounds of different frequency. Therefore, sound levels are usually measured using a frequency-weighted filter which emulates the frequency sensitivity of the human ear. This frequency-weighting is referred to as the "A-scale," and sounds measured in this way are designated in units of A-weighted decibels [dBA]. A dBA sound pressure level is a reasonable single-number representation of the perceived overall loudness of a complex sound that contains multiple different frequencies. For this reason, environmental noise limits in most jurisdictions, including Ontario, are specified in terms of dBA sound levels. As a rule of thumb, a change in sound level of less than about 3 dBA is typically considered imperceptible, while an increase of 10 dBA is perceived as an approximate doubling of loudness.

**Noise Barrier**

A noise barrier can be comprised of an earthen berm, wall, parapet or other construction with a minimum surface density of 20 kg per square meter. It can be of a wood, metal, plastic or masonry construction and must be free of gaps or cracks within or below its extent.

**Impulse Sounds**

Sounds produced by stationary sources can be broadly categorized into two types: *impulsive* sounds and *non-impulsive* sounds. An "impulse" is defined as a single pressure pulse or a single burst of pressure pulses (such as a gunshot, hammering, or railway car coupling). Non-impulsive sounds are those which are not a single pressure pulse, but which continue for periods of time longer than an instantaneous burst. These two types of sound are assessed separately, using two distinct measurement/evaluation methods. Since impulsive sounds are transient pressure bursts, they are measured in a special way, using the 'impulse' setting on an appropriately equipped sound level meter, in units of dBAI. (The "I" suffix denotes a measurement made using the impulse setting.)

**Quantifying Sounds that Vary Over Time**

Many sounds are not continuous in magnitude, but can vary in loudness over time. Non-impulsive sounds, which may start or stop or otherwise vary over time, are commonly measured in terms of the *energy-equivalent sound exposure level*, "$L_{EQ}$." The $L_{EQ}$ sound level in units of dBA is the logarithmic average of the acoustic energy occurring during a given measurement period. For impulse sounds, a sampling of individual impulses is measured and averaged logarithmically together to yield the *logarithmic mean impulse sound level*, "$L_{LM}$" in units of dBAI.

## 4.2 Noise Assessment Criteria

### 4.2.1 NPC-300, "Environmental Noise Guidelines Stationary and Transportation Sources – Approval and Planning"

As a basis of quantitative assessment, this study relies upon the noise guidelines of the Ministry of Environment ("MOE"), and in particular MOE Guideline NPC-300, "Environmental Noise Guidelines Stationary and Transportation Sources – Approval and Planning" which is accepted by the City of Hamilton. The City in their preliminary review of HGC Engineering's draft report has indicated that NPC-300 is the required guidance document. NPC-300 draws a distinction between traffic sound sources – such as roads, rail thoroughfares and aircraft – and "stationary" sound sources such as industrial or commercial facilities. A rail yard including all the noise sources and activities occurring on the rail yard lands is categorized as a stationary source because those activities occur within the bounds of a fixed site. Because the sound level limits, assessment methods and applicable abatement methods differ substantially for traffic and stationary sources, these two types of sources are assessed separately (not cumulatively), under MOE guidelines in this report.

#### 4.2.1.1 Stationary Sources of Sound (The Stuart Street Rail Yard)

In Ontario, under Section 9 of the Environmental Protection Act [Ref. 2], the owners/operators of industrial and commercial operations that emit noise to the outdoor environment are obligated to obtain an Environmental Compliance Approval for the facility from the MOE, the prerequisite for which includes compliance with the MOE sound level limits. Rail yards owned by CN and CP are not subject to this obligation, as they are considered to be federally regulated transportation infrastructure.

Nevertheless, when the need to assess a rail yard arises in Ontario in the context of a land use change or proposed noise sensitive development, the MOE sound level limits contained in NPC-300 are typically used. Accordingly, MOE guideline NPC-300 has been adopted herein as a basis for developing sound assessment criteria for noise from the rail yard and other significant stationary noise sources.

***Noise Sensitive Points of Reception***

The sound level criteria of the MOE apply at a noise sensitive point of reception, such as a residence, school, day-care, church, hospital or hotel. Thus, the amount of sound emitted by the source is not the primary concern, but the resulting sound level arriving at the point of reception is. In this respect, the MOE noise guidelines are considered to be "point of reception" criteria, as opposed to "point of emission" criteria.

Under MOE noise assessment guidelines, a point of reception is typically an outdoor location, either in an outdoor amenity space, or outside the plane of a window to a noise sensitive indoor room (e.g., bedrooms, living rooms, dining rooms). At new residential buildings located in the vicinity of a rail yard, windows of noise sensitive spaces such as living/dining rooms and bedrooms facing the rail yard can be protected inside an enclosed noise buffer as defined in

Section 4.1 and discussed below as a potential mitigation feature. In that case, the typical MOE assessment criteria will not apply directly as the sound is prevented from reaching the noise sensitive windows by the enclosed noise buffer.

***Characterization of the Acoustical Environment***

The subject site is best characterized as a Class 1, ("Urban") acoustical environment in NPC-300 because the background sound is dominated by man-made activities during both daytime and nighttime hours (e.g., road and rail traffic and some industrial sound from the rail yard).

In general, the sound level limits for stationary sources are site dependent, and are based on the existing ambient background sound levels in the area surrounding the subject site. In essence, the sound from the stationary sources is evaluated against (i.e. compared to) the typical background sound at a sound-sensitive point of reception.

***Applicable Criteria***

Specifically, publication NPC-300 stipulates that the assessment criteria for a stationary source which can operate during both daytime and nighttime hours in an Urban (Class 1) environment is the greater of the minimum one-hour $L_{EQ}$ background sound level, or the "exclusionary minimum" criteria of 50 dBA during daytime hours (07:00 to 23:00) and 45 dBA at night (23:00 to 07:00). The MOE guidelines also stipulate that the noise assessment shall consider a predictable worst-case hour, which is defined as an hour when typically busy operation of the stationary sources under consideration could coincide with an hour of low background sound.

The characteristic background sound levels can be determined through automatic monitoring for a period of at least 48 hours, or predicted from hourly traffic volumes in situations where traffic sound dominates. In this case however, to consider a the worst case scenario of future residential units facing the rail yard on the north side of buildings largely shielded form road traffic noise, it will be assumed that the sound levels at the those points of reception are less that the exclusionary minimum limits of 50 dBA daytime and 45 dBA nighttime and that the exclusionary minimum criteria of 50 dBA daytime and 45 dBA nighttime can be adopted as the applicable stationary source criteria for noise from the Stuart Street Rail Yard in the context of this study.

Some types of sound have a special quality which may tend to increase their audibility and potential for disturbance or annoyance. For tonal sound, the MOE guidelines stipulate that a penalty of 5 dBA is to be added to the measured source level. A tonal sound is defined as one which has a "pronounced audible tonal quality such as a whine, screech, buzz or hum." In this assessment, the 5 dBA adjustment has been applied to the sound of the blowers at the CargoFlo facility and the periodic rail/wheel squeal from the yard sidings, which were observed to be tonal in nature.

MOE Guidelines NPC-300 also provides acceptability limits for frequently occurring sounds (more than 9 per hour) that are impulsive in character (such as those from shunting rail cars. The limit is determined in a similar fashion to steady sounds, based on the background sound levels at that time of day.

Typically, impulse sounds from rail yards can occur on a frequent basis during a period of switching activity. Thus, the criteria for frequent impulses have been adopted herein, which are numerically equivalent to the limits for non-impulsive sounds (50 dBAI daytime and 45 dBAI nighttime).

Compliance with MOE criteria generally results in acceptable levels of sound at residential receptors although there may be residual audibility during periods of low background sound.

***Class 1 versus Class 4 Area***

This section of the report has been included to address specific questions from the Municipality concerning the implications of considering the site to be a Class 1 vs a Class 4 area. Definitions of Class 1 and Class 4 areas were provided in Section 4.1 above.

1) *What are the differences between a Class 1 and Class 4 area?*

The differences for assessment purposes relate primarily to the applicable sound level limits. For outdoor points of reception, a Class 4 area has a 5 dBA more relaxed criteria than a Class 1 area. Outside the plane of windows to noise sensitive spaces a Class 4 area has a 10 dBA more relaxed criteria than Class 1 areas.

*2) What are the additional noise mitigation options available within a Class 4 area;*

In a Class 4 area, the use of Enclosed Noise Buffer (ENB) is acceptable for high-rise multi-unit buildings within the context of an MOE approval. Since the Stuart Street yard is Federally regulated it does not require MOE approvals and in our opinion, enclosed noise buffers could be considered with regard to noise mitigation for the subject lands without Class 4 designation.

*3) Should the Study area be identified as a Class 4 area?*

The Study may be designated as a Class 4 area. If that were the case, the recommendations contained in this report would not change significantly. There may be some outdoor amenity areas which would require a somewhat reduced degree of mitigation due to the 5 decibel higher criterion.

#### 4.2.1.2 Road and Rail Traffic Noise Criteria

Guidelines for acceptable levels of road and rail traffic noise impacting residential developments are given in the MOE publication NPC-300, "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning", release date October 21, 2013, and are listed in Table III below. The values in Table I are energy equivalent (average) sound levels [$L_{EQ}$] in units of A-weighted decibels [dBA].

**Table III: MOE Road and Rail Traffic Noise Criteria (dBA)**

| Area | Daytime $L_{EQ}$ (16 hour) Road/Rail | Nighttime $L_{EQ}$(8 hour) Road/Rail |
|---|---|---|
| Outside Bedroom Windows | 55 dBA/50 dBA | 50 dBA/45 dBA |
| Outdoor Living Area | 55 dBA/55 dBA | -- |
| Inside Living/Dining Rooms | 45 dBA/40 dBA | 45 dBA/40 dBA |
| Inside Bedrooms | 45 dBA/40 dBA | 40 dBA/35 dBA |

Daytime refers to the period between 07:00 and 23:00. Night-time refers to the time period between 23:00 and 07:00. The term "outdoor living area" (OLA) is used in reference to an outdoor patio, a backyard, a terrace, or other area where passive recreation is expected to occur.

The MOE guidelines allow the daytime sound levels in an Outdoor Living Area to be exceeded by up to 5 dBA, without mitigation, if warning clauses are placed in the purchase and rental agreements to the property. Where OLA sound levels exceed 60 dBA, physical mitigation is recommended to reduce the OLA sound level to below 60 dBA and as close to 55 dBA as technically, economically and administratively feasible. The City of Hamilton generally requires mitigation to achieve as close to 55 dBA as possible.

Building components such as walls, windows and doors must be designed to achieve indoor sound level criteria when the plane of window nighttime sound level is greater than 60 dBA or the daytime sound level is greater than 65 dBA due to road traffic noise, or when the nighttime sound level is greater than 55 dBA or greater than 60 dBA during the daytime due to rail traffic noise. The use of warning clauses to notify future residents of possible excesses is also required.

MOE guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings impacted by more 60 dBA (24 hour $L_{eq}$), which are within 100 m of the right of way of a railway. This generally applies only to single family residences; multi-family buildings are typically designed to ensure that noise transmitted through walls is negligible in comparison with the windows.

The railways also provide minimum requirements for safety as well as sound and vibration for proposed residential developments located adjacent to their rights-of-way. These refer to minimum required setbacks, berms, fencing and warning clauses. The reader is referred to a copy of CN principal mainline requirements and GO Transit requirements for a new development adjacent to a principal main rail line along with guidelines for non-residential uses, which is located in Appendix B.

### 4.2.2 R.A.C/FCM Proximity Guidelines and Best Practices

The Canadian Railway Association has also developed a best practices guideline [Ref. 4], in conjunction with the Federation of Canadian Municipalities, which addresses issues of land use compatibility between railway lands and residential development, although in terms of specific noise/vibration assessment methods, that guideline essentially defers to the Provincial protocols, such as NPC-300. The assessment methods and sound level information contained in the guideline was reviewed and found to be consistent with the practices, assessment methods and criteria used in this study.

### 4.2.3 MOE Guidelines for Land Use Compatibility and Distance Separation

MOE Guidelines D-1, 'Land Use Compatibility' and D-6 'Compatibility Between Industrial Facilities and Sensitive Land Uses' were prepared to address the potential incompatibility of industrial land uses and noise sensitive land uses in relation to land use approvals under the Planning Act. They recommend that studies be conducted to investigate the feasibility of providing sufficient mitigation when noise sensitive land uses are proposed within the potential zone of influence of an existing industry/commercial facility. The mitigation can be provided at the source, or can be incorporated on the development lands where the industrial/commercial facility is operating in compliance with legislated Ministry requirements.

In planning a sensitive land use near an existing industrial/commercial area, guideline D-6 suggests certain potential zones of influence for the industry, depending on the characterization of that industry. Three classes of industry are defined, as follows:

***Class I Industrial Facility***

A place of business for a small scale, self-contained plant or building which produces/stores a product which is contained in a package and has a low probability of fugitive emissions. Outputs are infrequent, and could be point source or fugitive emissions for any of the following: noise, odour, dust and/or vibration. There are daytime operations only, with infrequent movement of products and/or heavy trucks and no outside storage.

***Class II Industrial Facility***

A place of business for medium scale processing and manufacturing with outdoor storage of wastes or materials (i.e. it has an open process) and/or there are periodic outputs of minor annoyance. There are occasional outputs of either point source or fugitive emissions for any of the following: noise, odour, dust and/or vibration, and low probability of fugitive emissions. Shift operations are permitted and there is frequent movement of products and/or heavy trucks during daytime hours.

***Class III Industrial Facility***

A place of business for large scale manufacturing or processing, characterized by: large physical size, outside storage of raw and finished products, large production volumes and continuous movement of products and employees during daily shift operation. It has frequent outputs of major annoyance and there is high probability of fugitive emissions. A rail yard is an example of a Class III industrial facility.

For screening purposes, guideline D-6 outlines some potential influence areas for the different classes of industry, as follows. Outside these potential influence areas, it is unlikely that an industry which has been appropriately classified will have significant impact.

Class I – 70 metres
Class II – 300 metres
Class III – 1000 metres

Guideline D-6 acknowledges that the actual influence areas may be less, subject to site specific studies performed in accordance with guideline NPC-300. Notwithstanding the actual influence area of an industry, in order to minimize the potential for future land use conflicts, the MOE recommends that certain minimum separation distances be respected, as follows:

Class I – 20 metres
Class II – 70 metres
Class III – 300 metres

The MOE recognizes that these minimum separation distances may not always be viable in certain cases, particularly in those cases of redevelopment, infilling and mixed-use areas, where the zoning or official plan has left no available land buffer and in the case of rail yards, where it is generally considered that there are no feasible means of mitigation at source. In those instances, the minimum distance setback can be reduced based on the results of technical studies which recommend mitigation measures that might be applied to address anticipated impacts.

We note that the concept plan has been developed such that commercially zoned lands will form a setback buffer zone of approximately 150 m between activity in the Stuart Street Rail yard and future residential land uses.

#### 4.2.5 Ground-borne Vibration Assessment Criteria

MOE and CN/GO Transit guidelines require measurements of ground-borne vibration when residential dwelling units are to be located within 75 metres of the property line of a principal mainline. CN and GO Transit Principal Mainline requirements are attached in Appendix B. It is noted that the designated residential lands (D5 and D6) are located more than 150 m from the railway right of way. At these distances, measurements of ground-borne vibration from rail traffic are not required.

The CN does not provide vibration criteria for commercial developments. While there are no specific vibration criteria for commercial developments, CN has recommended that the proponent assess the levels of vibration for the future use being contemplated (hotel, laboratory, precision manufacturing). CN does recommend an analysis of noise and vibration to make recommendations for mitigation to reduce the potential for any adverse impact on the future uses of the property.

There are guidelines for the design of sensitive equipment for use within buildings (as contained in Steel Design Guide Series 11, Floor Vibrations due to Human Activity, 1997). These guidelines were used as criteria in this report. In this report, vibration levels are quoted in terms of RMS velocity levels ($L_V$) in units of decibels [dB] relative to 1 mm/s (i.e., 1 mm/s = 0 dB). The guideline limit is 0.20 mm/s, which is equivalent to -14 dB re 1 mm/s for computer systems and operating rooms. For ease of reference, in this report the CN limit of -14 dB re 1 mm/s (0.20 mm/s) is identified on velocity plots in this report provided in Figures 3 to 11.

# 5 Traffic Noise Assessment

## 5.1 Road Traffic Data

Road traffic data for Barton Street West and Queen Street was obtained from the City of Hamilton in the form of turning movement counts for the year 2008, and is provided in Appendix C. The data was projected to the year 2025 (as required by the City of Hamilton) using a 2.5% growth rate. Commercial vehicle percentages of 3.1% was determined for Barton Street West from the counts and split into 1.9% heavy trucks and 1.2% medium trucks. A day/night split of 90%/10% was used for Barton Street West along with a speed limit of 50 km/h. Commercial vehicle percentages of 2.8% was determined for Queen Street from the counts and split into 1.7% heavy trucks and 1.1% medium trucks. A day/night split of 90%/10% was used for Queen Street along with a speed limit of 40 km/h. Table IV summarizes the traffic volume data used in this study.

Road traffic data for Bay Street North was obtained from the City of Hamilton in the form of turning movement counts for the year 2006, and is provided in Appendix C. A growth rate of 2.5% was applied to project the data to the year 2025. Commercial vehicle percentages of 14% were provided and split into 1% heavy trucks and 13% medium trucks. A day/night split of 90%/10% was used for Bay Street North along with a posted speed limit of 50 km/h. Table IV summarizes the traffic volume data used in this study.

**Table IV: Projected Road Traffic Data to Year 2025**

| Road Name | | Cars | Medium Trucks | Heavy Trucks | Total |
|---|---|---|---|---|---|
| **Bay Street North** | Daytime | 6 316 | 955 | 73 | 7 345 |
| | Nighttime | 702 | 106 | 8 | 816 |
| | **Total** | **7 018** | **1 061** | **82** | **8 161** |
| **Barton Street West** | Daytime | 8 064 | 100 | 158 | 8 322 |
| | Nighttime | 896 | 11 | 18 | 925 |
| | **Total** | **8 960** | **111** | **176** | **9 247** |
| **Queen Street** | Daytime | 5 668 | 64 | 99 | 5 832 |
| | Nighttime | 630 | 7 | 11 | 648 |
| | **Total** | **6 298** | **71** | **110** | **6 480** |

## 5.2 Rail Traffic Data

Rail traffic data for typical operations of the CN Grimsby Subdivision was obtained from CN personnel, and is provided in Appendix C. This data was projected to the year 2025 using a growth rate of 2.5%. The Grimsby Subdivision is used for freight, way freight operations and passenger trains and is a continuously welded principal double mainline track. The maximum permissible train speeds of 97 km/h (60 mph) for freight and way freight trains and 153 km/h (95 mph) for passenger trains in the area of the site were used in the analysis. In conformance with CN assessment requirements, these maximum speeds, maximum number of cars and locomotives per train were used in the traffic noise analysis to yield a worst case estimate of train noise. Table V summarises the rail traffic data used in the analysis.

**Table V: Projected CN Rail Traffic Data (Year 2025)**

| Type of Train | Number of locomotives Day/Night | Number of cars Day/Night | Max Speed (mph/kph) | Current Volume Day/Night | Projected Daytime (07:00-23:00) Trains | Projected Night-time (23:00-07:00) Trains |
|---|---|---|---|---|---|---|
| Freight | 4 / 4 | 140 / 140 | 60 / 97 | 4 / 0 | 5 | 0 |
| Way Freight | 2 / 2 | 0 / 0 | 60 / 97 | 0 / 0 | 0 | 0 |
| Passenger | 2 / 2 | 10 / 10 | 95 / 153 | 2 / 0 | 3 | 0 |

Note: The maximum speed through the rail yard tracks is 15 mph (24 kph).

Rail traffic data for the Southern Ontario Railway (SOR) was obtained from SOR personnel, and is attached in Appendix C. This line is for freight operations. The maximum permissible train speed in the area of the site is 24 kph (15 mph) for the freight trains. SOR personnel have indicated that freight traffic is expected to grow by 5% to 10% over the next three years. A growth rate of 7.5% was applied for 3 years to the year 2016. A growth rate of 2.5% was then applied for 7 years to project the data to 2025. Table VI summarises the SOR rail traffic data used herein.

**Table VI: Projected SOR Rail Traffic Data (Year 2025)**

| Type of Train | Number of locomotives Day/Night | Number of cars Day/Night | Max Speed (mph/kph) | Current Volume Day/Night | Projected Daytime (07:00-23:00) Trains | Projected Night-time (23:00-07:00) Trains |
|---|---|---|---|---|---|---|
| Freight | 2 / 1 | 80 / 65 | 15 / 24 | 6 / 3 | 10 | 4 |

Rail traffic data for the GO Transit railway line was obtained from GO Transit personnel and was verified in November 2013 and is provided in Appendix C. The data is for future operations. Table VII summarises the rail traffic data used in the analysis.

**Table VII: GO Transit Rail Traffic Data (Future Projections)**

| Type of Train | Number of Trains Day/Night | Maximum Number of locomotives | Average Number of cars | Max Speed (mph/kph) |
|---|---|---|---|---|
| GO | 10 / 2 | 1 | 12 | 95 / 153 |

Note: The maximum speed through the rail yard tracks is 15 mph (24 kph).

## 5.3 Road and Rail Traffic Noise Predictions

To assess the levels of road and rail traffic noise which will impact the study area in the future, predictions were made using STAMSON version 5.04, a computer algorithm developed by the MOE. Sample STAMSON output is included in Appendix C. Train whistle noise was not included in the predictions at the building facades to determine indoor sound levels since there are no at-grade crossings in the vicinity.

Sound levels were predicted at the plane of the top storey of the proposed residential buildings during the daytime and nighttime hours to investigate ventilation requirements and requirements for building constructions. Representative locations on the zoned residential lands were used in the analysis along with aerial imagery. Figure 12 identifies the sound level prediction locations. The results of the sound level predictions are summarized in Table VIII and IX.

**Table VIII: Future Daytime Sound Levels at the Facade, Combined Road and Rail Traffic, Without Mitigation [dBA, $L_{EQ(16)}$]**

| Prediction Location | Description | Road | Rail | Total |
|---|---|---|---|---|
| [A] | South façade, Fronting exposure to Barton Street, exposure to Queen Street and partial exposure to railway | 63 | 50 | 63 |
| | West façade, exposure to Barton Street, exposure to Queen Street and partial exposure to railway | 61 | 53 | 61 |
| [B] | Fronting exposure to Barton Street, partial exposure to railway | 63 | 50 | 63 |
| [C] | Fronting exposure to Barton Street, exposure to Bay Street | 64 | 50 | 64 |
| [D] | North façade, Full exposure to railway line | 53 | 59 | 60 |
| [E] | North façade, Full exposure to railway line | 48 | 57 | 58 |
| [F] | Commercial, fronting onto Stuart Street, full exposure to railway line | -- | 61 | 61 |
| [G] | North façade, Full exposure to railway line | 46 | 53 | 54 |
| [H] | Fronting exposure to Bay Street | 60 | -- | 60 |

**Table IX: Future Nighttime Sound Levels at the Facade, Combined Road and Rail Traffic, Without Mitigation [dBA, LEQ(16)]**

| Prediction Location | Description | Road | Rail | Total |
|---|---|---|---|---|
| [A] | South façade, Fronting exposure to Barton Street, exposure to Queen Street and partial exposure to railway | 56 | 46 | 57 |
| | West façade, exposure to Barton Street, exposure to Queen Street and partial exposure to railway | 54 | 49 | 55 |
| [B] | Fronting exposure to Barton Street, partial exposure to railway | 56 | 46 | 57 |
| [C] | Fronting exposure to Barton Street, exposure to Bay Street | 57 | 46 | 58 |
| [D] | North façade, Full exposure to railway line | 46 | 53 | 55 |
| [E] | North façade, Full exposure to railway line | 42 | 53 | 53 |
| [F] | Commercial, fronting onto Stuart Street, full exposure to railway line | -- | -- | -- |
| [G] | North façade, Full exposure to railway line | 40 | 50 | 50 |
| [H] | Fronting exposure to Bay Street | 53 | -- | 53 |

# 6 Traffic Noise Prediction Results and Recommendations

With no mitigation, there are sound level excesses at the future residential and commercial blocks with exposure to the major roadways and the railway line. Recommendations for noise control measures have been provided to meet MOE and CN/SOR and GO Transit guidelines.

## 6.1 Outdoor Living Areas and Sound Barriers

***i) Blocks with Exposure to the railway line***

As a general recommendation for residential developments adjacent to a principal mainline, CN typically recommends a minimum 5.5 m barrier (2.5 m berm and 3.0 m acoustic wall on top above the top of the property line) as indicated in Appendix A. Commercial lands and Stuart Street are proposed between the CN railway line and the zoned residential lands and it is likely that a safety berm is not required. GO Transit/Metrolinx is proposing a GO Transit Station at James Street along with a parking lot and other improvements along and to the north of Stuart Street. Drawings are provided in Appendix D.

In the D6 zoned residential lands, outdoor amenity areas are prohibited in the rear yard on the northerly side yard, as indicated in section 445).

Any large outdoor amenity areas on rooftops of buildings or above grade in the study area should be located on the side of buildings facing away from the rail yard. Consideration should be given to solid parapets around large above grade or rooftop outdoor amenity areas for reduction in sound levels.

## 6.2 Minimum Distance Setbacks

For noise control and safety reasons, the CN policies stipulate that the minimum required setback between a new residential dwelling and a principal main line is 30 meters. The nearest proposed residential uses will be located approximately 150 m from the railway right of way, meeting the minimum CN requirement.

## 6.3 Indoor Living Areas and Ventilation Requirements

***Provision for the Future Installation of Air Conditioning***

For the residential lands adjacent to Barton Street West, with exposure to Queen Street, with exposure to Bay Street North and with exposure to the railway line, the predicted nighttime sound levels are in the range of 51 to 60 dBA and the predicted daytime sound levels are in the range of 56 to 65 dBA. Any low rise residential dwellings (2-storey and 3-storey) will require forced air ventilation systems with ducts sized to accommodate the future installation of central air conditioning by the occupant. If residential buildings are mid-rise (4-storeys or higher), an alternative means of ventilation to open windows is required. Central air conditioning systems would meet and exceed that requirement. The location, installation and sound ratings of the outdoor air conditioning devices should minimize noise impacts and comply with criteria of MOE publication NPC-216, Residential Air Conditioning Devices.

## 6.4 Building Facade Constructions

Future rail traffic sound levels at blocks near the CN railway line are less than 55 dBA at night and less than 60 dBA during the daytime hours.

The building plans were not yet available for review by HGC Engineering at the time of this report, but preliminary calculations have been performed to determine the building envelope constructions likely to be required to maintain indoor sound levels within MOE guidelines. The calculation methods were developed by the National Research Council (NRC). They are based on the predicted future sound levels at the building facades, and the anticipated area ratios of the facade components (walls, windows and doors) and the floor area of the adjacent room.

**For Blocks With Exposure to the CN railway line**

***Exterior Wall Construction***

CN guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings that are in the first row of dwellings with exposure to the CN rail line. MOE guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings with a 24 hour $L_{EQ}$ that is greater than 60 dBA which are within 100 m of the right of way of the railway.

For the residential buildings, double glazed window construction meeting the minimum requirements of the Ontario Building Code (OBC) will provide adequate sound insulation for the dwelling units.

When the floor plans and elevations of the blocks or buildings adjacent to and with exposure to the railway line are available, an acoustical consultant should provide revised acoustical recommendations.

## 6.5 Rail Vibration Assessment

CN also recommends an analysis of noise and vibration to investigate the potential for any adverse impact on future uses of the property for commercial purposes.

Measurements were performed on the site at locations shown in in Figure 13, at approximately 40 m from the railway right-of-way. The results of the measurements are presented in Figures 3 to 11. Table X shows the peak vibration measurements during each of the train pass-bys.

**Table X: Peak Vibration Measurements of Train Pass-bys at 40 m from Right-of-Way**

| Train Pass-by | Location | Measured Level (mm/s) | Criteria (mm/s) |
|---|---|---|---|
| 1 | 1: Stuart and Caroline St | 0.04 | 0.20 |
| 2 | 1: Stuart and Caroline St | 0.02 | |
| 3 | 1: Stuart and Caroline St | 0.09 | |
| 4 | 1: Stuart and Caroline St | 0.07 | |
| 5 | 2: Stuart and Tiffany St | 0.03 | |
| 6 | 2: Stuart and Tiffany St | 0.16 | |
| 7 | 2: Stuart and Tiffany St | 0.07 | |
| 8 | 2: Stuart and Tiffany St | 0.13 | |
| 9 | 2: Stuart and Tiffany St | 0.12 | |

Note: Location 1 and 2 are shown on an aerial photo included as Figure 12.

Measured vibration levels were below 0.2 mm/s at the proposed location of the closest commercial building façades for the majority of pass-bys. The vibration measurements are reasonable for commercial uses, although vibration may be perceptible on occasion within the office building. For that reason we do not anticipate that vibration mitigation measures would be required for the commercial buildings, unless sensitive equipment is proposed in the commercial spaces. Detailed vibration studies should be conducted in that regard.

## 6.6 Warning Clauses

The MOE guidelines recommend that warning clauses be included in the property and tenancy agreements and offers of purchase and sale for all residential dwelling units with anticipated traffic sound level excesses. Examples are provided below.

Suggested wording for future dwellings which have sound level excess in the OLA's but do not require mitigation measures is given below.

Type A:

> Purchasers/tenants are advised that sound levels due to increasing road and rail traffic may occasionally interfere with some activities of the dwelling unit occupants as the sound levels exceed the Municipality's and the Ministry of the Environment's noise criteria.

Suggested wording for future dwellings for which physical mitigation has been provided is given below.

Type B:

> Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing road and rail may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the noise criteria of the Municipality and the Ministry of the Environment.

Suitable wording for future dwellings requiring forced air ventilation systems is given below.

Type C:

> This dwelling unit has been fitted with a forced air heating system and the ducting etc., was sized to accommodate central air conditioning. Installation of central air conditioning will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the noise criteria of the Municipality and the Ministry of the Environment. (Note: The location and installation of the outdoor air conditioning device should be done so as to minimize the noise impacts and comply with criteria of MOE publication NPC-216, Residential Air Conditioning Devices.)

Suitable wording for future dwellings requiring central air conditioning systems is given below.

Type D:

> This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the noise criteria of the Municipality and the Ministry of the Environment.

CN, SOR and GO may require a standard warning clause as this development is located near a principal mainline. The following sample clause is typical of those included in agreements of purchase and sale or lease on the Lands that are within 300 meters of the railway right-of-way.

Type E:

> Warning: Purchasers or tenants are to be advised that Canadian National Railway, southern Ontario Railway or Go Transit or their successors or assigns, have an operating right-of-way within 300 metres from the land subject hereof and there may be alterations to the right-of-way including the possibility that the Railway may expand its operations, which expansion may affect the living environment of the residents notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the subdivision and individual units, and that the Railway will not be responsible for complaints or claims arising from use of its facilities and/or operations.

These sample clauses are provided by the MOE as examples and can be modified by the Municipality as required.

# 7 Stuart Street Rail Yard Noise Assessment

## 7.1 Source Measurements at the Stuart Street Yard

HGC Engineering visited the site on several occasions in October and November of 2013 to identify the acoustical environment and significant sources of sound. Road and rail traffic and activity in the Stuart Street rail yard were identified as the dominant sound sources. Other than the Stuart Street yard, a metal fabricator (AVL) is presently in operation. This facility has open bay doors facing toward the north toward the railway yard away from existing and future residential units. Noises such as bangs, metal hitting the floor etc. may be heard. These sounds are not more significant than impulses sounds from the railway yard. In addition, the latest concept plan for the area indicates the AVL lands are proposed to become commercial lands.

Sound level measurements at the site and the rail yard were made previously conducted by HGC Engineering on May 22 and 29, 2009. During the first of those site visits, the CargoFlo facility was active but there was minimal sorting/classification activity occurring at the yard. During the second visit, the yard was active but there was minimal activity at the CargoFlo facility. In this sense, neither visit represented a "predictable worst case hour" of activity at the CN lands, because in general, both the CargoFlo and sorting/classification activities could happen simultaneously. Moreover, the background sound at the development site from daytime road traffic in the vicinity precluded making accurate measurements during the two visits. Therefore, acoustical modeling was utilized, to calculate the sound levels at the subject site, during a predictable worst case daytime and nighttime hour of activity, based on source sound levels measured close to the various equipment and activities within the yard.

Sound pressure levels were measured at the Stuart Street Yard using a Hewlett Packard model 3569A Real Time Frequency Analyzer, equipped with a Brüel Kjær model 4188 condenser microphone, following established acoustical engineering methods. The instrumentation was within its biennial laboratory calibration period, and correct calibration was field-verified before and after the measurements using a Brüel Kjær model 4231 acoustic calibrator.

Sound levels from a truck-mounted blower loading PVC from a rail car into a tanker truck were measured on May 22 at the CN CargoFlo facility between 11:00 and 11:30 am. Sound levels of sorting/classification activities were conducted in the east half of the SOR portion of the yard on May 29, 2009 between 08:00 am and 12:00 pm. The measurements of sorting/classification activities included sounds from coupling of rail cars (both free-rolling and forced) "stretching" of rail cars as the locomotive accelerated from a stop, rail/wheel squeal, and moving locomotives. A summary of measured sound levels is presented in Table XI below. Although the measurements were conducted in detailed full-octave frequency bands, only the overall dBA-summed values are presented herein, for brevity. The measurements were conducted at various distances from the sources, but have been normalized to a reference distance of 50 metres in Table XI, for ease of comparison.

**Table XI: Source Sound Levels Measured at Stuart Street Yard**

| Source/Activity | Sound Level @ 50 m |
|---|---|
| Truck-mounted PVC transfer blower at CargoFlo[1] | 78 dBA |
| Truck-mounted flour transfer blower at CargoFlo[1] | 74 dBA |
| Moving Locomotive | 71 dBA |
| Rail/wheel squeal[1] | 90 dBA |
| Rail car coupling[2] | 88 dBAI |

Notes:
1. Tonal source, 5 dBA penalty applicable (not included in levels shown)
2. Mixture of free-rolling coupling, forced coupling, stretching

## 7.2 Acoustical Modelling

There are two activities that can occur at the Stuart Street Yard, but which were not observed during the two visits in May, 2009, and could therefore not be measured. These included: load testing of a locomotive at the repair shop and idling locomotives. For these sources, sound levels on file previously measured by HGC Engineering at similar facilities were assumed. The $L_{EQ}$ sound levels assumed for these sources are: 73 dBA and 62 dBA, respectively, at 50 metres.

The source sound levels listed above and in Table XI above were used as input to a predictive acoustical model of the rail yard and the subject site. The model was developed using Cadna/A software (version 4.4.145), which is a computer implementation of ISO Standard 9613-2 [Ref. 5], and which takes into account the effects of geometric dispersion of sound over distance; shielding by intervening structures, topography and foliage; atmospheric/meteorological influences and attenuation by soft ground.

In order to consider the sound emissions during a "predictable worst case hour" of activity at the yard, operational details were obtained through discussions with CN and SOR personnel, and through observations made during the site visits to the yard. The CN CargoFlo facility normally operates during daytime hours only, with the possibility of two trucks loading simultaneously. The sound of the truck mounted blowers was penalized by 5 dBA, to account for the tonal character of this sound. With regard to sorting operations, two separate cases were considered: activities in the east half of the yard versus activities at the west half of the yard, either of which can occur during daytime and nighttime hours. Because the Barton Tiffany Study Area is situated toward the east end of the yard, the worst case operating scenario includes sorting/classification activities concentrated at the east end of the yard. While sorting/classification activities are ongoing, the model assumed that the locomotive would be in motion half of the time, and idling half of the time. Based on observations, rail/wheel squeal was assumed to occur sporadically throughout the hour (i.e., approximately 7% of the time), and a 5 dBA penalty was applied to account for the tonal character of this sound. The movement of the locomotives, the rail/wheel squeal and the impulse sounds from coupling and stretching were modeled as area sources, on the assumption that these activities are generally distributed evenly throughout the area in which the activities are occurring. Idling of locomotives and the loading of blower trucks were modeled as point sources of sound.

Although no load-testing of locomotives occurred at the maintenance shop during either of the May/09 site visits, this activity was assumed to occur for a full hour during the day only, and was modeled as a point source of sound at the east end of the maintenance shop.

The sound levels were calculated at a number pf proposed builds on the residentially zoned lands generally represented by the locations shown in Figure 12. The results are summarized in Table XII, below (at a mid-height of 13 metres above grade), and are shown graphically in Figures 14 through 16 as sound level contours. Locations [A] to [F] represent points outside the potential building facades as shown on Figure 12. Locations [A] to [C] represent points on the south facades, which are shielded from the yard by the proposed building itself. Locations [D] to [F] are facades which are directly exposed to the rail yard. Sound level contours for the Activities at the west end of the railway yard are provided in Appendix E.

**Table XII: Predicted Sound Levels at Subject Site, LEQ/LLM [dBA/dBAI]**

| Source | Location | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Two Trucks at CargoFlo* | 35 | 36 | 44 | 45 | 44 | 39 |
| Rail Yard – Locomotive Idling* | 26 | 28 | 41 | 43 | 43 | 46 |
| Rail Yard – Locomotive Load Test* | 35 | 34 | 41 | 41 | 47 | 44 |
| Locomotive Moving – East Yard | 33 | 34 | 43 | 45 | 47 | 50 |
| Rail/wheel squeal – East Yard | 38 | 39 | 56 | 58 | 60 | 63 |
| Impulses – East Yard | 45 | 46 | 63 | 65 | 67 | 71 |
| **Overall, non-impulsive, east yard (day/night)** | 42 / 39 | 42 / 40 | 56 / 56 | 59 / 58 | 60 / 60 | 63 / 63 |
| **Impulsive, east yard (day/night)** | 45 / 45 | 46 / 46 | 63 / 63 | 65 / 65 | 67 / 67 | 71 / 71 |

Note: * Daytime-only sources
Refer to Figure 12 for the prediction locations [A] to [F].

The analysis results in Table XII above are supported by the sound level measurements conducted at the development site, insofar as the individual events that were measurable over the background were within 1 to 2 dBA of the predicted results.

The results of this analysis indicate that noise from the Stuart Street Yard is expected to exceed the applicable MOE criteria at the windows on the north, east and west facades of the upper storeys of future residential buildings with a clear line of site to the yard and at the proposed townhouses at the west of the site.

## 7.3 Discussion and Recommendations With Respect to the Stuart Street Rail Yard

NPC-300 encourages noise mitigation at the source if possible. In this case, physical noise source mitigation options are quite limited due to the nature of the rail operations.

A noise barrier located along the south property line of the rail yard could provide a degree of noise mitigation for ground level points of reception on the adjacent commercially zoned lands, although mitigation is not required for those lands due to the commercial zoning. A GO Transit Station Facility is planned for the extent of the rail lands north of Stuart Street from east of the Bay Street Bridge to Hess Street which will incorporate some extent of noise barrier. A plan of the facility is included as Appendix D.

The residential lands benefit from the buffer zone of commercial uses located between the rail yard and proposed residential uses and ground level points of reception associated with future residential uses will benefit from the shielding provided by the intervening commercial buildings.

Notwithstanding the presence of the commercial blocks, rail noise excesses, and impulse sounds in particular are expected to occur at the upper story residential windows which do not benefit from shielding by the commercial uses and at the low rise residential block at the far west of the site. Since a noise barrier has to effectively break the line of sight between the source and the receiver, a noise barrier located adjacent to the rail lands would need to be unrealistically high to protect the upper story windows.

Remaining options relate to the design of the residential buildings themselves and would include acoustical design features such as:

- locating amenity space inside the buildings
- locating ground level outdoor amenity areas at locations shielded by the subject building or adjacent commercial buildings
- the use of glazed atria to protect amenity areas
- the use of rooftop parapets to shield rooftop amenity areas
- the use of enclosed noise buffers such as glazed solaria or enclosed balconies to prevent noise from reaching the plane of the windows of bedrooms or living/dining/family rooms.
- the use of single loaded corridors on sides of residential buildings exposed to the rail yard

Since the development of both the commercial and the residential sites are years away, the appropriate design response should be determined at that time for individual buildings.

We recommend that the residential buildings be designed to incorporate acoustical design features discussed above and detailed noise studies should be conducted for all the buildings for the approval of specific site plans for both commercial and residential uses.

While the MOE does not generally accept central air conditioning or mechanical ventilation as mitigation measures for stationary noise sources per se, we note in this case some alternative means of ventilation will be required for the residential buildings so that the windows can remain closed against traffic noise, and that would apply to the noise from the rail yard as well and it is likely that central air conditioning systems will be used in that regard.

The CN requires that the following warning clause be included in all property agreements and offers of purchase or sale for all dwelling units within 300 m of their Right of Way.

> "Warning: Purchasers or tenants are to be advised that <Canadian National Railway> <Southern Ontario Railway> <GO Transit> or its successors or assigns, have an operating right-of-way and a rail yard (Stuart Street Yard) within 300 metres from the land subject hereof and there may be alterations to the right-of-way including the possibility that the Railway may expand its operations, which expansion may affect the living environment of the residents notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the subdivision and individual units, and that the Railway will not be responsible for complaints or claims arising from use of its facilities and/or operations."

Finally, the RAC Proximity Guidelines and Best Practices Document [REF 4] suggests that Municipalities and Rail Lines should consider the use of environmental easements for operational emission, registered on title to development properties to ensure clear notification to those who may acquire an interest in the property. Such easements would provide the railway with a legal right to create emissions over a development property and reduce the potential for future land use conflicts.

# 8 Summary of Recommendations

## 8.1 Recommendations for Road and Rail Traffic Noise

The following list summarizes the recommendations made in this report. Please refer to Figure 11 for more information regarding the locations to which these recommendations apply.

1) Outdoor living areas are prohibited in the rear yards or northerly side yards, in accordance with the zoning by-law.

2) The inclusion of forced air ventilation systems with ducts sized for the future installation of central air conditioning by the occupant will be required for 2-storey or 3-storey residences. Some alternative means of ventilation to open windows will be required for the

4-storey or higher buildings. Central air conditioning would fulfil that requirement.

4) A masonry exterior wall construction is required for those residential buildings with direct exposure to the Stuart Street Rail Yard and railway lines.

5) Warning clauses should be placed in the property and tenancy agreements for the specified blocks.

The reader is referred to the above sections of the report where these recommendations are discussed in more detail.

## 8.2 Recommendations for Noise from Stationary Sources

1. Prior to site plan approval, detailed noise studies should be conducted for the commercial buildings on the D2 lands to ensure that noise emissions from the buildings produced by mechanical equipment or loading bay activity for example, comply with the criteria of MOE Publication NPC-300 with respect to neighbouring existing or proposed residential dwelling units.

2. The detailed studies for the commercial buildings should also consider the potential impact of road, rail or industrial noise or vibration on any proposed noise sensitive tenancies such as day care centres or schools, and the potential impact of ground-borne vibration to impact any proposed vibration sensitive tenancies such as laser eye clinics or medical diagnostic equipment.

3. The design of the residential buildings should be informed by the discussion, recommendations and design features provided in Section 7.3 above to address the noise emissions from the Stuart Street Rail Yard.

4. Prior to site plan approval, detailed noise studies should be conducted for all residential buildings to ensure that the noise from road and rail traffic and from activity in the Stuart Street Rail Yard is adequately mitigated as per the recommendations in this report and the

requirements of MOE Guideline NPC-300.

5. Warning clauses should be included in the property and tenancy agreements and offers of purchase and sale for all residential dwelling units as per the recommendations in Sections 6.6 and 7.3 above to inform the future owners/occupants of the noise issues and the presence of the road and rail traffic noise and activities in the Stuart Street Rail Yard.

6. CN may require the use of environmental easements for operational emission, registered on title to development properties to ensure clear notification to those who may acquire an interest in the property as recommended in RAC Proximity Guidelines and Best Practices Document.

The reader is referred to the previous sections of this report where these recommendations are discussed in more detail.

## 8.3 Recommendations for Implementation

The detailed noise studies recommended above should contain clauses similar to the following to ensure that the noise mitigation features, as approved, are fully implemented in the design and construction of the residential and commercial buildings.

1) When architectural floor plans and exterior elevation drawings are available, the City's building department or a Professional Engineer qualified to perform acoustical services in the Province of Ontario should review the plans to ensure that the noise mitigation features in the detailed noise study as approved have been implemented in their entirety.

2) Prior to the issuance of occupancy permits for this development, a Professional Engineer qualified to perform acoustical services in the province of Ontario or the City's building department shall certify that the noise mitigation measures, as approved, have been properly installed and constructed.

# 9 References


1) "Environmental Noise and Vibration Assessment – Stuart Street Rail Yard – Potential Area of Influence." Valcoustics Canada Limited, October 21, 2003.
2) Environmental Protection Act, R.S.O. 1990.
3) Ministry of Environment Publication NPC-300 "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning", dated August 2013.
4) "REPORT – Research Phase 3: Proximity Guidelines and Best Practices." Prepared for the Railway Association of Canada and the Federation of Canadian Municipalities, November, 2006.
5) International Organization for Standardization. ISO Standard 9613-2, "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation." Geneva, 1996.


Figure 1 – Key Plan

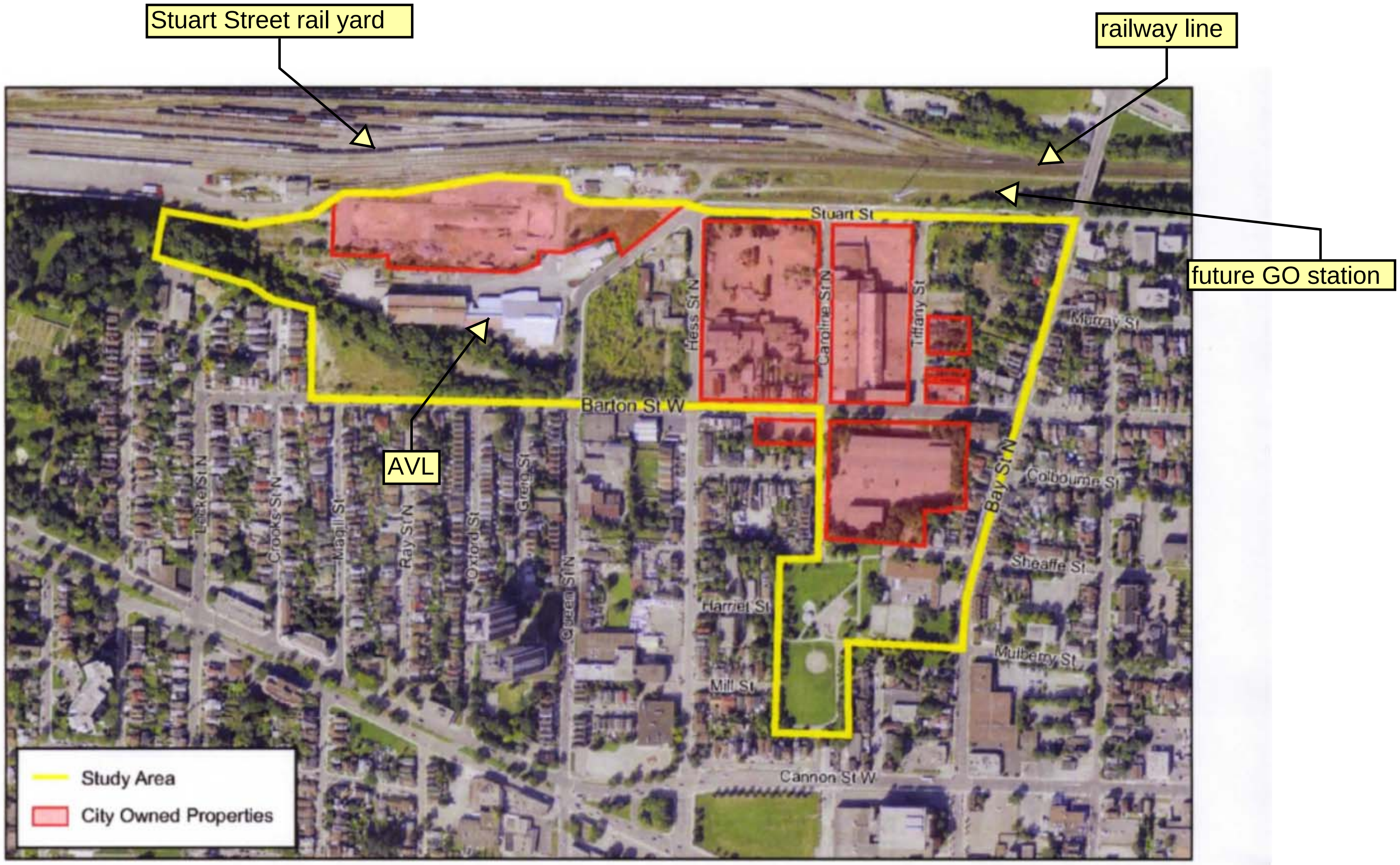



Figure 2 - Barton Tiffany Study Area Showing Surrounding Land Uses

**Figure 3a: Movement in Yard @ Location 1**
**Measured Vibratory Velocity Level**

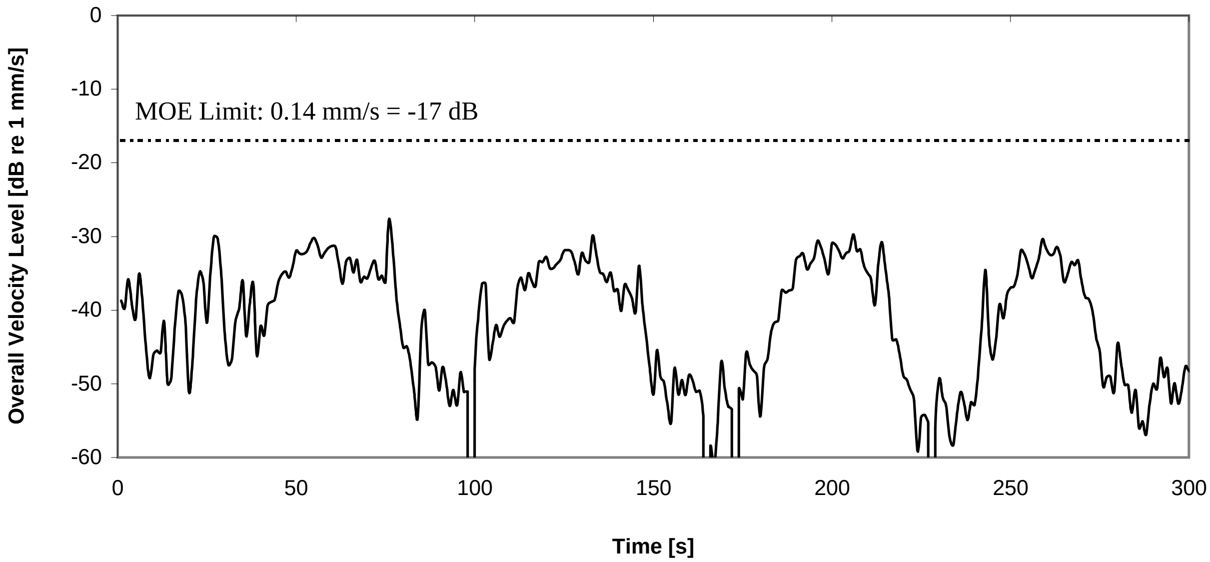



**Figure 3b: Movement in Yard @ Location 1**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**

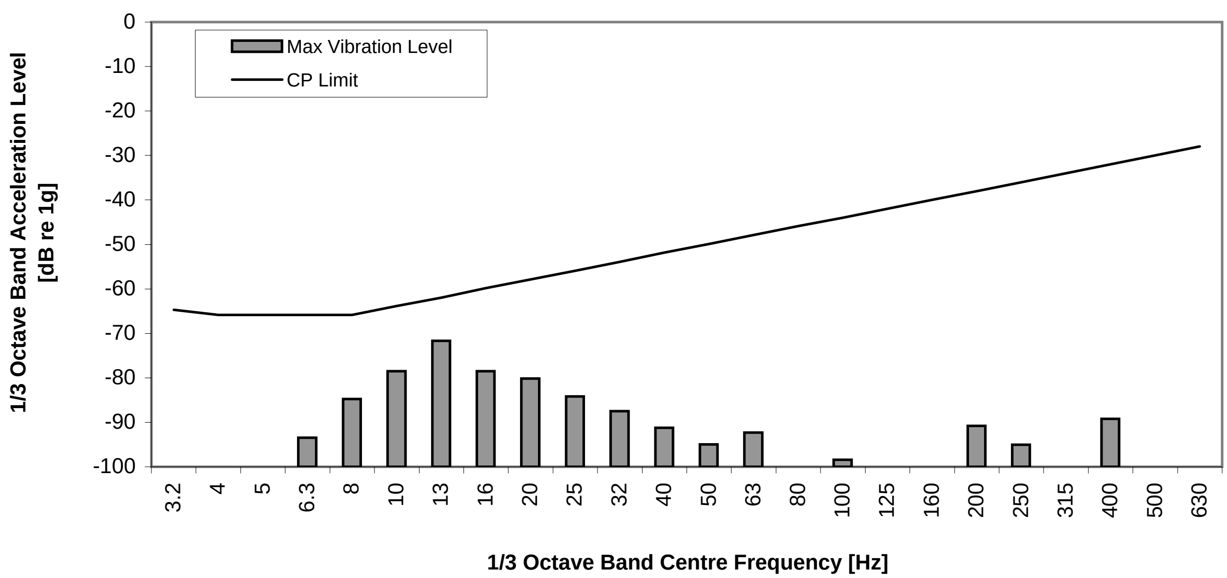


**Figure 4a: Ambient Conditions @ Location 1**
**Measured Vibratory Velocity Level**

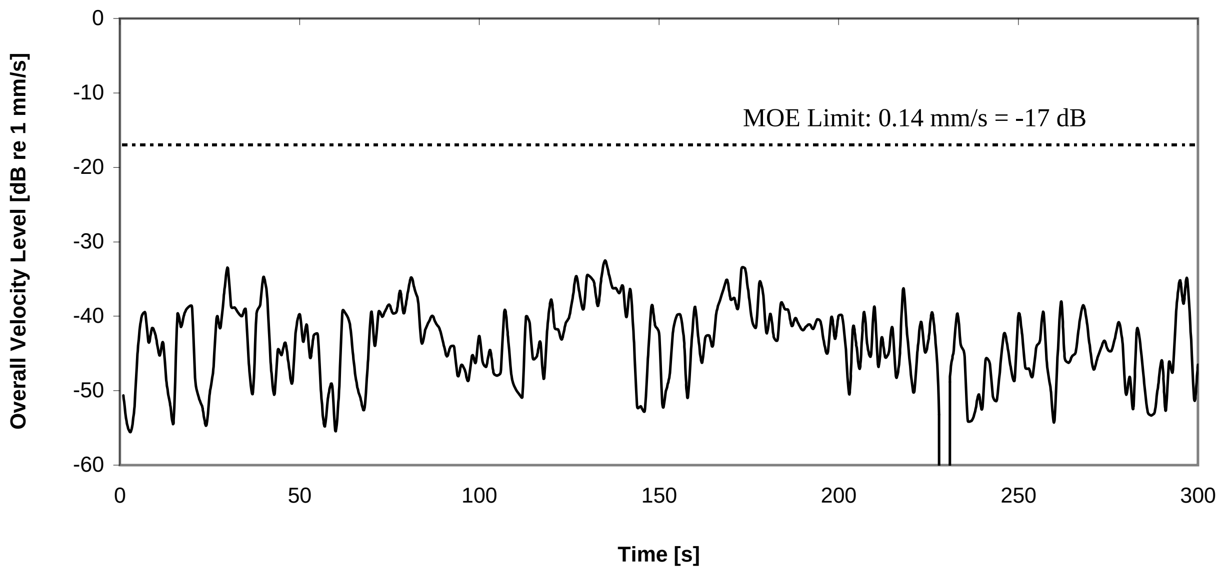



**Figure 4b: Ambient Condition @ Location 1**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**

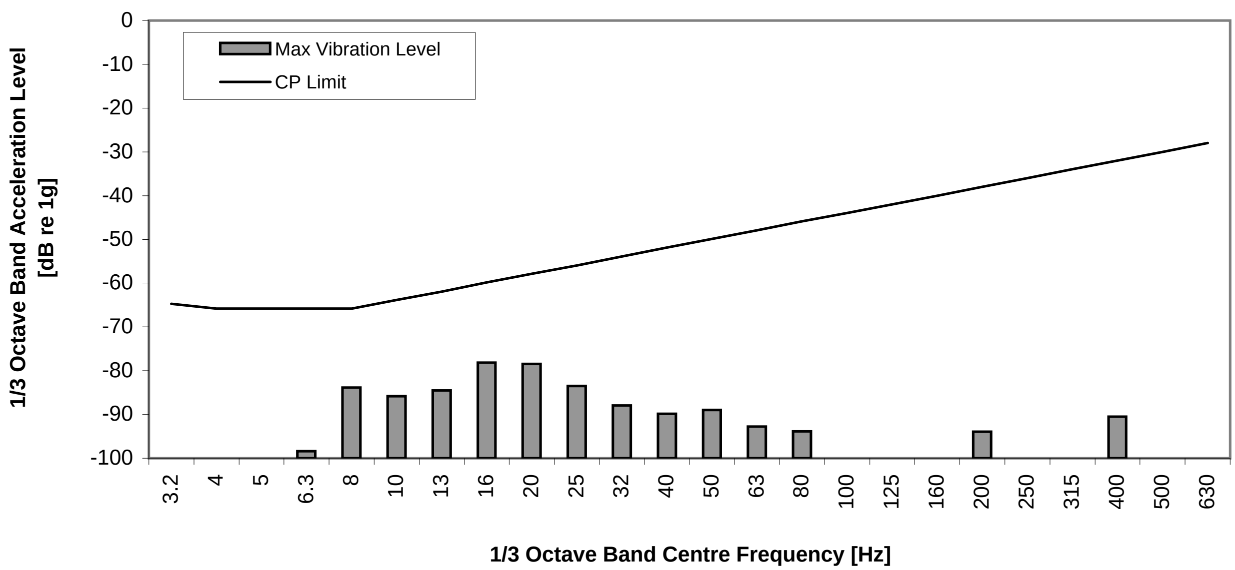


**Figure 5a: Eastbound Freight Train Pass-By @ Location 1**
**Measured Vibratory Velocity Level**

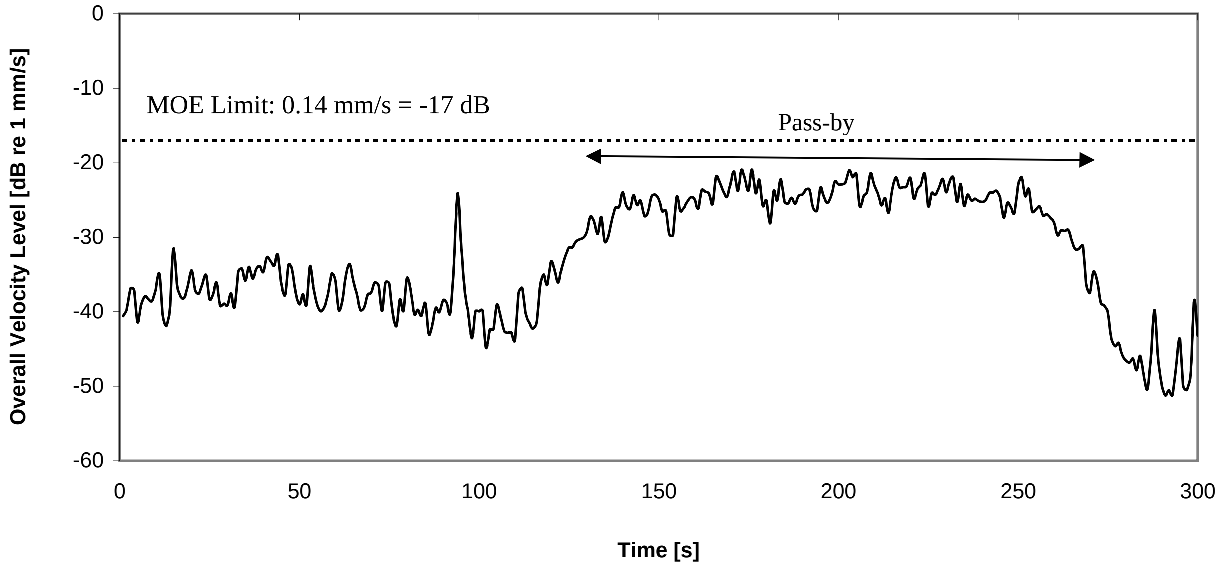



**Figure 5b: Eastbound Freight Train Pass-By @ Location 1**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**

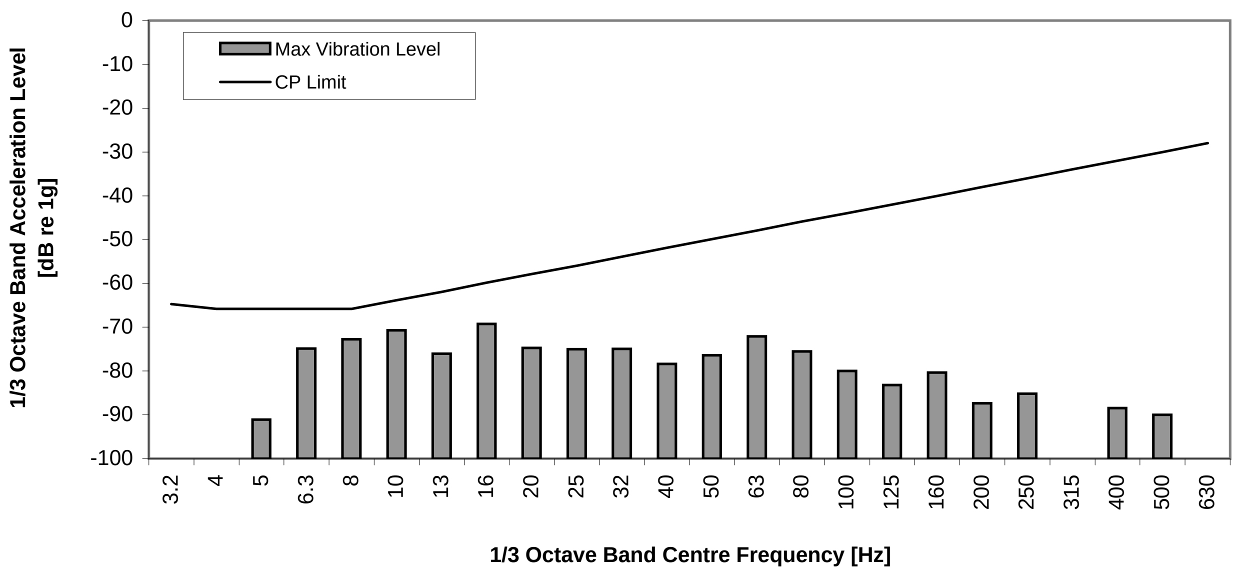


**Figure 6a: Westbound Freight Train Leaving Yard @ Location 1**
**Measured Vibratory Velocity Level**

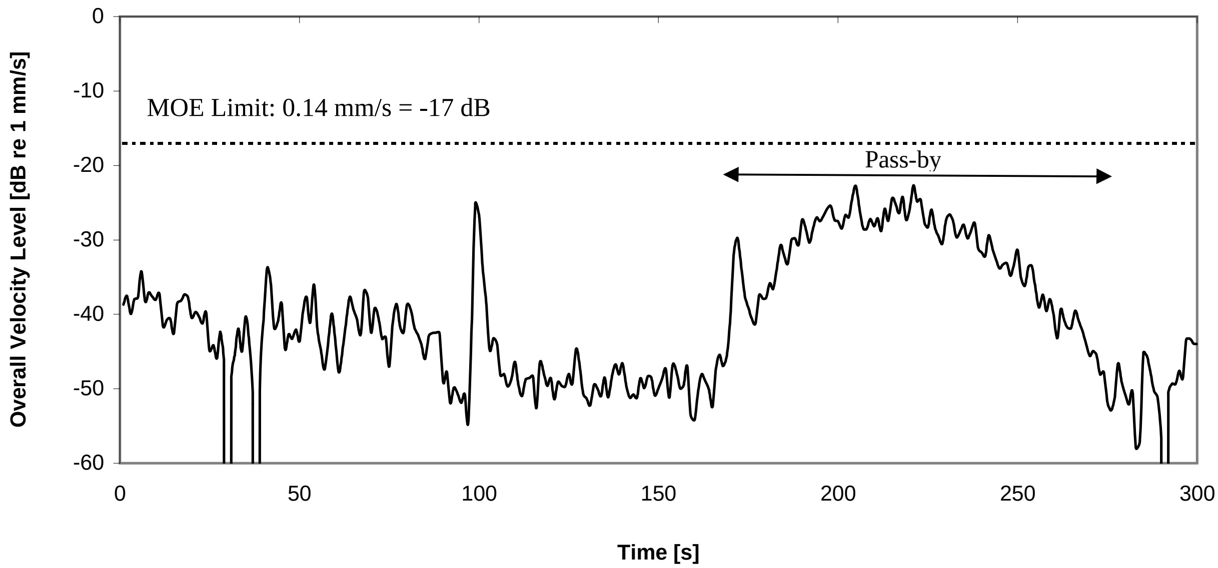
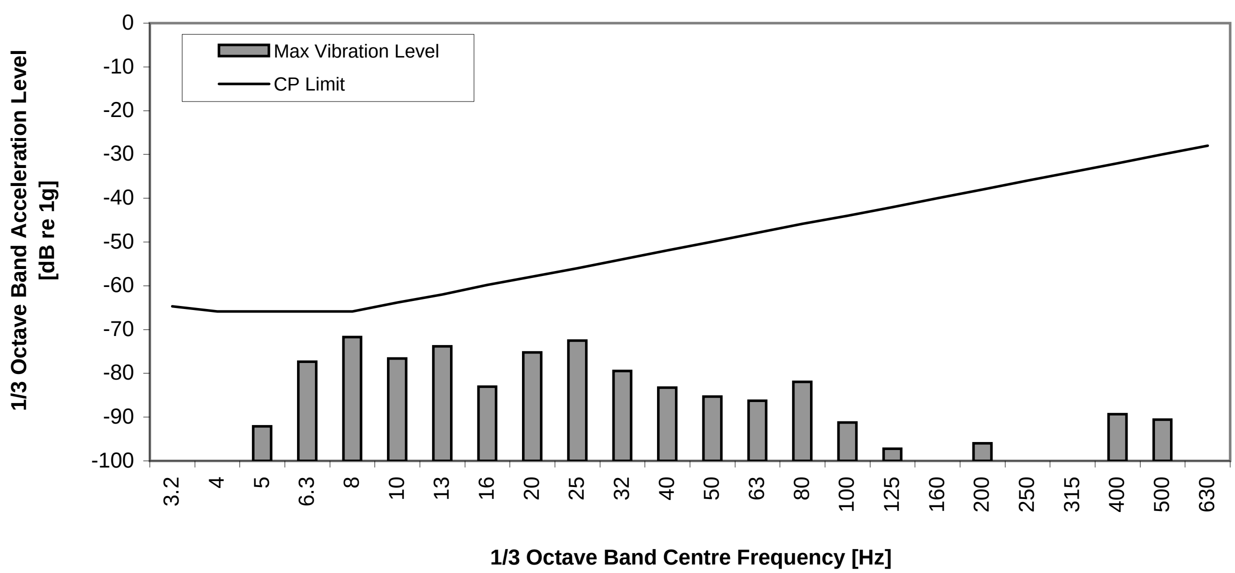
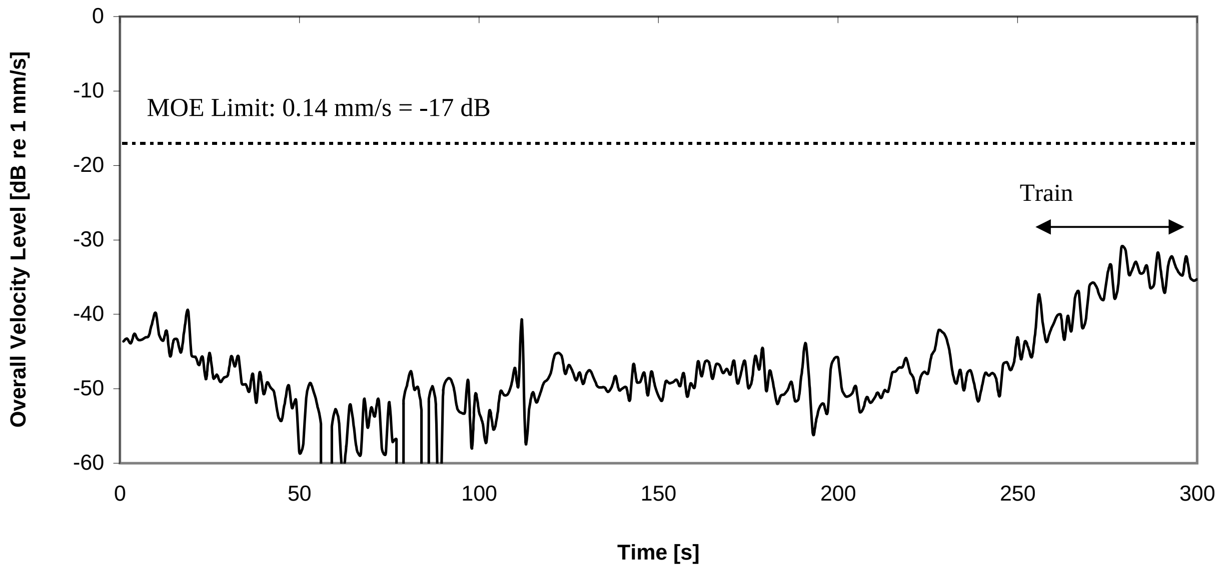


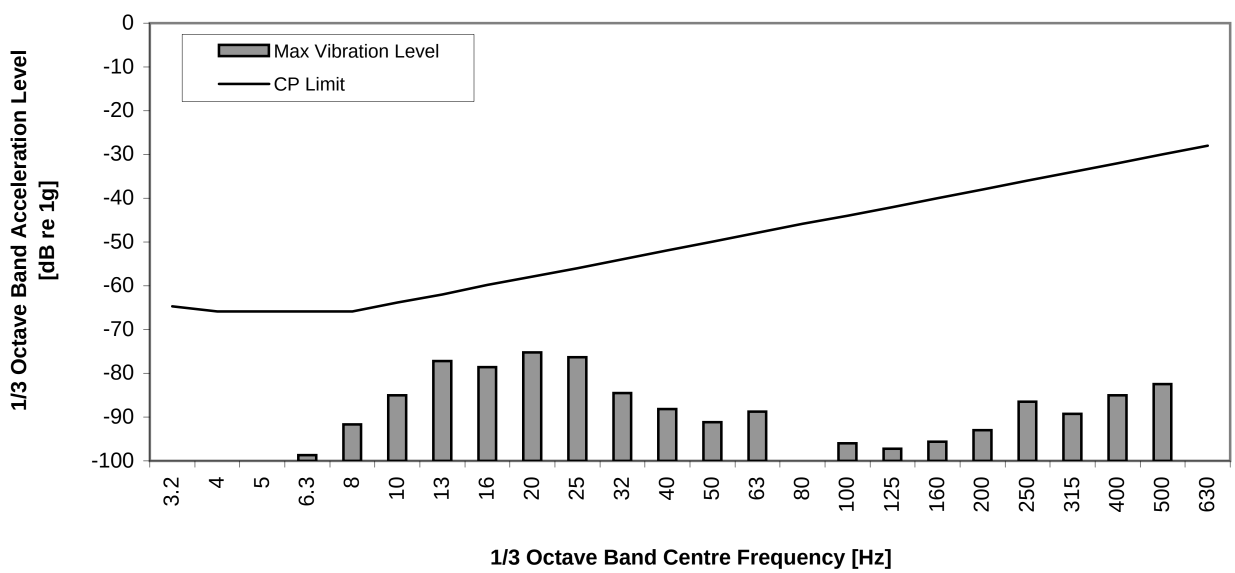

**Figure 6b: Westbound Freight Train Leaving Yard @ Location 1**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**



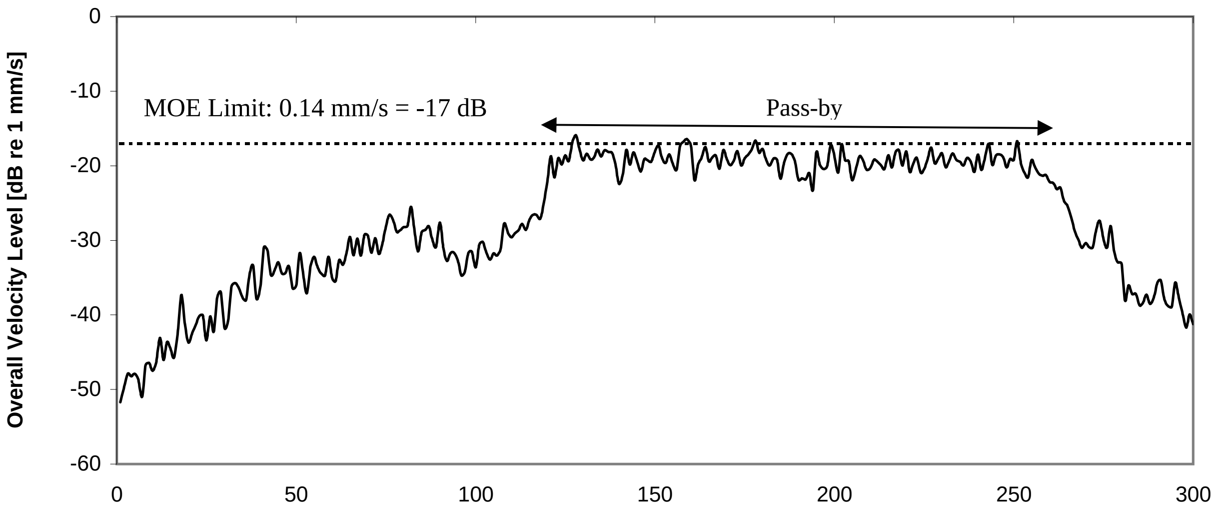
## Figure 7a: Ambient Conditions @ Location 2
## Measured Vibratory Velocity Level



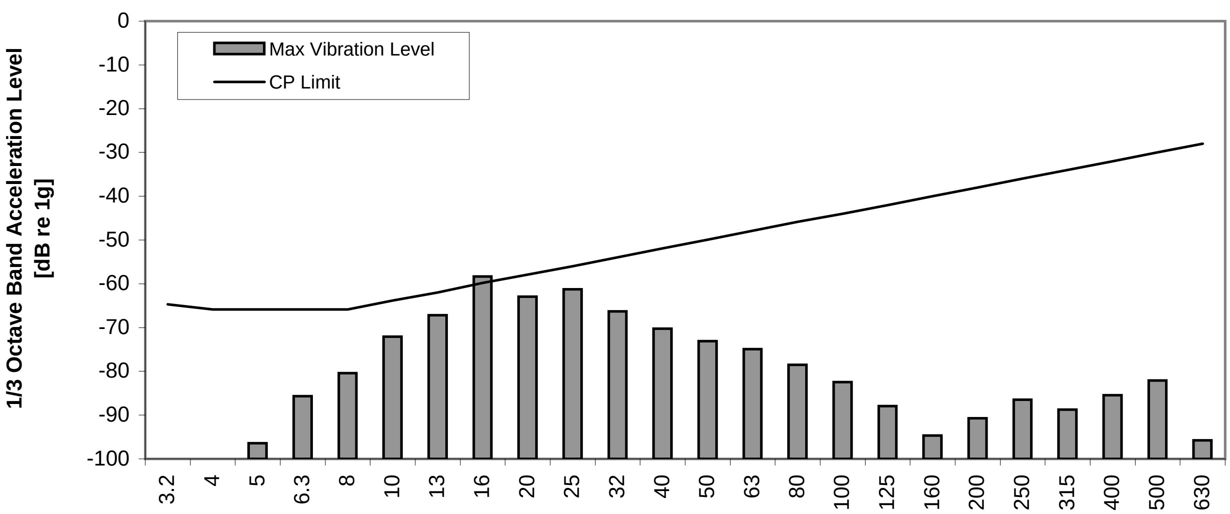

## Figure 7b: Ambient Conditions @ Location 2
## Acceleration Spectrum @ Peak Level (1 sec. Duration)



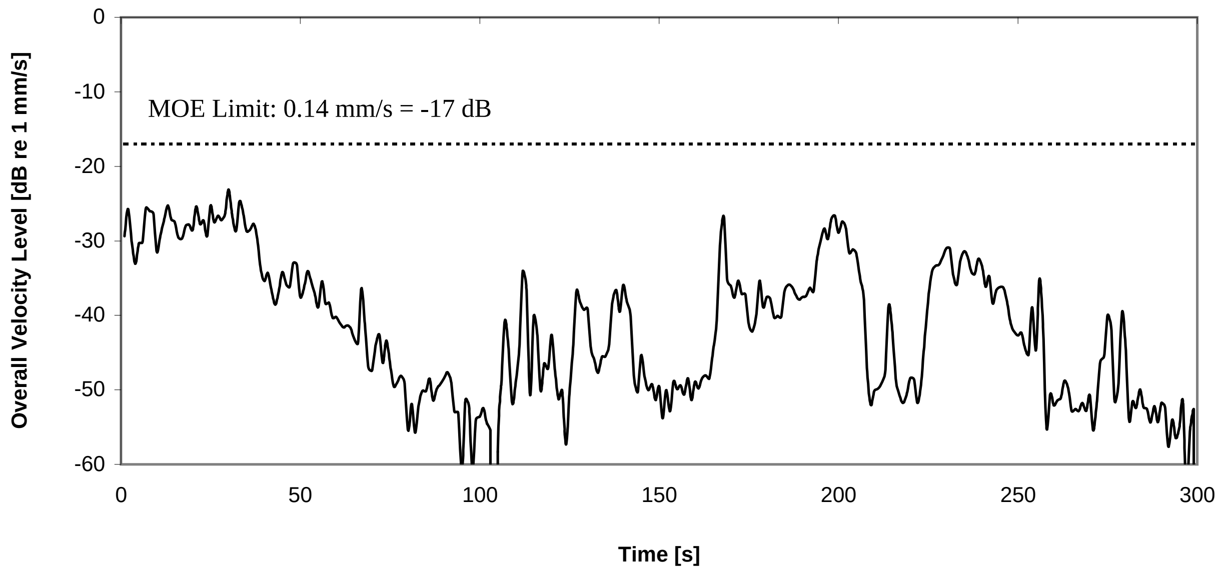
## Figure 8a: Eastbound Freight Train Pass-By @ Location 2
## Measured Vibratory Velocity Level




## Figure 8b: Eastbound Freight Train Pass-By @ Location 2
## Acceleration Spectrum @ Peak Level (1 sec. Duration)



## Figure 9a: Movement in Yard @ Location 2
## Measured Vibratory Velocity Level




## Figure 9b: Movement in Yard @ Location 2
## Acceleration Spectrum @ Peak Level (1 sec. Duration)

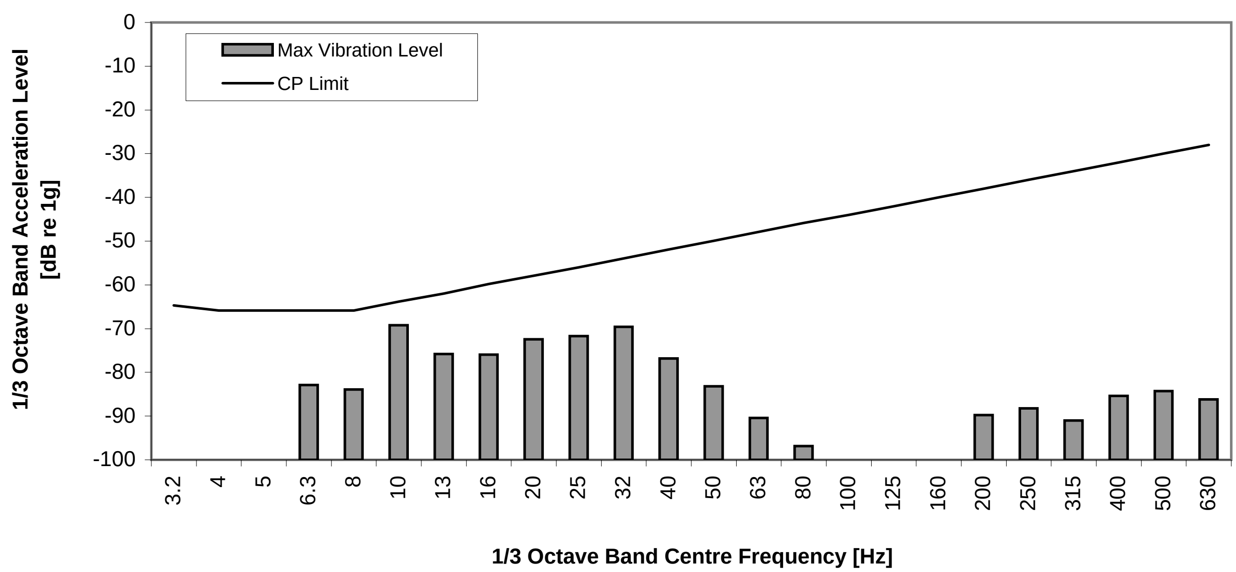


**Figure 10a: Movement in Yard @ Location 2**
**Measured Vibratory Velocity Level**

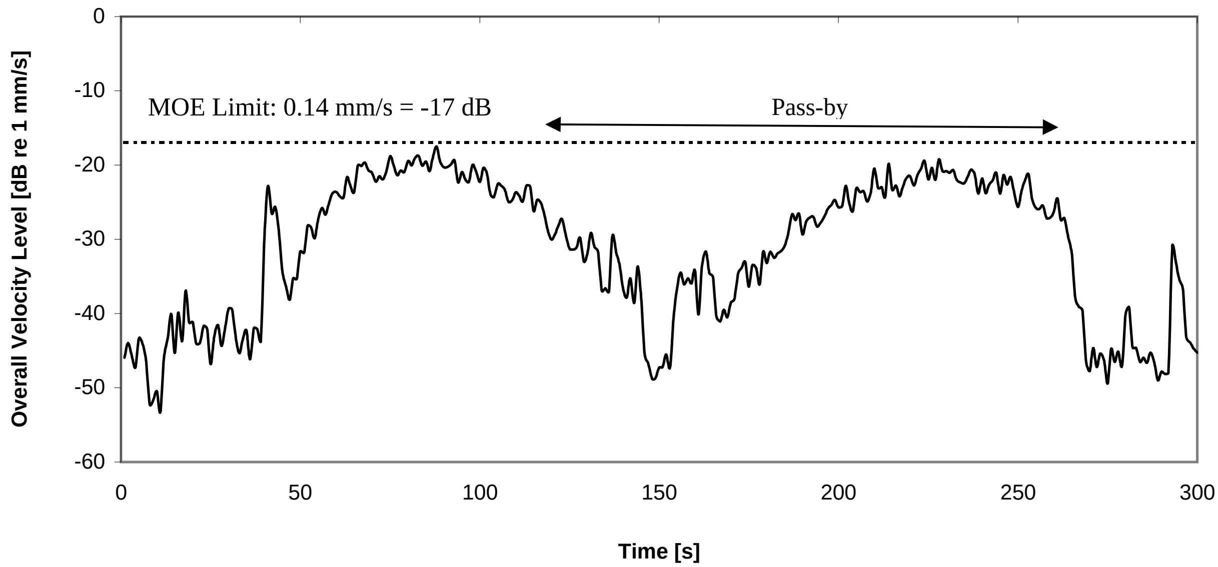



**Figure 10b: Movement in Yard @ Location 2**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**

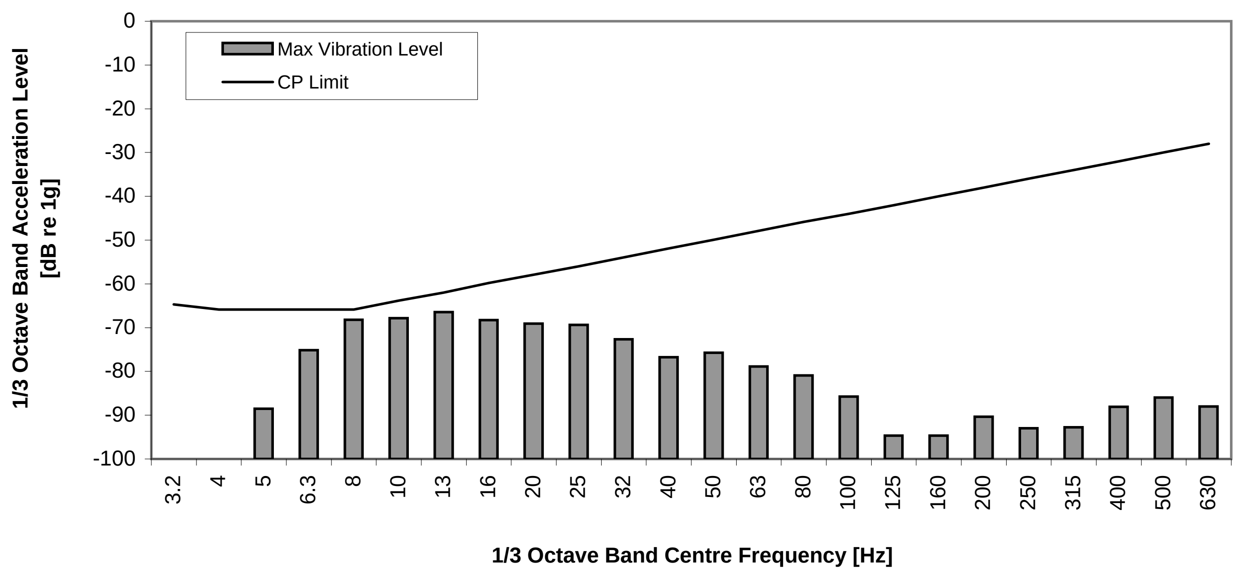


**Figure 11a: Westbound Freight Train Leaving Yard @ Location 2**
**Measured Vibratory Velocity Level**

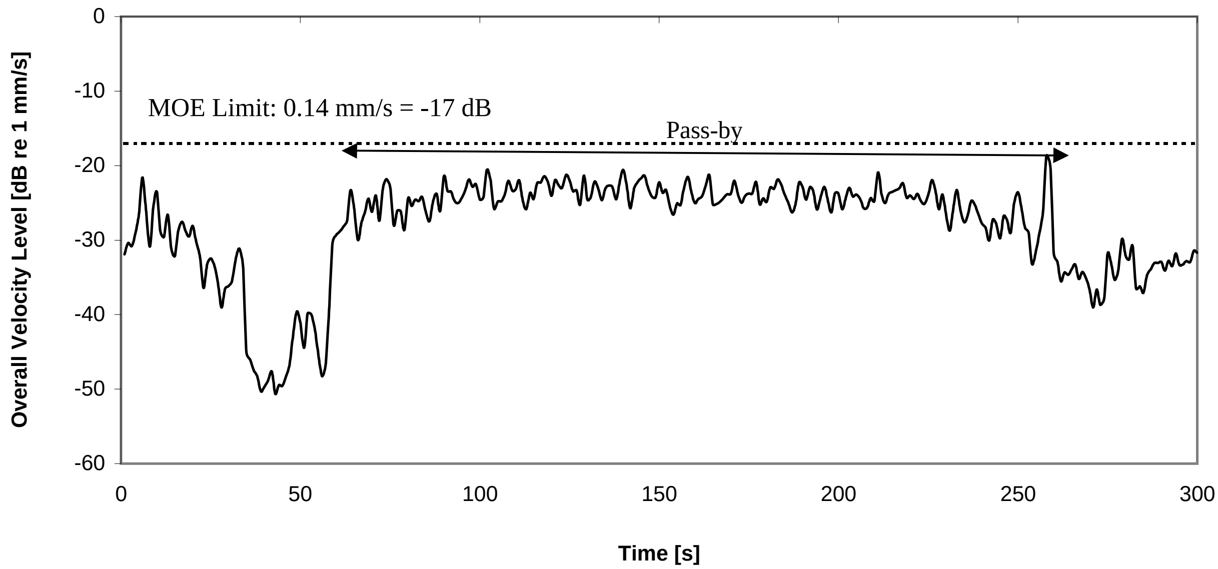
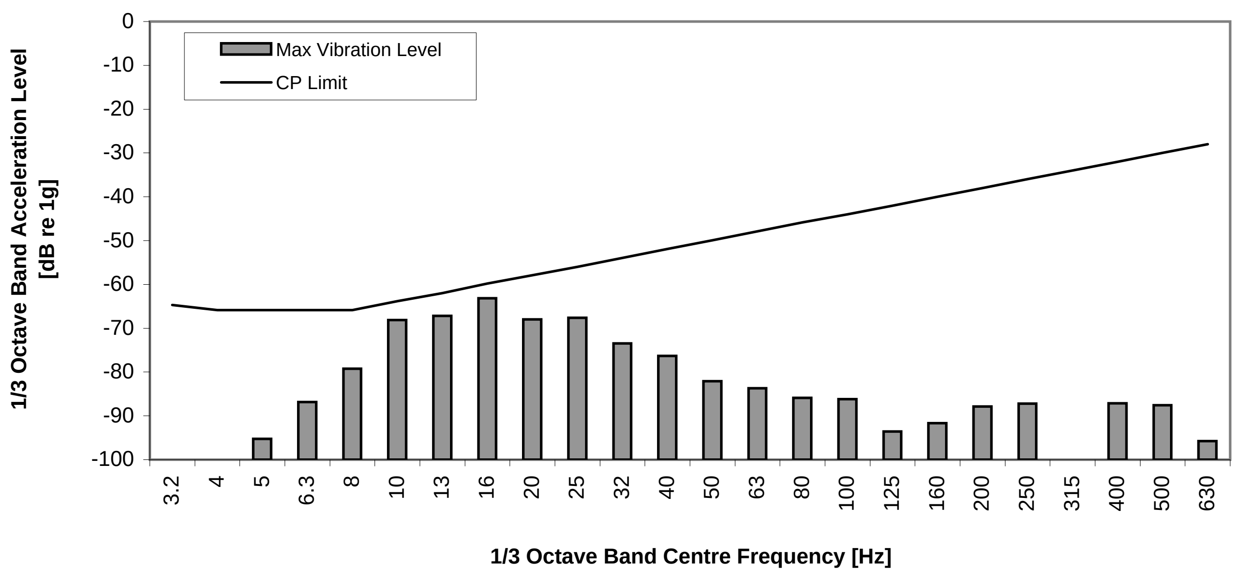



**Figure 11b: Westbound Freight Train Leaving Yard @ Location 2**
**Acceleration Spectrum @ Peak Level (1 sec. Duration)**



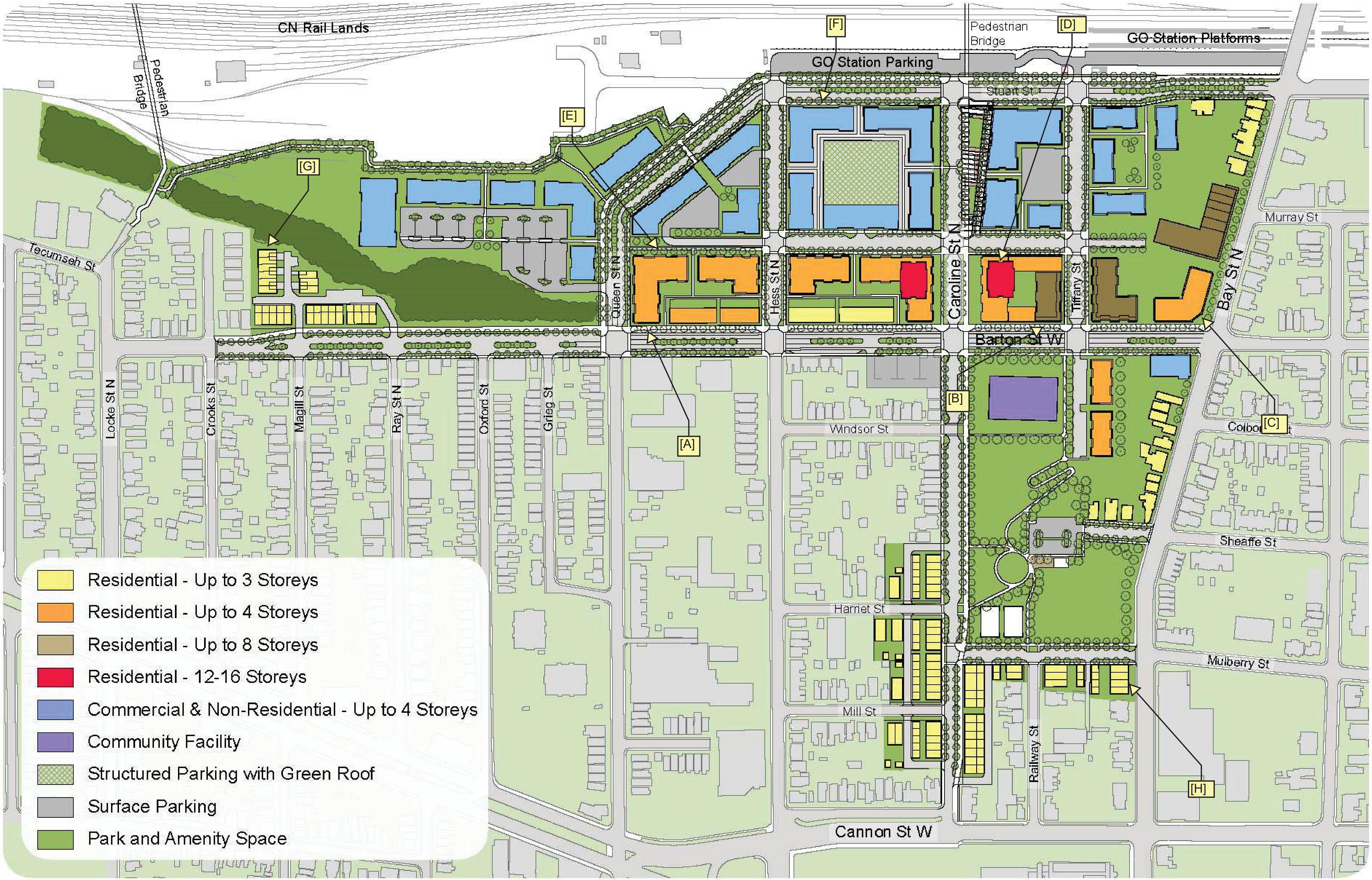



Figure 12 - Latest Concept Plan Showing Barton Tiffany Study Area and Prediction Locations

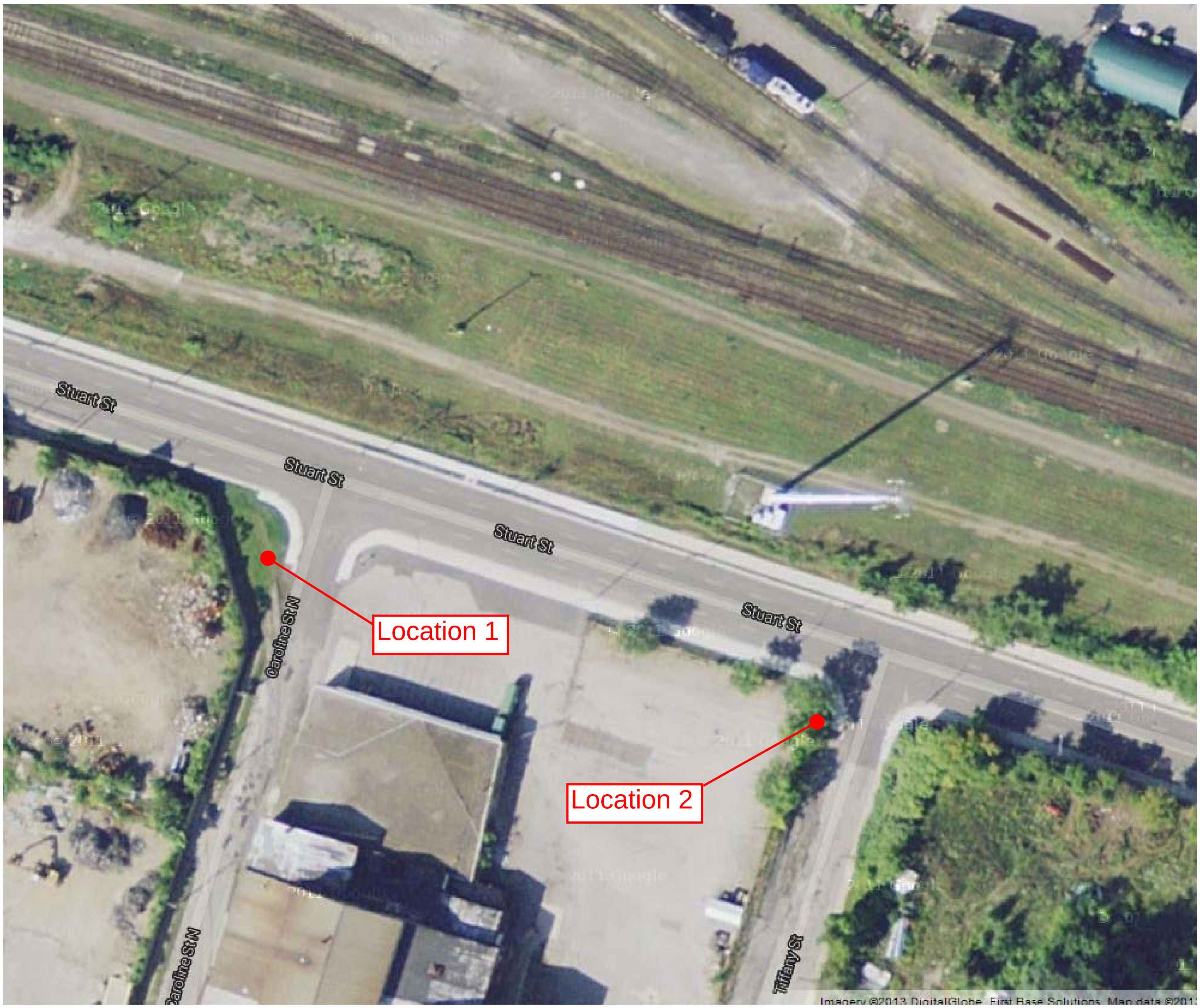



Figure 13 - Vibration Measurement Locations


Figure 14: Daytime Non-Impulsive Sound Level Predictions [dBA], 13 m above grade
Classification/Sorting Activities Concentrated in East End of Yard

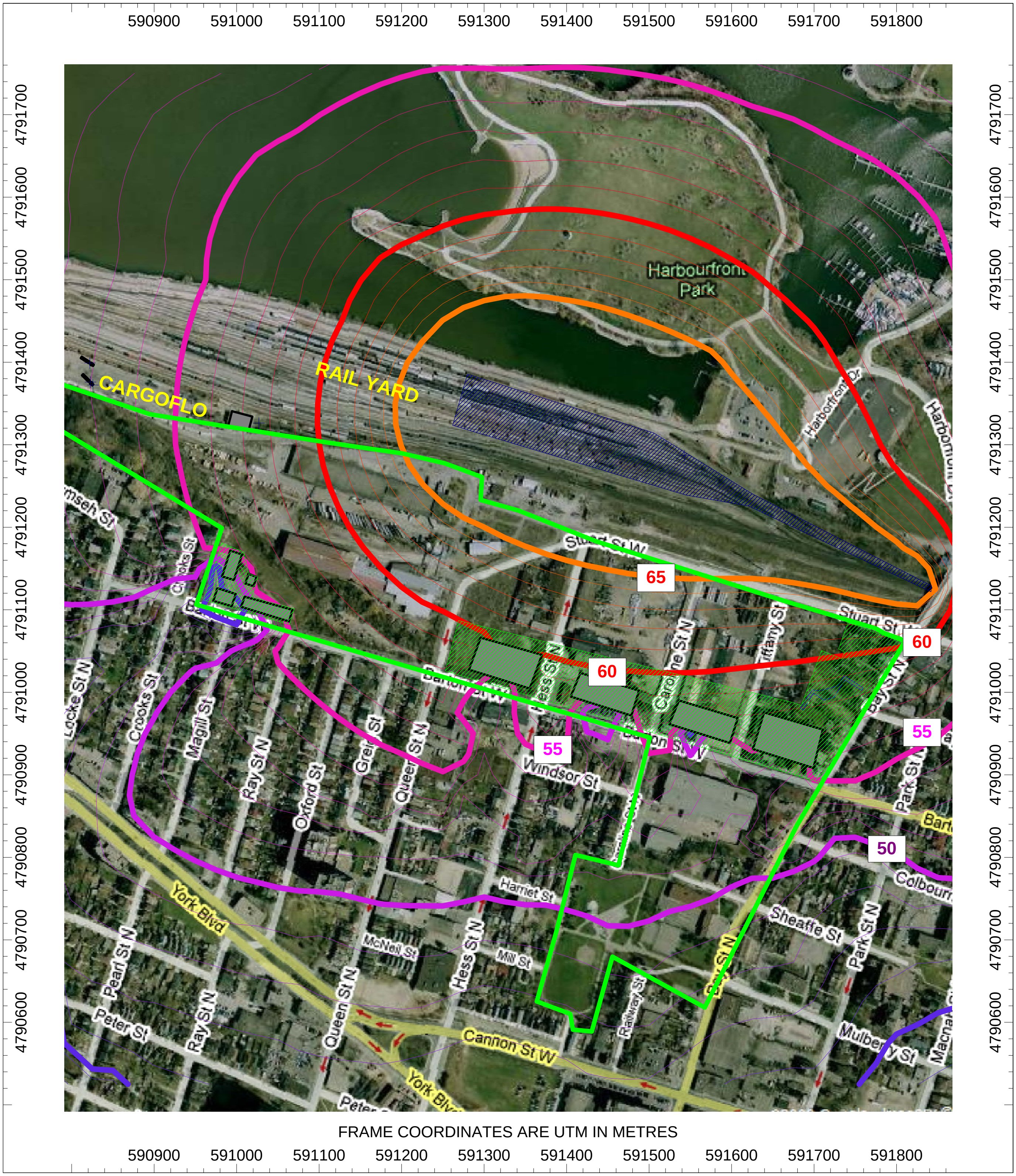



Figure 15: Nighttime Non-Impulsive Sound Level Predictions [dBA], 13 m above grade
Classification/Sorting Activities Concentrated in East End of Yard


Figure 16: Impulse Sound Level Predictions [dBAI], 13 m above grade

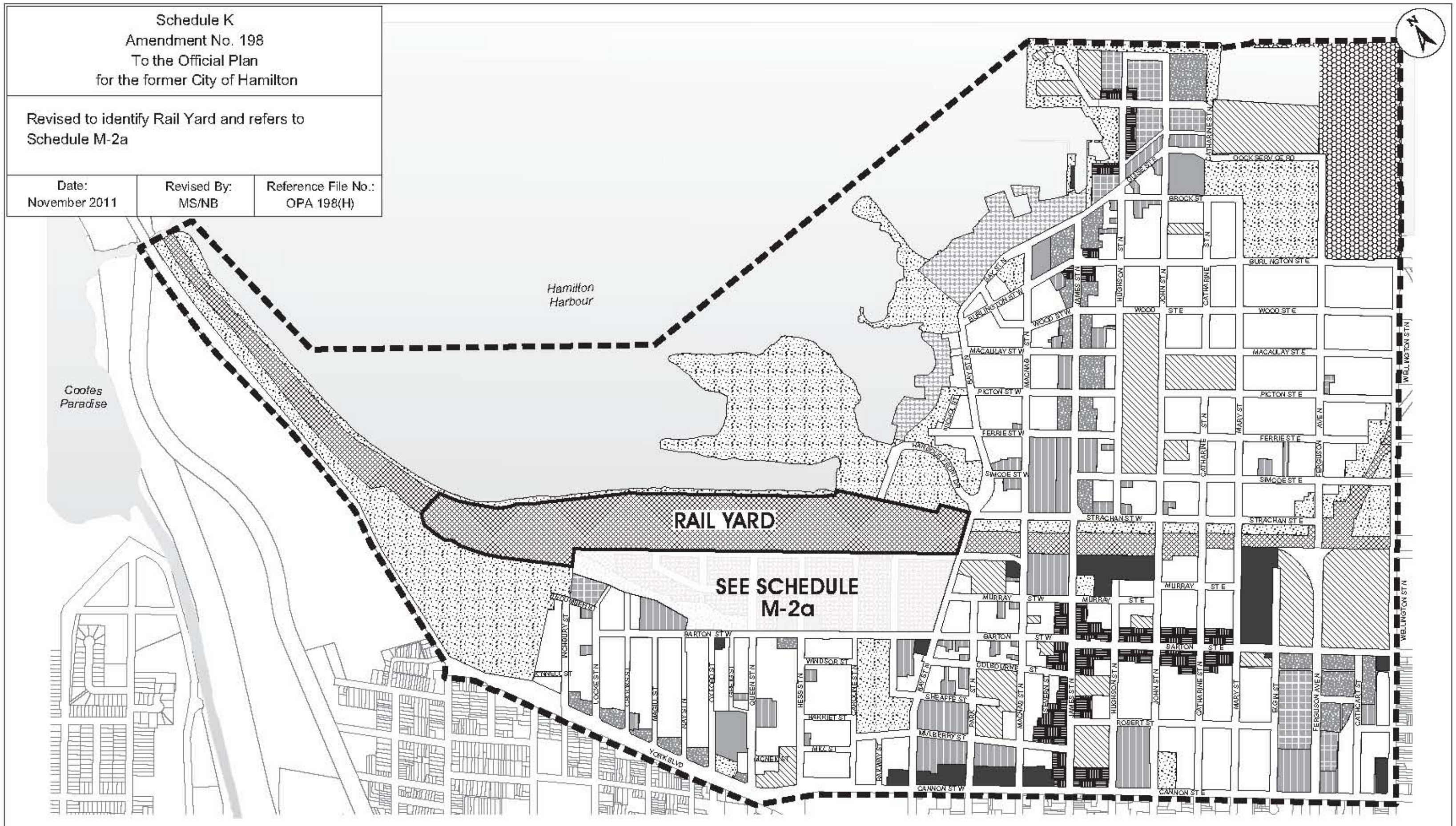
# APPENDIX A

Current Zoning Maps of Barton Tiffany Study Area and Consolidated Zoning Bylaw

Schedule K
Amendment No. 198
To the Official Plan
for the former City of Hamilton

Revised to identify Rail Yard and refers to Schedule M-2a

| Date: | Revised By: | Reference File No.: |
|---|---|---|
| November 2011 | MS/NB | OPA 198(H) |




**Legend**

- Low Density Residential
- Medium Density Residential 1
- Medium Density Residential 2
- High Density Residential
- Mixed Use
- Local Commercial
- Institutional
- Prime Retail
- Open Space
- Marine Recreational
- Utilities and Transportation
- Shipping & Navigation
- Special Policy Area
- Study Area Boundary

Setting Sail

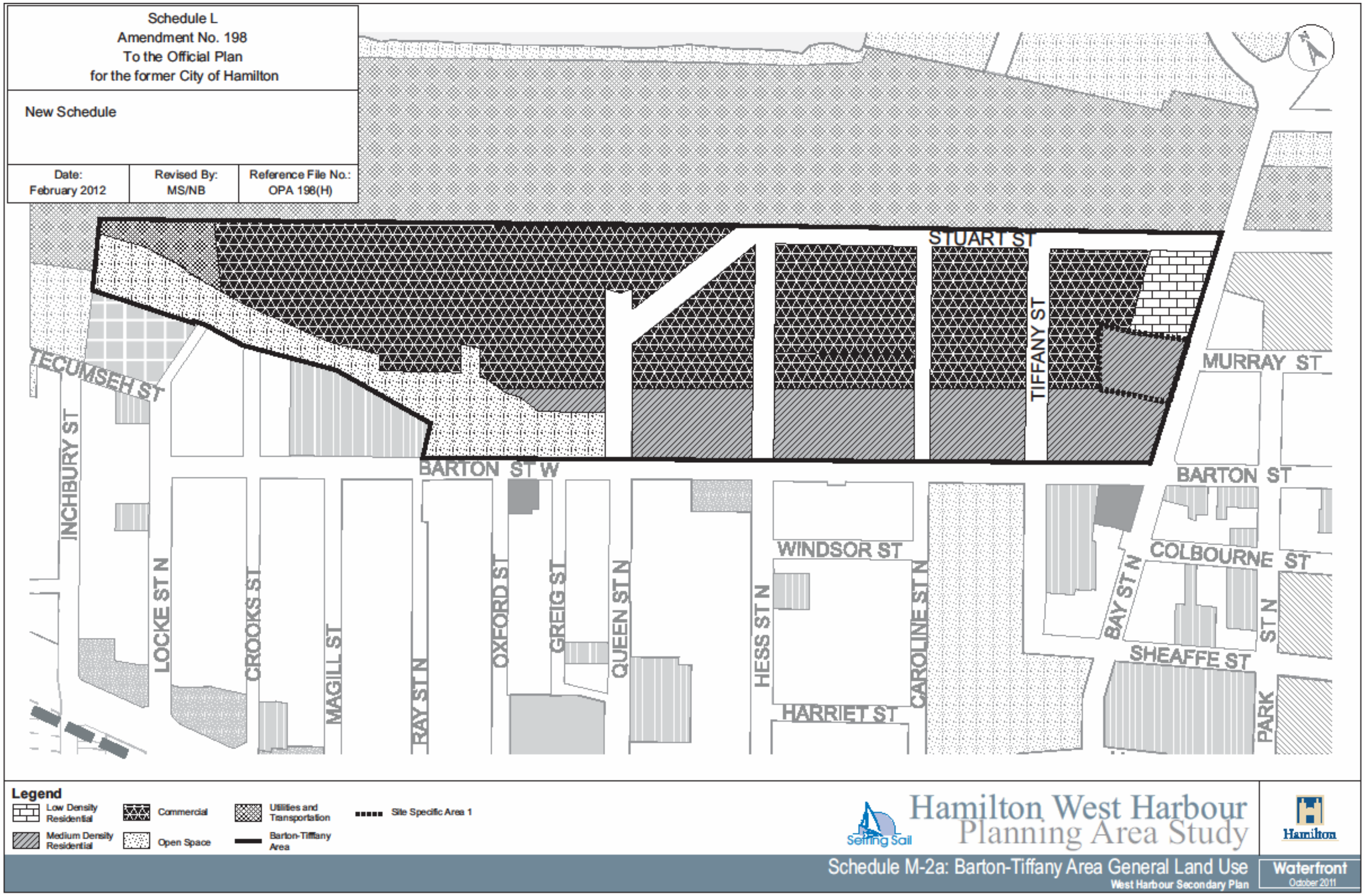
# Hamilton West Harbour Planning Area Study

Hamilton

## Schedule M-2: General Land Use

West Harbour Secondary Plan

Waterfront
October 2011


Schedule L
Amendment No. 198
To the Official Plan
for the former City of Hamilton
New Schedule
Date:
February 2012
Revised By:
MS/NB
Reference File No.:
OPA 198(H)
STUART ST
TIFFANY ST
MURRAY ST
TECUMSEH ST
INCHBURY ST
BARTON ST W
BARTON ST
LOCKE ST N
CROOKS ST
MAGILL ST
RAY ST N
OXFORD ST
GREIG ST
QUEEN ST N
HESS ST N
WINDSOR ST
HARRIET ST
CAROLINE ST N
BAY ST N
COLBOURNE ST
SHEAFFE ST
PARK ST N
Legend
Low Density Residential
Medium Density Residential
Commercial
Open Space
Utilities and Transportation
Barton-Tiffany Area
Site Specific Area 1
Setting Sail
Hamilton West Harbour
Planning Area Study
Hamilton
Schedule M-2a: Barton-Tiffany Area General Land Use
West Harbour Secondary Plan
Waterfront
October 2011

**Bill No. [redacted]**

# CITY OF HAMILTON

## BY-LAW No. [redacted]

## To Amend Zoning By-law 05-200, as Amended, Respecting the Barton-Tiffany Lands

**WHEREAS** the City of Hamilton has in force several Zoning By-laws which apply to the different areas incorporated into the City by virtue of the City of Hamilton Act, 1999, S.O. 1999, Chap. 14;

**AND WHEREAS** the City of Hamilton is the lawful successor to the former Municipalities identified in Section 1.7 of By-law 05-200;

**AND WHEREAS** Zoning By-law No. 05-200 was enacted on the 25th day of May, 2005;

**AND WHEREAS** the Ontario Municipal Board has ordered that Zoning By-law No. 05-200, be amended as hereinafter provided, and as set out in Board Order [redacted] dated [redacted]; and

**AND WHEREAS** this By-law is in conformity with the Official Plan of the Hamilton Planning Area, approved by the Minister under the Planning Act on June 1, 1982.

**NOW THEREFORE** the Council of the City of Hamilton enacts as follows:

1. That Map Nos. 867 and 868, of Schedule “A” of By-law 05-200, are amended by incorporating the Conservation/Hazard Land (P5) Zone (Block “1”), Downtown Multiple Residential (D6, 443, H45) Zone (Block “2”), Downtown Residential (D5, 444, H46) Zone (Block “3”), Downtown Prime Retail Streets (D2, 442, H44) Zone (Block “4”), Downtown Multiple Residential (D6, 445, H47) Zone (Block “5”) on the lands the extent and boundaries of which are shown on a plan hereto annexed as Schedule “A” to this By-law.

2. That Schedule “C” – Special Exceptions of By-law 05-200 is amended by adding the following Special Exceptions:

"442. Notwithstanding Section 6.3, on those lands zoned Downtown Prime Retail Streets (D2) Zone, identified on Maps 867 and 868 of Schedule "A" - Zoning Maps, the following special regulations shall apply:

No person shall erect, or use any building in whole or in part, or use any land in whole or in part, within the Downtown Mixed-Use (D3) for any purpose other than one or more of the following uses, or uses accessory thereto. Such erection or use shall also comply with the following prescribed regulations:

**a) PERMITTED USES**

Commercial Entertainment
Commercial Parking Facility
Commercial Recreation
Commercial School
Conference or Convention Centre
Craftsperson Shop
Financial Establishment
Medical Clinic
Office
Personal Services
Recreation
Repair Service
Restaurant
Retail
Studio
Tradesperson's Shop
Veterinary Service

**b) PROHIBITED USES**

i) Notwithstanding a) above, the following uses are prohibited even as an accessory use:

Dwelling Unit(s)
Drive Through Facility
Hotel

ii) Notwithstanding a) above, the following uses are prohibited except as an accessory use:

Garden Centre
Dry Cleaning Plant

**c) REGULATIONS**

| | | |
|---|---|---|
| i) | Minimum Rear Yard | 6.0 metres abutting a Residential Zone property line; |
| ii) | Minimum Interior Side Yard | 3.0 metres abutting a Residential Zone property line; |
| iii) | Maximum Building Height | 15.0 metres; |
| iv) | Maximum Gross Floor Area for a Retail Unit | 6,000 square metres; |
| v) | Maximum Lot Coverage for Retail Uses | 20 percent; |
| vi) | Maximum Floor Area Ratio for Retail Uses | 0.2; |
| vii) | Maximum Gross Floor Area for Office Uses within a Building | 3,000 square metres; |
| viii) | Built Form for New Development | In the case of buildings constructed or alterations to the exterior of existing buildings, excluding any alterations to façade, fenestration or doors, after the effective date of this By-law: |

A) The minimum length of the ground floor façade shall be equal to 25% or more of the measurement of the street line and shall be subject to the following:

1) A minimum building setback of 3.0 metres; and,

2) A maximum building setback of 4.5 metres; and,

3) Where a building(s) exists on a lot in conformity with A) 1) and A) 2) above, with a ground floor façade being equal to 25% or more of the measurement of any street line, section 2) above shall not apply to any additional building(s); and,

4) All principle entrances shall be accessible from the building façade with direct access from the public sidewalk.

| | | |
|---|---|---|
| ix) | Additional Requirements for Commercial Parking Facility | A) Shall only be contained within a building; and,<br><br>B) With the exception of an access driveway to the parking facility, the ground floor of the facility which faces any street shall only be used for uses listed in a) above, other than parking. |
| x) | Visual Barrier Requirements | A visual barrier is required along any yard abutting a Downtown Residential (D5) or Downtown Multiple Residential (D6) Zone, except where a building is located or the area used for an access driveway, in accordance with Section 4.19 of this By-law. |
| xi) | Outdoor Storage | A) No outdoor storage of goods, materials or equipment shall be permitted. |

B) Notwithstanding A) above, the display of goods or materials for retail purposes shall be permitted.

| | | |
|---|---|---|
| xii) | Accessory Buildings | In accordance with the requirements of Section 4.8 of this By-law. |
| xiii) | Parking | In accordance with the requirements of Section 5 of this By-law.” |

“443. Notwithstanding Section 6.6, on those lands zoned Downtown Multiple Residential (D6) Zone, identified on Maps 867 and 868 of Schedule “A” - Zoning Maps, the following special provisions shall apply:

No person shall erect, or use any building in whole or in part, or use any land in whole or in part, within the Downtown Multiple Residential (D6) Zone for any purpose other than one or more of the following uses, or uses accessory thereto. Such erection or use shall also comply with the following prescribed regulations:

**a) PERMITTED USES**

**Residential**

Multiple Dwelling
Home Business

**Commercial**

The following commercial uses shall only be permitted as part of a mixed-use building where the Commercial uses are contained jointly with residential uses in the same building or structure:

Commercial Entertainment
Commercial Recreation
Commercial School
Conference or Convention Centre
Craftsperson Shop
Day Nursery
Financial Establishment
Medical Clinic
Office

Personal Services
Recreation
Repair Service
Restaurant
Retail
Studio
Tradesperson’s Shop
Veterinary Service

**b) PROHIBITED USES**

Notwithstanding a), the following uses are prohibited, even as an accessory use:

Drive Through Facility
Garden Centre
Hotel
Dry Cleaning Plant

**c) REGULATIONS**

| | | |
|---|---|---|
| i) | Restriction of Commercial Uses permitted as part of a mixed use building | A) Commercial uses shall only be permitted on the ground floor;<br><br>B) The gross floor area of the Commercial uses shall not exceed the gross floor area of the Residential uses; and,<br><br>C) Pedestrian access to any Residential use shall be completely segregated from any Commercial use. |
| ii) | Minimum Side Yard | 3.0 metres; |
| iii) | Minimum Rear Yard | 6.0 metres; |
| iv) | Density requirements for Multiple Dwellings | Maximum 150 units per hectare; |
| v) | Maximum Floor Area Ratio | 0.6; |

vi) Built Form for New Development

In the case of buildings constructed or alterations to existing buildings after the effective date of this By-law:

A) The minimum width of the ground floor façade shall be equal to 25% or more of the measurement of the any street line and shall be subject to the following:

1) A Minimum Building setback of 3.0 metres; and,

2) A Maximum Building setback of 4.5 metres; and,

3) Where a building(s) exists on a lot in conformity with A) 1) and A) 2) above, with a ground floor façade being equal to 25% or more of the measurement of any street line, section 2) above shall not apply to any additional building(s); and,

4) All principle entrances shall be accessible from the building façade with direct access from the public sidewalk; and,

5) No parking, driveways or aisles shall be located between a building façade and the public street.

| | | |
|---|---|---|
| vii) | Building Height | A) Minimum 7.5 metres and 2 storeys; and,<br>B) Maximum 15.0 metres. |
| viii) | Visual Barrier Requirements | A visual barrier is required along any yard abutting a "D5" Zone, except where a building is located or the area used for an access driveway, in accordance with Section 4.19 of this By-law. |
| ix) | Outdoor Storage | A) No outdoor storage of goods, materials or equipment shall be permitted.<br>B) Notwithstanding A) above, the display of goods or materials for retail purposes shall be permitted. |
| xi | Accessory Buildings | In accordance with the requirements of Section 4.8.1 of this By-law. |
| xi) | Parking | In accordance with the requirements of Section 5 of this By-law." |

"444. Notwithstanding Section 6.5.1, 6.5.2.1 f), 6.5.2.2 f), 6.5.2.3 f), 6.5.2.4, 6.5.2.5, on those lands zoned Downtown Residential (D5) Zone, identified on Map 868 of Schedule "A" - Zoning Maps, the following special provisions shall apply:

**a) PERMITTED USES**

Single Detached Dwelling
Semi Detached Dwelling
Street Townhouse Dwelling

**b) SINGLE DETACHED DWELLING REGULATIONS**

i) Maximum Building Height 11.25 metres;

**c) SEMI-DETACHED DWELLING REGULATIONS**

i) Maximum Building Height 11.25 metres;

**d) STREET TOWNHOUSE DWELLING REGULATIONS**

i) Maximum Building Height 11.25 metres;"

"445. Notwithstanding Section 3, as it relates to the definition of "Grade", Sections 4.6(d), 6.6 and of this By-law, on those lands zoned Downtown Multiple Residential (D6) Zone, as identified on Map No. 868 of Schedule "A" - Zoning Maps and legally described as Part of Lot 3 and All of Lots 4, 5, 6, and 7, Block 30, Registered Plan 127 in the City of Hamilton. Designated as Parts 3, 4, 5, 6, 7, 8 on Plan 62R-19307, the following special provisions shall apply:

**a)** For the purposes of Special Exception No. 445, 'Grade' shall mean the average level of the proposed or finished ground of the Bay Street elevation.

No person shall erect, or use any building in whole or in part, or use any land in whole or in part, within the Downtown Multiple Residential (D6) Zone for any purpose other than one or more of the following uses, or uses accessory thereto. Such erection or use shall also comply with the following prescribed regulations:

**b) PERMITTED USES**

**Residential**

Multiple Dwelling
Home Business

**Commercial**

The following commercial uses shall only be permitted as part of a mixed use building where the Commercial uses are contained jointly with residential uses in the same building or structure:

Commercial Entertainment
Commercial Recreation
Commercial School
Conference or Convention Centre

Craftsperson Shop
Day Nursery
Financial Establishment
Medical Clinic
Office
Personal Services
Recreation
Repair Service
Restaurant
Retail
Studio
Tradesperson's Shop
Veterinary Service

**c) PROHIBITED USES**

Notwithstanding b) above, the following uses are prohibited, even as an accessory use:

Drive Through Facility
Garden Centre
Hotel
Dry Cleaning Plant

**d) REGULATIONS**

i) Restriction of Commercial Uses permitted as part of a mixed use building

A) Commercial uses shall only be permitted on the ground floor;

B) The gross floor area of the Commercial uses shall not exceed the gross floor area of the Residential uses; and,

C) Pedestrian access to any Residential use shall be completely segregated from any Commercial use.

ii) Building Setback from a Street Line

A) Maximum 4.5 metres, except,:

B) Where a visibility triangle shall be provided for a driveway access;

C) Notwithstanding A) above, the following regulations shall apply:

1. Where the ground floor is used for residential purposes the minimum setback shall be 3.0 metres;

2. Minimum setback shall be 6.5 metres for the fourth to eighth storeys; and,

3. Minimum 6.0 metres for that portion of a building providing an access driveway to a garage.

iii) Minimum Southerly Side Yard

A) 4.5 metres: and,

B) 6.5 metres for the fifth to eighth storeys.

iv) Minimum Northerly Side Yard

A) 7.0 metres, and,

B) 9.0 metres for the fifth to eighth storeys.

v) Building Height

A) Where the ground floor is used for commercial purposes:

1. Minimum 8.3 metres and two storeys;

2. Minimum 4.5 metres for the first storey; and,

3. Maximum 30.8 metres and eight storeys.

B) Where the ground floor is used for residential purposes:

1. Minimum 11.3 metres and three storeys;

2. Minimum 3.8 metres for the first storey; and

3. Maximum 30.0 metres and eight storeys.

vi) Density Requirements for Multiple Dwellings — Maximum 300 units per hectare.

vii) Built Form for New Development — In the case of buildings constructed or alterations to existing buildings after the effective date of this By-law:

A) The minimum width of the ground floor façade shall be equal to 25% or more of the measurement of the front lot line and shall be subject to the following:

1. Where a building(s) exists on a lot in conformity with d) ii) above, with a ground floor façade being equal to 25% or more of the measurement of any street line, section A) above shall not apply to any additional building(s); and,

2. All principle entrances shall be accessible from the building façade with direct access from the public sidewalk; and,

3. No parking, driveways or aisles shall be located between a building façade and the public

street.

| | | |
|---|---|---|
| viii) | Planning Strip Requirements | Where a property line abuts a property lot line within a Downtown Residential D5 Zone, or a Downtown Multiple Residential D6 Zone a minimum 3.0 metre wide Planting Strip shall be provided and maintained. |
| ix) | Visual Barrier Requirements | A visual barrier is required along any yard abutting a Downtown Residential (D5) Zone, except where a building is located or the area used for an access driveway, in accordance with Section 4.19 of this By-law. |
| x) | Outdoor Storage | A) No outdoor storage of goods, materials or equipment shall be permitted.<br><br>B) Notwithstanding A) above, the display of goods or materials for retail purposes shall be permitted. |
| xi) | Permitted Yard Encroachments | A porch, deck or canopy may encroach into any required yard to a maximum of 1.8 metres, or to a maximum of half the distance of the required yard. |
| xii) | Accessory Buildings | In accordance with the requirements of Section 4.8.1 of this By-law. |
| xiii) | Parking | In accordance with the requirements of Section 5 of this By-law.” |
| xiv) | Amenity Area Restriction | Outdoor amenity areas are prohibited in the rear yard and northerly side yard." |

3. That Schedule “D” - Holding Provisions of By-law 05-200 is hereby amended by adding the following Holding Provisions:

“44. Notwithstanding Section 6.3 and Special Exception No. 442 of this By-law, on those lands zoned Downtown Prime Retail Streets (D2) Zone, identified on Maps 867 and 868 of Schedule “A” - Zoning Maps no development shall be permitted until such time as:

i) a Vibration Study, prepared by a qualified Professional Engineer, completed to the satisfaction of the Director of Planning, Planning and Economic Development Department; and,

ii) an Urban Design Study for the Barton/Tiffany Area, to the satisfaction of the Director of Planning, Planning and Economic Development Department.”

“45. Notwithstanding Section 6.6 and Special Exception No. 443 of this By-law, on those lands zoned Downtown Multiple Residential (D6) Zone, identified on Maps 867 and 868 of Schedule “A” - Zoning Maps, no development shall be permitted until such time as:

i) a Noise Study, prepared by a qualified Professional Engineer, which shall address site layout and design including the location of outdoor amenity space, and building design including the location of non-habitable space, shall be completed in consultation with the appropriate railway company to the satisfaction of the Director of Planning, Planning and Economic Development Department to ensure that maximum sound levels are not exceeded in accordance with provincial guidelines including NPC 205;

ii) prior to any site alteration, a signed Record of Site Condition (RSC) shall be submitted to the City of Hamilton, Director of Planning, Planning and Economic Development Department and the Ministry of the Environment (MOE). This RSC must be to the satisfaction of the City of Hamilton, including acknowledgement of receipt of the RSC by the MOE; and,

iii) an Urban Design Study for the Barton/Tiffany Area, to the satisfaction of the Director of Planning, Planning and Economic Development Department.”

"46. Notwithstanding Section 6.5 and Special Exception No. 444 of this By-law, on those lands zoned Downtown Residential (D5) Zone, identified on Map 868 of Schedule "A" - Zoning Maps, no development shall be permitted until such time as:

i) receiving approval of a Site Plan Control Application, to the satisfaction of the Director of Planning, Planning and Economic Development Department; and,

ii) a Noise and Vibration Study, prepared by a qualified Professional Engineer, which shall address site layout and design including the location of outdoor amenity space, and building design including the location of non-habitable space, shall be completed in consultation with the appropriate railway company to the satisfaction of the Director of Planning, Planning and Economic Development Department to ensure that maximum sound levels are not exceeded in accordance with provincial guidelines including NPC 205; and,

iii) prior to any site alteration, a signed Record of Site Condition (RSC) submitted to the City of Hamilton, Director of Planning, Planning and Economic Development Department and the Ministry of the Environment (MOE). This RSC must be to the satisfaction of the City of Hamilton, including acknowledgement of receipt of the RSC by the MOE; and,

iv) an Urban Design Study for the Barton/Tiffany Area, to the satisfaction of the Director of Planning, Planning and Economic Development Department."

"47. Notwithstanding Section 6.6 and Special Exception No. 445 of this By-law, on those lands zoned Downtown Multiple Residential (D6) Zone, identified on Maps 867 and 868 of Schedule "A" - Zoning Maps and legally described as Part of Lot 3 and All of Lots 4, 5, 6, and 7, Block 30, Registered Plan 127 in the City of Hamilton. Designated as Parts 3, 4, 5, 6, 7, 8 on Plan 62R-19307, no development shall be permitted until such time as:

i) a Noise Study, prepared by a qualified Professional Engineer, which shall address site layout and design including the location of outdoor amenity space, and building design including the location of non-habitable space, shall be completed in consultation with the appropriate railway company to the satisfaction of the Director of Planning, Planning and Economic Development Department to ensure that maximum sound levels are not exceeded in accordance with provincial guidelines including NPC-205;

ii) prior to any site alteration, a signed Record of Site Condition (RSC) shall be submitted to the City of Hamilton and the Ministry of the Environment (MOE). This RSC must include an acknowledgement of receipt of the RSC by the MOE, and submission of the City of Hamilton's current RSC administration fee be to the satisfaction of the Director of Planning, Planning and Economic Development Department; and

iii) receiving final approval of a Site Plan Control Application in accordance with Schedule "B" - Property Details Figure 1, to the satisfaction of the Director of Planning, Planning and Economic Development Department."

4. That Schedule "F" – Special Figures of By-law 05-200 is amended by adding Figure 5: Property Details Sketch Related to Special Exemption 445.

5. That the Clerk is hereby authorized and directed to proceed with the giving of notice of passing of this By-law in accordance with the Planning Act.

6. That this By-law shall come into force and be deemed to have come into force in accordance with Sub-section 34(21) of the Planning Act, either upon the date of passage of this By-law or as provided by the said Sub-section.

**PASSED and ENACTED** this day of , 2012

| | |
|---|---|
| R. Bratina | Rose Caterini |
| Mayor | Clerk |


This is Schedule "A" to By-Law No. 12-

Passed the ........... day of ......................, 2012

Clerk

Mayor

# Schedule "A"

Map Forming Part of
By-Law No. 12-_____

to Amend By-law No. 05-200
Map 867 and 868

| Scale: N.T.S. | File Name/Number: Setting Sail-Barton Tiffany |
|---|---|
| Date: January 24, 2012 | Planner/Technician: SM/MB |

PLANNING AND ECONOMIC DEVELOPMENT DEPARTMENT

Hamilton

**Subject Property**
Barton Tiffany Area

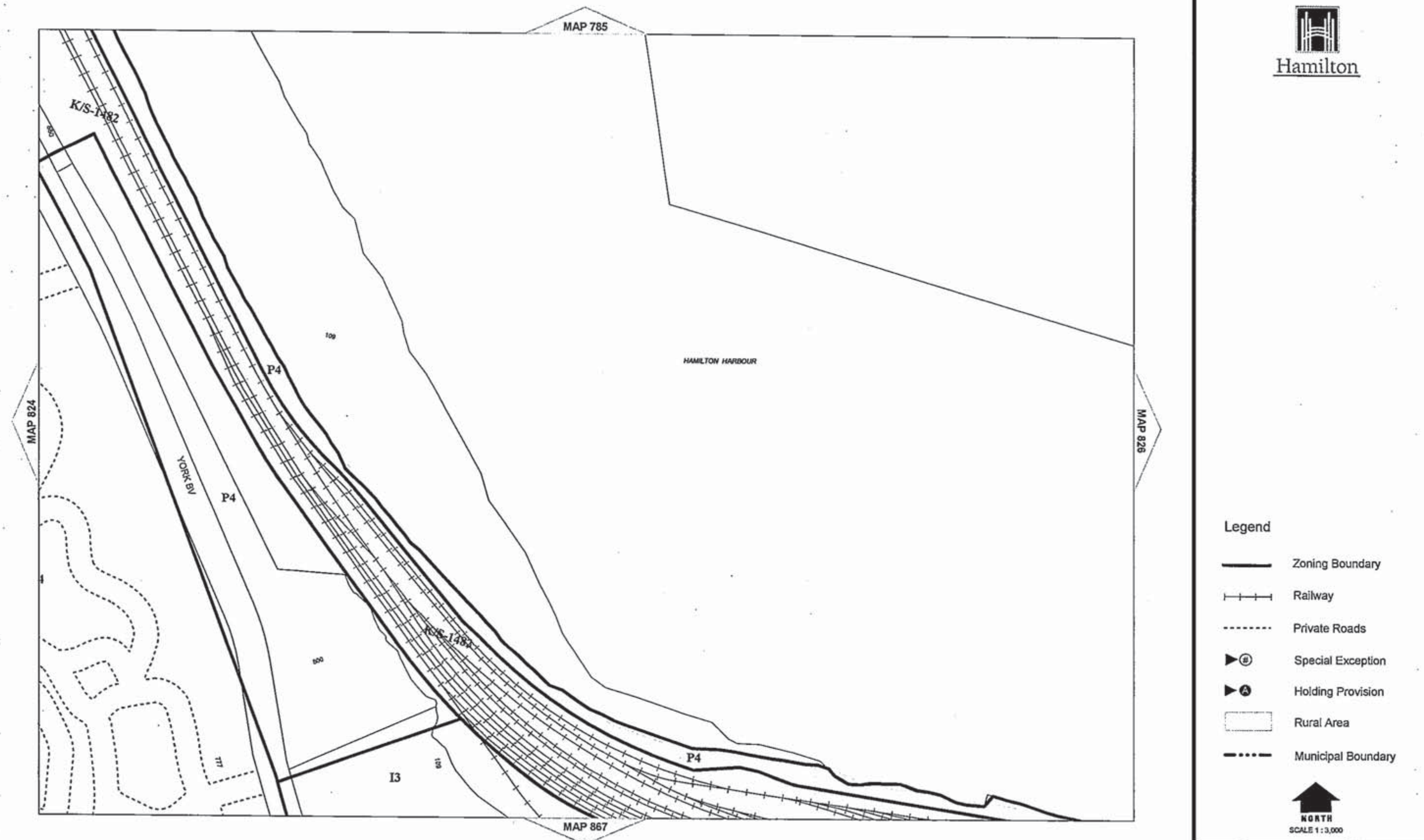
**Block 1** - Lands to be added to By-law No. 05-200 as Conservation Hazard Land (P5) Zone

**Block 2** - Lands to be added to By-law No. 05-200 as Downtown Multiple Residential (D6, 443, H45) Zone

**Block 3**- Lands to be added to By-law No. 05-200 as Downtown Residential (D5, 444, H46) Zone

**Block 4** - Lands to be added to By-law No. 05-200 as Downtown Prime Retail Streets (D2, 442, H44) Zone

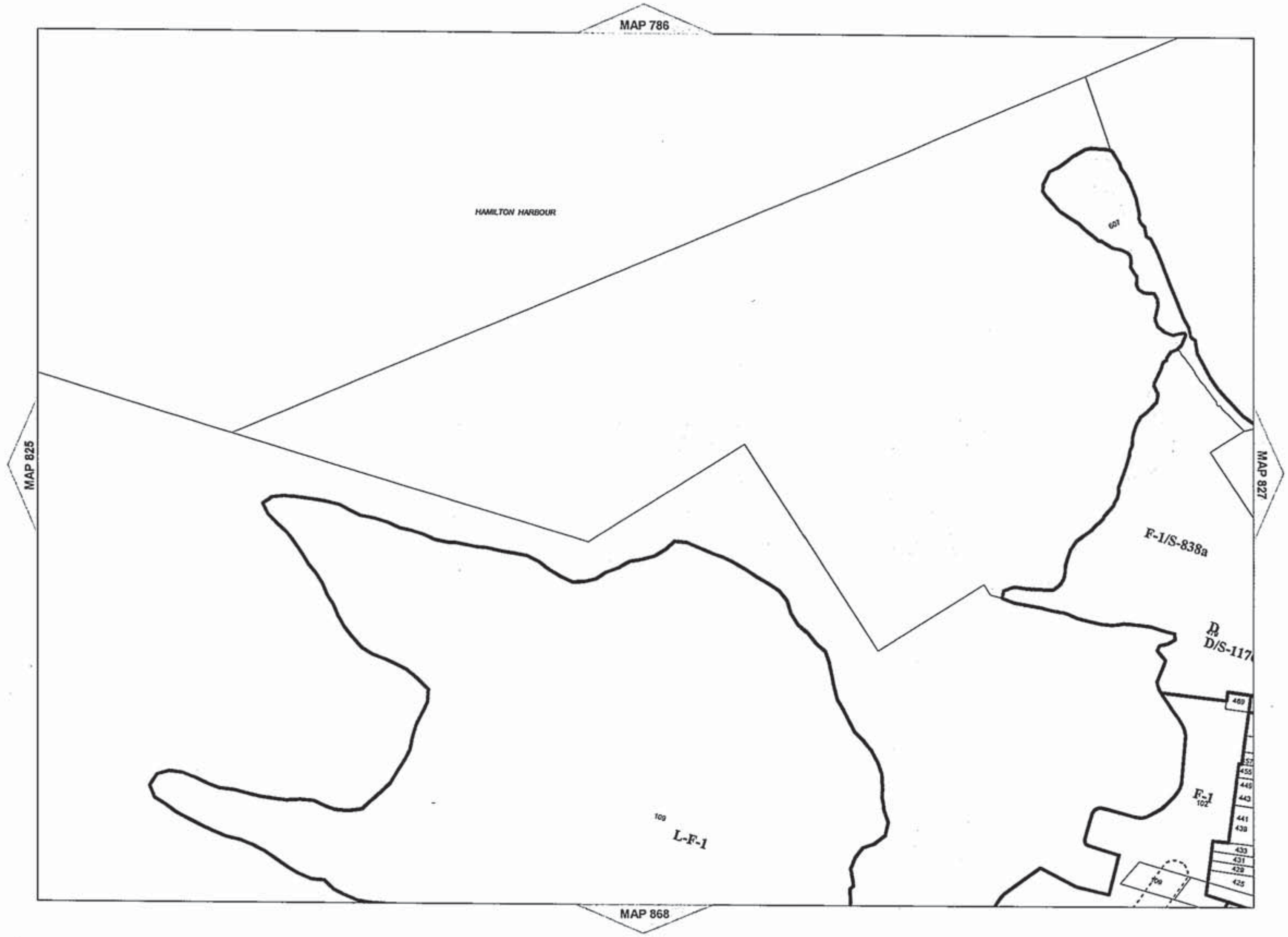
**Block 5** - Lands to be added to By-law No. 05-200 as Downtown Multiple Residential (D6, 445, H47) Zone




Hamilton

**URBAN ZONING MAP 825**

Plot Date 1/7/2013




Hamilton

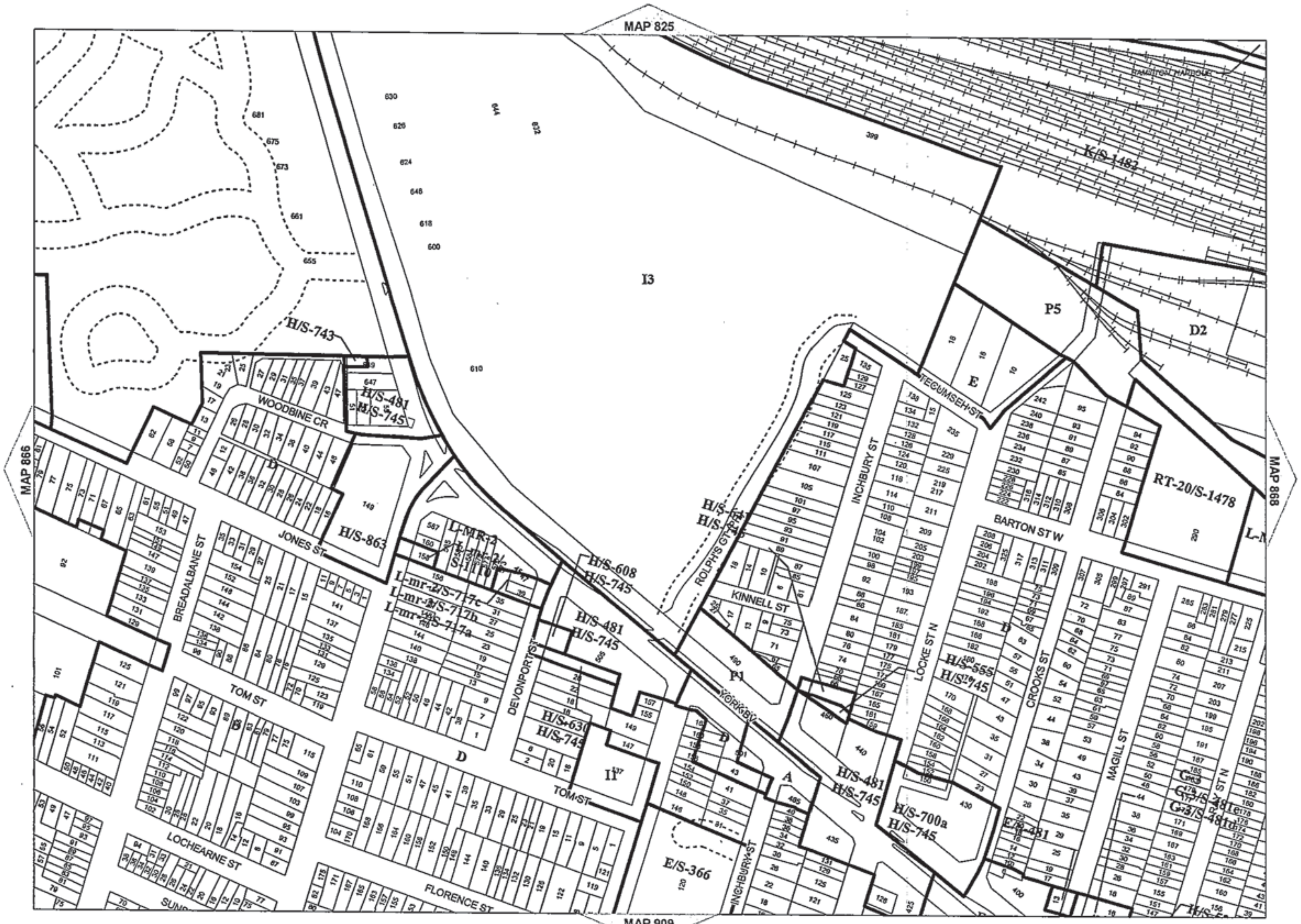
Legend

- Zoning Boundary
- Railway
- Private Roads
- Special Exception
- Holding Provision
- Rural Area
- Municipal Boundary

NORTH
SCALE 1 : 3,000

## URBAN ZONING MAP 826

Plot Date 1/7/2013




Hamilton

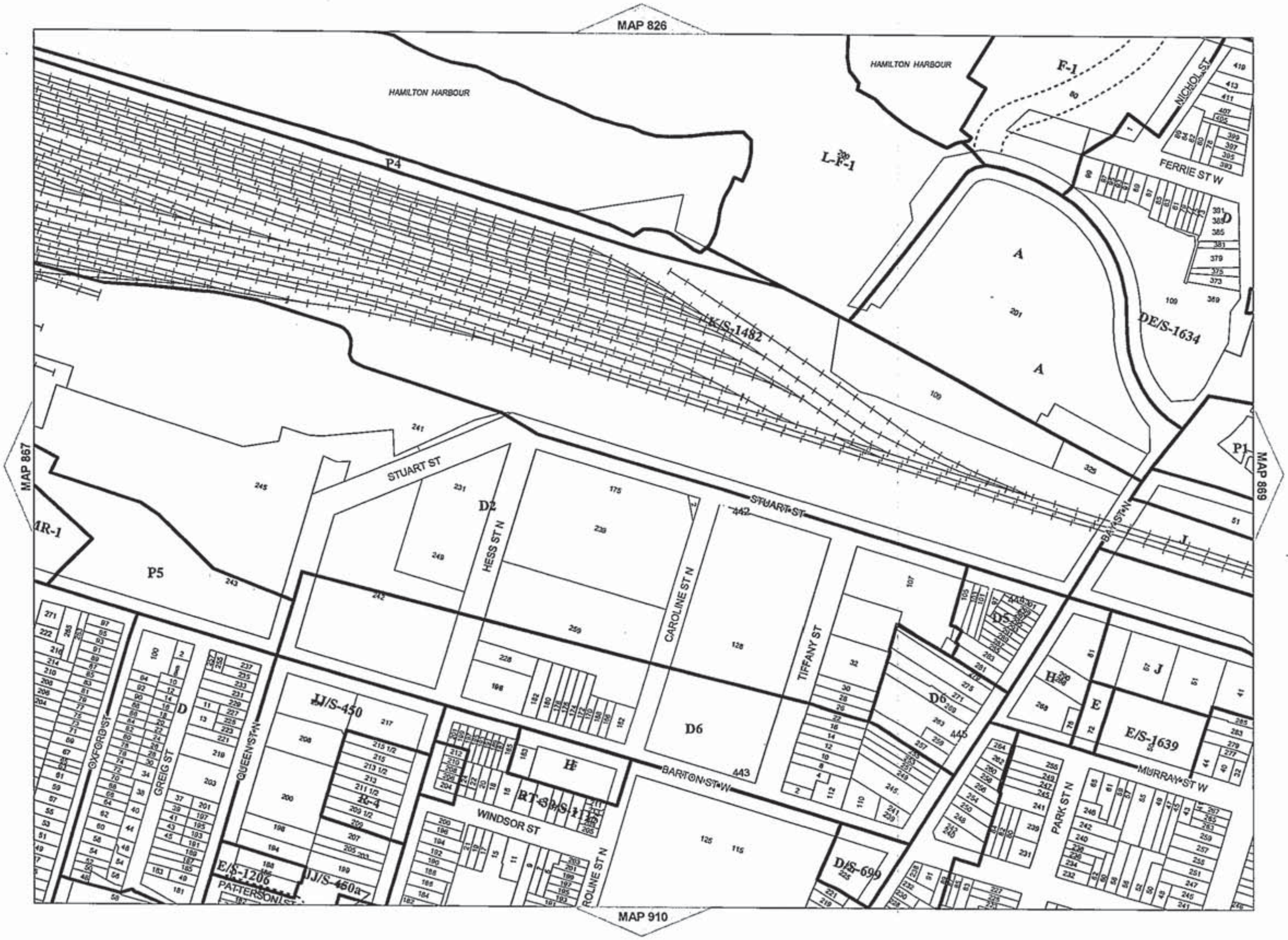
Legend

- Zoning Boundary
- Railway
- Private Roads
- Special Exception
- Holding Provision
- Rural Area
- Municipal Boundary

NORTH
SCALE 1 : 3,000

## URBAN ZONING MAP 867

Plot Date 1/7/2013




Hamilton

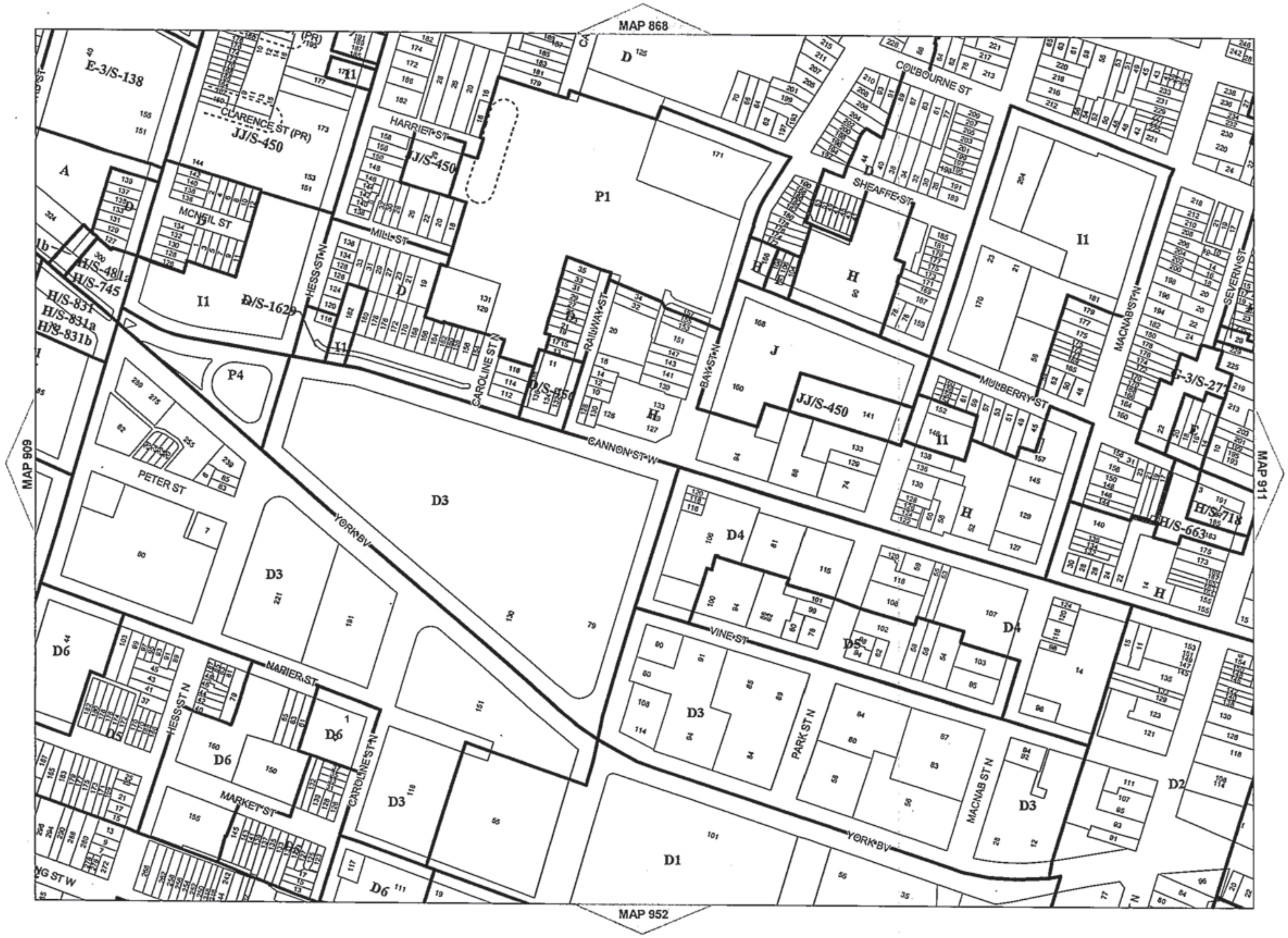
Legend

- Zoning Boundary
- Railway
- Private Roads
- Special Exception
- Holding Provision
- Rural Area
- Municipal Boundary

NORTH
SCALE 1 : 3,000

## URBAN ZONING MAP 868

Plot Date 1/7/2013




Hamilton

Legend

- Zoning Boundary
- Railway
- Private Roads
- Special Exception
- Holding Provision
- Rural Area
- Municipal Boundary

NORTH
SCALE 1 : 3,000

## URBAN ZONING MAP 910

Plot Date 1/7/2013

# APPENDIX B

CN Principal Mainline Requirements, GO Transit Mainline Requirements

Canadian National
1 Administration Road
Concord, Ontario
L4K 1B9

# PRINCIPAL MAIN LINE REQUIREMENTS

**A.** Safety setback of habitable buildings from the railway rights-of-way to be a minimum of 30 metres in conjunction with a safety berm. The safety berm shall be adjoining and parallel to the railway rights-of-way with returns at the ends, 2.5 metres above grade at the property line, with side slopes not steeper than 2.5 to 1.

**B.** The Owner shall engage a consultant to undertake an analysis of noise. At a minimum, a noise attenuation barrier shall be adjoining and parallel to the railway rights-of-way, having returns at the ends, and a minimum total height of 5.5 metres above top-of-rail. Acoustic fence to be constructed without openings and of a durable material weighing not less than 20 kg. per square metre of surface area. Subject to the review of the noise report, the Railway may consider other measures recommended by an approved Noise Consultant.

**C.** Ground-borne vibration transmission to be evaluated in a report through site testing to determine if dwellings within 75 metres of the railway rights-of-way will be impacted by vibration conditions in excess of 0.14 mm/sec RMS between 4 Hz and 200 Hz. The monitoring system should be capable of measuring frequencies between 4 Hz and 200 Hz, ±3 dB with an RMS averaging time constant of 1 second. If in excess, isolation measures will be required to ensure living areas do not exceed 0.14 mm/sec RMS on and above the first floor of the dwelling.

**D.** The Owner shall install and maintain a chain link fence of minimum 1.83 metre height along the mutual property line.

**E.** The following clause should be inserted in all development agreements, offers to purchase, and agreements of Purchase and Sale or Lease of each dwelling unit within 300m of the railway right-of-way: "Warning: Canadian National Railway Company or its assigns or successors in interest has or have a rights-of-way within 300 metres from the land the subject hereof. There may be alterations to or expansions of the railway facilities on such rights-of-way in the future including the possibility that the railway or its assigns or successors as aforesaid may expand its operations, which expansion may affect the living environment of the residents in the vicinity, notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the development and individual dwelling(s). CNR will not be responsible for any complaints or claims arising from use of such facilities and/or operations on, over or under the aforesaid rights-of-way."

**F.** Any proposed alterations to the existing drainage pattern affecting railway property must receive prior concurrence from the Railway and be substantiated by a drainage report to the satisfaction of the Railway.

**G.** The Owner shall through restrictive covenants to be registered on title and all agreements of purchase and sale or lease provide notice to the public that the safety berm, fencing and vibration isolation measures implemented are not to be tampered with or altered and further that the Owner shall have sole responsibility for and shall maintain these measures to the satisfaction of CN.

**H.** The Owner shall enter into an Agreement with CN stipulating how CN's concerns will be resolved and will pay CN's reasonable costs in preparing and negotiating the agreement.

**I.** The Owner shall be required to grant CN an environmental easement for operational noise and vibration emissions, registered against the subject property in favour of CN.

# PRINCIPAL MAIN LINE REQUIREMENTS

A. Safety setback of dwellings from the railway rights-of-way to be a minimum of 30 metres in conjunction with a safety berm. The safety berm shall be adjoining and parallel to the railway rights-of-way with returns at the ends, 2.5 metres above grade at the property line, with side slopes not steeper than 2.5 to 1.

B. Noise attenuation barrier shall be adjoining and parallel to the railway rights-of-way, having returns at the ends, and a minimum total height of 5.5 metres above top-of-rail. Acoustic fence to be constructed without openings and of a durable material weighing not less than 20 kg. per square metre of surface area. Subject to the review of the noise report, GO Transit may consider other measures recommended by an approved Noise Consultant.

C. Ground-borne vibration transmission to be evaluated in a report through site testing to determine if dwellings within 75 metres of the railway rights-of-way will be impacted by vibration conditions in excess of 0.14 mm/sec RMS between 4 Hz and 200 Hz. The monitoring system should be capable of measuring frequencies between 4 Hz and 200 Hz, $\pm$ 3 dB with an RMS averaging time constant of 1 second. If in excess, isolation measures will be required to ensure living areas do not exceed 0.14 mm/sec RMS on and above the first floor of the dwelling.

D. The Owner shall install and maintain a chain link fence of minimum 1.83 metre height along the mutual property line.

E. The following clause should be inserted in all development agreements, offers to purchase, and agreements of Purchase and Sale or Lease of each dwelling unit within 300m of the railway right-of-way.

> **Warning:** The Greater Toronto Transit Authority, carrying on business as GO Transit, and its assigns and successors in interest has or have a right-of-way within 300 metres from the land the subject hereof. There may be alterations to or expansions of the rail facilities on such right-of-way in the future including the possibility that GO Transit or any railway entering into an agreement with GO Transit to use the right-of-way or their assigns or successors as aforesaid may expand their operations, which expansion may affect the living environment of the residents in the vicinity, notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the development and individual dwelling(s). GO Transit will not be responsible for any complaints or claims arising from use of such facilities and/or operations on, over or under the aforesaid right-of-way.

F. Any proposed alterations to the existing drainage pattern affecting the railway right-of-way must receive prior concurrence from GO Transit and be substantiated by a drainage report to the satisfaction of GO Transit.

G. The Owner shall through restrictive covenants to be registered on title and all agreements of purchase and sale or lease provide notice to the public that the safety berm, fencing and vibration isolation measures implemented are not to be tampered with or altered and further that the Owner shall have sole responsibility for and shall maintain these measures to the satisfaction of GO Transit.

H. The Owner enter into an Agreement stipulating how GO Transit's concerns will be resolved and will pay GO Transit's reasonable costs in preparing and negotiating the agreement.

I. The Owner may be required to grant GO Transit an environmental easement for operational emissions, registered on title against the subject property in favour of GO.

# APPENDIX C

Road and Rail Traffic Data & Sample Calculations

**Date:** 2013/11/08 Project Number: GRM-39.00 – Barton Street

**Ms. Sheeba Paul**, MEng, PEng
Senior Engineer, Associate
**HGC Engineering**
2000 Argentia Road, Plaza One, Suite 203,
Mississauga, Ontario, Canada L5N 1P7

Dear **Sheeba Paul**:

**Re: Train Traffic Data – CN Grimsby Subdivision near Barton Street in Hamilton, ON**

The following is provided in response to Robert Barnett request for information regarding rail traffic in the vicinity of Barton Steet in Hamilton at approximately Mile 39.00 on CN's Grimsby Subdivision.

Typical daily traffic volumes are recorded below. However, traffic volumes may fluctuate due to overall economic conditions, varying traffic demands, weather conditions, track maintenance programs, statutory holidays and traffic detours that when required may be heavy although temporary. For the purpose of noise and vibration reports, train volumes must be escalated by 2.5% per annum for a 10-year period.

Typical daily traffic volumes at this site location are as follows:

***Maximum train speed is given in Miles per Hour**

| | 0700-2300 | | | |
|---|---|---|---|---|
| Type of Train | Volumes | Max.Consist | Max. Speed | Max. Power |
| Freight | 4 | 140 | 60 | 4 |
| Way Freight | 0 | 25 | 60 | 2 |
| Passenger | 2 | 10 | 95 | 2 |

| | 2300-0700 | | | |
|---|---|---|---|---|
| Type of Train | Volumes | Max.Consist | Max. Speed | Max. Power |
| Freight | 0 | 140 | 60 | 4 |
| Way Freight | 0 | 25 | 60 | 2 |
| Passenger | 0 | 10 | 95 | 2 |

The volumes recorded reflect westbound and eastbound freight and passenger operations on CN's Grimsby Subdivision.

Except where anti-whistling bylaws are in effect, engine-warning whistles and bells are normally sounded at all at-grade crossings. There is one at-grade crossing in the immediate vicinity of the study area at Mile 39.04 (Woodward Ave). Anti-whistling bylaws are not in effect at this crossing. Please note that engine warning whistles may be sounded in cases of emergency, as a safety and or warning precaution at station locations and pedestrian crossings and occasionally for operating requirements.

With respect to equipment restrictions, the gross weight of the heaviest permissible car is 283,000 lbs.

The Double mainline track is considered to be continuously welded rail throughout the study area.

The Canadian National Railway continues to be strongly opposed to locating developments near railway facilities and rights-of-way due to potential safety and environmental conflicts. Development adjacent to the Railway Right-of-Way is not appropriate without sound impact mitigation measures to reduce the incompatibility. For confirmation of the applicable rail noise, vibration and safety standards, Mr. Raymond Beshro, Canadian National Railway Properties at 514-399-7627 should be contacted directly.

I trust the above information will satisfy your current request.

Sincerely,

Stefan Linder B. Eng., MBA
Manager Public Works, Eastern Region
Stefan.linder@cn.ca

cc. Raymond Beshro – CN – via e-mail

## Sheeba Paul

**From:** NICK.COLEMAN@cn.ca
**Sent:** June-05-09 11:13 AM
**To:** Sheeba Paul
**Cc:** adam.snow@gotransit.com; douglas.mackenzie@railamerica.com; McCready, Colin
**Subject:** Re: Train Traffic Data - Oakville Subdivision at Hamilton Yard
**Attachments:** RPT-5000-059-09-22-Train Traffic-HGC.pdf

Sheeba, there is also a bulk transfer operation (CargoFlo) between rail car and truck using vacuums, and a small locomotive repair shop that occasionally performs load tests. There may be other areas in the yard where we might want to run other transfer operations.

We have existing complaints from the residents to the south of the yard, as well as from across the water on Bay Street. The 300m separation distance will likely be an issue, and meeting stationary noise guidelines at the plan-of-window will likely be similarly problematic.

Regards,
Nick

From: "McCready, Colin" <Colin.McCready@aecom.com>
To: "Sheeba Paul" <spaul@hgcengineering.com>
Cc: <NICK.COLEMAN@cn.ca>, <douglas.mackenzie@railamerica.com>, <adam.snow@gotransit.com>
Date: 2009/06/05 10:03
Subject: Train Traffic Data - Oakville Subdivision at Hamilton Yard

---

Sheeba,

See attached.

Colin McCready B.Eng., EIT
Transportation – Rail
Email: Colin.McCready@aecom.com
T 905.238.0007 x 8289
AECOM Canada Ltd.
5080 Commerce Blvd. Mississauga,ON,L4W 4P2
T 905.238.0007 x 8289 F 905.238.0038

SOUTHERN ONTARIO RAILWAY

241 Stuart Street West, P.O. Box 953, Hamilton, Ontario, Phone 905-777-1234 ex 226, Fax 905-777-8491

Ms. Sheeba Paul, PEng
HGC Engineering
Howe Gastmeier Chapnik Limited
2000 Argentia Road
Plaza One, Suite 203
Mississauga, Ontario, Canada
L5N 1P7

Re: Rail Traffic Data – Stuart Street Yard

As per your request, the following information is provided for the area in the vicinity of on Southern Ontario Railway's Stuart Street Yard.

The typical daily rail traffic volumes are representative of a twenty four (24) hour period, seven (7) days per week, but I must caution that such volumes are subject to overall economic conditions and will fluctuate with varying traffic demands, weather conditions, track maintenance programs and statutory holidays.

The Stuart Street Yard is currently a high use rail yard equipped with twenty three classification tracks for the purpose of marshalling and classifying rail traffic within the City of Hamilton, whistling except to prevent accident, warn persons on or about tracks is prohibited.

Rail cars are marshaled and classified in this yard seven days per week, including holidays currently scheduled to occur between the hours of 0700 and 2300.

At present the number of trains which are scheduled to operate between 0700 and 2300 through this yard are six (6) freight trains which normally operate with two (2) locomotives and average approximately eighty (80) rail cars.

Between the hours of 2300 to 0700, currently there are three (3) freight trains scheduled to operate through this yard facility which normally operate with two (2) locomotives and average sixty five (65) cars.

Current maximum speed on these yard tracks is limited to speeds below fifteen (15) miles per hour.

Based on current forecasts, freight traffic is expected to grow by a minimum of 5% per cent and a maximum of 10% annually over the next three (3) years.

In addition, CN operates a number of trains on their main track and a truck/rail car reload yard both of which is immediately adjacent to our Stuart Street Yard of which I cannot provide any information related to their train movements and suggest that if you have not already done so, you should make contact with a representative of CN to obtain their rail data.

If you have any further questions please feel free to contact me at 905 777-1234 Extension 226.

Yours truly,

Doug MacKenzie
General Manager
Goderich-Exeter Railway

a Genesee & Wyoming Company

SOUTHERN ONTARIO RAILWAY
241 Stuart Street West, Hamilton, Ontario, Phone 905-777-1234 ex 221

Ms. Sheeba Paul, PEng
HGC Engineering
Howe Gastmeier Chapnik Limited
2000 Argentia Road
Plaza One, Suite 203
Mississauga, Ontario, Canada
L5N 1P7

Rail Traffic Data – Hamilton Yard , Stuart Street Hamilton

As per your request, the following information is provided for the area in the vicinity of on Southern Ontario Railway's Stuart Street Yard.

The typical Annual rail traffic volumes is 20,000 carloads and are representative of a twenty four (24) hour period, seven (7) days per week, but I must caution that such volumes are subject to overall economic conditions and will fluctuate with varying traffic demands, weather conditions, track maintenance programs and statutory holidays.

The Stuart Street Yard is currently a high use rail yard equipped with twenty three classification tracks for the purpose of marshaling and classifying rail traffic within the City of Hamilton, whistling except to prevent accident, warn persons on or about tracks is Prohibited and is regulation as per CROR in the industry.

Rail cars are marshaled and classified in this yard seven days per week, including holidays currently 24 hours a day with a majority of the work being switched between 07h00 and 23h59. After 23h59 we do have switching but minimum until the following day at 07h00.

At present the number of trains which are scheduled to operate between 0700 and 2300 through this yard are six (6) freight trains which normally operate with two (2) locomotives and average approximately eighty (80) rail cars.

Between the hours of 2300 to 0700, currently there are three (3) freight trains scheduled to operate through this yard facility which normally operates with one locomotive and average sixty five (65) cars.

Current maximum speed on these yard tracks is limited to speeds below fifteen (15) miles per hour.

Based on current forecasts, freight traffic is expected to grow by a minimum of 5% per cent and a maximum of 10% annually over the next three (3) years.

In addition, CN operates a number of trains on their main track and a truck/rail car reload yard both of which is immediately adjacent to our Stuart Street Yard of which I cannot provide any information related to their train movements and suggest that if you have not already done so, you should make contact with a representative of CN to obtain their rail data.

If you have any further questions please feel free to contact me at 905 777-1234 Extension 221.

Yours truly,

Rick Mclellan
General Manager
Sothern Ontario Railway

## Sheeba Paul

**To:** Adam Snow
**Subject:** RE: rail traffic data request for Hamilton

**From:** Adam Snow [mailto:Adam.Snow@gotransit.com]
**Sent:** Monday, June 15, 2009 11:26 AM
**To:** Sheeba Paul
**Subject:** RE: rail traffic data request for Hamilton

Hi Sheeba,

This section of track is not currently used by GO Transit, but it will be soon as we begin summer weekend train service between Toronto and Niagara Falls. Four trains will run in each direction on Saturdays, Sundays and holidays from June 27 to October 12, 2009.

A feasibility study to examine the potential for future regular commuter service between Hamilton and St. Catherine's/Niagara Falls has just recently been initiated so the justification for, and operating parameters of, this service have yet to be defined. For the purposes of your analysis, it may be assumed that 6 trains will run during each of the weekday peak periods (i.e., for a total of 12 daily trains - assume 10 during daytime hours and 2 at night). Trains will be comprised of one locomotive and up to 12 passenger cars.

Since this rail corridor is owned by CN Rail, additional information pertaining to rail operations on this line, including freight volumes, train speeds etc.can be obtained from Colin McCready of AECOM Engineering.

I hope that this information meets your needs. Feel free to contact me should you have any additional questions.

Best regards,

Adam

Adam Snow
Transportation Planner
GO Transit Planning and Development - Head Office
416-869-3600, ext. 5408



---

**From:** Sheeba Paul
**Sent:** Thursday, June 11, 2009 4:44 PM
**To:** Adam Snow
**Subject:** RE: rail traffic data request for Hamilton

Hello Adam,

We need rail traffic data for the CN Oakville Subdivision in the Hamilton Yard. We have obtained data from SOR and from UMA.

The developments are located at Barton Street and Crooks Street and at Stuart Street and Tiffany Street in Hamilton, Ontario.

I have attached a Google map link for your reference.

http://maps.google.ca/maps?

f=q&source=s_q&hl=en&geocode=&q=barton+street+and+crooks,+hamilton,+ontario&sll=43.220502,-79.6983&sspn=0.022423,0.038452&ie=UTF8&ll=43.268183,-79.878706&spn=0.005601,0.009613&t=h&z=17

Please provide the rail traffic data for the GO Transit trains through this area. I will need volume of trains during the day and night, speeds, number of locomotives and cars, whistle or not, classification of the railway line and name of the railway line.

I have attached the rail yard data received from the SOR for your reference. Also please let me know how far from the rail yard the 15 mph restriction applies.

Thank you.

Ms. Sheeba Paul, PEng

HGC Engineering
Howe Gastmeier Chapnik Limited
2000 Argentia Road
Plaza One, Suite 203
Mississauga, Ontario, Canada L5N 1P7

Phone (905) 826-4044
Fax (905) 826-4940

spaul@hgcengineering.com
www.hgcengineering.com

## Sheeba Paul

**From:** Adam Snow <Adam.Snow@gotransit.com>
**Sent:** November-11-13 10:36 AM
**To:** Sheeba Paul
**Subject:** RE: Train Traffic Data Request Hamilton

**Follow Up Flag:** Follow up
**Flag Status:** Completed

Hi Sheeba – Sorry for the delay in my response (I don't have a student to assist me this term – Deepiga is no longer with us).

The information set out in my previous email (as you attached) remains applicable for this location.

Thanks,

Adam

---

**From:** Sheeba Paul [mailto:spaul@hgcengineering.com]
**Sent:** Friday, November 08, 2013 10:08 AM
**To:** Adam Snow; Adam Snow; Adam Snow; Deepiga Vigneswaran (Deepiga.Vigneswaran@gotransit.com)
**Subject:** FW: Train Traffic Data Request Hamilton

Hi Adam,

Just wondering if you had a chance to look at this data for me.

Thank you.

**Ms. Sheeba Paul**, MEng, PEng
**HGC Engineering** **NOISE | VIBRATION | ACOUSTICS**
**Howe Gastmeier Chapnik Limited**
**t**: 905.826.4044

---

**From:** Sheeba Paul
**Sent:** November-04-13 9:57 PM
**To:** 'Adam Snow (Adam.Snow@gotransit.com)'; 'Adam Snow'; 'Adam Snow (Adam.Snow@metrolinx.com)'
**Subject:** RE: Train Traffic Data Request Hamilton

Hi Adam,

HGC Engineering is performing a noise study for a proposed development in the City of Hamilton near the Stuart rail yard.

Please find attached a Google link for your reference.

https://maps.google.ca/maps?q=barton+street+and+tiffany+street,+hamilton,+on&hl=en&ll=43.265363,-79.860091&spn=0.027188,0.066047&sll=43.237825,-79.747524&sspn=0.108801,0.264187&hnear=Barton+St+W+%26+Tiffany+St,+Hamilton,+Hamilton+Division,+Ontario&t=m&z=15

We would like to request rail traffic data for the GO Transit railway line that runs east/west. We have some data for the same railway line in our files which is attached. It is quite old. Please verify if the data is valid for the railway line near the current site. If not, please provide new rail data.

Thank you.

**Ms. Sheeba Paul**, MEng, PEng
**HGC Engineering** **NOISE | VIBRATION | ACOUSTICS**
**Howe Gastmeier Chapnik Limited**
**t**: 905.826.4044

## Class/Volume Report Graph

Hi-Star ID: 6033
Street: Bay St.
State: ON
City: Hamilton
Area: btwn. Ferrie St. & Picton St.

Begin: 04/12/2006 12:00 AM
Lane: NB
Operator: MD
Posted Speed: 50
AADT Factor: 1

End: 04/13/2006 12:00 AM
Hours: 24:00
Period: 15
Raw Count: 2622
AADT Count: 2622

| NC97 - Meters | | 0.0 to 4.5 | 5.0 to 8.0 | 8.5 to 9.5 | 10.0 to 12.5 | 13.0 to 15.5 | 16.0 to 18.5 | 19.0 to 22.0 | 22.5 > | |
|---|---|---|---|---|---|---|---|---|---|---|
| 04/12/2006 [12:00 AM-12:15 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 04/12/2006 [12:15 AM-12:30 AM] | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [12:30 AM-12:45 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [12:45 AM-01:00 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 8 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04/12/2006 [01:00 AM-01:15 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [01:15 AM-01:30 AM] | 5 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 04/12/2006 [01:30 AM-01:45 AM] | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [01:45 AM-02:00 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 8 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04/12/2006 [02:00 AM-02:15 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [02:15 AM-02:30 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 04/12/2006 [02:30 AM-02:45 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [02:45 AM-03:00 AM] | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [03:00 AM-03:15 AM] | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 04/12/2006 [03:15 AM-03:30 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [03:30 AM-03:45 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [03:45 AM-04:00 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 7 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 04/12/2006 [04:00 AM-04:15 AM] | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [04:15 AM-04:30 AM] | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [04:30 AM-04:45 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 04/12/2006 [04:45 AM-05:00 AM] | 7 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | 12 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 04/12/2006 [05:00 AM-05:15 AM] | 17 | 15 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| 04/12/2006 [05:15 AM-05:30 AM] | 21 | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 04/12/2006 [05:30 AM-05:45 AM] | 16 | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 04/12/2006 [05:45 AM-06:00 AM] | 18 | 14 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| | 72 | 63 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 72 |
| 04/12/2006 [06:00 AM-06:15 AM] | 14 | 13 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 04/12/2006 [06:15 AM-06:30 AM] | 23 | 22 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 23 |
| 04/12/2006 [06:30 AM-06:45 AM] | 30 | 24 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 30 |
| 04/12/2006 [06:45 AM-07:00 AM] | 37 | 30 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 37 |
| | 104 | 89 | 13 | 1 | 0 | 1 | 0 | 0 | 0 | 104 |
| 04/12/2006 [07:00 AM-07:15 AM] | 50 | 42 | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 50 |
| 04/12/2006 [07:15 AM-07:30 AM] | 43 | 35 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 43 |
| 04/12/2006 [07:30 AM-07:45 AM] | 38 | 31 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| 04/12/2006 [07:45 AM-08:00 AM] | 48 | 42 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 47 |
| | 179 | 150 | 25 | 1 | 0 | 2 | 0 | 0 | 0 | 178 |
| 04/12/2006 [08:00 AM-08:15 AM] | 41 | 36 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 41 |
| 04/12/2006 [08:15 AM-08:30 AM] | 39 | 36 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 39 |
| 04/12/2006 [08:30 AM-08:45 AM] | 53 | 47 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 53 |
| 04/12/2006 [08:45 AM-09:00 AM] | 65 | 56 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 65 |
| | 198 | 175 | 22 | 0 | 0 | 0 | 1 | 0 | 0 | 198 |
| 04/12/2006 [09:00 AM-09:15 AM] | 43 | 39 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 04/12/2006 [09:15 AM-09:30 AM] | 35 | 25 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [09:30 AM-09:45 AM] | 35 | 31 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [09:45 AM-10:00 AM] | 39 | 33 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 39 |
| | 152 | 128 | 22 | 0 | 2 | 0 | 0 | 0 | 0 | 152 |
| 04/12/2006 [10:00 AM-10:15 AM] | 28 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| 04/12/2006 [10:15 AM-10:30 AM] | 38 | 32 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 38 |
| 04/12/2006 [10:30 AM-10:45 AM] | 23 | 18 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 23 |
| 04/12/2006 [10:45 AM-11:00 AM] | 33 | 30 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| | 122 | 108 | 11 | 1 | 2 | 0 | 0 | 0 | 0 | 122 |
| 04/12/2006 [11:00 AM-11:15 AM] | 27 | 21 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 27 |
| 04/12/2006 [11:15 AM-11:30 AM] | 34 | 27 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 34 |
| 04/12/2006 [11:30 AM-11:45 AM] | 29 | 24 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 29 |
| 04/12/2006 [11:45 AM-12:00 PM] | 58 | 51 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 58 |
| | 148 | 123 | 23 | 1 | 1 | 0 | 0 | 0 | 0 | 148 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 04/12/2006 [12:00 PM-12:15 PM] | 53 | 45 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 53 |
| 04/12/2006 [12:15 PM-12:30 PM] | 35 | 33 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [12:30 PM-12:45 PM] | 36 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| 04/12/2006 [12:45 PM-01:00 PM] | 35 | 27 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 35 |
| | 159 | 141 | 16 | 1 | 1 | 0 | 0 | 0 | 0 | 159 |
| 04/12/2006 [01:00 PM-01:15 PM] | 33 | 28 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| 04/12/2006 [01:15 PM-01:30 PM] | 43 | 34 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 04/12/2006 [01:30 PM-01:45 PM] | 38 | 31 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 38 |
| 04/12/2006 [01:45 PM-02:00 PM] | 38 | 35 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| | 152 | 128 | 23 | 1 | 0 | 0 | 0 | 0 | 0 | 152 |
| 04/12/2006 [02:00 PM-02:15 PM] | 39 | 32 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 39 |
| 04/12/2006 [02:15 PM-02:30 PM] | 36 | 30 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| 04/12/2006 [02:30 PM-02:45 PM] | 46 | 40 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 46 |
| 04/12/2006 [02:45 PM-03:00 PM] | 28 | 25 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| | 149 | 127 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 149 |
| 04/12/2006 [03:00 PM-03:15 PM] | 39 | 30 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 04/12/2006 [03:15 PM-03:30 PM] | 48 | 44 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| 04/12/2006 [03:30 PM-03:45 PM] | 58 | 48 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 58 |
| 04/12/2006 [03:45 PM-04:00 PM] | 39 | 35 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| | 184 | 157 | 26 | 1 | 0 | 0 | 0 | 0 | 0 | 184 |
| 04/12/2006 [04:00 PM-04:15 PM] | 65 | 58 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 65 |
| 04/12/2006 [04:15 PM-04:30 PM] | 48 | 43 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| 04/12/2006 [04:30 PM-04:45 PM] | 64 | 58 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 63 |
| 04/12/2006 [04:45 PM-05:00 PM] | 48 | 46 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| | 225 | 205 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 224 |
| 04/12/2006 [05:00 PM-05:15 PM] | 61 | 54 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 61 |
| 04/12/2006 [05:15 PM-05:30 PM] | 65 | 57 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 65 |
| 04/12/2006 [05:30 PM-05:45 PM] | 43 | 40 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 04/12/2006 [05:45 PM-06:00 PM] | 41 | 38 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 41 |
| | 210 | 189 | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 210 |
| 04/12/2006 [06:00 PM-06:15 PM] | 37 | 32 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 37 |
| 04/12/2006 [06:15 PM-06:30 PM] | 37 | 35 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 37 |
| 04/12/2006 [06:30 PM-06:45 PM] | 40 | 34 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 40 |
| 04/12/2006 [06:45 PM-07:00 PM] | 26 | 23 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| | 140 | 124 | 13 | 0 | 2 | 0 | 0 | 0 | 0 | 139 |
| 04/12/2006 [07:00 PM-07:15 PM] | 35 | 28 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 04/12/2006 [07:15 PM-07:30 PM] | 24 | 19 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 24 |
| 04/12/2006 [07:30 PM-07:45 PM] | 24 | 21 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| 04/12/2006 [07:45 PM-08:00 PM] | 17 | 15 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| | 100 | 83 | 15 | 0 | 1 | 0 | 0 | 0 | 0 | 99 |
| 04/12/2006 [08:00 PM-08:15 PM] | 17 | 12 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| 04/12/2006 [08:15 PM-08:30 PM] | 29 | 24 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 29 |
| 04/12/2006 [08:30 PM-08:45 PM] | 23 | 19 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 23 |
| 04/12/2006 [08:45 PM-09:00 PM] | 16 | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| | 85 | 70 | 14 | 0 | 1 | 0 | 0 | 0 | 0 | 85 |
| 04/12/2006 [09:00 PM-09:15 PM] | 20 | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| 04/12/2006 [09:15 PM-09:30 PM] | 21 | 18 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 21 |
| 04/12/2006 [09:30 PM-09:45 PM] | 17 | 15 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| 04/12/2006 [09:45 PM-10:00 PM] | 22 | 20 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| | 80 | 72 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 80 |
| 04/12/2006 [10:00 PM-10:15 PM] | 33 | 29 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| 04/12/2006 [10:15 PM-10:30 PM] | 27 | 26 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 27 |
| 04/12/2006 [10:30 PM-10:45 PM] | 17 | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 04/12/2006 [10:45 PM-11:00 PM] | 9 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| | 86 | 77 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 85 |
| 04/12/2006 [11:00 PM-11:15 PM] | 8 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04/12/2006 [11:15 PM-11:30 PM] | 16 | 13 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 04/12/2006 [11:30 PM-11:45 PM] | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 04/12/2006 [11:45 PM-12:00 AM] | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| | 39 | 33 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| Daily Totals: | 2622 | 2275 | 317 | 10 | 11 | 3 | 1 | 0 | 0 | 2617 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Counted: | 2622 | | 0.0 to 4.5 | 5.0 to 8.0 | 8.5 to 9.5 | 10.0 to 12.5 | 13.0 to 15.5 | 16.0 to 18.5 | 19.0 to 22.0 | 22.5 > | |
| Total Classified: | 2617 | 2622 | 2275 | 317 | 10 | 11 | 3 | 1 | 0 | 0 | 2617 |
| Total UnClassified: | 5 | | | | | | | | | | |
| Report Percentages: | | | 86.93% | 12.11% | 0.38% | 0.42% | 0.11% | 0.04% | 0.00% | 0.00% | |

Peak Time: 04/12/2006 [08:45 AM-09:00 AM]
Peak Count: 65

# Class/Volume Report Graph

Hi-Star ID: 8596
Street: Bay St.
State: ON
City: Hamilton
Area: btwn. Ferrie St. & Picton St.

Begin: 04/12/2006 12:00 AM
Lane: SB
Operator: MD
Posted Speed: 50
AADT Factor: 1

End: 04/13/2006 12:00 AM
Hours: 24:00
Period: 15
Raw Count: 2483
AADT Count: 2483

| NC97 - Meters | | 0.0 to 4.5 | 5.0 to 8.0 | 8.5 to 9.5 | 10.0 to 12.5 | 13.0 to 15.5 | 16.0 to 18.5 | 19.0 to 22.0 | 22.5 > | |
|---|---|---|---|---|---|---|---|---|---|---|
| 04/12/2006 [12:00 AM-12:15 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [12:15 AM-12:30 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 04/12/2006 [12:30 AM-12:45 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [12:45 AM-01:00 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 04/12/2006 [01:00 AM-01:15 AM] | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [01:15 AM-01:30 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [01:30 AM-01:45 AM] | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [01:45 AM-02:00 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 7 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 04/12/2006 [02:00 AM-02:15 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [02:15 AM-02:30 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [02:30 AM-02:45 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [02:45 AM-03:00 AM] | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 04/12/2006 [03:00 AM-03:15 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [03:15 AM-03:30 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [03:30 AM-03:45 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [03:45 AM-04:00 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 04/12/2006 [04:00 AM-04:15 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [04:15 AM-04:30 AM] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/2006 [04:30 AM-04:45 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [04:45 AM-05:00 AM] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 04/12/2006 [05:00 AM-05:15 AM] | 9 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 04/12/2006 [05:15 AM-05:30 AM] | 9 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| 04/12/2006 [05:30 AM-05:45 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 04/12/2006 [05:45 AM-06:00 AM] | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | 24 | 19 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 24 |
| 04/12/2006 [06:00 AM-06:15 AM] | 13 | 9 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 13 |
| 04/12/2006 [06:15 AM-06:30 AM] | 13 | 10 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| 04/12/2006 [06:30 AM-06:45 AM] | 12 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 04/12/2006 [06:45 AM-07:00 AM] | 16 | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| | 54 | 45 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 54 |
| 04/12/2006 [07:00 AM-07:15 AM] | 21 | 16 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 21 |
| 04/12/2006 [07:15 AM-07:30 AM] | 24 | 21 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 24 |
| 04/12/2006 [07:30 AM-07:45 AM] | 31 | 25 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 31 |
| 04/12/2006 [07:45 AM-08:00 AM] | 35 | 31 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| | 111 | 93 | 16 | 1 | 1 | 0 | 0 | 0 | 0 | 111 |
| 04/12/2006 [08:00 AM-08:15 AM] | 35 | 31 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [08:15 AM-08:30 AM] | 38 | 30 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 37 |
| 04/12/2006 [08:30 AM-08:45 AM] | 50 | 43 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 50 |
| 04/12/2006 [08:45 AM-09:00 AM] | 37 | 30 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 37 |
| | 160 | 134 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 159 |
| 04/12/2006 [09:00 AM-09:15 AM] | 24 | 20 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| 04/12/2006 [09:15 AM-09:30 AM] | 31 | 27 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 31 |
| 04/12/2006 [09:30 AM-09:45 AM] | 30 | 28 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 30 |
| 04/12/2006 [09:45 AM-10:00 AM] | 24 | 20 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 23 |
| | 109 | 95 | 12 | 0 | 1 | 0 | 0 | 0 | 0 | 108 |
| 04/12/2006 [10:00 AM-10:15 AM] | 28 | 24 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 28 |
| 04/12/2006 [10:15 AM-10:30 AM] | 29 | 22 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |
| 04/12/2006 [10:30 AM-10:45 AM] | 21 | 17 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 04/12/2006 [10:45 AM-11:00 AM] | 21 | 16 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 21 |
| | 99 | 79 | 17 | 3 | 0 | 0 | 0 | 0 | 0 | 99 |

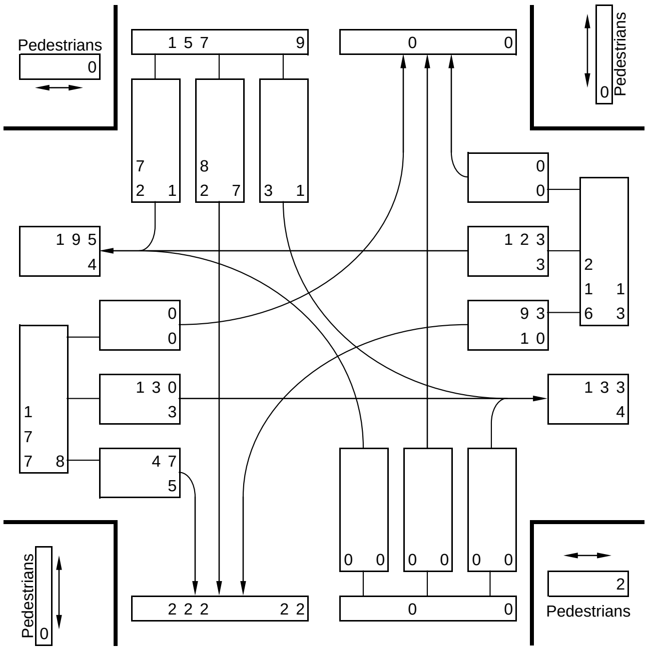
| Interval | Total | 0.0 to 4.5 | 5.0 to 8.0 | 8.5 to 9.5 | 10.0 to 12.5 | 13.0 to 15.5 | 16.0 to 18.5 | 19.0 to 22.0 | 22.5 > | Classified |
|---|---|---|---|---|---|---|---|---|---|---|
| 04/12/2006 [11:00 AM-11:15 AM] | 28 | 27 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| 04/12/2006 [11:15 AM-11:30 AM] | 35 | 30 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [11:30 AM-11:45 AM] | 40 | 30 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| 04/12/2006 [11:45 AM-12:00 PM] | 45 | 40 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 45 |
| | 148 | 127 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 148 |
| 04/12/2006 [12:00 PM-12:15 PM] | 45 | 38 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 45 |
| 04/12/2006 [12:15 PM-12:30 PM] | 34 | 33 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 34 |
| 04/12/2006 [12:30 PM-12:45 PM] | 34 | 28 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 04/12/2006 [12:45 PM-01:00 PM] | 36 | 28 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| | 149 | 127 | 21 | 0 | 0 | 1 | 0 | 0 | 0 | 149 |
| 04/12/2006 [01:00 PM-01:15 PM] | 48 | 35 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| 04/12/2006 [01:15 PM-01:30 PM] | 40 | 28 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 40 |
| 04/12/2006 [01:30 PM-01:45 PM] | 42 | 33 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 42 |
| 04/12/2006 [01:45 PM-02:00 PM] | 33 | 31 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| | 163 | 127 | 34 | 1 | 1 | 0 | 0 | 0 | 0 | 163 |
| 04/12/2006 [02:00 PM-02:15 PM] | 56 | 45 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 56 |
| 04/12/2006 [02:15 PM-02:30 PM] | 35 | 32 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 35 |
| 04/12/2006 [02:30 PM-02:45 PM] | 43 | 31 | 11 | 0 | 0 | 0 | 1 | 0 | 0 | 43 |
| 04/12/2006 [02:45 PM-03:00 PM] | 40 | 32 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 40 |
| | 174 | 140 | 31 | 2 | 0 | 0 | 1 | 0 | 0 | 174 |
| 04/12/2006 [03:00 PM-03:15 PM] | 79 | 69 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 79 |
| 04/12/2006 [03:15 PM-03:30 PM] | 79 | 65 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 78 |
| 04/12/2006 [03:30 PM-03:45 PM] | 69 | 57 | 10 | 1 | 0 | 0 | 0 | 0 | 1 | 69 |
| 04/12/2006 [03:45 PM-04:00 PM] | 57 | 43 | 11 | 1 | 2 | 0 | 0 | 0 | 0 | 57 |
| | 284 | 234 | 43 | 2 | 3 | 0 | 0 | 0 | 1 | 283 |
| 04/12/2006 [04:00 PM-04:15 PM] | 65 | 55 | 8 | 1 | 1 | 0 | 0 | 0 | 0 | 65 |
| 04/12/2006 [04:15 PM-04:30 PM] | 78 | 58 | 15 | 2 | 1 | 0 | 0 | 0 | 0 | 76 |
| 04/12/2006 [04:30 PM-04:45 PM] | 114 | 95 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 114 |
| 04/12/2006 [04:45 PM-05:00 PM] | 75 | 62 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 75 |
| | 332 | 270 | 55 | 3 | 2 | 0 | 0 | 0 | 0 | 330 |
| 04/12/2006 [05:00 PM-05:15 PM] | 80 | 72 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 80 |
| 04/12/2006 [05:15 PM-05:30 PM] | 61 | 54 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 61 |
| 04/12/2006 [05:30 PM-05:45 PM] | 64 | 55 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 64 |
| 04/12/2006 [05:45 PM-06:00 PM] | 51 | 43 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 51 |
| | 256 | 224 | 31 | 1 | 0 | 0 | 0 | 0 | 0 | 256 |
| 04/12/2006 [06:00 PM-06:15 PM] | 46 | 42 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 46 |
| 04/12/2006 [06:15 PM-06:30 PM] | 27 | 22 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 27 |
| 04/12/2006 [06:30 PM-06:45 PM] | 38 | 34 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| 04/12/2006 [06:45 PM-07:00 PM] | 23 | 19 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| | 134 | 117 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 134 |
| 04/12/2006 [07:00 PM-07:15 PM] | 38 | 33 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| 04/12/2006 [07:15 PM-07:30 PM] | 25 | 23 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| 04/12/2006 [07:30 PM-07:45 PM] | 19 | 14 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| 04/12/2006 [07:45 PM-08:00 PM] | 33 | 27 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| | 115 | 97 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 115 |
| 04/12/2006 [08:00 PM-08:15 PM] | 15 | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 04/12/2006 [08:15 PM-08:30 PM] | 16 | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 04/12/2006 [08:30 PM-08:45 PM] | 12 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 04/12/2006 [08:45 PM-09:00 PM] | 16 | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| | 59 | 52 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 59 |
| 04/12/2006 [09:00 PM-09:15 PM] | 14 | 11 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 04/12/2006 [09:15 PM-09:30 PM] | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04/12/2006 [09:30 PM-09:45 PM] | 11 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 04/12/2006 [09:45 PM-10:00 PM] | 12 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| | 45 | 38 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 45 |
| 04/12/2006 [10:00 PM-10:15 PM] | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 04/12/2006 [10:15 PM-10:30 PM] | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 04/12/2006 [10:30 PM-10:45 PM] | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 04/12/2006 [10:45 PM-11:00 PM] | 5 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| | 25 | 23 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| 04/12/2006 [11:00 PM-11:15 PM] | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04/12/2006 [11:15 PM-11:30 PM] | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 04/12/2006 [11:30 PM-11:45 PM] | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 04/12/2006 [11:45 PM-12:00 AM] | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | 23 | 20 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| Daily Totals: | 2483 | 2079 | 372 | 15 | 9 | 1 | 1 | 0 | 1 | 2478 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Counted: | 2483 | | 0.0 to 4.5 | 5.0 to 8.0 | 8.5 to 9.5 | 10.0 to 12.5 | 13.0 to 15.5 | 16.0 to 18.5 | 19.0 to 22.0 | 22.5 > | |
| Total Classified: | 2478 | 2483 | 2079 | 372 | 15 | 9 | 1 | 1 | 0 | 1 | 2478 |
| Total UnClassified: | 5 | | | | | | | | | | |
| Report Percentages: | | | 83.90% | 15.01% | 0.61% | 0.36% | 0.04% | 0.04% | 0.00% | 0.04% | |

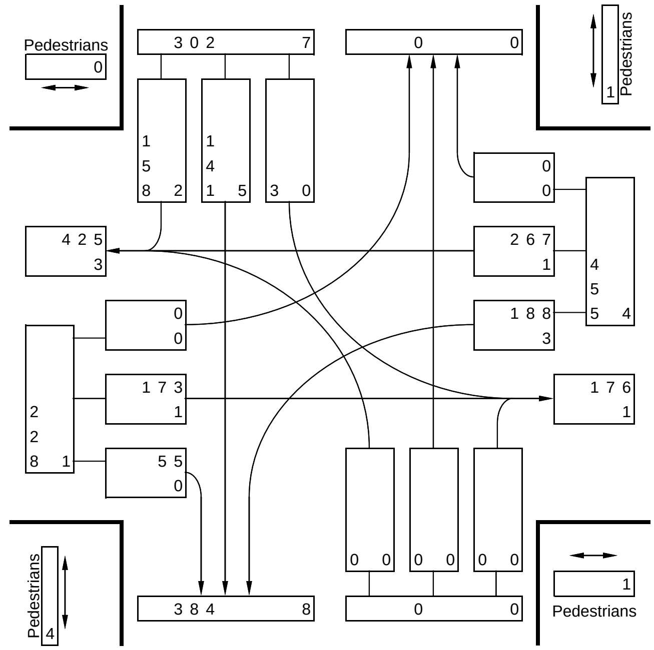
Peak Time: 04/12/2006 [04:30 PM-04:45 PM]
Peak Count: 114

**City of Hamilton** | **T U R N I N G M O V E M E N T F L O W C H A R T** | Loc. Code: 57

Intersection: **Barton St** **at** **Queen St** | Total Vehicles: 4,492 | Date: Monday
Direction: (East/West) (North/South) | M.V.E./Year: 3.085 | Jun 23, 2008
Road Condition: Dry | Weather: Cloudy | AWDT Factor: 2.02 | Period: 7 hours
Comments:

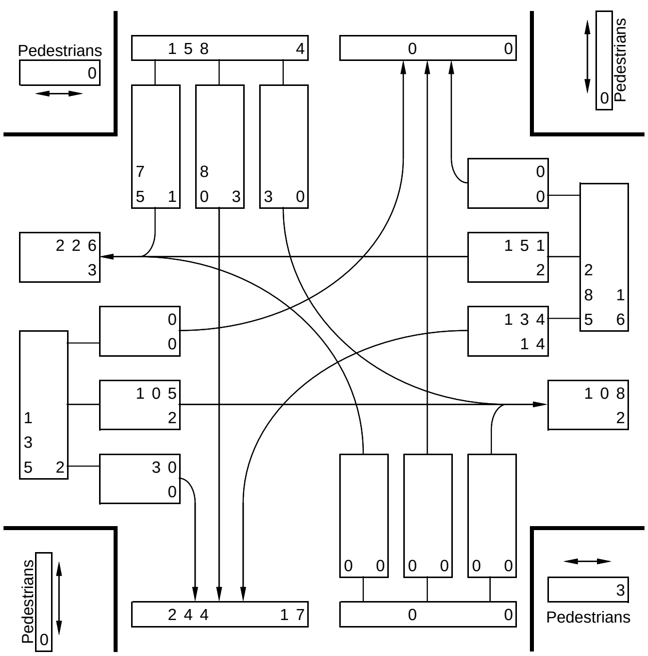



A.M. PEAK HOUR = 8:15 AM - 9:15 AM

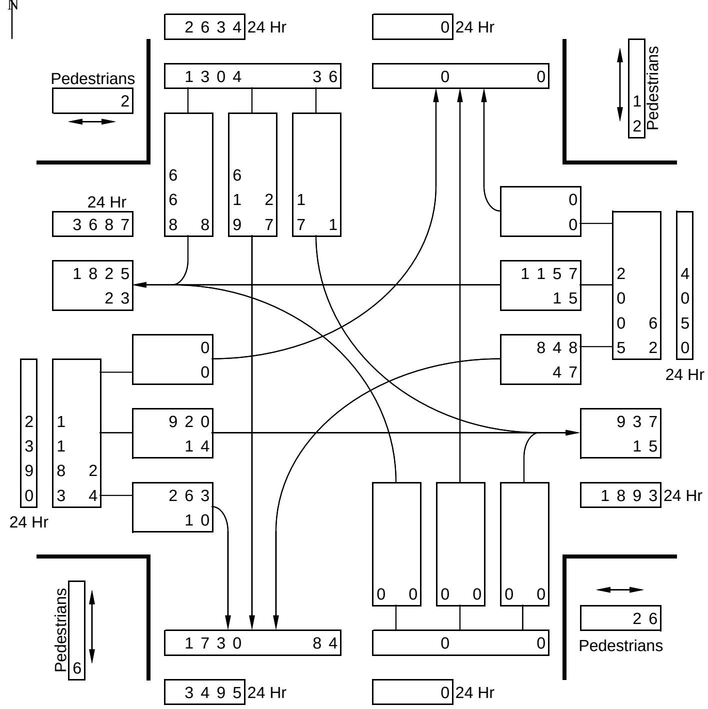



P.M. PEAK HOUR = 4:30 PM - 5:30 PM

N




NORMAL HOUR = 2:00 PM - 3:00 PM

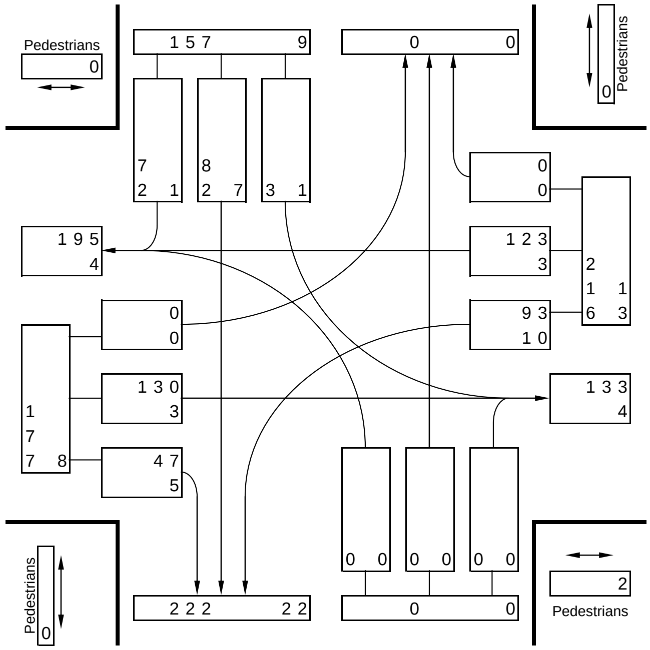



7 Hr & 24 Hr TOTAL VOLUMES

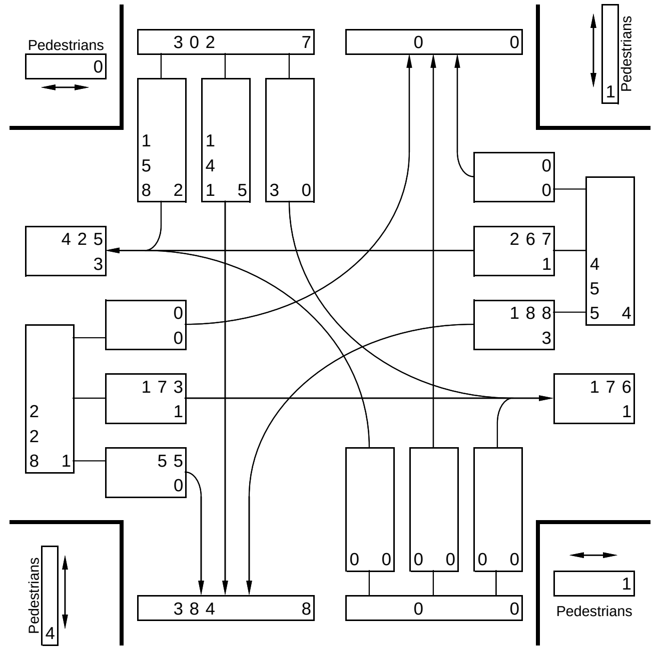
**City of Hamilton** **T U R N I N G   M O V E M E N T   F L O W   C H A R T** Loc. Code: 57

| | | | | | |
|---|---|---|---|---|---|
| Intersection: | **Barton St** | **at** | **Queen St** | Total Vehicles: 4,492 | Date: Monday |
| Direction: | (East/West) | | (North/South) | M.V.E./Year: 3.085 | Jun 23, 2008 |
| Road Condition: Dry | | Weather: Cloudy | | AWDT Factor: 2.02 | Period: 7 hours |

Comments:




A.M. PEAK HOUR = 8:15 AM - 9:15 AM




P.M. PEAK HOUR = 4:30 PM - 5:30 PM

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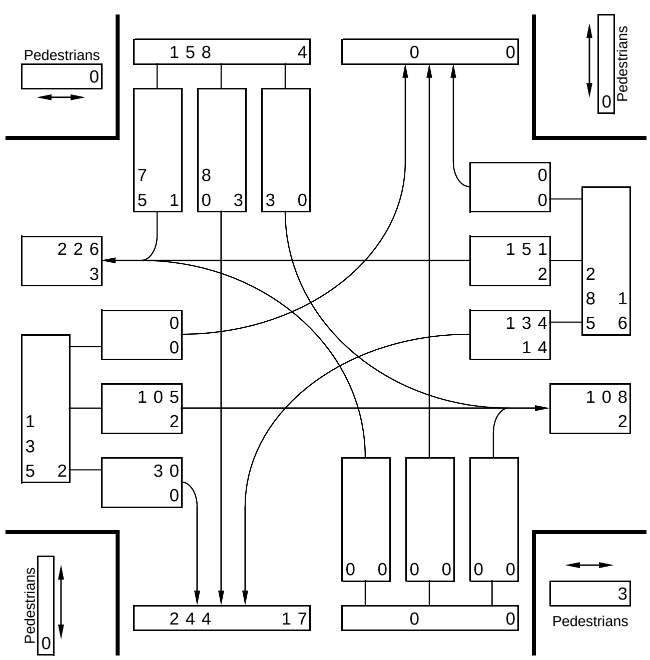
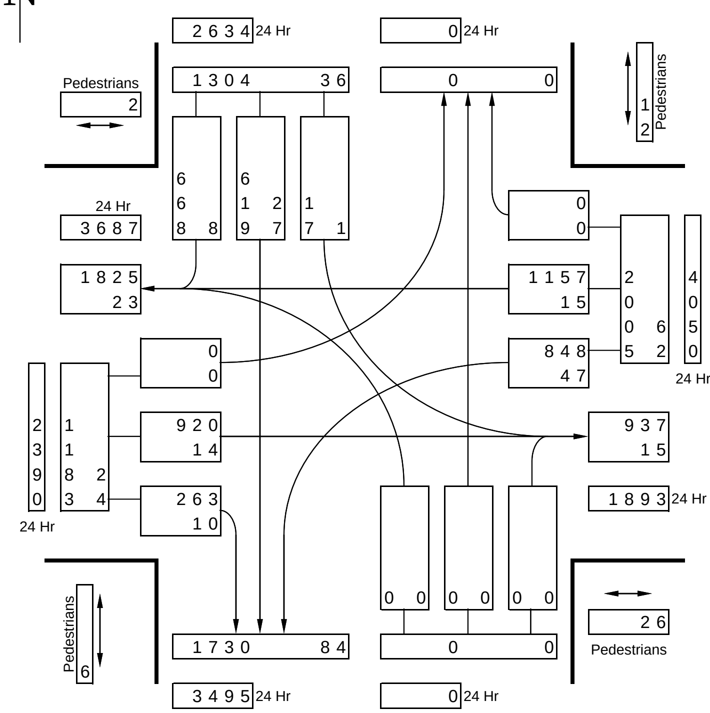



NORMAL HOUR = 2:00 PM - 3:00 PM




7 Hr & 24 Hr TOTAL VOLUMES

```
STAMSON 5.0        SUMMARY REPORT        Date: 30-05-2014 12:49:22
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: a.te                     Time Period: Day/Night 16/8 hours
```
Description: ***Daytime and nighttime sound levels at the South façade, fronting exposure to Barton Street, exposure to Queen Street and partial exposure to the railway***

```
Rail data, segment # 1: CN (day/night)
--------------------------------------
Train             ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type              !             !(km/h) !/Train!/Train! type !weld
-----------------+------------+------+-----+-----+-----+---
  1. Freight     !   5.0/0.0   !  24.0 !  4.0 !140.0 !Diesel!  No
  2. Way Freight !   0.0/0.0   !  24.0 !  2.0 !  0.0 !Diesel!  No
  3. Passenger   !   3.0/0.0   !  24.0 !  2.0 ! 10.0 !Diesel!  No

Data for Segment # 1: CN (day/night)
------------------------------------
Angle1   Angle2           : -90.00 deg   -45.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 250.00 / 250.00 m
Receiver height           :   1.50 / 1.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :  16.00 m
Reference angle           :   0.00

Rail data, segment # 2: SOR (day/night)
---------------------------------------
Train             ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type              !             !(km/h) !/Train!/Train! type !weld
-----------------+------------+------+-----+-----+-----+---
  1. Freight     !  10.0/4.0   !  24.0 !  2.0 ! 80.0 !Diesel!  No

Data for Segment # 2: SOR (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   -45.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 250.00 / 250.00 m
Receiver height           :   1.50 / 1.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :  16.00 m
Reference angle           :   0.00

Rail data, segment # 3: GO (day/night)
--------------------------------------
Train             ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type              !             !(km/h) !/Train!/Train! type !weld
```

```
----------------+-----------+------+-----+-----+-----+---
  1. GO          !  10.0/2.0   !  24.0 !  1.0 ! 12.0 !Diesel!  No

Data for Segment # 3: GO (day/night)
------------------------------------
Angle1   Angle2           : -90.00 deg   -45.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 250.00 / 250.00 m
Receiver height           :   1.50 / 1.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :  16.00 m
Reference angle           :   0.00

Result summary (day)
--------------------

                    !   Loc    !  Wheel   ! Whistle  ! Whistle  !  Total
                    !   Leq    !   Leq    ! Left Leq ! Right Leq!   Leq
                    !  (dBA)   !  (dBA)   !  (dBA)   !  (dBA)   !  (dBA)
--------------------+---------+---------+---------+---------+---------
 1.CN               !    45.48 !    36.43 !       -- !       -- !
45.99 *
 2.SOR              !    45.79 !    36.78 !       -- !       -- !
46.30 *
 3.GO               !    38.58 !    28.78 !       -- !       -- !
39.01 *
--------------------+---------+---------+---------+---------+---------
                      Total
49.56 dBA

  * Bright Zone  !

Result summary (night)
----------------------

                    !   Loc    !  Wheel   ! Whistle  ! Whistle  !  Total
                    !   Leq    !   Leq    ! Left Leq ! Right Leq!   Leq
                    !  (dBA)   !  (dBA)   !  (dBA)   !  (dBA)   !  (dBA)
--------------------+---------+---------+---------+---------+---------
 1.CN               !     0.00 !     0.00 !       -- !       -- !
0.00 *
 2.SOR              !    44.82 !    35.81 !       -- !       -- !
45.33 *
 3.GO               !    34.60 !    24.80 !       -- !       -- !
35.03 *
--------------------+---------+---------+---------+---------+---------
                      Total
45.72 dBA

  * Bright Zone  !
```

```
Road data, segment # 1: Barton St W (day/night)
-----------------------------------------------
Car traffic volume  :  8064/896   veh/TimePeriod  *
Medium truck volume :   100/11    veh/TimePeriod  *
Heavy truck volume  :   158/18    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   6077
    Percentage of Annual Growth        :   2.50
    Number of Years of Growth          :  17.00
    Medium Truck % of Total Volume     :   1.20
    Heavy Truck  % of Total Volume     :   1.90
    Day (16 hrs) % of Total Volume     :  90.00

Data for Segment # 1: Barton St W (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      3       (Elevated; no barrier)
Elevation                 :  16.00 m
Reference angle           :   0.00

Road data, segment # 2: Queen St (day/night)
--------------------------------------------
Car traffic volume  :  5668/630   veh/TimePeriod  *
Medium truck volume :    64/7     veh/TimePeriod  *
Heavy truck volume  :    99/11    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   3495
    Percentage of Annual Growth        :   2.50
    Number of Years of Growth          :  25.00
    Medium Truck % of Total Volume     :   1.10
    Heavy Truck  % of Total Volume     :   1.70
    Day (16 hrs) % of Total Volume     :  90.00

Data for Segment # 2: Queen St (day/night)
------------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
```

Receiver source distance : 30.00 / 30.00 m
Receiver height : 1.50 / 1.50 m
Topography : 3 (Elevated; no barrier)
Elevation : 16.00 m
Reference angle : 0.00

Result summary (day)

| | source height (m) | Road Leq (dBA) | Total Leq (dBA) |
|---|---|---|---|
| 1.Barton St W | 1.17 | 62.43 | 62.43 |
| 2.Queen St | 1.14 | 52.01 | 52.01 |
| Total | | | 62.81 dBA |

Result summary (night)

| | source height (m) | Road Leq (dBA) | Total Leq (dBA) |
|---|---|---|---|
| 1.Barton St W | 1.18 | 55.95 | 55.95 |
| 2.Queen St | 1.14 | 45.47 | 45.47 |
| Total | | | 56.32 dBA |

TOTAL Leq FROM ALL SOURCES (DAY): 63.01
(NIGHT): 56.68

# APPENDIX D

Proposed GO Transit Station Facility

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

## GENERAL NOTES:

1. THE CONTRACTOR MUST MAKE CAREFUL EXAMINATION OF EXISTING SITE SURFACE CONDITIONS AND TOPOGRAPHY AND ADVISE THE CONSULTING LANDSCAPE ARCHITECT OF UNSATISFACTORY SITE SURFACE CONDITIONS AND TOPOGRAPHY PRIOR TO COMMENCEMENT OF CONSTRUCTION. COMMENCEMENT OF CONSTRUCTION WILL MEAN THAT THE CONTRACTOR HAS ACCEPTED THE EXISTING SITE SURFACE CONDITIONS AND TOPOGRAPHY AND NO ALLOWANCE WILL BE MADE LATER FOR ANY EXPENSES INCURRED THROUGH FAILURE TO NOTE UNSATISFACTORY CONDITIONS.

2. DO NOT SCALE DRAWINGS. CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS AND CONDITIONS ON THE JOB AND THE LANDSCAPE ARCHITECT SHALL BE INFORMED OF ANY VARIATIONS FROM THE DIMENSIONS AND CONDITIONS SHOWN ON THE DRAWING PRIOR TO CONTINUING WITH THE WORK.

3. ALL WORKMANSHIP TO CONFORM WITH THE STANDARDS OF THE ONTARIO LANDSCAPE CONTRACTOR'S ASSOCIATION AND LANDSCAPE ONTARIO'S SPECIFICATION STANDARDS.

4. CONSTRUCTION ACCESS AND STAGING AREAS TO BE DETERMINED AT PRECONSTRUCTION MEETING.

5. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH PROJECT SPECIFICATIONS.

6. THE CONTRACTOR IS TO ENSURE THAT THERE IS NO PUBLIC ACCESS THROUGH THE DESIGNATED CONSTRUCTION AREA DURING THE ENTIRE CONSTRUCTION PERIOD.

7. THE CONTRACTOR SHALL INFORM ITSELF, BEFORE TENDERING, OF ALL ADMINISTRATIVE PRACTICES REQUIRED AND SHALL ENSURE THE SAFETY OF EMPLOYEES AND THE GENERAL PUBLIC AT ALL TIMES. SAFETY MEASURES TO BE UNDERTAKEN BY THE CONTRACTOR SHALL INCLUDE BUT NOT BE LIMITED TO THE ERECTION AND MAINTENANCE OF TEMPORARY FENCING AND WARNING SIGNAGE AS PER DRAWINGS AND WHEREVER ELSE REQUIRED TO ENSURE PUBLIC SAFETY, RESTRICT ENTRY TO CONSTRUCTION AREAS, STAGING AREAS AND EQUIPMENT, AND TO PROTECT AREAS THAT ARE TO REMAIN UNCHANGED. SAFETY MEASURES SHALL REMAIN IN PLACE UNTIL THE CONSTRUCTION AREAS ARE SAFE FOR PUBLIC USE.

8. THE CONTRACTOR HAS TO ENSURE THAT THERE IS NO MUD TRACKING FROM VEHICLES LEAVING THE CONSTRUCTION SITE.

9. THE CONTRACTOR WILL ARRANGE AND PAY FOR ALL STAKEOUTS TO LOCATE ALL EXISTING BURIED SERVICES. HAND DIG WITHIN 2 METRES OF ALL SERVICES ON ALL SIDES TO ALLOW ACCESS TO SERVICES.

10. THE CONTRACTOR WILL CLEAN AND REINSTATE ALL AREAS AFFECTED BY WORKS OUTSIDE OF THE CONSTRUCTION ZONES TO CONDITIONS THAT EXISTED BEFORE CONSTRUCTION OR BETTER AND TO THE SATISFACTION OF THE CITY AND AT THE EXPENSE OF THE CONTRACTOR.

11. WARRANTY INSPECTION TO OCCUR AFTER THE 1st YEAR ON ALL WORK. DEPENDING ON THE NATURE OF REPLACEMENTS REQUIRED, EXTENDED WARRANTIES MAY APPLY. REPLACEMENTS SHALL BE MADE WITHIN 30 DAYS FROM THE DATE OF INSPECTION UNLESS OTHERWISE DIRECTED BY THE CITY.

## LAYOUT NOTES:

1. THE CONTRACTOR IS RESPONSIBLE TO ACCURATELY SURVEY AND LAYOUT THE PROPOSED WORK FOR CONSTRUCTION. ANY DISTURBED OR LOST SURVEY MARKERS TO BE REPLACED, AS REQUIRED, BY THE CONTRACTOR. THE CONTRACTOR IS RESPONSIBLE TO VERIFY GRADES, LINES, LEVELS, DIMENSIONS AND EXISTING CONDITIONS, AND REPORT ANY ERRORS, OMISSIONS, OR INCONSISTENCIES TO THE LANDSCAPE ARCHITECT BEFORE COMMENCING WORK.

2. ALL SITE DIMENSIONS IN METRES UNLESS OTHERWISE NOTED.

3. THE CONTRACTOR TO BE RESPONSIBLE FOR COORDINATING HOSE BIB FOR MANUAL IRRIGATION.

4. SEE ARCHITECTURAL DRAWINGS FOR BUILDING LAYOUT.

5. SEE ARCHITECTURAL SITE PLAN FOR ADDITIONAL SITE INFO.

6. SEE CIVIL DRAWINGS FOR REMOVALS AND PROPOSED SITE SERVICING INFO.

7. SEE ELECTRICAL DRAWINGS FOR LIGHTING INFO.

## GRADING NOTES:

1. SEE CIVIL DRAWINGS FOR GRADING INFO.

2. ALL GRADES NOT TO EXCEED 3:1 SLOPE.

3. CONTRACTOR IS RESPONSIBLE FOR STRIPPING AND REPLACING TOPSOIL SHOUD THE DESIRABLE BLEND NOT BE AVAILABLE TO BE CREATED ON-SITE.

4. TO MEET FIELD CONDITIONS OR TO ENHANCE THE CHARACTER OF THE GRADING DESIRED, THE CONTRACTOR MAY BE REQUIRED TO ADJUST PROPOSED GRADES OR CUT-FILL QUANTITIES AS DIRECTED BY THE LANDSCAPE ARCHITECT. THE LANDSCAPE ARCHITECT MAY DIRECT ON-SITE CHANGES TO THE FINE GRADING TO SUIT ACTUAL FIELD CONDITIONS AND TO ACHIEVE ARTISTIC INTENT. SUCH CHANGES SHALL BE DONE AT NO INCREASE IN PRICE TO THE CONTRACT. GRADING OPERATIONS TO BALANCE CUT AND FILL VOLUMES.

5. CONTRACTOR TO SOD AND MAKE GOOD ALL DISTURBED AREAS.

## PLANTING NOTES:

1. THE CONTRACTOR IS RESPONSIBLE TO VERIFY GRADES, LINES, LEVELS, DIMENSIONS AND EXISTING CONDITIONS, AND REPORT ANY ERRORS, OMISSIONS, OR INCONSISTENCIES TO THE LANDSCAPE ARCHITECT BEFORE COMMENCING WORK.

2. QUANTITIES NOTED WITHIN THE PLAN SUPERSEDE THOSE IN THE PLANT SCHEDULE.

3. ANY SUBSTITUTIONS ARE TO BE APPROVED IN WRITING BY THE LANDSCAPE ARCHITECT.

4. ALL NURSERY STOCK SHALL MEET STANDARDS OF THE CANADIAN NURSERY TRADES ASSOCIATION, LATEST EDITION. ALL PLANT MATERIAL SHALL BE STAKED FOR LOCATION BY LANDSCAPE ARCHITECT AND CONTRACTOR JOINTLY.

5. UNLESS OTHERWISE STATED, ALL WORK SHALL CONFORM TO THE LANDSCAPE ONTARIO SPECIFICATIONS STANDARDS.

6. CONTRACTOR IS REQUIRED TO NOTIFY LANDSCAPE ARCHITECT AND OBTAIN APPROVAL FOR ALL PLANT MATERIALS AT NURSERY PRIOR TO DELIVERY ON SITE.

7. AN INSPECTION TO APPROVE PLANT MATERIAL AND LOCATIONS WILL OCCUR PRIOR TO INSTALLATION. CONTRACTOR TO PROVIDE 48 HOURS NOTIFICATION TO LANDSCAPE ARCHITECT.

8. PLANTINGS MAY BE MINIMALLY ADJUSTED TO SUIT LOCATIONS OF SITE UTILITY STRUCTURES OR SERVICES.

9. BACKFILL IN ALL PLANTING AREAS TO CONSIST OF SOIL NATIVE TO THE SITE OR GENERAL SOIL TYPE/CLASS NATIVE TO THE SITE UNLESS OTHERWISE DETAILED OR SPECIFIED.

10. SOD ALL AREAS SHOWN ON DRAWINGS WITHIN THE CONSTRUCTION LIMITS NOT COVERED BY VEGETATION, PAVING OR STRUCTURES. SODDED AREAS TO BE LAID ON MINIMUM 100mm CLEAN TOPSOIL. IT IS TO THE BENEFIT OF THE CONTRACTOR TO PRESERVE ALL EXISTING SOD THAT IS IN GOOD CONDITION AND NOT IN CONFLICT WITH CONSTRUCTION.

11. CONTRACTOR SHALL MAINTAIN ALL AREAS OF PROJECT UNTIL SUBSTANTIAL COMPLETION OF PROJECT.

12. THE CONTRACTOR AGREES TO CONTACT THE COMMUNITY SERVICES DEPARTMENT AT (905) 896-5382, 24 TO 48 HOURS PRIOR TO THE DELIVERY OF ALL TREES, SHRUBS, GROUNDCOVERS AND ORNAMENTAL GRASSES TO BE PLANTED ON THE MUNICIPAL BOULEVARD TO ARRANGE FOR INSPECTION AND ACCEPTANCE OF PLANT MATERIAL BY THE COMMUNITY SERVICES DEPARTMENT ON ARRIVAL.

13. THE CONTRACTOR AGREES TO INSURE PROPER MAINTENANCE OF THE INSTALLED PLANT MATERIAL THROUGHOUT THE DURATION OF THE 1 YEAR WARRANTY PERIOD, THAT COMMENCES UPON PROVISION OF PRELIMINARY ACCEPTANCE LETTER BY THE COMMUNITY SERVICES DEPARTMENT. ALL WATERING, FERTILIZING AND PRUNING TO BE CARRIED OUT TO THE SATISFACTION OF THE COMMUNITY SERVICES DEPARTMENT.

14. PRIOR TO THE CITY'S PRELIMINARY ACCEPTANCE OF THE BOULEVARD PLANTING AND REDUCTION OF SECURITIES, THE CONSULTING LANDSCAPE ARCHITECT IS TO PROVIDE THE CITY WITH A STAMPED CERTIFICATE STATING THAT ALL WORKS HAVE BEEN INSTALLED AS PER THE APPROVED PLANS AND HAVE BEEN INSPECTED/ APPROVED BY THE LANDSCAPE ARCHITECT DURING THE INSTALLATION.

15. AT THE TIME OF FINAL INSPECTION ALL PLANT MATERIAL SHALL BE IN A HEALTHY, VIGOROUS GROWING CONDITION, PLANTED IN FULL ACCORDANCE WITH DRAWINGS AND CONDITIONS.

## CONTENTS:



## LEGEND:

- PROPERTY LINE
- DECORATIVE METAL FENCE CLEAR VU OR APPROVED EQUAL
- BUILDING ENTRANCE/EXIT (PEDESTRIAN OR VEHICULAR)
- DECIDUOUS TREE
- CONIFEROUS TREE
- LARGE MULTI-STEM SHRUB
- SMALL SHRUBS
- PERENNIAL/ORNAMENTAL GRASSES
- VINE
- SOD
- "NOMOWGRASS"
- PLANT KEY
- PRE-CAST CONC. PLANTER WALL
- C.I.P. CONC. WALL WITH CORTEN STEEL CLADDING
- C.I.P. CONCRETE PAVING
- C.I.P. CONCRETE PAVING BANDS
- EX. C.I.P. CONCRETE PAVING TO REMAIN
- UNIT PAVERS - 300x600 RUNNING BOND
- UNIT PAVERS - RANDOM
- RECYCLED GLASS PAVING
- POROUS CONCRETE PAVING
- BENCH - EP 1901 BY EQUIPARC SEE L-502
- CUSTOM BENCH - SEE L-502
- CUSTOM BENCH - SEE L-501
- CUSTOM BENCH - SEE L-502
- TRASH/RECYCLING RECEPTACLE


METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
|---|---|---|---|---|---|---|
| | | 2 | 13.09.06 | ISSUED FOR 95% SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

| | |
|---|---|
| DRAWN BY: J.C.M. 13/07.04 | DESIGNED BY: J.C.M. 13/07/04 |
| CHECKED BY: N.K. 13/07/12 | APPROVED BY: T.M. 13/07/12 |
| SCALE: | FULL SIZE ONLY |


IBI GROUP ARCHITECTS
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Fax: (416) 596-0644


A Division of METROLINX

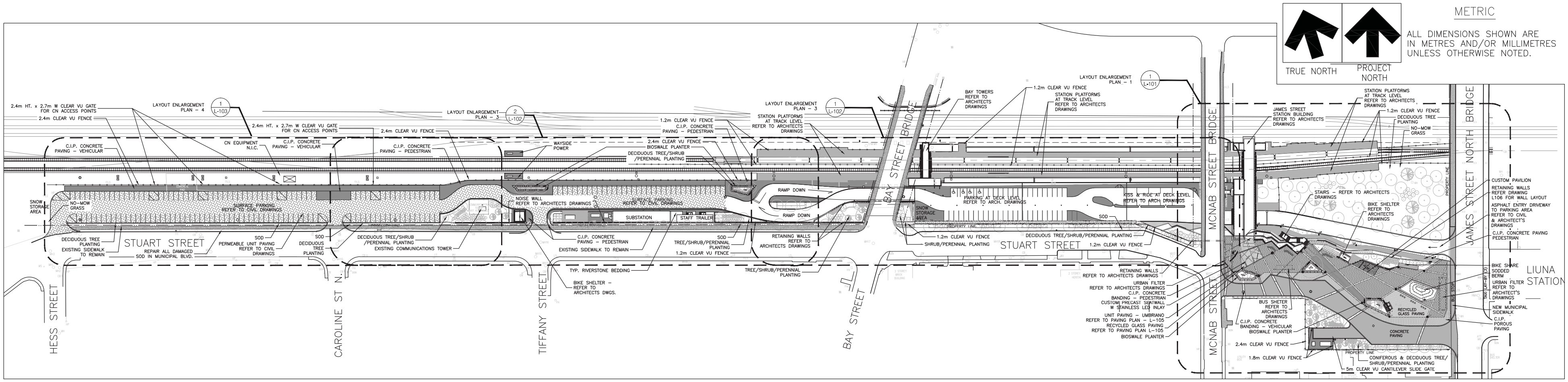
# JAMES STREET NORTH
## NEW STATION & LAYOVER FACILITY
LANDSCAPE
COVER PAGE

| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-000 | | 1/15 |

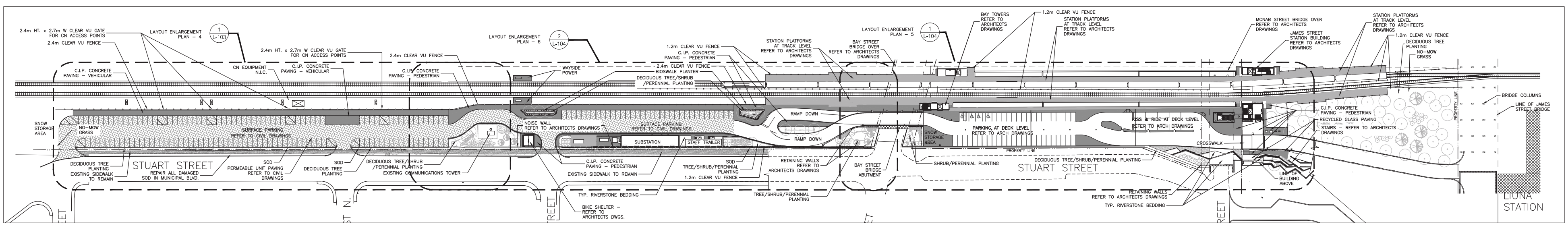
METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

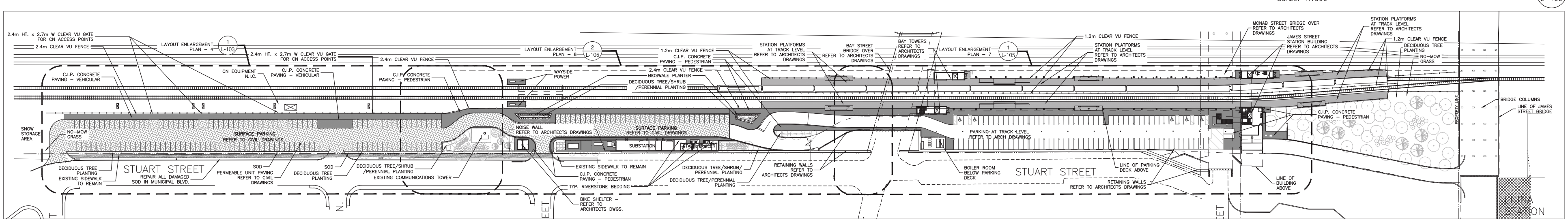
TRUE NORTH | PROJECT NORTH




OVERALL LANDSCAPE @ PLAZA LEVEL (1 / L-100)
SCALE: 1:1000




OVERALL LANDSCAPE @ DECK LEVEL (2 / L-100)
SCALE: 1:1000




OVERALL LANDSCAPE @ PLATFORM LEVEL (3 / L-100)
SCALE: 1:1000

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
|---|---|---|---|---|---|---|
| | | 2 | 13.09.06 | 95% DESIGN SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

DRAWN BY: J.C.M. 13/09/06
DESIGNED BY: J.C.M.
CHECKED BY: N.K.
APPROVED BY:
SCALE: FULL SIZE ONLY

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5th Floor, 230 Richmond Street West
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Fax: (416) 596-0644

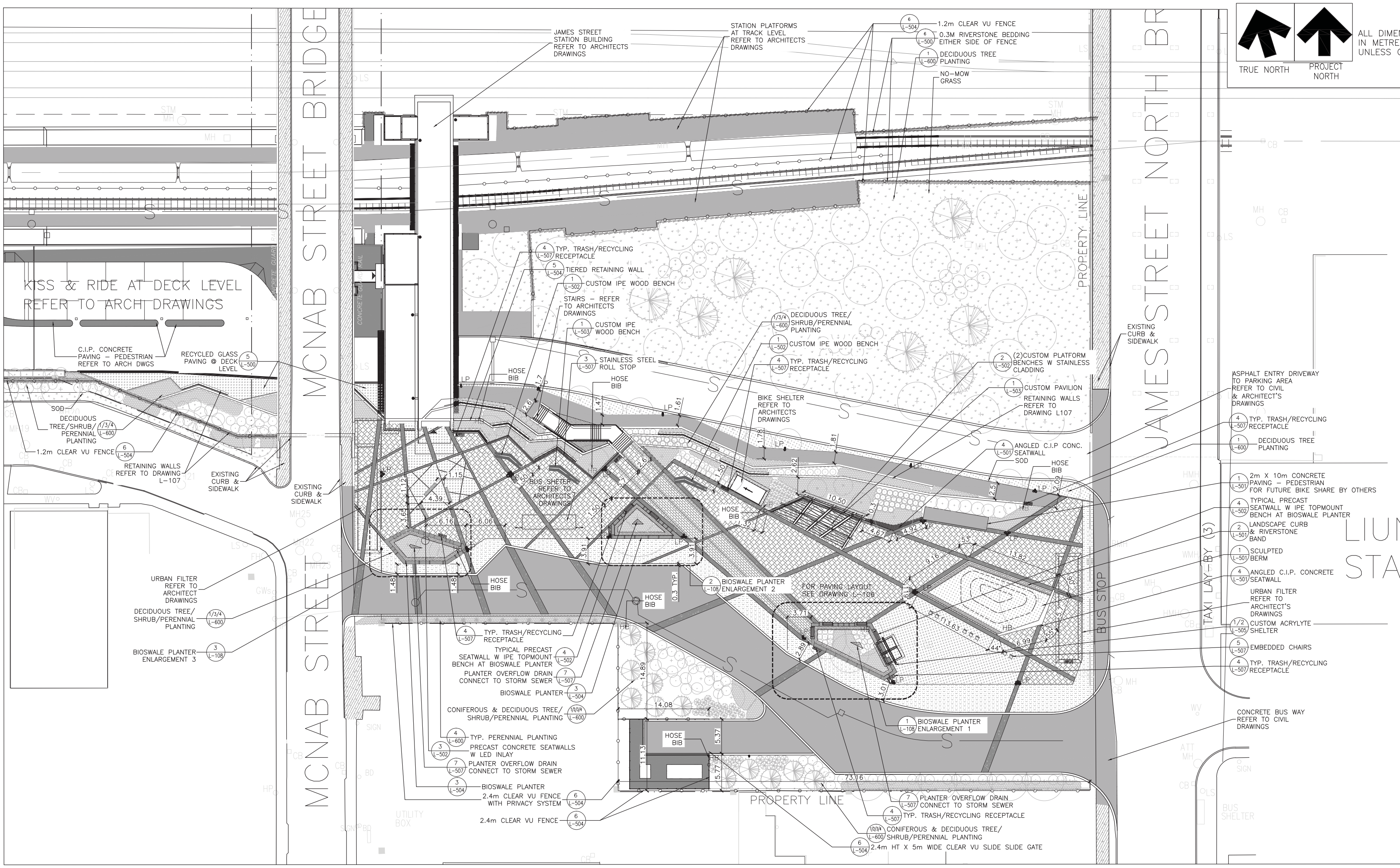
A Division of METROLINX

# JAMES STREET NORTH
## NEW STATION & LAYOVER FACILITY
OVERALL LANDSCAPE PLAN

| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-100 | | |

METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.




ENLARGEMENT @ PLAZA LEVEL (1 / L-101)
SCALE: 1:300

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
|---|---|---|---|---|---|---|
| | | 2 | 13.09.06 | 95% DESIGN SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

DRAWN BY: J.C.M. 13/09/06
DESIGNED BY: J.C.M.
CHECKED BY: N.K.
APPROVED BY:
SCALE: FULL SIZE ONLY

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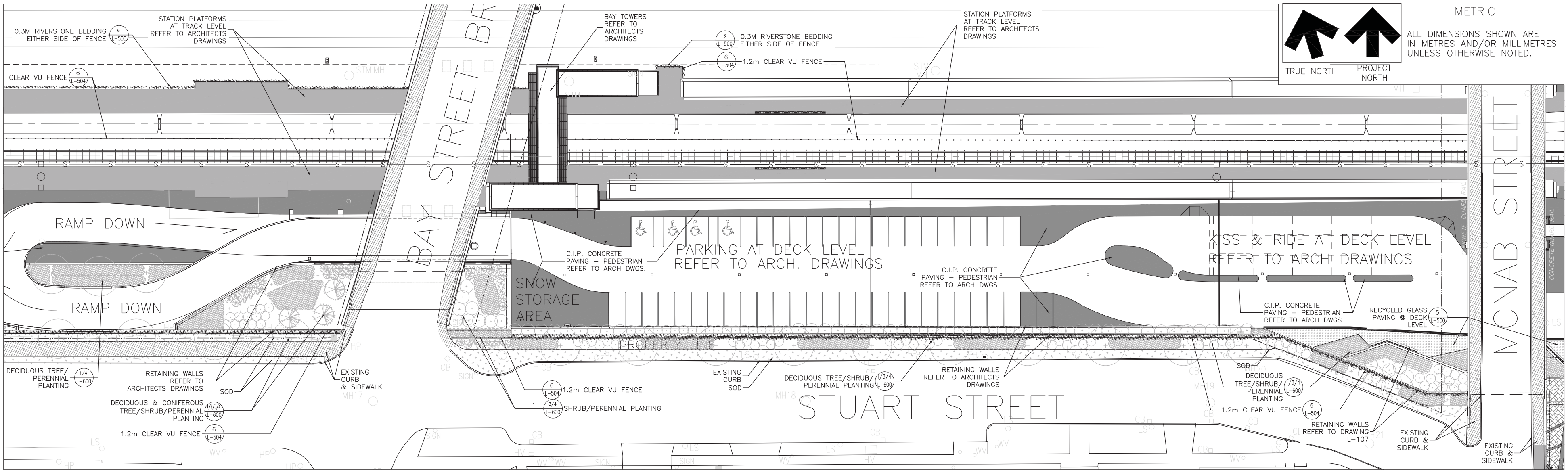
A Division of METROLINX

# JAMES STREET NORTH
## NEW STATION & LAYOVER FACILITY
ENLARGEMENT @ PLAZA LEVEL
LAYOUT & MATERIALS PLAN

CONTRACT NO. IT-2013-S1-057
DWG. NO. L-101
REV.
SHEET




ENLARGEMENT @ PLAZA LEVEL 1 (1/L-102)
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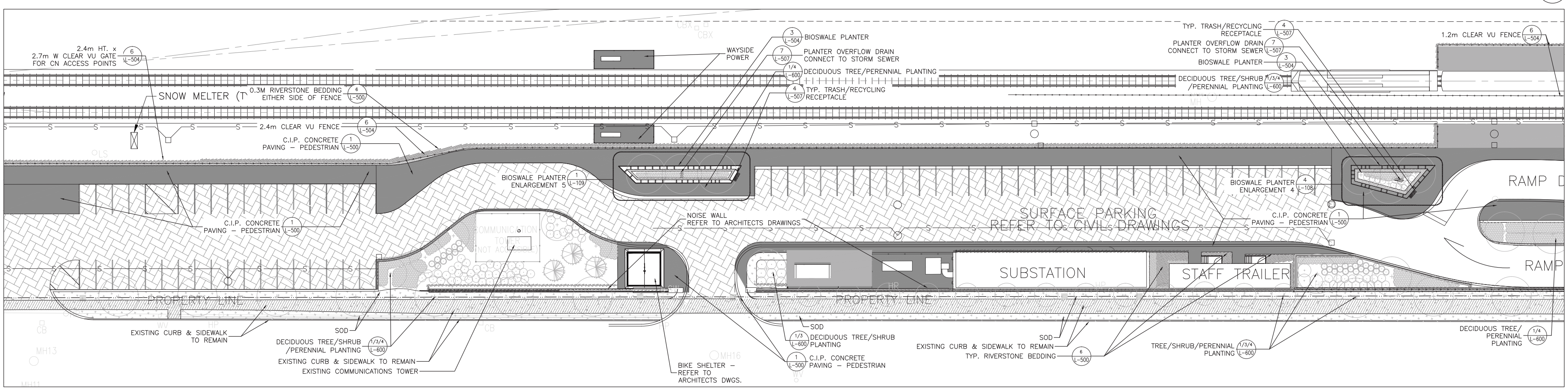



ENLARGEMENT @ PLAZA LEVEL 2 (2/L-102)
SCALE: 1:300

METRIC
ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

TRUE NORTH / PROJECT NORTH

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
|---|---|---|---|---|---|---|
| | | 2 | 13.09.06 | 95% DESIGN SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

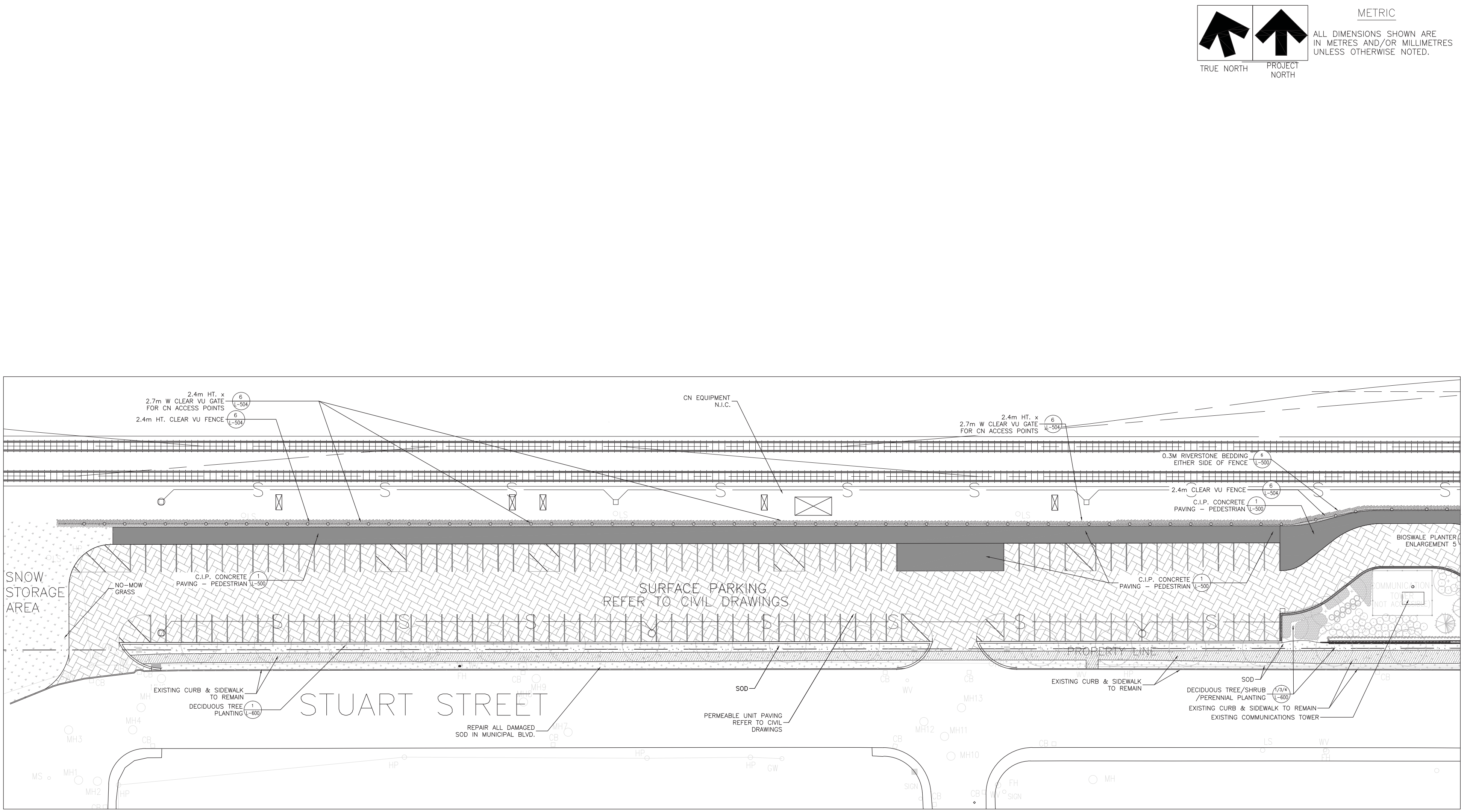
DRAWN BY: J.C.M. 13/09/06
DESIGNED BY: J.C.M.
CHECKED BY: N.K.
APPROVED BY:
SCALE: FULL SIZE ONLY

IBI GROUP ARCHITECTS
Architects, Engineers, Planners
5th Floor, 230 Richmond Street West
Toronto, ON
M5V 1V6, Canada
Tel (416) 596-1930
Fax (416) 596-0644

A Division of METROLINX

# JAMES STREET NORTH
## NEW STATION & LAYOVER FACILITY
ENLARGEMENTS AT DECK LEVEL
LAYOUT & MATERIALS PLAN

| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-102 | | |




METRIC

ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED.

ENLARGEMENT @ WEST END (1 / L-103)
SCALE: 1:300

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
|---|---|---|---|---|---|---|
| | | 2 | 13.09.06 | 95% DESIGN SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

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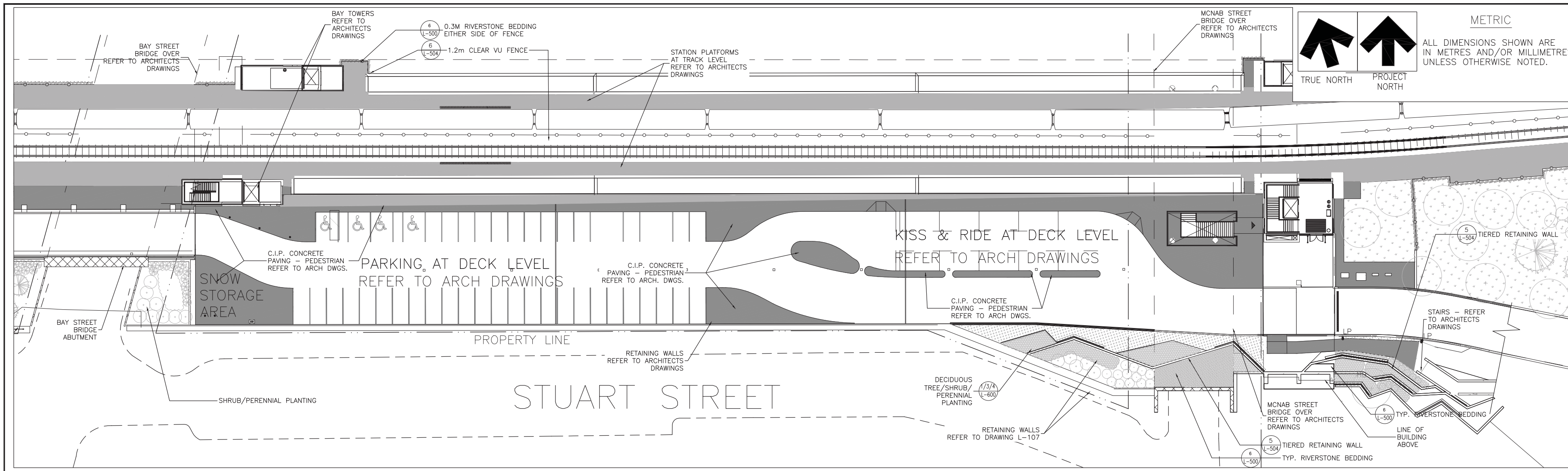
## NEW STATION & LAYOVER FACILITY
ENLARGEMENT AT WEST END
LAYOUT & MATERIALS PLAN

| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-103 | | |




ENLARGEMENT @ DECK LEVEL 1 (1 / L-104)
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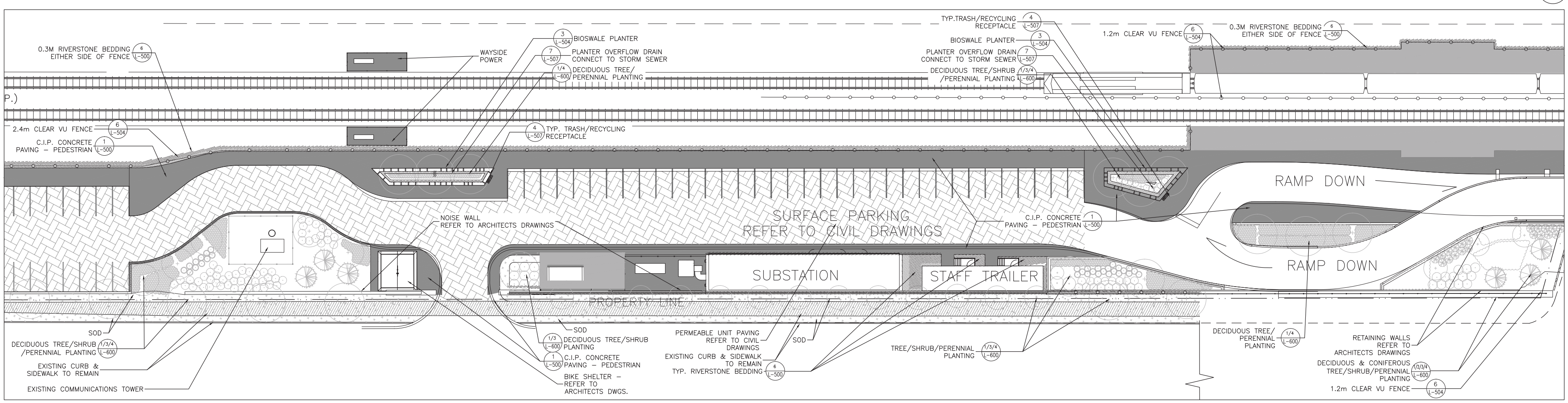


ENLARGEMENT @ DECK LEVEL 2 (2 / L-104)
SCALE: 1:300

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | | |
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| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | | |
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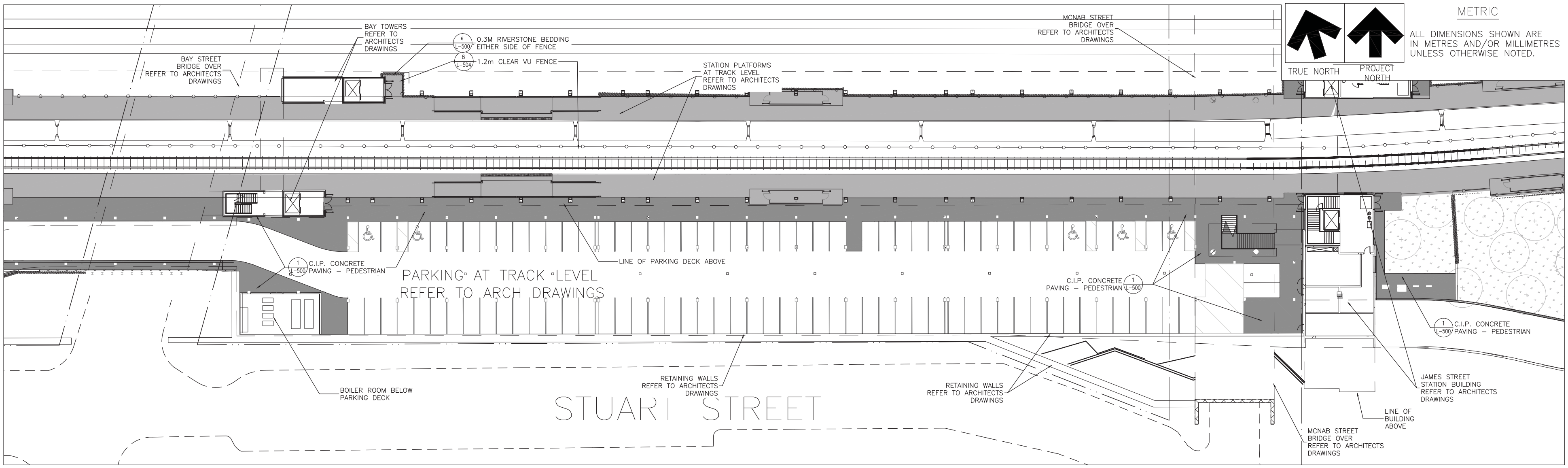
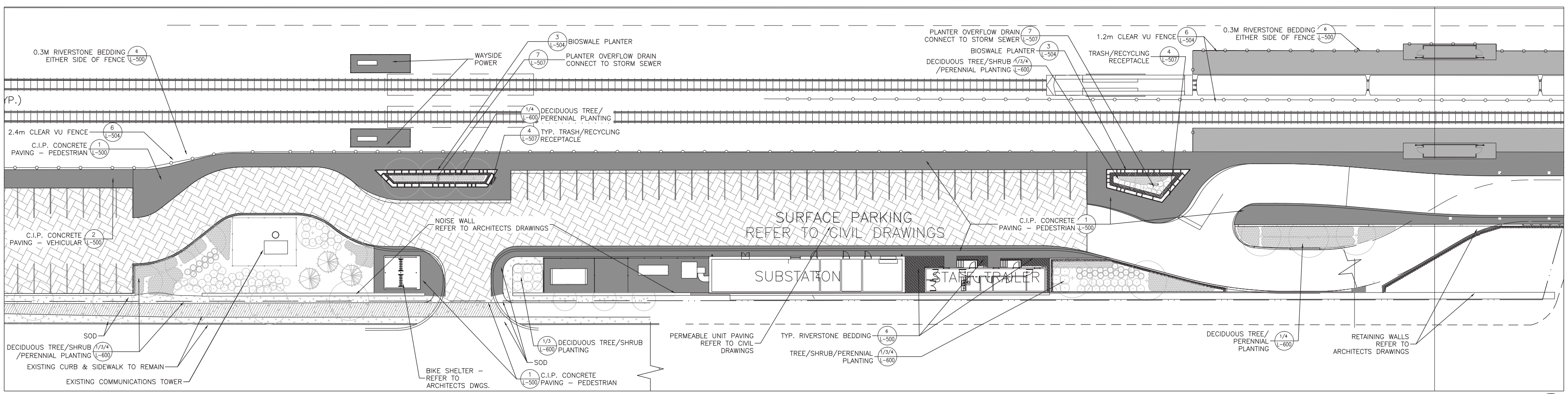
| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-104 | | |




ENLARGEMENT @ TRACK LEVEL 1 (1/L-105)
SCALE: 1:300




ENLARGEMENT @ TRACK LEVEL 2 (2/L-105)
SCALE: 1:300

METROLINX PROJECT NO.

| REFERENCE DRAWINGS | | ISSUE | | | REVISIONS | |
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| | | 2 | 13.09.06 | 95% DESIGN SUBMISSION | | |
| | | 1 | 13.07.12 | ISSUED FOR 50% SUBMISSION | | |
| DWG NO. | TITLE | NO. | DATE | ISSUED FOR | REV. | DATE |

DRAWN BY: J.C.M. 13/09/06
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CHECKED BY: N.K.
APPROVED BY:
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## NEW STATION & LAYOVER FACILITY
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LAYOUT & MATERIALS PLAN

| CONTRACT NO. | DWG. NO. | REV. | SHEET |
|---|---|---|---|
| IT-2013-S1-057 | L-105 | | |

# APPENDIX E

Sound Level Contours Resulting from Activities at West End of Stuart Street Rail Yard

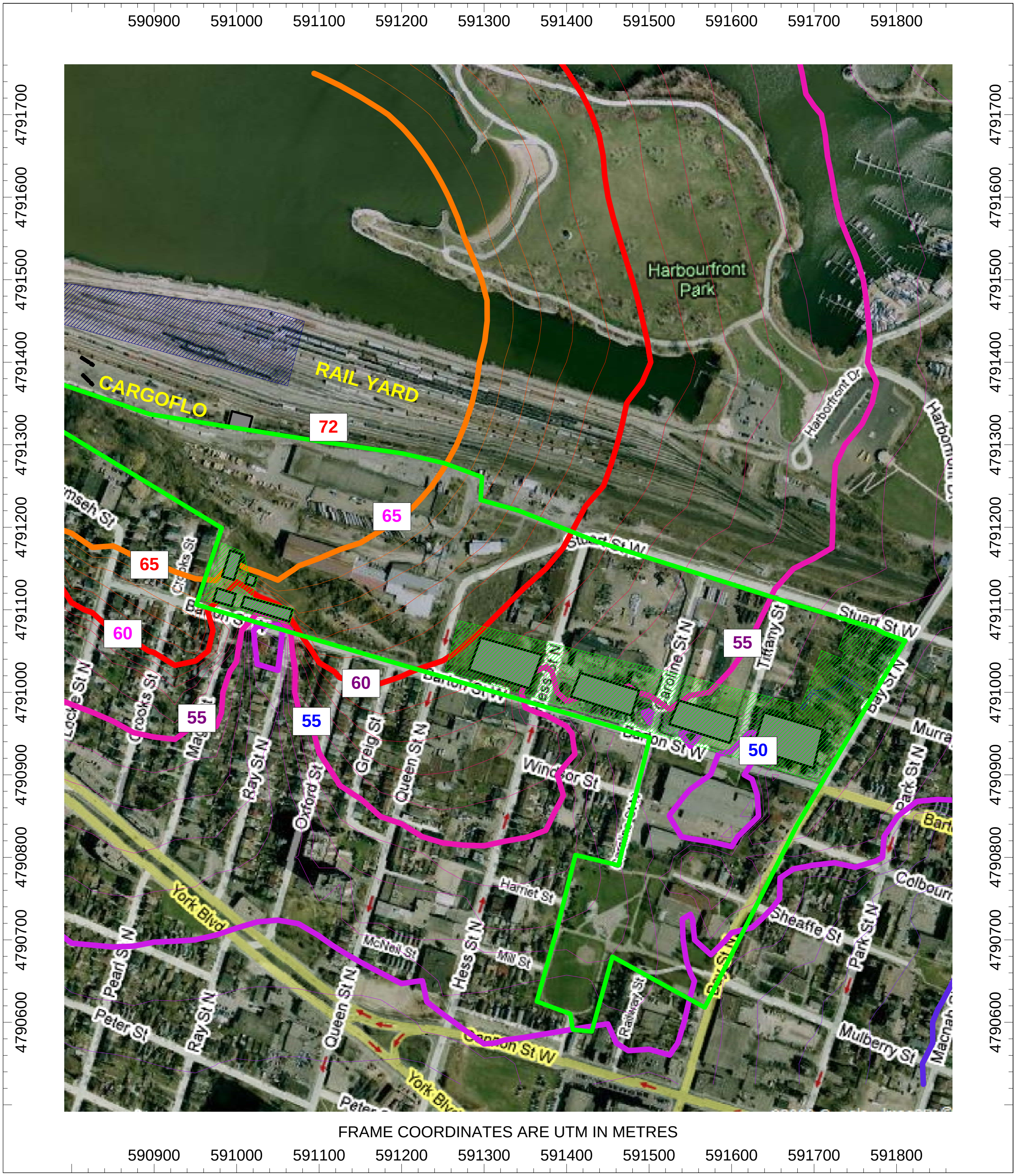


Figure Impulse Sound Level Predictions [dBAI], 13 m above grade west end of yard

# APPENDIX F

Preliminary Comments from the City of Hamilton dated May 8, 2014

## Sheeba Paul

**From:** Travis, Heather <Heather.Travis@hamilton.ca>
**Sent:** May-23-14 2:32 PM
**To:** Sheeba Paul
**Subject:** RE: Barton Tiffany - CN/MOE noise requirements
**Attachments:** noise study with comments.pdf

Sheeba,
Please find attached the noise study with comments.

As for your question regarding the City's process for the Class 4 area designation, I will need to get back to you on this. We have not yet experienced an application with proposes a Class 4 designation. But we are meeting in the near future to discuss this issue, so I will report back to you shortly.

Thanks,

***Heather Travis, MCIP, RPP***

*Senior Planner (Legislative Approvals)*
*Development Planning, Heritage and Design Section, Planning Division*
*Planning and Economic Development Department*
*City of Hamilton, 71 Main St. W, 5th floor, L8R 2K3*
*Ph: (905) 546-2424 ext. 4168*
*Fax: (905) 546-4202*
*Email: Heather.Travis@hamilton.ca*

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**From:** Sheeba Paul [mailto:spaul@hgcengineering.com]
**Sent:** May-22-14 2:08 PM
**To:** Travis, Heather
**Cc:** Brenda Khes (bkhes@gspgroup.ca); Bill Gastmeier
**Subject:** RE: Barton Tiffany - CN/MOE noise requirements

Hello Heather,

I left a voice mail for you.

Thank you for the comments related to our draft noise report for the Barton/Tiffany Lands. Our preliminary responses are provided below.

1. The noise study is using Ministry of Environment (MOE) Guideline LU-131 in its review of noise impacts within the study area. Guideline LU-131 has been replaced by a new MOE Guideline NPC-300, which came into effect October 21, 2013. Staff are of the opinion that Guideline NPC-300 should be utilized for this study. Further, a discussion should be included in the study about the NPC-300 Guideline, and in particular, the new Class 4 designation. The study should discuss the following in relation to the study area:

   We can revise our report to reflect NPC-300 and include a discussion of a Class 4 area.

   - What are the differences between a Class 1 and Class 4 area;

   We can include a discussion of the differences between Class 1 and Class 4 areas in our report.

- What are the additional noise mitigation options available within a Class 4 area;

We have discussed the various options for the subject site relative to the CN railway yard. The recommendations at the subject site would not change if the site was changed to Class 4 since the excesses due to the rail yard are significant.

- Should the Study area be identified as a Class 4 area?

The area can be designated as a Class 4 Area. What is the City's process for the change in designation? We can include the process in our report.

2. Figures and appendices were not included in the draft which was circulated for review. The figures and appendices must be provided in order for staff to provide a fulsome review.

The figures and appendices are to be included in the final version of the noise report.

3. The study indicates that the only stationary noise source in the study area is the rail yard. Was the AVL Building, located at 243 Queen St N., specifically reviewed to determine if it is a potential noise source?

The most significant stationary noise source in the area is the rail yard.

4. Additional comments/notes have been made within the study itself, which has been attached to this email.

Please forward the additional comments/notes. We did not receive this attachment.

Thank you.

**Ms. Sheeba Paul**, MEng, PEng
**HGC Engineering** **NOISE | VIBRATION | ACOUSTICS**
**Howe Gastmeier Chapnik Limited**
**t**: 905.826.4044

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**From:** Brenda Khes [mailto:bkhes@gspgroup.ca]
**Sent:** May-08-14 4:47 PM
**To:** Bill Gastmeier; Sheeba Paul
**Cc:** Glenn Scheels; Kevin Muir; Monika Keliacius
**Subject:** RE: Barton Tiffany - CN/MOE noise requirements

Hi Bill and Sheeba
At long last we have received comments from the City related to your report.
Below are the comments we have received in the format that it was sent to me. You will note in #4 that reference is made to additional comments that were included in their email; I am in the process of tracking this email down.

If you have any questions regarding the comments, please contact Heather Travis directly and cc me any correspondence between the two of you.

Regards
Brenda

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Comments received from City of Hamilton regarding Noise and Vibration Study:

Heather Travis, MCIP, RPP
Senior Planner (Legislative Approvals)
Development Planning, Heritage and Design Section, Planning Division
Planning and Economic Development Department
71 Main St. W, 5th floor

Ph: (905) 546-2424 ext. 4168
Email: Heather.Travis@hamilton.ca

Staff have reviewed the draft noise study prepared by HGC Engineering, titled "Noise and Vibration Feasibility Study for the Barton-Tiffany Area of Hamilton, Ontario", dated November 15, 2013. The following significant areas of concern have been identified and should be addressed:

1. The noise study is using Ministry of Environment (MOE) Guideline LU-131 in its review of noise impacts within the study area. Guideline LU-131 has been replaced by a new MOE Guideline NPC-300, which came into effect October 21, 2013. Staff are of the opinion that Guideline NPC-300 should be utilized for this study. Further, a discussion should be included in the study about the NPC-300 Guideline, and in particular, the new Class 4 designation. The study should discuss the following in relation to the study area:
   - What are the differences between a Class 1 and Class 4 area;
   - What are the additional noise mitigation options available within a Class 4 area;
   - Should the Study area be identified as a Class 4 area?

2. Figures and appendices were not included in the draft which was circulated for review. The figures and appendices must be provided in order for staff to provide a fulsome review.

3. The study indicates that the only stationary noise source in the study area is the rail yard. Was the AVL Building, located at 243 Queen St N., specifically reviewed to determine if it is a potential noise source?

4. Additional comments/notes have been made within the study itself, which has been attached to this email.