
Shannon Park, Halifax, NS

Traffic Impact Study

Prepared for:



CANADA LANDS COMPANY
SOCIÉTÉ IMMOBILIÈRE DU CANADA

Final Report
October 20, 2022

Project No. 192057



Project Name: Shannon Park Traffic Impact Study

Project Number: 192057

Prepared for:

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Status:

Final Report
October 20, 2022

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Executive Summary

The Canada Lands Company (CLC) has plans to redevelop Shannon Park to include a mixed use residential and commercial development. The traffic impact study was completed to support the development application for Shannon Park. The traffic impact study evaluates the impact of the development during the weekday morning and afternoon peak hours of traffic and identifies road network improvements required to accommodate the development.

Study Area

Shannon Park is located south of Princess Margaret Boulevard in Dartmouth, Nova Scotia. Shannon Park is uniquely located with established transportation network connections to multiple key corridors in HRM including the MacKay Bridge, Highway 111, and Windmill Road.

The study area for the traffic impact study, includes Windmill Road between Victoria Road and Albro Lake Road and Princess Margaret Boulevard. Nine intersections within the study area were included in the analysis, the study intersections include:

- Princess Margaret Boulevard & BIO Access
- Princess Margaret Boulevard & MacKay Bridge (Halifax)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth)
- Princess Margaret Boulevard & Iroquois Drive
- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Nootka Avenue
- Windmill Road & Albro Lake Road

Shannon Park Development Proposal

The proposed Shannon Park development will include approximately 3,000 residential units and 150,000 square feet of commercial space. The residential will include a mixture of mid-rise and high-rise residential buildings. The commercial space will include restaurants and neighbourhood type retail land uses.

The development concept includes two access points on Princess Margaret Boulevard, including a new access, referred to as “Main Street”, across from the Dartmouth-bound MacKay Bridge off-ramp and the reconfiguration of the existing access at Iroquois Drive, referred to as “Collector B”, one access point on Windmill Road through the existing access at Nootka Avenue, and one access point on Baffin Boulevard.

The Millbrook First Nation (Millbrook) owns approximately 3.65 hectares (9 acres) of land at Tufts Cove, adjacent to the CLC property. The development of the CLC lands will extend public roadways and infrastructure to the Millbrook property enabling its development. No specific land uses or density have been included for the Millbrook property in this traffic impact study.

Weekday Morning and Afternoon Peak Hour Transportation Demand Projections

Existing Traffic Volumes: Weekday traffic data was collected during the morning (7:00am to 9:00am) and afternoon (4:00pm to 6:00pm) peak periods of traffic on a typical weekday in August 2016 and July 2019. The traffic counts were used to determine the peak traffic hours for the study area. The peak hours were determined to be 7:15am to 8:15am and 4:00pm to 5:00pm. The traffic volumes were adjusted using HRM's average annual weekday traffic (AAWT) conversion factors to account for day-of-week and month of data collection. To develop base traffic volumes for the study area, the traffic volumes throughout the corridor were balanced according to the 2019 traffic counts.

Background Traffic Forecasts: To develop future traffic forecasts for the study horizon (2027), a background growth was applied to the base volumes. The traffic volumes were factored using a background traffic growth rate of 1.0 percent per year to reflect normal increases in traffic on the study area road network.

To provide a complete outlook of future conditions for the study timeframes, other developments in the study area were also included in the background traffic forecasts. The adjacent developments include:

- 396-400 Windmill Road
- Bedford Institute of Oceanography (BIO)

Shannon Park Development: Transportation forecasts for the proposed residential development were estimated using the traditional four-step model: trip generation, modal split, trip distribution and traffic assignment. The weekday peak hour trip generation estimates for the residential and commercial land uses were quantified using trip generation rates from the *Trip Generation Manual* (10th edition) published by the Institute of Transportation Engineers (ITE).

The trip generation estimates were adjusted to account for internal trips, modal split and pass-by trips. On a typical weekday, the Shannon Park development is expected to generate 1111 vehicle trips (375 entering/736 exiting) during the morning peak hour and 1268 vehicle trips (789 entering/479 exiting) during the afternoon peak hour; all of which would be considered new or primary trips.

Trips associated with the Shannon Park development were distributed to the study area road network using the following trip distribution:

- 25% to/from Halifax via the MacKay Bridge,
- 15% to/from Bedford and areas to the north via Windmill Road,
- 25% to/from Dartmouth and areas south via Windmill Road, and
- 35% to/from the rest of the metro area via Highway 111.

Trips associated with the Shannon Park development were assigned to the three access points using the following trip assignment:

- 60 percent to/from "Main Street",
- 15 percent to/from "Collector B", and
- 25 percent to/from Nootka Avenue.

Weekday Morning and Afternoon Peak Hour Traffic Analysis

The performance of the study intersections was evaluated during the weekday morning and afternoon peak hours under five scenarios to quantify the impact of the proposed development on the study area road network. The assessment scenarios included:

- Scenario 1 – Existing Conditions (2019)
- Scenario 2 – Background Growth and Adjacent Developments (2027)
- Scenario 3 – Shannon Park Development (2027)
- Scenario 4 – Future Development Conditions with Improvements (2027)
- Scenario 5 – Five-Year timeframe after Shannon Park Development (2032)

Scenario 1 – Existing Conditions (2019): The Existing Conditions (2019) scenario provides an assessment of the existing operations in the study area based on existing traffic volumes, lane configurations and signal timing plans. The existing conditions show that the study intersections generally experience no congestion to light congestion during the weekday morning and afternoon peak hours. The overall performance of all study intersections is acceptable (Level of Service ‘D’ or better) during both weekday peak hours. However, there are individual movements at the intersections of Princess Margaret Boulevard & MacKay Bridge (Dartmouth) and Windmill Road & Victoria Road which experience longer delays and/or queues.

Scenario 2 – Background Growth and Adjacent Developments (2027): The Background Growth and Adjacent Developments (2027) scenario provides an assessment of future operations in the study area without the proposed development based on the projection of normal traffic growth to the year 2027 and the projected traffic volumes associated adjacent developments. The future background conditions show that congestion levels will increase throughout the study area. Traffic growth and adjacent developments will contribute to the deterioration of existing operational problems at the intersections of Princess Margaret Boulevard & MacKay Bridge (Dartmouth) and Windmill Road & Victoria Road.

Scenario 3 – Shannon Park Development (2027): The Shannon Park Development (2027) scenario provides an assessment of future operations in the study area with the proposed development in place based on background traffic volumes and the projected traffic volumes associated with the Shannon Park development. The scenario is used to determine the impact of the proposed development and identify if improvements are required to accommodate the proposed development.

The Shannon Park development will contribute to the deterioration of existing/background operational problems and create operational problems at a number of intersections. Operational problems will be observed at seven of the nine study intersections, including:

- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”
- Princess Margaret Boulevard & “Collector B”
- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Nootka Avenue

Queue lengths at intersections along Princess Margaret Boulevard will affect operations at the MacKay Bridge toll plaza and the at-grade CN rail crossing on Princess Margaret Boulevard. Road network improvements are required to mitigate the impact of the development and improve conditions throughout the study area.

Scenario 4 – Future Development Conditions with Improvements (2027): The Future Development Conditions with Improvements (2027) scenario provides an assessment of future operations in the study area with road network improvements required to accommodate the proposed development. The following road network improvements are included in the scenario:

- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** Intersection upgraded to a single lane roundabout to improve operations while minimizing queuing on the MacKay Bridge approach.
- **Princess Margaret Boulevard & Baffin Boulevard:** Right-in, right-out access restrictions for the Baffin Boulevard approach.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”:** Intersection upgraded to a single lane roundabout with a right turn by-pass on the eastbound approach (Princess Margaret Boulevard) to accommodate the right turn movement into the Shannon Park development.
- **Princess Margaret Boulevard & “Collector B”:** Right-in, right-out access restrictions for the “Collector B” approach.
- **Windmill Road & Victoria Road:** Modifications to the morning peak hour signal timings.
- **Windmill Road & Princess Margaret Boulevard:** New lane configuration on the eastbound approach (Princess Margaret Boulevard) to provide a left turn storage lane and extend the right turn storage lane. New lane configuration on the southbound approach (Windmill Road) to provide a right turn storage lane.
- **Windmill Road & Nootka Avenue:** New lane configuration on the westbound approach (Nootka Avenue) to provide a left turn storage lane.

Operations at the intersections where improvements are proposed will be improved. The improvements ensure that the intersection operations will not impact operations at the MacKay Bridge toll plaza or the at-grade CN rail crossings on Princess Margaret Boulevard and Nootka Avenue.

Scenario 5 – Five-Year timeframe after Shannon Park Development (2032): The Five-Year timeframe after Shannon Park Development (2032) scenario provides an assessment of future operations in the study area based on the projection of normal traffic growth five-years after full build out of the Shannon Park development. The five-year timeframe confirms that the proposed road network improvements will accommodate the proposed development and allow room for future traffic growth.

Princess Margaret Boulevard Corridor Analysis

The intersection performance analysis identified a number of road network improvements required along Princess Margaret Boulevard to mitigate the impact of the Shannon Park development. Under existing conditions, traffic flows freely along the entire length of the Princess Margaret Boulevard corridor until the signalized intersection at Windmill Road. The proposed improvements include changes to intersection controls along the corridor which will introduce delay and queues along the corridor.

The intersections along Princess Margaret Boulevard are closely spaced making it important to identify interactions between adjacent intersections. Different types of software were used to model the intersections based on the type of intersection control. While the queue length results from the various analyses are a good indicator of intersections between adjacent intersections, a supplemental corridor analysis was completed along Princess Margaret Boulevard using PTV Vissim software to confirm the results of the intersection performance analysis.

The study area for the corridor analysis was limited to the section of Princess Margaret Boulevard from the ramps to the MacKay Bridge toll plaza to Windmill Road. Five study intersections were included in the analysis:

- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)
- Princess Margaret Boulevard & Iroquois Drive
- Princess Margaret Boulevard & Windmill Road

The performance of the study intersections during the weekday morning and afternoon peak hours was reevaluated under two of the previous scenarios:

- **Scenario 1 – Existing Conditions (2019):** The results of the Vissim corridor analysis are consistent with the intersection performance analysis results; all intersections operate at acceptable levels of service.
- **Scenario 5 – Five-Year timeframe after Shannon Park Development (2032):** The results of the Vissim analysis are consistent with the intersection performance analysis results. All intersections will operate at acceptable levels of service during the peak hours. The analysis confirms that the queue lengths on the Princess Margaret Boulevard will not impact the at-grade CN rail crossing and the queue lengths on the MacKay Bridge ramps will not impact the toll plaza.

The corridor analysis confirms that the proposed road network improvements will be sufficient to accommodate the proposed development during the weekday peak hours and confirms that the Shannon Park development will not impact the MacKay Bridge toll plaza or the CN rail crossing.

Road Network Improvements

A number of road network improvements are required to mitigate the impact of the Shannon Park development during the weekday peak hours. The improvements include:

1. **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) should be upgraded to a single lane roundabout.
2. **Princess Margaret Boulevard & Baffin Boulevard:** Access to Baffin Boulevard should be restricted to right-in, right-out only by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp. Speed tables will be required on Princess Margaret Boulevard between the Mackay Bridge (Halifax—bound) ramp and Hudson Way to reduce the impacts of the increase in volumes travelling through the residential area as a result of the turning restrictions at Baffin Boulevard.
3. **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”:** The intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) should be upgraded to a single lane roundabout. The single lane roundabout will require a right turn by-pass on the eastbound approach (Princess Margaret Boulevard) to accommodate the right turn movement into the Shannon Park development.

Improvements to the intersection are required to improve existing and future background operations at the intersection and to accommodate the main access to the Shannon Park development. The roundabout will need to be constructed on both the CLC lands and HRM property.

4. **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** Access to “Collector B” should be restricted to right-in, right-out only with no restrictions on the HHB driveway.
5. **Windmill Road & Princess Margaret Boulevard:** The intersection should be widened to accommodate new lane configurations on the eastbound (Princess Margaret Boulevard) and southbound (Windmill Road) approaches. The existing right turn storage lane should be extended (50 metres) and a left turn storage lane (75 metres) should be provided on the eastbound approach. A right turn storage lane (40 metres) should be provided on the southbound approach. The existing left turn storage lane should be extended (75 metres) on the northbound approach.
6. **Windmill Road & Nootka Avenue:** A left turn storage lane (25 metres) should be provided on the westbound approach (Nootka Avenue). The existing crosswalk should be upgraded to an RRFB to provide appropriate pedestrian crossing control based on future traffic volumes.

The total cost of the roadway infrastructure improvements is estimated at \$4,875,000. The cost estimates do not include allowances for engineering, property acquisitions, utility relocations or harmonized sales tax (HST).

Shannon Park Ferry Terminal

Halifax Transit is currently reviewing the abutting Millbrook Lands for a future ferry terminal. HRM staff have requested that the potential ferry terminal be accounted in in the traffic study. The Shannon Park Route, identified in the Rapid Transit Strategy, would include a connection from a new ferry terminal on the Millbrook Lands abutting the Shannon Park development to the Halifax Ferry Terminal.

The Rapid Transit Strategy recognizes that the development of Shannon Park into a mixed-used development will increase density in the area and provides the opportunity to create a transit-oriented development. The Strategy indicates that active transportation and transit connections to the ferry terminal will be prioritized to provide access to the ferry. While Park & Ride options will be considered at ferry terminals where there is space, the priority will be to encourage ridership through transit-oriented development and connections to transit routes and active transportation.

The ferry service and additional transit and active transportation connections are expected to significantly increase the non-auto mode share for the Shannon Park development. With the presence of a ferry terminal, a non-auto mode share (including ferry, transit and active transportation trips) of 50 percent was assumed for the Shannon Park development, consistent with the IMP's non-auto mode share for the Regional Centre. Ferry trips are expected to account for approximately half of the non-auto trips.

The performance of the study intersections during the weekday morning and afternoon peak hours was evaluated under an additional scenario to quantify the impact of the proposed development with the presence of a ferry terminal on the study area road network:

- Scenario 6 – Five-Year timeframe after Shannon Park Development (2032) with Ferry Terminal on Millbrook Lands: A projection of normal traffic growth five-years after full build out of the Shannon Park development, where the projected traffic volumes associated with the Shannon Park development assume a higher mode share reduction and the additional vehicle trips generated by the ferry terminal's Park & Ride facility. This scenario includes the proposed improvements identified in Scenario 4 that required to accommodate the Shannon Park Development.

The reduced vehicle trips from the Shannon Park development will outweigh new vehicles trips generated by the ferry terminal's Park & Ride facility, resulting in lower traffic volumes throughout the study area and slightly improved operations at most intersections when compared to the same scenario without the ferry terminal (Scenario 5 - Five-year Timeframe after Shannon Park Development). The results of the analysis indicate that the proposed road network improvements proposed improvements are still required to accommodate the development and will be sufficient to accommodate the ferry terminal during the weekday peak hours.

Recommendations

Based on the findings of this study, it is recommended that:

- The intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) be upgraded to a single lane roundabout with a right turn by-pass on the eastbound approach (Princess Margaret Boulevard).
- The intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) be upgraded to a single lane roundabout.
- Access to Baffin Boulevard be restricted to right-in, right-out only by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp.
- Traffic calming measures (vertical deflections) be installed on Princess Margaret Boulevard between the Mackay Bridge (Halifax—bound) ramp and Hudson Way.
- Access to “Collector B” be restricted to right-in, right-out only. Detailed design should consider the feasibility of further access management at this intersection such as extending the continuous concrete median on Princess Margaret Boulevard and relocating the HHB driveway to maintain fully directional access.
- A left turn storage lane be provided on the Nootka Avenue approach.
- The existing crosswalk at Windmill Road & Nootka Avenue be upgraded to an RRFB.
- The intersection of Windmill Road & Princess Margaret Boulevard be widened to extend the existing eastbound (Princess Margaret Boulevard) right turn storage lane and provide an eastbound left turn storage lane, extend the existing northbound (Windmill Road) left turn storage lane, and provide a southbound (Windmill Road) right turn lane.
- Traffic calming measures (vertical deflections) be installed adjacent to the school.
- HRM implement the recommendations previously identified in the at-grade crossing assessment completed in 2018 for the Princess Margaret Boulevard crossing.
- Roadway infrastructure improvements be implemented based on the phasing of the development as outlined in the implementation plan and a monitoring plan be implemented to ensure regular monitoring of the intersections as development occurs to ensure the improvements are implemented earlier if traffic patterns indicate operational issues on MacKay Bridge ramps or Princess Margaret Boulevard.
- The requirements of the internal road network intersections (control type, lane configuration, storage lane requirements) be determined during detailed design.

Table of Contents

1	Introduction and Understanding	1
1.1	Project Scope and Objectives.....	1
1.2	Methodology.....	1
2	Study Context.....	2
2.1	Study Area Description	2
2.2	Site Visit and Sight Distance Review	4
2.3	Collision History	4
2.4	Existing Traffic Volumes	5
2.5	Background Traffic Forecasting.....	6
2.1	Modal Split	6
3	Stakeholder Consultation.....	6
3.1	Halifax Regional Municipality.....	6
3.2	Nova Scotia Transportation and Infrastructure Renewal	7
3.3	Halifax Harbour Bridges	7
3.4	Bedford Institute of Oceanography	7
3.5	Canadian National Railway	7
4	Shannon Park Development Proposal	8
5	Adjacent Development Proposals.....	10
5.1	Bedford Institute of Oceanography	10
5.2	396, 398, 400 Windmill Road	10
5.3	Millbrook First Nations.....	11
5.4	Wallace Heights	11
5.5	Windmill Road Area (including the Shannon Plaza).....	11
6	Transportation Demand Projections.....	11
6.1	Trip Generation and Modal Split.....	11
6.2	Trip Distribution and Assignment	14
7	Intersection Performance Analysis	15
7.1	Measures of Effectiveness	15
7.2	Analysis Software	15
8	Weekday Morning and Afternoon Peak Hour Analysis	16
8.1	Scenario 1 - Existing (2019).....	17
8.2	Scenario 2 – Background Growth and Adjacent Developments (2027)	18
8.3	Scenario 3 – Shannon Park Development (2027)	23
8.4	Scenario 4 – Shannon Park Development with Improvements (2027).....	25
8.5	Scenario 5 – Five-year Timeframe after Shannon Park Development (2032)	31
8.6	Residual Capacity	35
9	Princess Margaret Boulevard Corridor Analysis	36
9.1	Scenario 1 – Existing (2019)	37
9.2	Scenario 5 – Five-Year Timeframe after Shannon Park Development (2032)	38
10	Roadway Infrastructure Improvements.....	41

10.1 Discussion of Potential Improvements	41
10.2 Proposed Improvements	47
10.3 Cost Estimates.....	48
10.4 Implementation Plan	49
10.5 Monitoring Plan	51
11 Concept Plan Review.....	51
11.1 Roadway Classification.....	52
11.2 Internal Intersections.....	53
11.3 Emergency Response	53
12 CN Rail Crossing Review.....	53
12.1 Princess Margaret Boulevard Crossing	54
12.2 Requirements for Pedestrian and Cycling Crossings	55
13 Active Transportation	55
13.1 Pedestrians.....	55
13.2 Cycling	56
13.3 Proposed Active Transportation Route.....	58
14 Transit	59
15 Shannon Park Ferry Terminal.....	61
15.1 Ferry Assumptions	61
15.2 Scenario 6 – Five-Year Timeframe after Shannon Park Development (2032) with Ferry Terminal on Millbrook Lands	66
16 Conclusions and Recommendations	71
16.1 Conclusions	71
16.2 Recommendations	75

Appendices

- Appendix A – Traffic Count Data
- Appendix B – NCHRP Internal Trip Calculations
- Appendix C – Traffic Volumes
- Appendix D – Analysis Summary
- Appendix E – Analysis Reports
- Appendix F – Corridor Analysis Outputs
- Appendix G – Traffic Signal Warrants
- Appendix H – Concept Plans
- Appendix I – Ferry Traffic Volumes
- Appendix J – Ferry Analysis Summary and Reports

List of Tables

Table 1: Census 2006 Mode Split	6
Table 2: Trip Generation Rates	12
Table 3: Shannon Park Development Trip Generation Estimates.....	13
Table 4: Adjacent Developments Trip Generation Estimates	14
Table 5: Level of Service Criteria	15
Table 6: Maximum v/c ratios	35
Table 7: Scenario 1 – Existing (2019) Weekday AM/PM Corridor Analysis	37
Table 8: Scenario 5 – Five-Year Timeframe (2032) Weekday AM/PM Corridor Analysis	40
Table 9: Costs Associated with Improvements	48
Table 10: Implementation Plan	50
Table 11: Characteristics of Street Classes	52
Table 12: Emergency Response Route Travel Time	53
Table 13: Princess Margaret Boulevard Rail Crossing Improvements	54
Table 14: Average Weekday Peak Hour Boardings.....	62
Table 15: Shannon Park Ferry Ridership	62
Table 16: Existing Ferry Park & Ride Facilities	62
Table 17: Ferry Trip Generation.....	63
Table 18: Change in Non-Auto Trip Reductions.....	64
Table 19: Shannon Park Development with Ferry Terminal Trip Generation Estimates	65

List of Figures

Figure 1: Study Area	3
Figure 2: Preferred Development Concept.....	9
Figure 3: Development Land Use Plan	9
Figure 4: Adjacent Developments.....	10
Figure 5: Scenario 1 – Existing (2019) – Weekday AM/PM.....	21
Figure 6: Scenario 2 – Background Growth and Adjacent Dev. (2027) – Weekday AM/PM	22
Figure 7: Scenario 3 – Shannon Park Development (2027) – Weekday AM/PM.....	29
Figure 8: Scenario 4 – Shannon Park Dev. with Improvements (2027) – Weekday AM/PM.....	30
Figure 9: Scenario 5 – Five-year Timeframe after Shannon Park Dev. (2032) – Weekday AM/PM	33
Figure 10: Development Phasing Plan	49
Figure 11: HRM Sidewalks Map	56
Figure 12: HRM Proposed Bicycle Network	57
Figure 13: HRM Candidate Bikeway Routes and Greenway Network	57
Figure 14: Shannon Park AT Route (shown in green dashed line)	58
Figure 15: Existing and Proposed Transit Routes.....	60
Figure 16: Ferry Travel Time Comparison (Source: Rapid Transit Strategy)	61
Figure 17: Scenario 6 – Five-year Timeframe after Dev. (2032) with Ferry Terminal– Weekday AM/PM.....	69

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1 Introduction and Understanding

Harbourside Transportation Consultants and DesignPoint Engineering and Surveying Ltd. were retained by the Canada Lands Company (CLC) to prepare a traffic impact study to support the development application for the redevelopment of Shannon Park in Dartmouth, Nova Scotia.

CLC has plans to redevelop Shannon Park to include a mixed use residential and commercial development. The proposed development will include approximately 3,000 residential units and 150,000 square feet of commercial space. The traffic impact study evaluates the impact of the development during the weekday morning and afternoon peak hours of traffic and identifies road network improvements required to accommodate the development.

The Millbrook First Nation (Millbrook) owns approximately 9 acres of land at Tufts Cove, adjacent to the CLC property. Development of the CLC lands will extend public roadways and infrastructure to the Millbrook property enabling its development. At this time, no detailed plans for the development of the Millbrook property have been made public; however, general indications are that the development could include a mix of residential and commercial land uses similar to the proposed development for the CLC lands. The traffic impact study does not include land uses or density for the Millbrook property.

1.1 Project Scope and Objectives

The scope of the traffic impact study was discussed and confirmed with the Halifax Regional Municipality (HRM) and the Nova Scotia Transportation Infrastructure Renewal (NSTIR).

The objectives of the traffic impact study include:

- An assessment of the existing road network intersections in the study area during both the morning (AM) and afternoon (PM) peak traffic periods on a typical weekday.
- Establishing the trip generation rates for the proposed development.
- Establishing the trip distribution patterns for the proposed development.
- An assessment of the anticipated traffic conditions of the study area streets and intersections with the proposed development reflecting normal growth rates to the full build-out time horizon.
- Identifying the impacts of the proposed development on the study area streets and intersections during both the AM and PM peak traffic periods.
- Identifying any required improvements to the study area streets and intersections that may be required to accommodate the proposed development.
- A review of the development concept plan's internal road network.
- A review of previous transportation studies in the study area including the 2006 Wrights Cove Land Use and Transportation Plan.

1.2 Methodology

The traffic study was completed in accordance with HRM's *Guidelines for the Preparation of Transportation Impact Studies (8th revision)*. The methodology for the traffic impact study is outlined below:

1. Project Initiation and Information Gathering
2. Stakeholder Meetings
3. Traffic Operations Analysis
 - a) Establish the context for the TIS (horizon year, time periods for analysis, growth rate, etc.)
 - b) Estimate traffic volumes that will be generated by the development (trip generation, mode split adjustments and trip distribution)
 - c) Establish existing traffic conditions and background traffic conditions
 - d) Evaluate the impacts of the site-generated traffic and identify any improvements required to mitigate the effects of the proposed development.
4. Public Transit
5. Active Transportation
6. Draft Report Documentation
7. Final Report Documentation

After HRM's initial review of the first draft report, HRM required that a corridor analysis be completed using PTV Vissim to supplement the analysis and confirm results. The corridor analysis was not included in the initial scope developed and agreed upon with HRM and are not typically required as part of a traffic impact study.

2 Study Context

2.1 Study Area Description

Shannon Park is located south of Princess Margaret Boulevard in Dartmouth, Nova Scotia. Shannon Park is uniquely located with established transportation network connections to multiple key corridors in HRM including the MacKay Bridge, Highway 111, and Windmill Road. The study area for the traffic impact study, shown in Figure 1, includes Windmill Road between Victoria Road and Albro Lake Road and Princess Margaret Boulevard.

Windmill Road is a collector roadway that runs from downtown Dartmouth to Burnside Park, Windmill Road becomes an arterial roadway in Burnside Park where it connects to Victoria Road. Victoria Road is an arterial roadway that runs from Burnside Park to downtown Dartmouth. The Windmill Road/Victoria Road corridor provides connections to Bedford/Lower Sackville, the MacKay Bridge, Highway 111 and the MacDonald Bridge making it a key commuting corridor.

In the Burnside Park area, Windmill Road and Victoria Road have a four-lane cross section with turning lanes at key intersections. In the Shannon Park area, Windmill Road has a two-lane cross section with turning lanes at key intersections.

Princess Margaret Boulevard is an east-west local roadway that connects Windmill Road to the MacKay Bridge and Highway 111 and residential areas. Princess Margaret Boulevard has a two-lane cross section with turning lanes at key intersections.

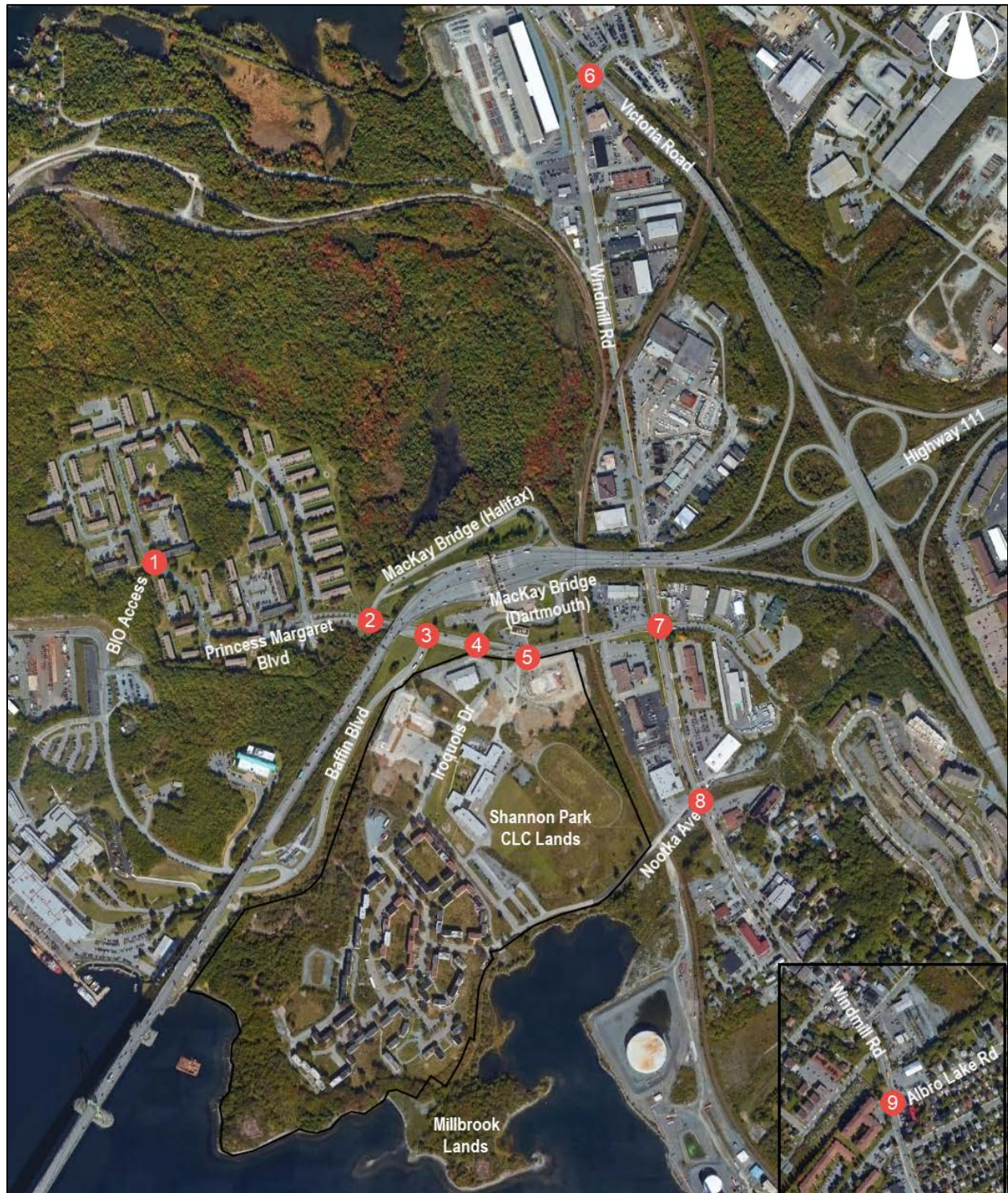


Figure 1: Study Area

Nine intersections within the study area were included in the analysis, the study intersections include:

- Princess Margaret Boulevard & BIO Access
- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)
- Princess Margaret Boulevard & Iroquois Drive
- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Nootka Avenue
- Windmill Road & Albro Lake Road

2.2 Site Visit and Sight Distance Review

A site visit was conducted on August 17th, 2016 to document existing conditions. Existing intersections, transit stops, pedestrian crossings, and active transportation (AT) connections were documented.

The sight distance at the study intersections was reviewed against the sight distance requirements set out by the Transportation Association of Canada (TAC) in the Geometric Design Guide for Canadian Roads.

For a two-lane roadway posted to a speed of 50 km/h, 100m of sight distance is required for crossing movements and vehicles turning left across vehicles approaching from the left. For turning movements with vehicles approaching in the intended direction of travel 100m of sight distance is required for vehicles to turn left without being overtaken by a vehicle approaching from the right or to turn right without being overtaken by a vehicle approaching from the left. For a four-lane roadway posted to a speed of 60 km/h, 130m of sight distance is required for vehicles turning left across vehicles approaching from the left. For turning movements with vehicles approaching in the intended direction of travel, 125m of sight distance is required for vehicles to turn left without being overtaken by a vehicle approaching from the right or to turn right without being overtaken by a vehicle approaching from the left.

The minimum sight distance is adequate at all study intersections. At Windmill Road/Nootka Avenue and Windmill Road/Albro Lake Road, trees are present within the sight lines and reduce visibility. Sight lines should be kept clear of vegetation.

2.3 Collision History

Collision data for the study area was obtained from HRM for 2013 to 2016. These data indicate 12 collisions at the intersection of Windmill Road/Princess Margaret Boulevard, of which 10 were without injury and 2 with injury. A collision with no injury was also reported at Princess Margaret Boulevard/MacKay Bridge Ramp (Dartmouth bound).

The collision data obtained from police departments lacks the detail required to perform safety reviews of individual intersections. The data could not be used to perform safety analyses and only used for a high-level review of potential issues. Given the high volumes observed at the intersection, twelve collisions with no details over more than three years does not appear to be problematic. HRM has indicated that detailed collision reports of the existing intersections can be provided during detailed design stage to ensure any existing safety issues can be addressed during infrastructure upgrades.

2.4 Existing Traffic Volumes

Manual traffic counts were collected during the morning and afternoon peak periods of traffic in August 2016 at eight study intersections.

- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)
- Princess Margaret Boulevard & Iroquois Drive
- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Nootka Avenue
- Windmill Road & Albro Lake Road

The new access to the Bedford Institute of Oceanography was constructed in 2019, affecting travel patterns on Princess Margaret Boulevard. Traffic counts were collected/updated during the morning and afternoon peak periods of traffic at the following intersections to reflect changes in travel patterns caused by the new BIO Access on Princess Margaret Boulevard:

- Princess Margaret Boulevard & BIO Access
- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard

Weekday traffic data was collected at the using Miovision 'Scout' video data collection devices. Turning movement counts were collected during the morning (7:00am to 9:00am) and afternoon (4:00pm to 6:00pm) peak periods of traffic on a typical weekday in July, 2019. Traffic volumes (categorized as 'light' and 'other' vehicles) and pedestrians were recorded in 15-minute intervals. The traffic count data can be found in Appendix A.

The weekday peak hour traffic volumes from the 2016 counts at these intersections were found to be higher than the traffic volumes observed in the updated 2019 counts. Additional afternoon peak period counts were processed at the following intersections to confirm the trend throughout the study area:

- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Albro Lake Road

The traffic counts were used to determine the peak hours for the study area; the peak hours were 7:15am to 8:15am and 4:00pm to 5:00pm. The traffic volumes were adjusted using HRM's average annual weekday traffic (AAWT) conversion factors to account for day-of-week and month of data collection. The weekday peak hour traffic volumes from the 2016 counts were found to be higher than the traffic volumes observed in the updated 2019 counts. To develop base traffic volumes for the study area, the traffic volumes throughout the corridor were balanced according to the 2019 traffic counts.

2.5 Background Traffic Forecasting

The Shannon Park development is expected to be constructed by 2027. To develop future traffic forecasts for the study horizon, a background growth rate was applied to the base volumes. While a comparison of 2016 and 2019 traffic volumes at some of the study intersections showed decreases in traffic volumes along the corridor, the timeframe is insufficient to conclude that there is no growth in the study area. Therefore, to remain conservative, the base traffic volumes were factored using a background traffic growth rate of 1.0 percent per year to reflect normal increases in traffic on the study area road network. To provide a complete outlook of future conditions for the study timeframes, other developments in the study area were also included in the background traffic forecasts.

2.1 Modal Split

The modal split for the Shannon Park area was developed using 2006 Census data. While not the most recent Census data available, discussions with Halifax Transit indicated that 2006 Census data was considered more reliable in terms of reflecting HRM data for transit ridership. Three areas of Halifax believed to represent similar conditions to those anticipated for the Shannon Park development were identified: Portland Hills and Montebello areas in Dartmouth, and the area north of Larry Uteck Boulevard in Bedford. The 2006 modal split for these areas are noted in Table 1. After discussions with HRM, a transit, walk, bike and 'other' split of 10%, 4%, 1% and 0.5% respectively was assumed for Shannon Park, for total modal split of 15.5% for sustainable transportation modes in the study area.

It should be noted that this mode split assumes that there is no future ferry terminal located in Shannon Park area. Halifax Transit is currently reviewing the abutting Millbrook Lands for a future ferry terminal, the impact of the ferry terminal on the Shannon Park development is discussed in Section 15.0 Shannon Park Ferry Terminal.

Table 1: Census 2006 Mode Split

Mode Split	Portland Hills	Montebello	Larry Uteck
Vehicle	83.1%	88.9%	84.4%
Transit	11.5%	6.7%	9.7%
Walk	4.4%	2.6%	4.1%
Bike	0.7%	1.3%	0.4%
Other	0.4%	0.6%	1.3%

3 Stakeholder Consultation

A series of stakeholder meetings were conducted was to confirm the scope of work with approval agencies and identify future development and planned changes to the transportation network in the study area. Meetings/interviews were held with HRM, Halifax Transit, NSTIR, Halifax Harbour Bridges (HHB), BIO and Canadian National Railway (CN).

3.1 Halifax Regional Municipality

A meeting was held with Halifax Development, Traffic and Transit on August 25, 2016. HRM confirmed the study scope. A few items of note from the meeting include:

- HHB is in the process of studying options for replacing the MacKay Bridge;
- BIO is looking at access road upgrades to their facility and are in the preliminary stages of discussing with the Municipality having their private road taken over by the Municipality;
- HRM staff present at the meeting did not believe that HRM's Centre Plan has any significant items pertaining to traffic that may impact this project;
- No additional developments in the surrounding areas have been identified that may impact the traffic study;
- HRM is working on an Integrated Mobility Plan, it is not anticipated that there will be any major items in the plan that will identify the project's study area.

A second meeting was held with Halifax Active Transportation, Transit, Transportation and Planning. The meeting consisted of a preliminary discussion on preferred active transportation routes through the site. HRM would like to see a main route through the site that includes bike lanes. There are plans to install a painted bike lane on Windmill Road but it is not a high priority due to the low demand in the area. Once Shannon Park is built, demand in the area will likely increase. At this point, HRM would be looking at either Windmill Road bike lane or an AT path that runs along the harbourfront. It was also noted that the MacKay Bridge upgrade may include pedestrian/bike facilities which would add to increased demand for the area.

3.2 Nova Scotia Transportation and Infrastructure Renewal

A phone interview was conducted with Dwayne Cross of NSTIR on August 19, 2016. NSTIR confirmed the study scope and indicated that they would require not additional analysis than what was being proposed to HRM.

3.3 Halifax Harbour Bridges

A meeting was held with Ahsan Chowdhury (Chief Engineer) and Gord Helm (Operations Manager) on August 24, 2016. They outlined their future plans at the MacKay Bridge, which included removal of the toll plaza and the need to replace the deck. The deck replacement may result in the construction of a new bridge. HHB is in the process of studying options for replacing the MacKay bridge. One of the options being considered is building a new bridge parallel to the existing bridge. Both the north and south sides are being assessed as options. The future plans for HHB have no impact on the scope of this study.

3.4 Bedford Institute of Oceanography

A meeting was held with Jeff Hilchey (Project Engineer) on August 30, 2016 to discuss their new access road project. Pending HRM review, they are planning to tender the project in 2016 and begin construction in 2016. The majority of the construction will take place in 2017. The project will provide a new connection into the BIO site and upgrade their driveway to HRM standards, before the road becomes the property of HRM.

3.5 Canadian National Railway

A phone interview was conducted with Raymond Beshro of CN Rail on September 16, 2016. CN indicated that the study needs to take into account Transport Canada's Grade Crossing Standards (2014) and address any requirements. CN has some concern regarding queues from adjacent intersections spilling back onto existing crossings. CN will need to review the capacity analysis.

The capacity analysis shows that with certain improvements in place, the development will not impact the CN track and at-grade crossings located within the study area. A memo summarizing the results of the analysis has been sent to CN for comment. At this time, no comment has been received.

The Nootka Avenue crossing currently does not have a gate system and CN does not believe the site generated traffic will be enough to warrant gates. However, it must be ensured that adequate sightlines for the track operating speed are maintained at the crossing. The track currently operates at a maximum speed of 25 mph. Therefore, when re-designing Nootka Avenue, the road design will need to meet HRM and CN requirements.

CN provided a document with guidelines regarding new development near existing tracks. Guidelines include the following:

- Residential buildings should be set back a minimum of 15m from the railway right-of-way in conjunction with a safety berm.
- In the absence of a safety berm, sensitive uses such as residential development should be set back at least 60m from the railway right-of-way.
- The document states that the owner/developer must have a noise analysis completed and evaluate ground-borne vibration transmission.
- The owner must install and maintain a chain link fence along the mutual property line.
- Clauses to be inserted in all development agreements, offers to purchase, and agreements of Purchase and Sale or Lease of each dwelling unit within 300 m of the railway right-of-way.
- Any alterations to existing drainage pattern affecting railway property must receive prior concurrence by CN and be substantiated by a drainage report.
- In addition, CN will be seeking registration on title of a railway noise and vibration covenant and will provide standard wording for this in due time.

4 Shannon Park Development Proposal

The proposed redevelopment of Shannon Park will include a mixed use residential and commercial development. The preferred development concept for Shannon Park is shown in Figure 2 and the land use plan is shown in Figure 3. The proposed development will include approximately 3,000 residential units and 150,000 square feet of commercial space. The residential will include a mixture of mid-rise and high-rise residential buildings. The commercial space will include restaurants and neighbourhood type retail land uses.

The development concept includes two access points on Princess Margaret Boulevard, including a new access, referred to as “Main Street”, across from the Dartmouth-bound MacKay Bridge ramp to and the reconfiguration of the existing access at Iroquois Drive, referred to as “Collector B”; one access point on Windmill Road through the existing access at Nootka Avenue; and one access point on Baffin Boulevard.

The Millbrook First Nation (Millbrook) owns approximately 9 acres of land at Tufts Cove (Block 27), adjacent to the CLC property. The development of the CLC lands will extend public roadways and infrastructure to the Millbrook property enabling its development. No specific land uses or density have been included for the Millbrook property in this traffic impact study.



Figure 2: Preferred Development Concept

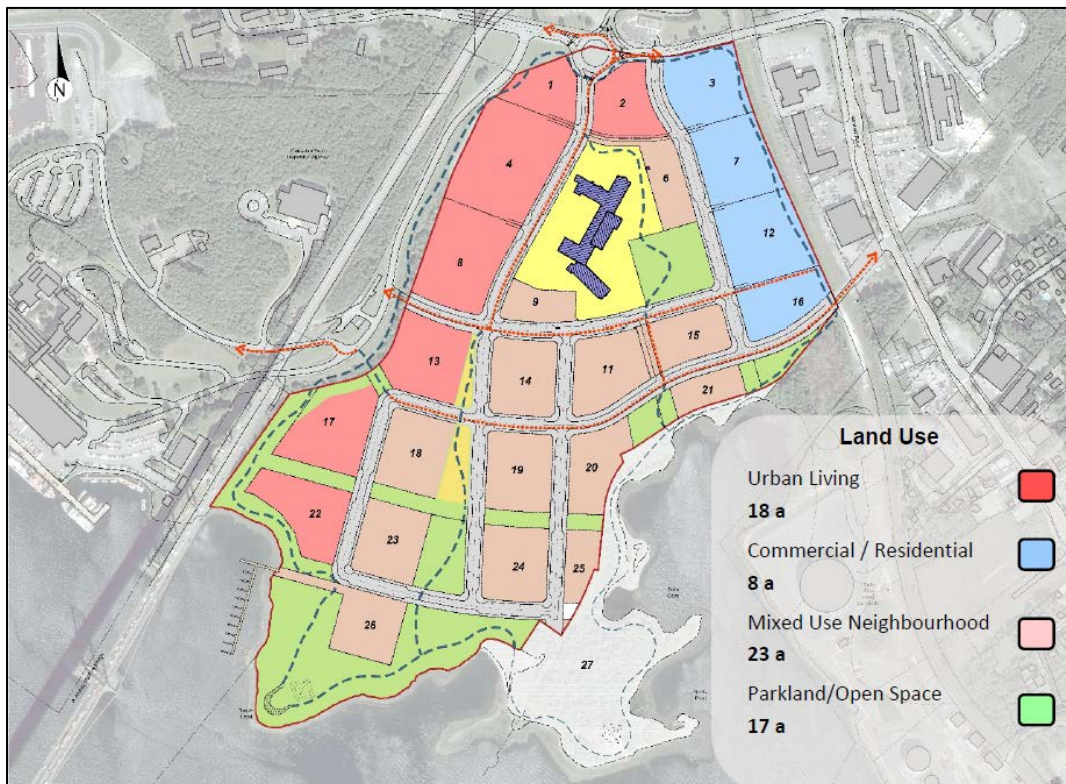


Figure 3: Development Land Use Plan

5 Adjacent Development Proposals

Other developments in the study area anticipated to coincide with the Shannon Park development's timeframe were identified through stakeholder interviews. The development proposals were reviewed and confirmed by HRM. The adjacent developments are identified in Figure 4 and described in the following sections.



Figure 4: Adjacent Developments

5.1 Bedford Institute of Oceanography

The new access to the Bedford Institute of Oceanography was constructed in 2019. A traffic impact study completed in August 2016 to support the access indicated that the facility will grow by 200 employees by 2021 (BIO currently number of employees is approximately 800), resulting in 200 new trips to the study area. The study anticipated that up to 42 percent of the vehicles accessing the BIO campus would use the new access in Wallace Heights.

5.2 396, 398, 400 Windmill Road

The Harbour East and Marine Drive Community Council has approved the development agreement to enable the redevelopment of the Ship Victory Restaurant and Lounge site for a 10-storey mixed-use building consisting of two towers on a two-storey podium. The development agreement allows for a maximum gross floor area of 14,800 square feet of commercial use and 121,363 square feet of residential use. In addition, 50% of the residential units must contain two or more bedrooms.

5.3 Millbrook First Nations

The Millbrook First Nation (Millbrook) owns approximately 9 acres of land at Tufts Cove, adjacent to the CLC property. Development of the CLC lands will extend public roadways and infrastructure to the Millbrook property enabling its development. No detailed plans for the development of the Millbrook property have been made public, however, general indications are that the development could include a mix of residential and commercial land uses similar to the proposed development for the CLC lands.

5.4 Wallace Heights

The existing development in Wallace Heights, also known as Ocean Breeze Estates, consists of approximately 400 units in 50 buildings. The development includes a variety of apartment sizes and townhouses spanned over 67 acres of land.

The proposed Centre Plan Package A, which is currently under review by Regional Council, places this site in the Higher Order Residential Designation and Zone. As part of the review of Centre Plan documents, on June 25th, 2019, Regional Council provided direction to allow an increased amount of development on the site by changing the proposed zoning to HR-2 with a 38-metre height limit (12 storeys).

HRM planning staff are currently processing a subdivision application to subdivide the existing buildings onto separate lots. HRM is not aware of any specific development proposals at this time, but anticipate future interest in new multi-unit buildings given the proposed HR-2 zoning and subdivision activity.

5.5 Windmill Road Area (including the Shannon Plaza)

The portion of Windmill Road adjacent to the Shannon Park site will be considered as part of the Centre Plan Package B planning process. While the 2017 Centre Plan document identifies this area as “Employment Intensive” (industrial/commercial uses), the Centre Plan Package A that is currently under review by Regional Council identifies Windmill Road from Fernhill Road south as a “Corridor” (mixed use) with maximum building heights of 20 metres (4 storeys). It is unclear at this time which designation and zone will be applied to the portion of Windmill Road located adjacent to Shannon Park.

While increased development interest in the area is expected given the potential community stadium and planned redevelopment of Shannon Park, further reviews and consultation with property owners is needed to clarify the development potential of the area and the planning policies and zones that should be applied through the Centre Plan Package B planning process.

6 Transportation Demand Projections

Transportation forecasts for the proposed residential development were estimated using the traditional four-step model: trip generation, modal split, trip distribution and traffic assignment. Demand projections were developed for the weekday morning and afternoon peak hours of adjacent street traffic.

6.1 Trip Generation and Modal Split

The weekday peak hour trip generation estimates for the residential and commercial land uses were quantified using trip generation rates from the *Trip Generation Manual* (10th edition) published by the Institute of Transportation Engineers (ITE). The trip generation rates used to quantify the trip generation estimates are summarized in Table 2.

Table 2: Trip Generation Rates

ITE Land Use Code	Units	AM Peak Hour			PM Peak Hour		
		Rate ¹	In	Out	Rate ¹	In	Out
221 - Multifamily Housing (Mid-Rise)	Units	0.36	26%	74%	0.44	61%	39%
222 - Multifamily Housing (High-Rise)	Units	0.31	24%	76%	0.36	61%	39%
715 - General Office Building	1000 ft ²	1.16	86%	14%	1.15	16%	84%
814 - Variety Store	1000 ft ²	3.18	57%	43%	6.84	52%	48%
851 - Convenience Market	1000 ft ²	62.54	50%	50%	49.11	51%	49%
899 - Liquor Store	1000 ft ²	0.00	0%	0%	16.37	50%	50%
911 - Walk-In Bank	1000 ft ²	0.00	0%	0%	12.13	44%	56%
918 - Hair Salon	1000 ft ²	1.21	50%	50%	1.45	17%	83%
925 - Drinking Place	1000 ft ²	0.00	0%	0%	11.36	66%	34%
930 - Fast Casual Restaurant	1000 ft ²	2.07	67%	33%	14.13	55%	45%
931 - Quality Restaurant	1000 ft ²	0.73	50%	50%	7.80	67%	33%
932 - High-Turnover (Sit-Down) Restaurant	1000 ft ²	9.94	55%	45%	9.77	62%	38%
933 - Fast-Food Restaurant without Drive-Through	1000 ft ²	25.10	60%	40%	28.34	50%	50%
936 - Coffee/Donut Shop without Drive-Through	1000 ft ²	101.14	51%	49%	36.31	50%	50%
1. Trip generation rates are in 'vehicles per hour per unit'.							

The weekday morning and afternoon peak hour trip generation estimates and adjustments for the Shannon Park development are summarized in Table 3. The trip estimates were adjusted to reflect internal trips and modal split:

- Internal trips:** Internal trips are trips generated by a mixed-use development that both begin and end within the development. The internal captures were calculated using the National Cooperative Highway Research Program's (NCHRP) methodology outlined in *Report 684 Enhancing Internal Trip Capture Estimation for Mixed Use Developments*. This methodology is the recommended practice in the *ITE Trip Generation Handbook* (3rd edition). The NCHRP worksheets can be found in Appendix B.
- Mode Split:** The trip estimates were reduced by a mode split of 15.5% to account for trips made using non-auto transportation modes such as transit and active transportation. The mode split was developed in the original traffic impact study based on census data from three areas of HRM, Portland Hills, Montebello and Larry Uteck, believed to represent similar conditions to those anticipated for the Shannon Park development and discussions with HRM. It should be noted that this mode split assumes that there is no future ferry terminal located in Shannon Park area. The impact of the ferry terminal on mode split and the Shannon Park development is reviewed in an addendum to the traffic study.

Table 3: Shannon Park Development Trip Generation Estimates

Land Use	Units		AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
221 - Multifamily Housing (Mid-Rise)	380	Units	138	36	102	169	104	65
222 - Multifamily Housing (High-Rise)	2,620	Units	814	195	619	944	576	368
715 - General Office Building	23.50	1000 ft ²	27	23	4	27	4	23
814 - Variety Store	34.00	1000 ft ²	109	63	46	233	121	112
851 - Convenience Market	3.00	1000 ft ²	188	94	94	147	75	72
899 - Liquor Store	6.00	1000 ft ²	0	0	0	98	49	49
911 - Walk-In Bank	5.00	1000 ft ²	0	0	0	61	27	34
918 - Hair Salon	11.00	1000 ft ²	13	7	6	16	3	13
925 - Drinking Place	5.50	1000 ft ²	0	0	0	62	41	21
930 - Fast Casual Restaurant	6.00	1000 ft ²	12	8	4	84	46	38
931 - Quality Restaurant	19.00	1000 ft ²	0	0	0	148	99	49
931 - Quality Restaurant	20.00	1000 ft ²	14	8	6	156	104	52
932 - High-Turnover (Sit-Down) Restaurant	5.00	1000 ft ²	50	28	22	49	30	19
933 - Fast-Food Restaurant w/o DT	3.00	1000 ft ²	0	0	0	85	43	42
933 - Fast-Food Restaurant w/o DT	2.00	1000 ft ²	50	30	20	57	29	28
936 - Coffee/Donut Shop w/o DT	2.00	1000 ft ²	202	103	99	73	37	36
Total Trips Generated			1617	595	1022	2409	1388	1021
Internal Trips			182	91	91	778	389	389
External Trips			1435	504	931	1631	999	632
Reduction for non-auto modes (15.5 percent)			222	78	144	253	155	98
Adjusted Vehicle Trips			1213	426	787	1378	844	534
Pass-by Trips			102	51	51	110	55	55
Primary Trips			1111	375	736	1268	789	479

On a typical weekday, the Shannon Park development is expected to generate 1213 vehicle trips (426 entering/787 exiting) during the morning peak hour and 1378 vehicle trips (844 entering/534 exiting) during the afternoon peak hour. The site-generated vehicle trip estimates were further refined to account for different trip types, such as commercial pass-by trips and primary trips:

- **Pass-by trips:** A pass-by trip is a trip made as an intermediate stop on a primary trip and therefore does not consist of a new trip added to the adjacent street traffic. It was assumed that 25 percent of commercial vehicle trips (after adjustments) would consist of pass-by trips.
- **Primary trips:** The remaining trips are considered primary trip, which are new trips added to the adjacent street traffic. Of the total site-generated trips, 1111 vehicle trips (375 entering/736 exiting) during the morning peak hour and 1268 vehicle trips (789 entering/479 exiting) during the afternoon peak hour are expected to be primary trips.

The weekday morning and afternoon peak hour trip generation estimates and adjustments for the adjacent developments are summarized in Table 4. The trip estimates were adjusted to reflect modal split. On a typical weekday, the adjacent developments are expected to generate 206 vehicle trips (188 entering/18 exiting) during the morning peak hour and 210 vehicle trips (19 entering/191 exiting) during the afternoon peak hour.

Table 4: Adjacent Developments Trip Generation Estimates

Land Use	Units		AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
396-400 Windmill Road								
221 - Multifamily Housing (Mid-Rise)	72	Units	26	7	19	32	20	12
715 - General Office Building	14.8	1000 ft²	17	15	2	17	3	14
BIO								
New Employees	200	Jobs	200	200	0	200	0	200
Total Trips Generated			243	222	21	249	23	226
Reduction for non-auto modes (15.5 percent)			37	34	3	39	4	35
Adjusted Vehicle Trips			206	188	18	210	19	191

6.2 Trip Distribution and Assignment

Trips associated with the Shannon Park development and adjacent developments were distributed to the study area road network using the following trip distribution:

- 25% to/from Halifax via the MacKay Bridge,
- 15% to/from Bedford and areas to the north via Windmill Road,
- 25% to/from Dartmouth and areas south via Windmill Road, and
- 35% to/from the rest of the metro area via Highway 111.

The trip distribution is based on previous studies completed in the area including: the BIO Transportation Review and the Wrights Cove Land Use and Transportation Plan.

Trips associated with the Shannon Park development were assigned to the three access points using the following trip assignment:

- 60 percent to/from "Main Street",
- 15 percent to/from "Collector B", and
- 25 percent to/from Nootka Avenue.

The trip assignment was developed based on the development concept and location of access points relative to the gateways in and out of the study area. The distribution and assignment of the vehicle trip estimates associated with the Shannon Park development and adjacent developments at the study intersections are shown diagrammatically in Appendix C.

7 Intersection Performance Analysis

7.1 Measures of Effectiveness

The performance of an intersection can be evaluated using a number of measures of effectiveness (MOEs), including level of service (LOS), delay, volume-to-capacity ratio (v/c) and vehicle queuing.

Level of service is a qualitative measure used to describe the level of performance of an intersection in terms of traffic movement. Level of service for intersections is defined in terms of delay, which is a measure of driver discomfort, frustration and increased travel time. The quality of traffic movement is divided into six levels ranging from A to F, where level of service A represents the best quality of traffic where the driver has the freedom to drive with free flow speed and level of service F represents the worst quality of traffic where the level of congestion is considered unacceptable to most drivers. The level of service criteria for intersections (Table 5) are stated in terms of average control delay per vehicle.

Table 5: Level of Service Criteria

LOS	Description	Signalized Intersection Control Delay	Unsignalized Intersection Control Delay
A	No congestion; most vehicles do not stop. (Excellent)	≤ 10 sec/veh	≤ 10 sec/veh
B	Very light congestion; some vehicles stop. (Very Good)	10-20 sec/veh	10-15 sec/veh
C	Light congestion; most vehicles stop. (Good)	20-35 sec/veh	15-25 sec/veh
D	Noticeable congestion; vehicles must sometimes wait through more than one red light. No long-standing queues are formed. (Satisfactory)	35-55 sec/veh	25-35 sec/veh
E	Congestion; vehicles must sometimes wait through more than one red light. Long-standing queues are formed. (Unsatisfactory)	55-80 sec/veh	35-50 sec/veh
F	Severe congestion; demand exceeds the capacity of the intersection. (Unacceptable)	≥ 80 sec/veh	≥ 50 sec/veh

The volume-to-capacity (v/c) ratio is a measure of how the peak hour traffic volume on an approach to an intersection compares to the theoretical maximum volume that could be accommodated on that intersection approach. As the v/c ratio approaches 1.0, the movement has reduced ability to accommodate any additional volume of traffic.

The 95th percentile queue (95th% queue) is the estimated length in metres of a queue of vehicles stopped on an intersection approach which is only exceeded five percent of the time. Since a stopped vehicle occupies approximately seven metres of queue length, a 95th% queue of 14 metres indicates that less than five times of out 100 the queue may exceed two vehicles on the approach. The 95th% queue is typically used to determine if sufficient vehicle storage is available to maintain efficient traffic flow.

7.2 Analysis Software

The Synchro Studio 10 software package was used to complete the intersection performance analysis for signalized and unsignalized intersections. The software package includes two modelling applications: Synchro, a macroscopic analysis and optimization application, and SimTraffic, a microsimulation and

animation application. The two applications allow the analyst to analyze the intersections using two different approaches.

Synchro is used to analyze network intersections based on the methodology of the *Highway Capacity Manual* (6th edition) published by the Transportation Research Board. Synchro analyzes each intersection in isolation, while SimTraffic analyzes the network as a whole by simulating individual vehicles traversing the network. SimTraffic identifies interactions between adjacent intersections such as spillbacks from upstream and/or downstream intersections.

The Junctions 8 ARCADY software was used to complete the intersection performance analysis for roundabouts. ARCADY uses an empirical model based on the application of statistical regression of a large data set of observed roundabout operations in the United Kingdom.

8 Weekday Morning and Afternoon Peak Hour Analysis

The performance of the study intersections during the weekday AM and PM peak hours was evaluated under five scenarios to quantify the impact of the proposed development on the study area road network. The assessment scenarios included:

- Scenario 1 – Existing Conditions (2019): A scenario reflecting the existing conditions in the study area. This scenario provides an assessment of current operations based on existing traffic volumes, lane configurations and signal timing plans.
- Scenario 2 – Background Growth and Adjacent Developments (2027): A projection of normal traffic growth to the year 2027 and the projected traffic volumes associated adjacent developments. This scenario provides an assessment of future operations without the proposed development.
- Scenario 3 – Shannon Park Development (2027): A projection of background traffic volumes (from Scenario 2) and the projected traffic volumes associated with the Shannon Park development. This scenario provides an assessment of future operations with the proposed development in place which is used to identify if improvements are required to accommodate the proposed development.
- Scenario 4 – Future Development Conditions with Improvements (2027): A projection of future background and development traffic volumes (from Scenario 3) with the proposed improvements. This scenario provides an assessment of future operations with the proposed improvements.
- Scenario 5 – Five-Year timeframe after Shannon Park Development (2032): A projection of normal traffic growth five-years after full build out of the Shannon Park development.

The following sections summarize the results of the weekday peak hour intersection performance analysis. The traffic volumes used in each scenario are shown diagrammatically in Appendix C.

8.1 Scenario 1 - Existing (2019)

Scenario 1 is an analysis of existing conditions throughout the study area. The traffic volumes for this scenario correspond to the peak one-hour period of traffic from the weekday morning (7:15 to 8:15 am) and afternoon peak periods (4:00 to 5:00pm).

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 5. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths can be found in Appendix D. The detailed Synchro and SimTraffic reports can be found in Appendix E.

Under existing conditions, all study intersections generally experience no congestion to light congestion during the weekday morning and afternoon peak hours. A few individual movements at the intersections of Princess Margaret Boulevard & MacKay Bridge (Dartmouth) and Windmill Road & Victoria Road experience longer delays and/or queues, however, the overall performance of all study intersections is acceptable during both weekday peak hours. The operations at each of the study intersections are described below:

- **Princess Margaret Boulevard & BIO Access:** The unsignalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Halifax):** The unsignalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.
- **Princess Margaret Boulevard & Baffin Boulevard:** The unsignalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth):** The unsignalized intersection experiences no congestion (LOS A) during the morning peak hour; all movements operate at acceptable levels of service.

The intersection experiences light congestion (LOS C) during the afternoon peak hour. The southbound movements (MacKay Bridge) operate at LOS F in Synchro; however, the SimTraffic analysis indicates that the southbound movements operate at acceptable levels of service.

- **Princess Margaret Boulevard & Iroquois Drive:** The unsignalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.
- **Windmill Road & Victoria Road:** The signalized intersection experiences light congestion (LOS C) during the morning peak hour. The northbound left movement (Windmill Road) operates at LOS E in Synchro; however, the SimTraffic analysis indicates that the movement operates at an acceptable level of service.

The intersection experiences light congestion (LOS C) during the afternoon peak hour; all movements operate at acceptable levels of service.

- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection experiences very light congestion (LOS B) during the peak hours; all movements operate at acceptable levels of service. The 95th% queue lengths for the eastbound right movement (Princess Margaret Boulevard) indicate that existing queues exceed the storage capacity of the right turn lane during the afternoon peak hour.
- **Windmill Road & Nootka Avenue:** The unsignalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.
- **Windmill Road & Albro Lake Road:** The signalized intersection experiences no congestion (LOS A) during the peak hours; all movements operate at acceptable levels of service.

The 95th% queue lengths for the southbound left movement (Windmill Road) indicate that existing queues exceed the storage capacity of the left turn lane during the afternoon peak hour.

8.2 Scenario 2 – Background Growth and Adjacent Developments (2027)

Scenario 2 is an analysis of future conditions throughout the study area without the proposed development. The traffic volumes for this scenario reflect to the existing traffic volumes from Scenario 1 factored using a growth rate of 1.0 percent per year over eight years (2019-2032) to account for background traffic growth and the projected traffic volumes associated with adjacent developments in the study area, including BIO and 396-400 Windmill Road.

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 6. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths can be found in Appendix D. The detailed Synchro and SimTraffic reports can be found in Appendix E.

Under future background conditions, congestion levels increase throughout the study area. Background traffic growth and adjacent developments contribute to the deterioration of existing operational problems at the intersections of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) and Windmill Road & Victoria Road. The operations at each of the study intersections are described below:

- **Princess Margaret Boulevard & BIO Access:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Princess Margaret Boulevard & Baffin Boulevard:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound):** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience severe congestion (LOS F) during the afternoon peak hour. The southbound movements (MacKay Bridge) will continue to operate at LOS F in Synchro. The southbound approach will be over capacity and experience 95th percentile queues greater than 150 metres. However, the SimTraffic analysis indicates that the southbound movements will operate at LOS E with 95th percentile queues under 100 metres.

- **Princess Margaret Boulevard & Iroquois Drive:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Windmill Road & Victoria Road:** The signalized intersection will experience noticeable congestion (LOS D) during the morning peak hour. The northbound left movement (Windmill Road) will continue to operate at LOS E and the eastbound through movement (Windmill Road) will be over capacity and operate at LOS E in Synchro. The SimTraffic analysis indicates that these movements will operate at acceptable levels of service, but the southbound through movement (Lynch Estates Court) will operate at LOS E.

The intersection will experience light congestion (LOS C) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service.

- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection will experience very light (LOS B) congestion during the morning peak hour; all movements will continue to operate at acceptable levels of service. The signalized intersection will experience light congestion (LOS C) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service.

The 95th% queue lengths for the eastbound right movement (Princess Margaret Boulevard) will continue to exceed the storage capacity of the right turn lane during the afternoon peak hour and be nearing the capacity of the right turn lane during the morning peak hour. The 95th% queue lengths for the northbound left movement (Windmill Road) will exceed the storage capacity of the left turn lane during the afternoon peak hour.

- **Windmill Road & Nootka Avenue:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Windmill Road & Albro Lake Road:** The signalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service. The intersection will experience very light congestion (LOS B) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service.

The 95th% queue lengths for the southbound left movement (Windmill Road) will continue to exceed the storage capacity of the left turn lane during the afternoon peak hour.

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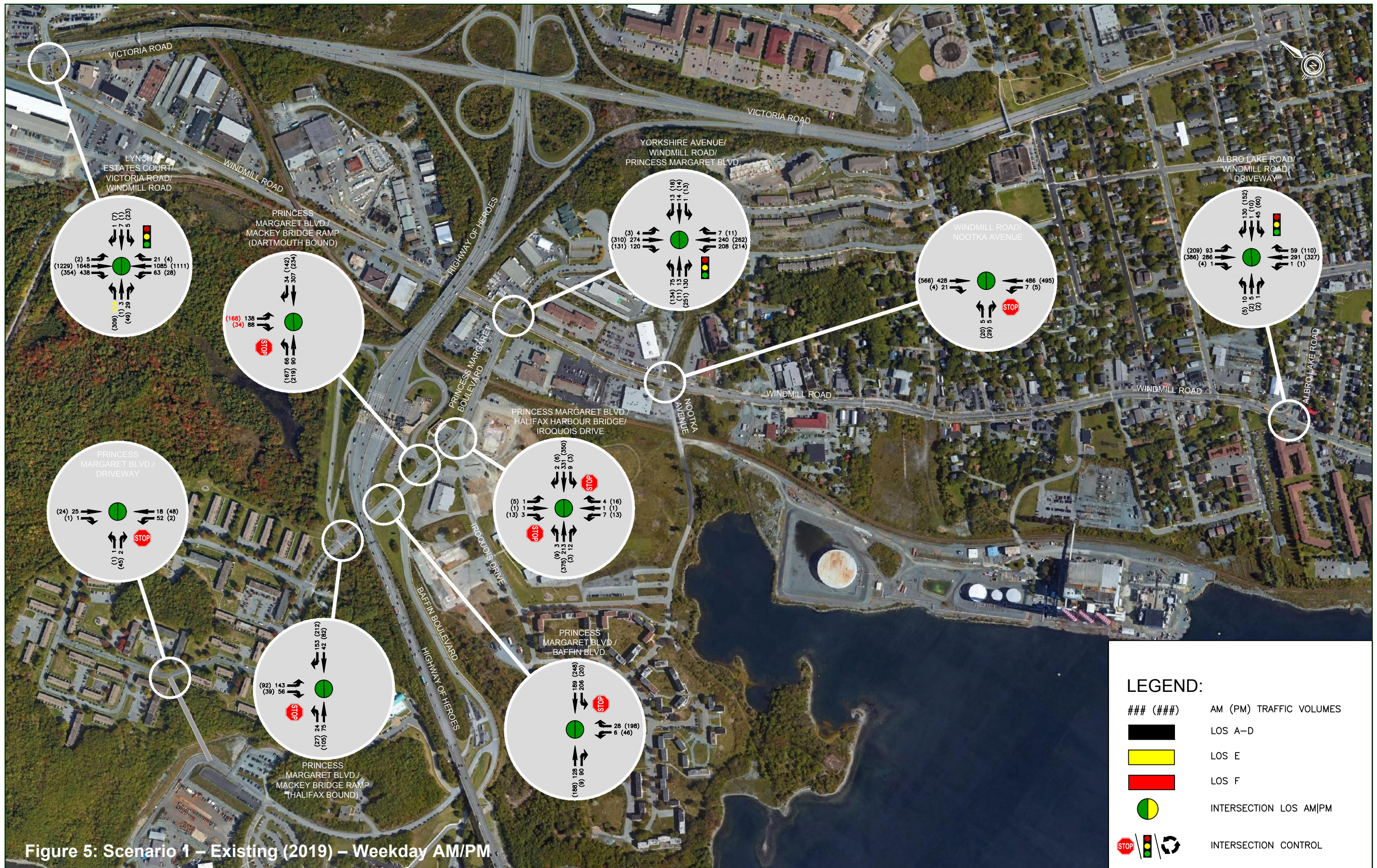


Figure 5: Scenario 1 – Existing (2019) – Weekday AM/PM

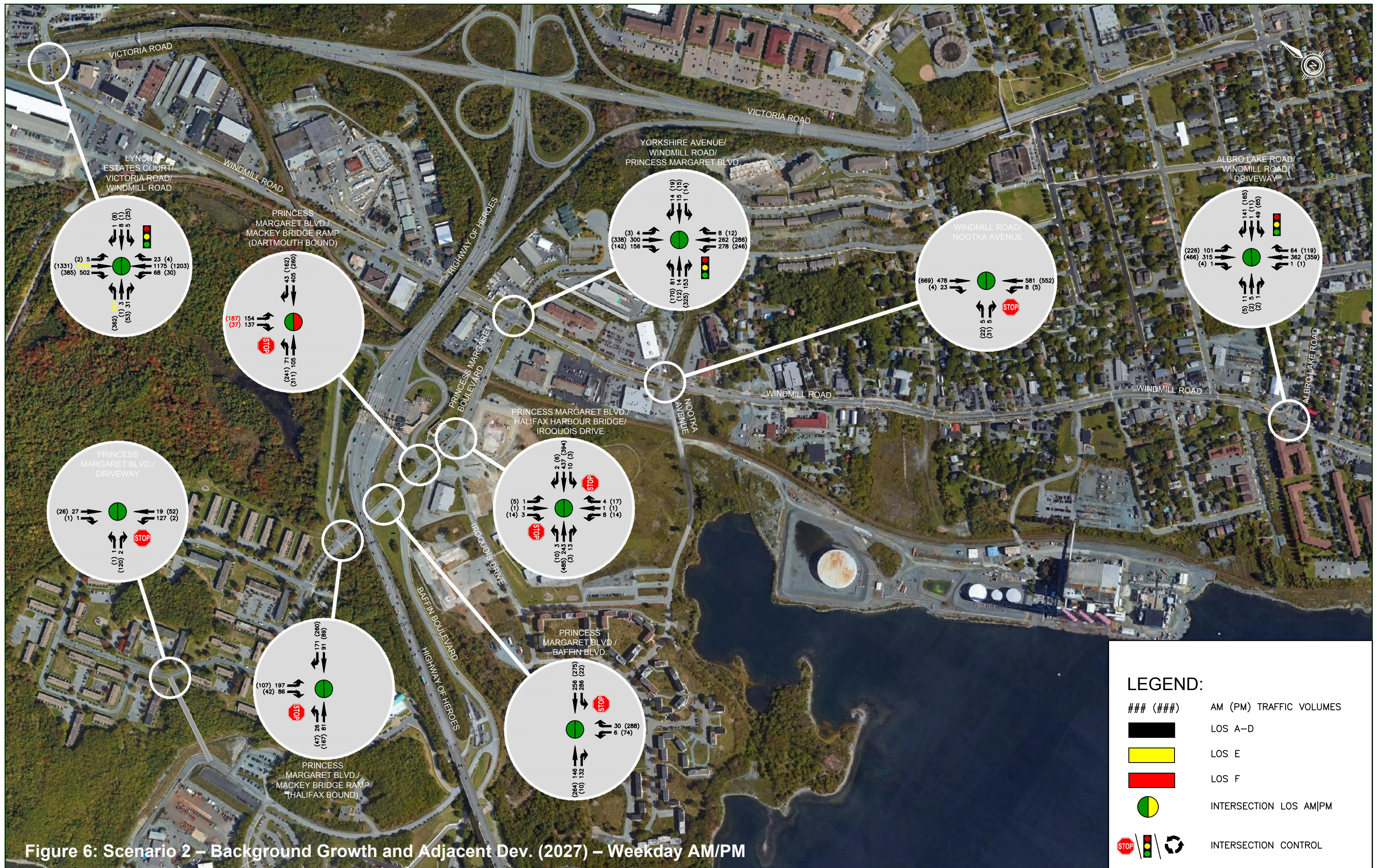


Figure 6: Scenario 2 – Background Growth and Adjacent Dev. (2027) – Weekday AM/PM

8.3 Scenario 3 – Shannon Park Development (2027)

Scenario 3 is an analysis of future conditions throughout the study area with the full build-out of the Shannon Park development. The traffic volumes for this scenario reflect the future background traffic volumes from Scenario 2 and the projected traffic volumes associated with the Shannon Park development.

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 7. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths can be found in Appendix D. The detailed Synchro and SimTraffic reports can be found in Appendix E.

The Shannon Park development contributes to the deterioration of existing operational problems and creates operational problems with individual movements at all study intersections with the exception of Princess Margaret Boulevard & BIO Access and Windmill Road & Albro Lake Road. The impacts of the development on operations at each of the study intersections are discussed below:

- **Princess Margaret Boulevard & BIO Access:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The unsignalized intersection will experience very light congestion (LOS B) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience severe congestion (LOS F) during the afternoon peak hour. The development will cause the southbound movements (MacKay Bridge) to operate at LOS F in Synchro. The southbound approach will be over capacity and experience 95th percentile queues greater than 150 metres. However, the SimTraffic analysis indicates that the southbound movements will operate at acceptable levels of service with 95th percentile queues under 100 metres.

- **Princess Margaret Boulevard & Baffin Boulevard:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The northbound left movement (Baffin Boulevard) will operate at LOS E in Synchro; however, the SimTraffic analysis indicates that the movement will operate at an acceptable level of service.

The intersection will experience light congestion (LOS C) during the afternoon peak hour. The northbound movements (Baffin Boulevard) will operate at LOS F in Synchro; however, the SimTraffic analysis indicates that the movements will operate at acceptable levels of service.

The 95th percentile queue lengths for the northbound left movement will exceed the storage capacity of the left turn lane during the afternoon peak hour.

- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) / "Main Street":** The main access to the development will become the fourth leg to the unsignalized intersection. The development will deteriorate existing operational problems at the intersection. The unsignalized

intersection will experience severe congestion (LOS F) during the morning and afternoon peak hours. The development will cause the northbound movements ("Main Street") and southbound movements (MacKay Bridge) to be over capacity and operate at LOS F during both peak hours. The southbound approach will experience 95th percentile queues that will back up onto the MacKay Bridge toll plaza.

- **Princess Margaret Boulevard & "Collector B" (formerly Iroquois Drive):** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The development will cause the northbound movements ("Collector B") to operate at LOS F in Synchro; however, the SimTraffic analysis indicates that the northbound movements will operate at acceptable levels of service.

The intersection will experience light congestion (LOS C) during the afternoon peak hour. The development will cause the northbound movements ("Collector B") to be over capacity and operate at LOS F in Synchro; however, the SimTraffic analysis indicates that the northbound movements will operate at acceptable levels of service.

- **Windmill Road & Victoria Road:** The signalized intersection will experience noticeable congestion (LOS D) during the morning peak hour. The northbound left movement (Windmill Road) and the eastbound through movement (Windmill Road) will continue to operate at LOS E; the development will cause the northbound through and right movements to operate at LOS E in Synchro. However, the SimTraffic analysis continues to indicate that these movements will operate at acceptable levels of service.

The intersection will experience light congestion (LOS C) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service

- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection will experience light congestion (LOS C) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience noticeable congestion (LOS D) during the afternoon peak hour. The development will cause the northbound left movement (Windmill Road) to be over capacity and operate at LOS F in Synchro. However, the SimTraffic analysis indicates that the movement will operate at an acceptable level of service, but the southbound left and through movements (Windmill Road) will operate at LOS E.

The 95th queue lengths for the eastbound right movement (Princess Margaret Boulevard) and the northbound left movement (Windmill Road) will exceed the storage capacity of the turning lanes during both peak hours.

- **Windmill Road & Nootka Avenue:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The development will cause the eastbound movements (Nootka Avenue) to operate at LOS E in Synchro; however, the SimTraffic analysis indicates that the eastbound movements will operate at acceptable levels of service.

The intersection will experience light congestion (LOS C) during the afternoon peak hour. The development will cause the eastbound movements (Nootka Avenue) to be over capacity and operate at LOS F in Synchro. However, the SimTraffic analysis indicates that the eastbound left movement will operate at LOS E while the eastbound right movement will operate at an acceptable level of service.

- **Windmill Road & Albro Lake Road:** The signalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience very light congestion (LOS B) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service.

The 95th% queue lengths for the southbound left movement (Windmill Road) will continue to exceed the storage capacity of the left turn lane during the afternoon peak hour and be nearing the capacity of the left turn lane during the morning peak hour.

8.4 Scenario 4 – Shannon Park Development with Improvements (2027)

Scenario 4 is an analysis of future conditions throughout the study area with the full build-out of the Shannon Park development with road network improvements in place to mitigate the impact of the development. The traffic volumes for this scenario reflect the future background traffic volumes and the projected traffic volumes associated with the Shannon Park development from Scenario 3.

The following road network improvements are included in this scenario, further discussion regarding the proposed improvements is provided in Section 10.0 :

- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** A single-lane roundabout is recommended to improve operations while minimizing queuing on the MacKay Bridge approach.
- **Princess Margaret Boulevard & Baffin Boulevard:** Right-in, right-out access restrictions are recommended for the Baffin Boulevard approach.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street”:** A single-lane roundabout with an eastbound right turn by-pass is recommended to improve operations while minimizing queuing on the MacKay Bridge approach and Princess Margaret Boulevard. The eastbound right turn lane is required to maintain acceptable traffic operations at the roundabout.
- **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** Right-in, right-out access restrictions are recommended for the “Collector B” approach.
- **Windmill Road & Victoria Road:** Changes to the morning peak hour signal timings are recommended.
- **Windmill Road & Princess Margaret Boulevard:** A left turn storage lane (75 metres) on the Princess Margaret Boulevard eastbound approach is recommended to separate the left turn movement, it is also recommended that the existing right turn storage lane be extended to 50 metres. Eastbound queues greater than 100 metres on the Princess Margaret Boulevard approach

would impact the CN at-grade crossing on Princess Margaret Boulevard, the new lane configuration will minimize queue lengths on the approach. A right turn storage lane (40 metres) on the Windmill Road southbound is also recommended to separate the high-volume right turn movement from the through movement and improve operations for both movements.

- **Windmill Road & Nootka Avenue:** A left-turn storage lane (25 metres) on the Nootka Avenue approach is recommended to separate the left turn movement and improve operations for the right turn movement. Queues greater than 75 metres on the Nootka Avenue approach would impact the CN at-grade crossing on Nootka Avenue, the storage lane will minimize queue lengths on the approach.

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 8. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths can be found in Appendix D. The detailed Synchro and SimTraffic reports can be found in Appendix E.

The proposed improvements improve operations at the five intersections where improvements were proposed. The impacts of the improvements on operations at each of the study intersections are described below:

- **Princess Margaret Boulevard & BIO Access:** No improvements were proposed for the unsignalized intersection; however, the intersection will experience an increase in traffic volumes caused by the proposed access restrictions at Baffin Boulevard. The unsignalized intersection will continue to experience no congestion (LOS A) during the peak hours; all movements will operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach.
- **Princess Margaret Boulevard & Baffin Boulevard:** The right-in, right-out access restrictions will improve operations at the unsignalized intersection. The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will operate at acceptable levels of service. The unsignalized intersection will experience very light congestion (LOS B) during the afternoon peak hour, the northbound right turn movement (Baffin Boulevard) will continue to operate at LOS F in Synchro. The SimTraffic analysis indicates that the northbound right movement will operate at an acceptable level of service.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ "Main Street":** The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach.

- **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** The right-in, right-out access restrictions will improve operations at the unsignalized intersection. The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will operate at acceptable levels of service.
- **Windmill Road & Victoria Road:** The signalized intersection will continue to experience noticeable congestion (LOS D) during the morning peak hour, however, changes to the signal timings will improve operations for the eastbound through movement to an acceptable level of service (LOS D). The northbound movements will continue to operate at LOS E. The intersection will continue to experience light congestion (LOS C) during the afternoon peak hour.
- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection will experience very light congestion (LOS B) during the morning peak hour; all movements will continue to operate at acceptable levels of service. Average delay per vehicle at the intersection will be reduced by approximately 7.5 seconds.

The intersection will experience very light congestion (LOS B) during the afternoon peak hour; all movements will operate at acceptable levels of service. Average delay per vehicle at the intersection will be reduced by approximately 21.5 seconds.

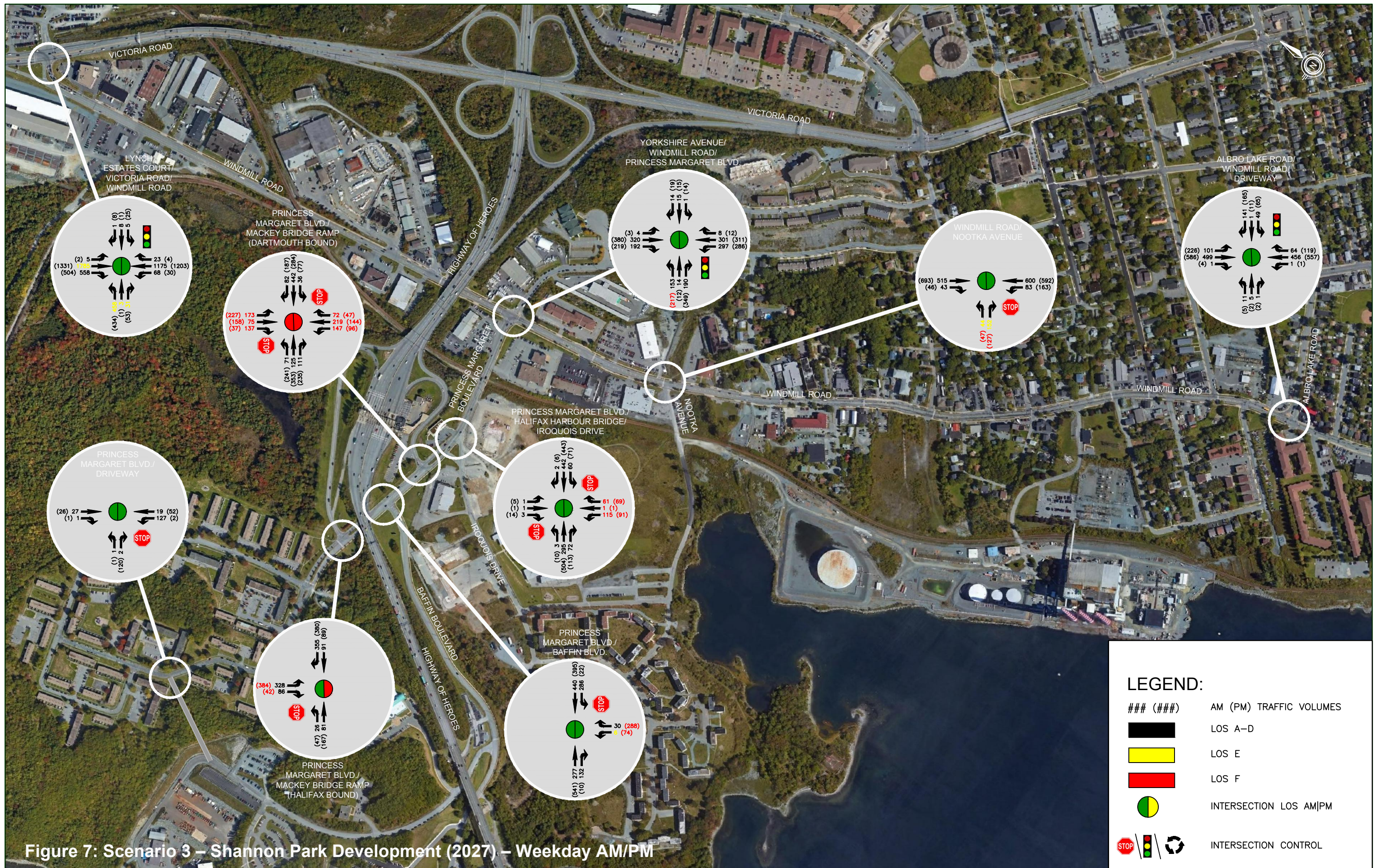
The 95th percentile queue lengths on the Princess Margaret eastbound approach indicate that intersection queues will not impact the at-grade CN rail crossing.

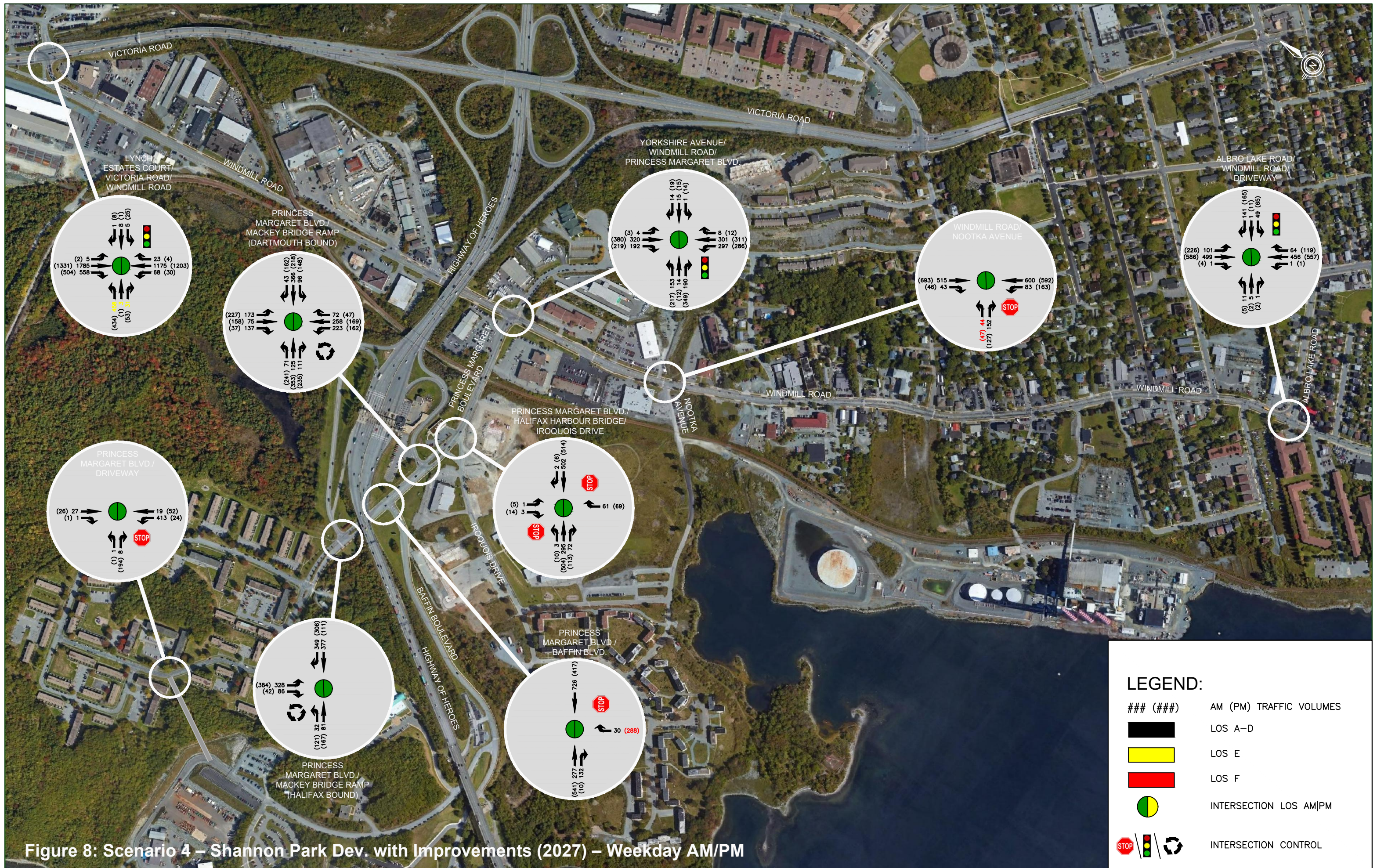
- **Windmill Road & Nootka Avenue:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The new lane configuration on the eastbound approach (Nootka Avenue) will improve operations for the eastbound right movement to an acceptable level of service while the eastbound left movement will operate at LOS F in Synchro. The SimTraffic analysis continues to indicate that the eastbound left movement will operate at an acceptable level of service. Average delay per vehicle at the intersection will be reduced by approximately 3.4 seconds.

The intersection will experience no congestion (LOS A) during the afternoon peak hour. The new lane configuration will improve operations for the eastbound right movement to an acceptable level of service while the eastbound left movement will continue to operate at LOS F in Synchro. The eastbound movements will no longer be over capacity. The SimTraffic analysis indicates that the eastbound left movement will operate at LOS E. Average delay per vehicle at the intersection will be reduced by approximately 9.7 seconds. The 95th percentile queue lengths on the Nootka Avenue approach indicate that intersection queues will not impact the at-grade CN rail crossing.

- **Windmill Road & Albro Lake Road:** No improvements were proposed for the signalized intersection, conditions will remain the same during both peak hours. The signalized intersection will continue experience no congestion (LOS A) during the morning peak hour and very light congestion (LOS B) during the afternoon peak hour; all movements will operate at acceptable levels of service.

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8.5 Scenario 5 – Five-year Timeframe after Shannon Park Development (2032)

Scenario 5 is an analysis of future conditions throughout the study area five years after the full build-out of the Shannon Park development. The traffic volumes for this scenario reflect the future background traffic volumes and the projected traffic volumes associated with the Shannon Park development from Scenario 3 factored using a growth rate of 1.0 percent per year over five years (2027-2032) to account for background traffic growth. The road network reflects the proposed improvements from Scenario 4.

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 9. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths can be found in Appendix D. The detailed Synchro and SimTraffic reports can be found in Appendix E. Traffic growth will increase congestion levels throughout the study area and contribute to the deterioration of operational problems with individual movements. The operations at each of the study intersections are described below:

- **Princess Margaret Boulevard & BIO Access:** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach.
- **Princess Margaret Boulevard & Baffin Boulevard:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience light congestion (LOS C) during the afternoon peak hour. The northbound right movement (Baffin Boulevard) will continue to operate at LOS F in Synchro; the right movement will be over capacity. The SimTraffic analysis indicates that the northbound right movement will operate at an acceptable level of service.

Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street”: The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach.

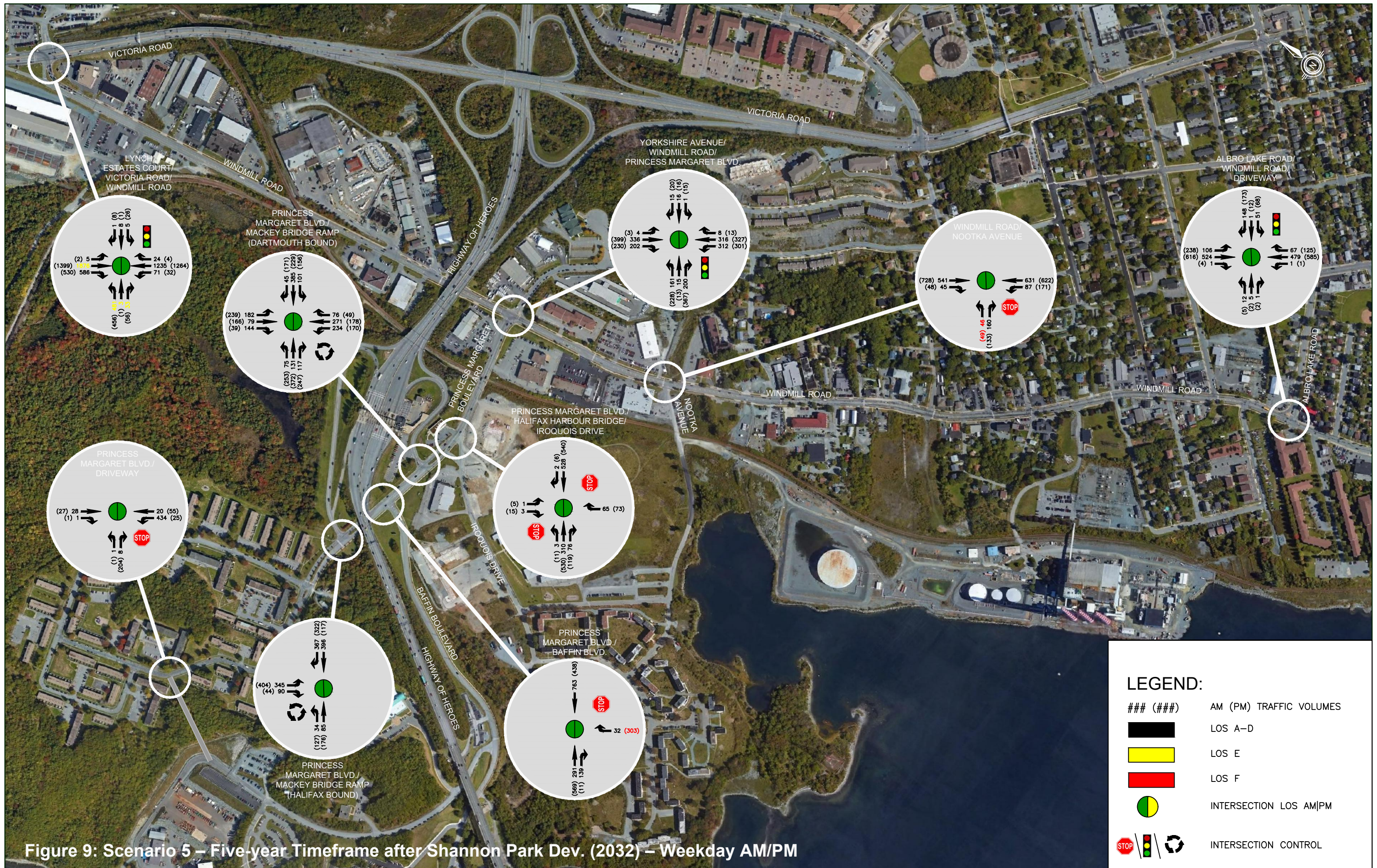
- **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** The unsignalized intersection will experience no congestion (LOS A) during the peak hours; all movements will continue to operate at acceptable levels of service.
- **Windmill Road & Victoria Road:** The signalized intersection will experience noticeable congestion (LOS D) during the morning peak hour; operations for the eastbound through movement will deteriorate to LOS E and the northbound movements will continue to operate at LOS E. The intersection will continue to experience light congestion (LOS C) during the afternoon peak hour.

- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection will experience very light congestion (LOS B) during the morning peak hour; all movements will continue to operate at acceptable levels of service. The signalized intersection will experience light congestion (LOS C) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service. The 95th percentile queue lengths on the Princess Margaret eastbound approach continue to indicate that intersection queues will not impact the at-grade CN rail crossing.
- **Windmill Road & Nootka Avenue:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The eastbound left movement (Nootka Avenue) will continue to operate at LOS F in Synchro. The SimTraffic analysis continues to indicate that the movement will operate at an acceptable level of service.

The unsignalized intersection will experience no congestion (LOS A) during the afternoon peak hour. The eastbound left movement (Nootka Avenue) will continue to operate at LOS F in Synchro. The 95th percentile queue lengths on the Nootka Avenue approach continue to indicate that intersection queues will not impact the at-grade CN rail crossing.

- **Windmill Road & Albro Lake Road:** The signalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service.

The intersection will experience very light congestion (LOS B) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service in Synchro. The SimTraffic analysis indicates that the southbound left movement (Windmill Road) will operate at LOS E. The 95th percentile queue lengths for the southbound left movement will continue to exceed the storage capacity of the left turn lane during the afternoon peak hour.



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8.6 Residual Capacity

The proposed improvement plan ensures that there will be no operational issues on Princess Margaret Boulevard during the peak hours on a typical weekday. However, incidents or closures on the Harbour Bridges can have a significant impact on travel patterns and cause significant increase in traffic volumes on Princess Margaret Boulevard.

At the roundabout intersections, the maximum volume to capacity ratios from the analysis provide an indication of residual capacity at intersections. The peak hour volume to capacity ratios from Scenario 5 are summarized in Table 6.

During the morning peak hour, the peak direction of traffic is westbound on Princess Margaret Boulevard heading towards the MacKay Bridge (Halifax-bound). The maximum volume-to-capacity ratio at both roundabouts are observed on the Princess Margaret Boulevard westbound roundabout approaches:

- 0.65 at the Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- 0.60 at the Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street

During the afternoon peak hour, the peak direction of traffic is eastbound on Princess Margaret Boulevard. The maximum volume to capacity ratios at the roundabouts are observed on the MacKay Bridge Ramp (Halifax-bound) and the Princess Margaret Boulevard eastbound roundabout approaches:

- 0.40 at the Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- 0.70 at the Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street

The maximum volume-to-capacity ratio indicate the roundabouts could accommodate peak hour peak direction traffic volumes increases up to 30 percent on Princess Margaret Boulevard.

Table 6: Maximum v/c ratios

Intersection	Approach	Max v/c Ratio	
		AM Peak Hour (2032)	PM Peak Hour (2032)
Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)	Princess Margaret Boulevard (EB)	0.12	0.32
	Princess Margaret Boulevard (WB)	0.65	0.39
	MacKay Bridge (Halifax-bound)	0.45	0.40
Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street”	Princess Margaret Boulevard (EB)	0.21	0.70
	Princess Margaret Boulevard (WB)	0.60	0.64
	“Main Street”	0.59	0.54
	MacKay Bridge (Dartmouth-bound)	0.50	0.49

At the signalized intersection of Windmill Road and Princess Margaret Boulevard, the intersection capacity utilization (ICU) values reported in the Synchro analysis provide an indication of how much residual capacity is available to handle traffic fluctuations and incidents. Synchro reported the following ICU results for the intersection of Windmill Road and Princess Margaret Boulevard in 2032:

- AM Peak Hour ICU of 66.8%. The ICU corresponds to an ICU LOS C (>64% to 73%) where traffic fluctuations, accidents and lane closures may cause some congestion. This intersection can accommodate up to 20% more traffic on all movements.
- PM Peak Hour ICU of 73.3%. The ICU corresponds to an ICU LOS D (>73% to 82%) where traffic fluctuations, accidents and lane closures can cause significant congestion. This intersection can accommodate up to 10% more traffic on all movements.

9 Princess Margaret Boulevard Corridor Analysis

The intersection performance analysis identified a number of road network improvements required along Princess Margaret Boulevard to mitigate the impact of the Shannon Park development. Under existing conditions, the Princess Margaret Boulevard corridor includes unsignalized intersections with minor street stop control; traffic flows freely along the entire length of the corridor until the signalized intersection at Windmill Road. The proposed improvements include changes to intersection controls along the corridor, such as roundabout at the Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ 'Main Street' intersection, which will introduce delay and queues along the corridor.

The intersections along Princess Margaret Boulevard are closely spaced making it important to identify interactions between adjacent intersections. Different types of software were used to model the intersections based on the type of intersection control. While the queue length results from the various analyses are a good indicator of intersections between adjacent intersections, a supplemental corridor analysis was completed along Princess Margaret Boulevard to confirm the results of the intersection performance analysis completed using Synchro and Arcady. PTV Vissim was used to complete the corridor analysis PTV Vissim is a microscopic multi-modal traffic flow simulation software.

The study area for the corridor analysis was limited to the section of Princess Margaret Boulevard from the ramps to the MacKay Bridge toll plaza to Windmill Road. Five study intersections were included in the analysis:

- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)
- Princess Margaret Boulevard & Iroquois Drive
- Princess Margaret Boulevard & Windmill Road

The performance of the study intersections during the weekday AM and PM peak hours was reevaluated under two of the previous scenarios to evaluate the interactions between adjacent intersections (unsignalized, signalized and roundabout), identify any potential impacts to the at-grade rail crossing on Princess Margaret Boulevard and confirm the proposed improvements. The assessment scenarios included:

- Scenario 1 – Existing (2019)
- Scenario 5 – Five-Year timeframe after Shannon Park Development (2032)

The Vissim models were developed from the MacKay Bridge toll model provided by HHB. It should be noted that the models do not include dynamic assignment.

The following sections summarize the results of the weekday peak hour corridor analysis. The traffic volumes used in each scenario correspond to the traffic volumes used in the intersection performance analysis for each scenario, the volumes shown diagrammatically in Appendix C.

9.1 Scenario 1 – Existing (2019)

Scenario 1 is an analysis of existing conditions on Princess Margaret Boulevard. The traffic volumes for this scenario correspond to the peak one-hour period of traffic from the weekday morning (7:15 to 8:15 am) and afternoon peak periods (4:00 to 5:00pm).

The MOE results including delay, level of service and queue lengths are summarized in Table 7. The detailed Vissim outputs can be found in Appendix F. The results of the Vissim analysis are consistent with the Synchro/SimTraffic results; all intersections operate at acceptable levels of service.

Table 7: Scenario 1 – Existing (2019) Weekday AM/PM Corridor Analysis

Scenario 1 - Existing (2019)		PTV Vissim							
Intersection		Weekday AM Peak Hour				Weekday PM Peak Hour			
		Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)	Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)
Princess Margaret Blvd & MacKay Bridge (Halifax-bound)		3.9	A			2.5	A		
Princess Margaret Blvd	EB-L	2.4	A	0.0	8.2	3.0	A	0.1	9.4
	EB-T	0.0	A	0.0	0.0	0.0	A	0.0	0.5
	WB-T	1.0	A	0.0	0.0	1.2	A	0.0	0.0
	WB-R	0.6	A	0.0	0.0	0.8	A	0.0	0.0
MacKay Bridge (Halifax)	SB-L	9.1	A	2.9	34.1	8.1	A	1.7	24.6
	SB-R	7.3	A	3.3	35.7	6.5	A	1.9	26.1
Princess Margaret Blvd & Baffin Blvd		1.3	A			3.1	A		
Princess Margaret Blvd	EB-T	0.8	A	0.0	0.0	0.9	A	0.0	0.0
	EB-R	0.5	A	0.0	0.0	0.5	A	0.0	0.0
	WB-L	2.1	A	0.2	19.0	1.6	A	0.0	6.5
	WB-T	0.1	A	0.0	3.2	0.1	A	0.0	0.0
Baffin Blvd	NB-L	8.5	A	0.3	12.5	7.7	A	2.8	32.6
	NB-R	6.1	A	0.5	17.5	8.2	A	4.4	37.7
Princess Margaret Blvd & MacKay Bridge (Dartmouth-bound)		3.1	A			3.4	A		
Princess Margaret Blvd	EB-L	2.6	A	0.1	11.0	3.7	A	0.5	21.9
	EB-T	0.2	A	0.0	0.0	0.4	A	0.1	10.4
	WB-T	0.1	A	0.0	0.0	0.1	A	0.0	1.6
	WB-R	0.0	A	0.0	0.0	0.0	A	0.0	1.6
MacKay Bridge (Dartmouth)	SB-L	9.7	A	2.9	27.7	15.7	C	4.3	41.4
	SB-R	8.1	A	4.4	33.1	11.6	B	5.6	46.7

Scenario 1 - Existing (2019)		PTV Vissim							
Intersection		Weekday AM Peak Hour				Weekday PM Peak Hour			
		Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)	Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)
Princess Margaret Blvd & Iroquois Dr		1.1	A			1.5	A		
Princess Margaret Blvd	EB-L	1.9	A	0.0	0.0	2.7	A	0.0	7.2
	EB-T	1.6	A	0.0	0.0	1.4	A	0.0	0.0
	WB-L	1.3	A	0.0	7.7	3.1	A	0.0	2.5
	WB-T	0.3	A	0.0	2.5	0.4	A	0.0	0.0
	WB-R	0.1	A	0.0	2.5	0.0	A	0.0	0.0
Iroquois Dr	NB-L	8.8	A	0.1	9.1	9.7	A	0.3	13.7
	NB-T	9.2	A	0.1	11.0	10.3	B	0.4	15.6
	NB-R	7.2	A	0.3	17.9	9.8	A	0.6	22.5
HHB	SB-L	10.5	B	0.1	18.4	12.2	B	0.3	21.2
	SB-T	10.8	B	0.1	18.4	10.8	B	0.3	21.2
	SB-R	7.2	A	0.1	21.1	6.9	A	0.4	23.9
Iroquois Dr		2.8	A			2.0	A		
Princess Margaret Blvd	EB-R	6.3	A	0.1	9.3	6.2	A	0.0	9.2
Iroquois Dr	NB-T	1.8	A	0.0	0.0	1.7	A	0.0	0.0
	SB-T	0.1	A	0.0	0.0	0.1	A	0.0	0.0
Windmill Rd & Princess Margaret Blvd		11.3	B			14.2	B		
Princess Margaret Blvd	EB-L	30.9	C	4.2	41.1	27.9	C	6.2	67.7
	EB-T	30.3	C	4.2	41.1	29.6	C	6.2	67.7
	EB-R	2.2	A	4.2	41.1	3.1	A	6.2	67.7
Yorkshire Ave	WB-L	30.2	C	0.6	13.5	33.7	C	1.3	19.3
	WB-T	31.2	C	0.6	13.5	30.0	C	1.3	19.3
	WB-R	3.3	A	1.5	22.9	7.6	A	2.9	28.7
Windmill Rd	NB-L	9.7	A	2.2	46.6	14.0	B	3.8	52.6
	NB-T	5.6	A	1.9	41.5	9.5	A	3.8	54.4
	NB-R	0.5	A	0.0	0.0	1.7	A	0.0	0.6
	SB-L	13.8	B	8.2	73.9	14.7	B	13.2	74.6
	SB-T	15.2	B	8.2	73.9	19.3	B	13.2	74.6
	SB-R	10.7	B	8.2	73.9	15.1	B	13.2	74.6

9.2 Scenario 5 – Five-Year Timeframe after Shannon Park Development (2032)

Scenario 5 is an analysis of future conditions on Princess Margaret Boulevard five years after the full build-out of the Shannon Park development. The traffic volumes for this scenario reflect the future background traffic volumes and the projected traffic volumes associated with the Shannon Park development factored using a growth rate of 1.0 percent per year over five years (2027-2032) to account for background traffic growth. The road network reflects the proposed road network improvements, including:

- Single lane roundabout at Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Right-in, right-out configuration at Baffin Boulevard
- Single lane roundabout with eastbound right turn by-pass at Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/'Main Street'
- Right-in, right-out configuration at 'Collector B'
- Lane reconfiguration at Princess Margaret Boulevard & Windmill Road

In addition, the MacKay Bridge ramps were modelled as merge lanes to a free-flow highway to represent the future automated toll system.

The MOE results including delay, level of service and queue lengths are summarized in Table 8. The detailed Vissim outputs can be found in Appendix F. The results of the Vissim analysis are generally consistent with the Synchro/SimTraffic and Arcady results for the morning and afternoon peak hour; all intersections will operate at acceptable levels of service.

- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** Maximum queues lengths on the MacKay Bridge Ramp will not exceed 100 metres, queues will not impact the toll plaza. Maximum queue lengths on Princess Margaret Boulevard will not exceed 40 metres, queues will not extend into the adjacent roundabout at the MacKay Bridge Ramp (Dartmouth-bound).
- **Princess Margaret Boulevard & Baffin Boulevard:** Similar to the SimTraffic analysis, Vissim indicates that the northbound right movement (Baffin Boulevard) will operate at acceptable levels of service.
- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound):** Maximum queues lengths on the MacKay Bridge Ramp will not exceed 75 metres, queues will not impact the toll plaza. Maximum queue lengths on Princess Margaret Boulevard will not exceed 75 metres, queues will not extend into the adjacent roundabout at the MacKay Bridge Ramp (Halifax-bound) or impact the at-grade CN rail crossing.
- **Windmill Road & Princess Margaret Boulevard:** Maximum eastbound queue lengths on Princess Margaret Boulevard will not exceed 75 metres, queues will not impact the at-grade CN rail crossing.

The Vissim analysis confirms that the queue lengths on the Princess Margaret Boulevard will not impact the at-grade CN rail crossing and the queue lengths on the MacKay Bridge ramps will not impact the toll plaza.

Table 8: Scenario 5 – Five-Year Timeframe (2032) Weekday AM/PM Corridor Analysis

Scenario 5 - Five-Year Timeframe (2032)		PTV Vissim							
Intersection		Weekday AM Peak Hour				Weekday PM Peak Hour			
		Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)	Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)
Princess Margaret Blvd & MacKay Bridge (Halifax-bound)		2.3	A			1.5	A		
Princess Margaret Blvd	EB-L	1.8	A	0.1	10.3	2.2	A	0.2	23.2
	EB-T	1.9	A	0.1	10.3	2.2	A	0.2	23.2
	WB-T	0.5	A	0.0	19.4	0.7	A	0.1	14.4
	WB-R	0.5	A	0.0	19.4	0.8	A	0.1	14.4
MacKay Bridge (Halifax)	SB-L	5.9	A	3.2	66.8	1.8	A	0.4	32.2
	SB-R	5.1	A	3.2	66.8	1.8	A	0.4	32.2
Princess Margaret Blvd & Baffin Blvd		0.5	A			4.1	A		
Princess Margaret Blvd	EB-T	0.6	A	0.0	0.0	0.4	A	0.0	0.0
	EB-R	0.6	A	0.0	0.0	0.5	A	0.0	0.0
	WB-T	0.2	A	0.0	0.0	0.1	A	0.0	0.0
Baffin Blvd	NB-R	6.6	A	0.4	17.0	17.3	C	11.1	63.5
Princess Margaret Blvd & MacKay Bridge (Dartmouth-bound)		4.0	A			6.5	A		
Princess Margaret Blvd	EB-L	1.0	A	0.1	10.6	3.7	A	1.8	57.0
	EB-T	1.1	A	0.1	10.6	3.6	A	1.8	57.0
	EB-R	1.2	A	0.1	8.9	5.3	A	1.3	32.6
	WB-L	6.6	A	5.2	74.8	9.6	A	9.1	76.4
	WB-T	6.7	A	5.2	74.8	9.6	A	9.1	76.4
	WB-R	6.5	A	5.2	74.8	9.0	A	9.1	76.4
"Main Street"	NB-L	2.2	A	1.0	50.7	9.4	A	5.6	69.4
	NB-T	2.4	A	1.0	50.7	9.3	A	5.6	69.4
	NB-R	2.2	A	1.0	50.7	9.6	A	5.6	69.4
MacKay Bridge (Dartmouth)	SB-L	5.3	A	1.6	40.6	4.6	A	1.8	44.8
	SB-T	5.1	A	1.6	40.6	4.8	A	1.8	44.8
	SB-R	4.5	A	1.5	40.9	4.5	A	1.8	45.5
Princess Margaret Blvd & "Collector B"		1.4	A			2.0	A		
Princess Margaret Blvd	EB-L	1.6	A	0.0	2.4	3.2	A	0.1	25.9
	EB-T	0.5	A	0.0	0.0	0.7	A	0.0	13.2
	EB-R	0.5	A	0.0	0.0	0.5	A	0.0	13.2
	WB-T	0.8	A	0.2	22.9	1.6	A	0.5	33.2
	WB-R	0.4	A	0.2	22.9	0.8	A	0.5	33.2
"Collector B"	NB-R	10.6	B	1.2	23.3	12.8	B	1.4	23.6
HHB	SB-L	15.5	C	0.1	20.0	12.1	B	0.3	22.7
	SB-R	8.5	A	0.1	21.3	10.5	B	0.5	24.0
	SB-T								

Scenario 5 - Five-Year Timeframe (2032)		PTV Vissim							
Intersection		Weekday AM Peak Hour				Weekday PM Peak Hour			
		Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)	Delay (s/veh)	LOS	Average Queue (m)	Max Queue (m)
Windmill Rd & Princess Margaret Blvd		13.6	B			16.7	B		
Princess Margaret Blvd	EB-L	33.5	C	8.8	55.3	28.8	C	10.6	72.3
	EB-T	28.9	C	2.0	22.6	24.8	C	4.7	38.6
	EB-R	7.8	A	4.5	30.3	11.1	B	8.3	46.2
Yorkshire Ave	WB-L	44.1	D	0.9	16.1	31.7	C	1.4	20.4
	WB-T	30.0	C	0.9	16.1	27.2	C	1.4	20.4
	WB-R	5.8	A	2.1	25.6	6.0	A	3.2	29.9
Windmill Rd	NB-L	14.2	B	6.3	69.6	25.1	C	12.4	83.0
	NB-T	7.4	A	3.4	51.8	11.5	B	5.9	66.4
	NB-R	1.2	A	0.0	0.6	3.2	A	0.1	6.4
	SB-L	15.2	B	11.4	76.3	21.5	C	16.8	80.9
	SB-T	19.3	B	11.4	76.3	22.1	C	16.8	80.9
	SB-R	0.9	A	0.0	7.7	0.9	A	0.0	8.0

10 Roadway Infrastructure Improvements

10.1 Discussion of Potential Improvements

Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)

The intersection experiences poor levels of service and longer queues on the MacKay Bridge approach during the afternoon peak hour under future development conditions. Providing a left-turn storage lane on the MacKay Bridge approach to separate the left turn movement would improve operations for the right turn movement. However, with the exclusive turning lane, the MacKay Bridge Ramp southbound left movement is expected to operate at LOS F during the afternoon peak hour with a volume to capacity ratio exceeding 1.0. The analysis indicates the potential for significant queues to form on the MacKay Bridge approach.

TAC developed the Canadian Traffic Signal Warrant Matrix Procedure in 2005 to provide a basis for making rational, defensible decisions on the installation of traffic signals. The matrix uses a “cumulative factors methodology” to evaluate vehicle to vehicle and vehicle to pedestrian interactions while considering local factors such as demographics and roadway characteristics. The Canadian Traffic Signal Warrant Matrix Procedure considers 100 warrant points as an indication that traffic signals will provide a positive impact.

TAC traffic signal warrants were completed for the intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) under each timeframe. The traffic signal warrant worksheets can be found in Appendix G. The scores generated by the signal warrants for each timeframe are summarized below.

Existing (2019)	16 points (not warranted)
Background Growth and Adjacent Developments (2027)	23 points (not warranted)

Shannon Park Development (2027)

48 points (not warranted)

Five-Year Timeframe After Development (2032)

50 points (not warranted)

Traffic signals will not be warranted at the intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) based on the projected traffic volumes.

While traffic signals are not expected to be warranted at the intersection, without a higher form of traffic control the intersection will have limited ability to accommodate additional growth in the five-year timeframe after the buildout of the Shannon Park development. Significant queues are expected to materialize on the MacKay Bridge Ramp (Halifax-bound) that could impact operations at the toll plaza requiring additional mitigation measures. A single-lane roundabout is recommended to improve operations while minimizing queuing on the MacKay Bridge approach.

Princess Margaret Boulevard & Baffin Boulevard

Intersection spacing on Princess Margaret Boulevard is a concern and as such HRM has requested that the intersection of Princess Margaret Boulevard & Baffin Boulevard be reviewed for removal or restricted access options. In 2032, the morning peak hour volumes project approximately 300 left turning vehicles and approximately 140 right turning vehicles from Princess Margaret Boulevard into Baffin Boulevard. The afternoon peak hour volumes project approximately 80 left turning vehicles and approximately 300 right turning vehicles from Baffin Boulevard onto Princess Margaret Boulevard.

The intersection will experience poor levels of service on the Baffin Boulevard approach during both peak hours. Baffin Boulevard is the primary access to BIO and while a secondary access (Hudson Way) has been constructed to the west, it is possible that the full closure of the Baffin Boulevard access would be met with some opposition.

A full closure of the Baffin Boulevard access would result in 380 (PM) to 440 (AM) additional vehicles travelling through the residential area during peak hours to access Hudson Way. If Baffin Boulevard were restricted to a right-in, right-out access the increase in additional vehicles travelling through the residential area during peak hours to access Hudson Way would range from 80 (PM) to 300 (AM) vehicles.

While the intersection of Princess Margaret Boulevard and Hudson Way in its current configuration could accommodate the additional traffic volumes from the partial or full closure of the Baffin Boulevard access with no operational issues, the additional through traffic at the intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) could not be accommodated without mitigation measures at the intersection such as a single-lane roundabout to mitigate queues on the MacKay Ramp Bridge.

A primary concern of maintaining the fully directional access at Baffin Boulevard is that the queues for the left turn movement on Princess Margaret Boulevard could exceed the storage lane and extend into the proposed roundabout at Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/"Main Street." Converting the intersection to a right-in, right-out access to Baffin Boulevard will eliminate potential interactions with the roundabout and contribute to a lesser impact to the residential area in comparison to the full closure.

It is recommended that the intersection be converted to a right-in, right-out access by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp. Speed tables will be required between the Mackay Bridge (Halifax—bound) ramp and Hudson Way to reduce the impacts of the increase in volumes on Princess Margaret Boulevard travelling through the residential area as a result of the turning restrictions at Baffin Boulevard.

Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”

The intersection experiences poor levels of service and longer queues on the MacKay Bridge approach under existing and future background conditions; these operational problems are further exacerbated when the main entrance to the Shannon Park development is added as a fourth leg to the intersection. The future traffic volumes at the intersection cannot be accommodated by an unsignalized intersection (two-way stop control), a higher form of traffic control is required at the intersection.

TAC traffic signal warrants were completed for the intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) under each timeframe. The traffic signal warrant worksheets can be found in Appendix G. The scores generated by the signal warrants for each timeframe are summarized below.

Existing (2019)	61 points (not warranted)
Background Growth and Adjacent Developments (2027)	80 points (not warranted)
Shannon Park Development (2027)	>172 points (warranted)

Traffic signals will be warranted at the intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) based on the projected traffic volumes with the full-build-out of the Shannon Park development.

Installing a traffic signal at the intersection would improve operations but create significant queues on Princess Margaret Boulevard that would impact the CN at-grade crossing and operations at adjacent intersections (Baffin Boulevard and Iroquois Drive). A single-lane roundabout with an eastbound right turn by-pass is recommended to improve operations while minimizing queuing on the MacKay Bridge approach and Princess Margaret Boulevard.

While it would be ideal to have single lane entries on all approaches to the roundabout, the eastbound right turn lane will be required to maintain acceptable traffic operations at the roundabout. Removing the right turn lane would result in the eastbound approach operating at a LOS F with a volume-to-capacity ratio nearing capacity ($v/c = 0.97$) in Scenario 5 – Five-Year Timeframe After Development (2032). The analysis indicates that queues on the approach would exceed 500 metres, indicating impacts to adjacent intersections and the toll plaza.

Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive)

A left-turn storage lane (25 metres) on the Princess Margaret Boulevard westbound approach is recommended to separate the left turn movement. Westbound queues greater than 90 metres on the Princess Margaret Boulevard approach would impact the CN at-grade crossing on Princess Margaret Boulevard, the storage lane will reduce queue lengths on the approach. The “Collector B” approach should

be constructed with a left-turn storage lane (50 metres) to separate the left turn movement and improve operations for the right turn movement. Under a fully directional access configuration, the “Collector B” (formerly Iroquois Drive) northbound left turn movement is expected to operate at LOS F during the peak hours. The volume to capacity ratios will exceed 1.0 during the afternoon peak hour.

Intersection spacing on Princess Margaret Boulevard is a concern and, as such, HRM has requested that the intersection of Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive) be reviewed for removal or restricted access options.

The intersection is the only direct access to the commercial portion of the Shannon Park development, removing or restricting the access will increase traffic volumes on Main Street in the school zone and residential areas. The full removal of the access point is not recommended; however, the intersection could be restricted to a right-in, right-out access redirecting the left turning traffic to the roundabout at Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street.”

The additional traffic volumes can be accommodated at the roundabout and it is expected that left turn would naturally redirect to the roundabout during the peak hours if faced with significant delays at the “Collector B” approach. In addition, restricting left turns from Princess Margaret Boulevard to “Collector B” would eliminate the potential for westbound queues to impact the CN at-grade crossing on Princess Margaret Boulevard.

Ideally a raised median concrete median on Princess Margaret Boulevard should be used to prevent left-turns in and out of the “Collector B” approach, however, this would impact the HHB Office driveway located opposite of “Collector B” also converting it to a right-in, right-out access. Left turns out of the driveway could be accommodated by turning right onto Princess Margaret Boulevard and completing a U-turn maneuver at the Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street” roundabout. Left turns into the driveway (approximately 10 vehicles or less during peak hours) could not be accommodated without providing a break in the median, these vehicles would be required to find an alternate route to Windmill Road to access the driveway volume of left turns. Allowing a break in the median could encourage illegal left turn into the “Collector B” approach.

Limiting access from the toll plaza and other HHB facilities to the HHB office could have an impact on HHB operations and it is possible that the restriction to the HHB driveway would be met with some opposition. Given the low volumes of left turns in and out of the HHB driveway the analysis shows that allowing full access to the driveway is not expected to create any operational issues on Princess Margaret Boulevard.

It is recommended that the intersection be converted to a right-in, right-out access on “Collector B”, with no restrictions on the HHB driveway. The intersection should be designed to discourage illegal left turn into the “Collector B” approach without the use of a raised concrete median on Princess Margaret Boulevard. While no issues are expected, the intersection should be monitored as development occurs to identify if any of the issues arise:

- Left turns into the HHB driveway create queues on Princess Margaret Boulevard and impact operations on Princess Margaret Boulevard and the adjacent roundabout at the MacKay Bridge (Dartmouth-bound)
- High number of illegal left turn maneuvers into the “Collector B” create queues on Princess Margaret Boulevard and impact operations on Princess Margaret Boulevard and the adjacent CN rail crossing.

Should either of these issues arise, further mitigation measures would be warranted such as extending the continuous concrete median on Princess Margaret Boulevard from the roundabout at the MacKay Bridge (Dartmouth-bound) ramp through the “Collector B” intersection to physically prevent left turn into the “Collector B” approach. The HHB driveway would be restricted to a right-in, right-out access, or alternative it could be relocated further east on Princess Margaret Boulevard to allow fully directional access.

Princess Margaret Boulevard & Windmill Road

The intersection should be widened to accommodate new lane configurations on the eastbound (Princess Margaret Boulevard) and southbound (Windmill Road) approaches.

The existing right turn storage lane should be extended (50 metres) and a left turn storage lane (75 metres) should be provided on the Princess Margaret Boulevard eastbound approach to separate the left turn movement from the through movement. The reconfiguration of lanes on the eastbound approach is required to ensure that queues from the traffic signal do not extend onto the CN Rail crossing. Eastbound queues greater than 100 metres on the Princess Margaret Boulevard approach would impact the CN at-grade crossing on Princess Margaret Boulevard.

A right turn storage lane (40 metres) should be provided on the Windmill Road southbound approach to separate the high-volume right turn movement from the through movement and improve operations for both movements. The southbound approach currently has a shared through/right lane and a left turn lane, with the additional right turn lane the approach will have a separate lane for each movement (left, through and right). Consideration was given to combining the through and left lanes to reduce the intersection footprint and minimize the need for widening. Combining the through and left turn lanes would increase delay for the southbound left movement by approximately 5.0 sec/veh during the morning peak hour and 7.5 sec/veh during the afternoon peak hour. Given the low volumes for the left turn movement, the increase in average delay for the southbound through movement would be minimal - less than 1.5 sec/veh, and the impact on queue lengths negligible – increase of less than 2.0 metres. The overall average delay per vehicle at the intersection would increase by less than 0.5 sec/veh during the peak hours. The southbound through and left turn lanes could be combined with a minimal impact on traffic operations at the intersection.

While the change would reduce the intersection footprint and have a minimal impact from an operations perspective, combining the lanes would cause alignment issues for the southbound through lane. Therefore, it is recommended that the through and left turn lanes remain separated and that the intersection be widened to accommodate the new right turn lane.

The existing left turn storage lane on the Windmill Road northbound approach should be extended (75 metres) to provide adequate storage. It should be noted that this would require the removal of the adjacent left turn lane into the Comfort Inn.

The geometric changes combined with signal timing updates will ensure the intersection of Princess Margaret Boulevard & Windmill Road operations at acceptable levels of service with volume to capacity ratios for all individual or shared movements below 0.85.

Windmill Road & Victoria Road

With signal timing updates, the Windmill Road northbound movements are expected to operate at LOS E during the morning peak hour and the volume to capacity ratios will remain below the thresholds of 1.0 for an exclusive turning movement and 0.85 for a shared through/turning movement.

The Windmill Road eastbound through movement is expected to experience poor levels during the morning peak hour with a volume to capacity ratio exceeding 1.0. It should be noted that the eastbound through movement is expected to exceed capacity with background traffic growth and that the Shannon Park Development will not contribute additional traffic volumes to this movement.

Improvements could be made to this intersection such as adding a third eastbound through lane or converting it to a multi-lane roundabout. However, improvements should not be recommended at this intersection without considering the effects of the upstream/downstream signals which are outside of the scope of this traffic impact study. A corridor study would be required to determine appropriate improvements at the intersection.

In addition, the Burnside Drive Extension currently under construction is expected to have a significant impact on traffic volumes on Windmill Road. Traffic operations at the intersection should be reassessed through after the completion of the Burnside Drive Extension.

Windmill Road & Nootka Avenue

TAC traffic signal warrants were completed for the intersection of Windmill Road & Nootka Avenue under each timeframe. The traffic signal warrant worksheets can be found in Appendix G. The scores generated by the signal warrants for each timeframe are summarized below.

Existing (2019)	11 points (not warranted)
Background Growth and Adjacent Developments (2027)	14 points (not warranted)
Shannon Park Development (2027)	82 points (not warranted)
Five-Year Timeframe After Development (2032)	93 points (not warranted)

Traffic signals will not be warranted at the intersection of Windmill Road & Nootka Avenue based on the projected traffic volumes. Traffic volumes may be nearing the threshold for traffic signals in 2032, therefore traffic volumes at the intersection of Windmill Road and Nootka Avenue should be monitored after the full-build out of the development to ensure the need for traffic signals is reviewed periodically.

A left turn storage lane (25 metres) should be provided on the westbound approach (Nootka Avenue) to separate the left turn movement and improve operations for the right turn movement. Queues greater

than 75 metres on the Nootka Avenue approach would impact the CN at-grade crossing on Nootka Avenue, the storage lane will minimize queue lengths on the approach. While the left turn movement from Nootka Avenue will experience longer delays, the volume to capacity ratio will remain below the threshold of 1.0 for an exclusive turning movement.

The volume for the left turn movement is less than 50 vehicles per hour during both the morning and afternoon peak hours. If faced with significant delays at the Nootka Avenue approach during the peak hours, it is expected that a portion of the left turning traffic would redirect to the “Collector B” approach where there is excess capacity to accommodate the additional traffic.

The pedestrian crosswalk at the intersection should be monitored as the Shannon Park lands develop to ensure appropriate pedestrian crossing control is provided at the crosswalk based on pedestrian and traffic volumes. The crosswalk should be assessed regularly using the TAC Pedestrian Crossing Control Guide’s Decision Support Tool for Pedestrian Crossing Control. The Treatment Selection Matrix recommends a Rectangular Rapid Flashing Beacons (RRFB) as the appropriate type of control for a crosswalk on a roadway with a speed limit of 50 km/hr, three lanes and daily volumes ranging from 12,000 to 15,000 vpd. If vehicle volumes exceed 15,000 vpd an RA-5 crossing would be required.

HRM has indicated that the developer will be responsible for upgrading the existing marked crosswalk to an RRFB.

Windmill Road & Albro Lake Road

The intersection of Windmill Road & Albro Lake Road is expected to operate at acceptable levels of service with volume to capacity ratios for all individual or shared movements below 0.85. No improvements are required at the intersection of Windmill Road & Albro Lake Road.

10.2 Proposed Improvements

A number of road network improvements are required to mitigate the impact of the Shannon Park development. The proposed improvements include:

1. **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) should be upgraded to a single lane roundabout.
2. **Princess Margaret Boulevard & Baffin Boulevard:** Access to Baffin Boulevard should be restricted to right-in, right-out only by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp. Speed tables will be required on Princess Margaret Boulevard between the Mackay Bridge (Halifax—bound) ramp and Hudson Way to reduce the impacts of the increase in volumes travelling through the residential area as a result of the turning restrictions at Baffin Boulevard.
3. **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street”:** The intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) should be upgraded to a single lane roundabout. The single lane roundabout will require a right turn by-pass

on the eastbound approach (Princess Margaret Boulevard) to accommodate the right turn movement into the Shannon Park development.

Improvements to the intersection are required to improve existing and future background operations at the intersection and to accommodate the main access to the Shannon Park development. The roundabout will need to be constructed on both the CLC lands and HRM property.

4. **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** Access to “Collector B” should be restricted to right-in, right-out only with no restrictions on the HHB driveway.
5. **Windmill Road & Princess Margaret Boulevard:** The intersection should be widened to accommodate new lane configurations on the eastbound (Princess Margaret Boulevard) and southbound (Windmill Road) approaches. The existing right turn storage lane should be extended (50 metres) and a left turn storage lane (75 metres) should be provided on the eastbound approach. A right turn storage lane (40 metres) should be provided on the southbound approach. The existing left turn storage lane should be extended (75 metres) on the northbound approach.
6. **Windmill Road & Nootka Avenue:** A left turn storage lane (25 metres) should be provided on the westbound approach (Nootka Avenue). The existing crosswalk should be upgraded to an RRFB to provide appropriate pedestrian crossing control based on future traffic volumes.

Concept plans for the proposed improvements can be found in Appendix H.

10.3 Cost Estimates

High level cost estimates were developed for the proposed improvements. The cost estimates do not include allowances for engineering, property acquisitions, utility relocations or harmonized sales tax (HST). The costs associated with the improvements are summarized in Table 9. The total cost of the roadway infrastructure improvements is estimated at \$4,875,000.

Table 9: Costs Associated with Improvements

Intersection	Improvement	Estimated Cost
Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)	Single-lane roundabout	\$2,000,000
Princess Margaret Boulevard & Baffin Boulevard	Right-in, right-out restriction with raised median.	\$150,000
Traffic Calming on Princess Margaret Boulevard	Speed tables	\$100,000
Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”	Single-lane roundabout	\$2,000,000
Princess Margaret Boulevard & “Collector B”	Right-in, right-out restriction	\$100,000
Windmill Road & Princess Margaret Boulevard	Lane reconfiguration and widening	\$400,000
Windmill Road & Nootka Avenue	Left turn lane	\$50,000
	Crosswalk upgrade	\$75,000
Total Estimated Cost		\$4,875,000

10.4 Implementation Plan

An implementation plan was developed for the proposed roadway infrastructure improvement based on the phasing of the development. The phasing plan for Shannon Park is shown in Figure 10 and includes four phases. The improvement plan is summarized in Table 10.

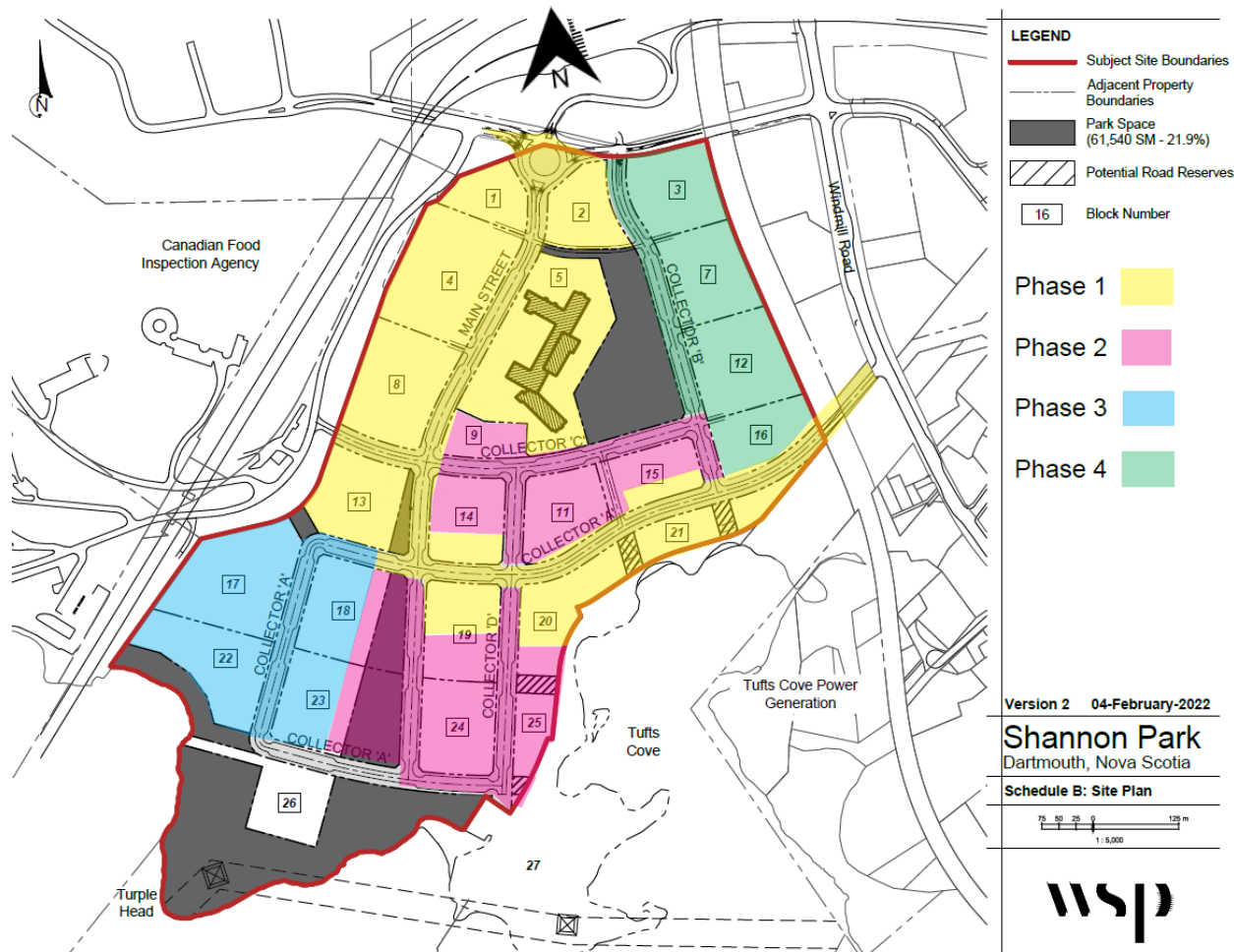


Figure 10: Development Phasing Plan

The improvements at the two primary Shannon Park access points, “Main Street” and Nootka Avenue, should be implemented with the first phase of the development. The following improvements should also be implemented with the construction of the roundabout at Princess Margaret Boulevard & MacKay Bridge Ramp (Dartmouth-bound)/ “Main Street”:

- The access restrictions at the Baffin Boulevard intersection;
- Traffic calming on Princess Margaret Boulevard between the MacKay Bridge and Hudson Way; and
- The right-in, right-out access at Princess Margaret Boulevard & “Collector B” should be constructed when the existing Iroquois Drive approach is eliminated as a result of the roundabout. The approach should be blocked off until “Collector B” is constructed in Phase 4.

The total cost of the Phase 1 roadway infrastructure improvements is estimated at \$2,475,000.

While Phase 1 includes the internal connection between the development and Baffin Boulevard, the connection is not required from an operational perspective. The connection would be of use to employees of BIO living in the Shannon Park development and provide a loop option for transit routing, but it introduces the potential for shortcutting traffic through the development. The construction of this connection could be delayed to Phase 2 or 3 when higher levels of residential density are achieved.

No improvements are required with second phase of the development. However, regular monitoring of intersections will be important during Phase 2 to identify if any of the Phase 3 improvements require early implementation based on traffic patterns. Details regarding the monitoring plan are provided in Section 10.5.

The improvements at the intersections of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) and Windmill Road & Princess Margaret Boulevard should be implemented with the third phase of the development. The total cost of the Phase 3 roadway infrastructure improvements is estimated at \$2,400,000. Phase 3 will complete the recommended improvement plan; no improvements will be required in Phase 4.

Table 10: Implementation Plan

Improvements	Estimated Cost
Phase 1 – Blocks 1, 2, 4, 5, 8, 13, 19, 20 and 21	
Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”	\$2,000,000
Princess Margaret Boulevard & Baffin Boulevard	\$150,000
Traffic Calming on Princess Margaret Boulevard	\$100,000
Princess Margaret Boulevard & “Collector B”	\$100,000
Windmill Road & Nootka Avenue	\$125,000
Phase 1 Total Estimated Cost	\$2,475,000
Phase 2 – Blocks 9, 11, 14, 15, 19, 24 and 25	
No Improvements - Continued Monitoring	-
Phase 3 – Blocks 17, 18, 22, 23 and 26	
Princess Margaret Boulevard & MacKay Bridge (Halifax)	\$2,000,000
Windmill Road & Princess Margaret Boulevard	\$400,000
Phase 3 Total Estimated Cost	\$2,400,000
Phase 4 - Blocks 3, 7, 12 and 16	
No Improvements	-

10.5 Monitoring Plan

The intersections with improvements proposed under Phase 3 should be monitored regularly as development occurs in Phases 1 and 2 to ensure the proposed improvements are implemented prior to Phase 3 if traffic patterns show the following problems:

- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound): High delays and/or significant queues occur on the MacKay Bridge ramp.
- Windmill Road & Princess Margaret Boulevard: Eastbound queues on Princess Margaret Boulevard extend close to the CN rail crossing.

In addition, traffic volumes at the intersection of Windmill Road and Nootka Avenue should be monitored after the full-build out of the development to ensure the need for traffic signals is reviewed periodically. HRM has indicated that the developer will be responsible for monitoring.

11 Concept Plan Review

The preferred development concept plan and proposed development block plan were reviewed, the following commentary applies:

Access: The development plan shows an access to the development on Baffin Boulevard. Baffin Boulevard serves as an access to BIO and this connection would mainly be of use to employees of BIO living in the Shannon Park development. However, the access creates a shortcut between Baffin Boulevard and Windmill Road, there is concern that employees of BIO travelling to and from Windmill Road will use the development to by-pass Princess Margaret Boulevard.

Internal Road Layout: The internal road network appears to provide connectivity within the development. There are no cul-de-sacs, with the exception of the access to the Millbrook lands. The internal road network consists of two-lane roadways, with the majority of streets having on street parallel parking on both sides.

Curb Extensions: The concept plan shows the use of curb extensions (bulb outs) throughout the development at intersections and midblock locations adjacent to green space (potential trail crossings). Curb extensions are not included in the HRM Red Book; however, they are being introduced by HRM on existing roads including North Park Street and Spring Garden Road. They are typically used as a traffic calming feature to enhance pedestrian safety and streetscape character. A few advantages and disadvantage of curb extensions are listed below.

Advantages:

- Increased pedestrian visibility through improved sightlines at intersections,
- Reduced crossing distances for pedestrians,
- Reduced vehicle turning speeds by narrowing the roadway,
- Increased pedestrian waiting space,
- Additional space for street furnishings,
- Reduced illegal parking at corners, crosswalks and bus stops, and
- Facilitated ability to provide two curb ramps per corner.
- Aesthetics

Disadvantages:

- More expensive to construct and maintain,
- More difficult for snow removal,
- Reduced flexibility of the roadway in construction routing, and
- Reduced flexibility in making changes to the location of bus zones, roadway lane layout or crosswalks.

Overall, the concept plan appears to provide a well-connected road network and feature some elements of a complete street approach creating an environment that is intended to be attractive to vulnerable road users.

11.1 Roadway Classification

The internal roadways were classified according to the HRM Red Book Street Classes. The characteristics of the street classes are detailed in Table 11.

Table 11: Characteristics of Street Classes

Characteristic	Arterial	Collector		Local Industrial	Local
		Major	Minor		
1. Traffic service function	First consideration	Traffic movement first consideration, land access second consideration	Traffic movement of equal importance with land access, parking permitted	Traffic movement second consideration with land access first consideration, parking permitted	Traffic movement second consideration with land access first consideration, parking permitted
2. Land access function	Limited access with no parking				
3. Design daily traffic volume	More than 20,000	More than 12,000	Up to 12,000	Less than 3,000	Less than 3,000
4. Traffic flow	Uninterrupted flow except at signals; with pedestrian overpasses	Uninterrupted flow except at signals and crosswalks	Interrupted flow	Interrupted flow	Interrupted flow
5. Avg running speed off-peak conditions	50-70 km/h	40-60 km/h	30-50 km/h	15-30 km/h	15-30 km/h
6. Vehicle types	All types	All types but trucks may be limited	All types with truck limitation	All types	Passenger vehicles and service vehicles; large vehicles restricted
7. Connects to	Expressways, arterials, major/minor collectors	Expressways, arterials, major/minor collectors, some locals	Arterials, major/minor collectors, locals	Some major collectors, minor collectors, locals	Some major collectors, minor collectors, locals

Using the rule of thumb that the afternoon peak hour traffic volumes represent approximately 10 percent of daily traffic volumes, daily traffic volumes were estimated for the development's three main roadways. Based on full build out traffic volumes the following daily traffic volumes are expected:

- "Main Street": approximately 7600 vehicle per day
- "Collector B": approximately 3500 vehicle per day
- Nootka Avenue: approximately 3800 vehicle per day

Based on the projected traffic volumes "Main Street", "Collector B" and Nootka Avenue are expected to be classified as minor collector streets. All other roadways within the development are expected to be classified as local streets.

11.2 Internal Intersections

Determining the requirements of the internal road network intersections (control type, lane configuration, storage lane requirements) was outside the scope of this study. HRM has indicated that the developer will be responsible for providing this information to HRM prior to design review.

HRM will also be requesting that vertical deflections be installed adjacent to the school as this is new practice under the HRM Traffic Calming Program.

11.3 Emergency Response

Emergency response to the Shannon Park will be provided by Halifax Region Fire & Emergency Station 12 located in Highfield Park. The CN Rail line is located between Shannon Park and Station 12. Halifax Fire has indicated that the Nootka Avenue and "Collector B" cannot be consider viable access points as emergency vehicles travelling from Windmill Road would need to cross the rail line. "Main Street" and the access on Baffin Boulevard will be accessible at all times through Highway 111 and the MacKay Bridge toll plaza.

Approximate travel times for each route obtained from Google Maps are summarized in Table 12. The travel time range represent travel times for off-peak and morning/afternoon peak hours. The travel times indicate that the Highway 111 route will provide the best response times.

Table 12: Emergency Response Route Travel Time

Route	Distance	Travel Time Range
Highway 111	3.2 km	5-7 minutes
Windmill Road (South)	3.4 km	6-12 minutes
Windmill Road (South)	3.7 km	6-9 minutes

12 CN Rail Crossing Review

In 2014, Transport Canada published new standards for at-grade crossings. A seven-year period was granted by Transport Canada after the regulations came into force for railway companies and road authorities to upgrade all existing grade crossings to meet new standards set forth in the document.

Currently, the new safety standards must be met at all new crossings built after November 27, 2014 or at any existing grade crossings at which major modifications occur. Major modifications would include such things as adding a traffic lane or an increase in road or railway traffic speeds.

The road network improvements required to accommodate the Shannon Park development identified in the traffic impact study do not include major modifications to the crossings. Thus, the two rail crossings in the study area will need to be reviewed against the new standards and upgraded accordingly, prior to the end of the seven-year period (November 2021).

At the time of this report, it remains unknown which authority has ownership of the Nootka Avenue crossing.

12.1 Princess Margaret Boulevard Crossing

HRM has ownership of the Princess Margaret Boulevard crossing. An assessment of the at-grade crossing was completed in 2018 by Harbourside Transportation Consultants, True North Safety Group and Paradigm Transportation Solutions Limited to:

- Determine the conformance of the HRM's at-grade rail crossings with the Transport Canada Grade Crossing Regulations (the 'Regulations') and the applicable standards; and
- Identify proven engineering measures with the potential to mitigate the identified nonconformities and deficiencies at the crossings.

The crossing at Princess Margaret Boulevard (Dartmouth Subdivision Mile 10.33) is a single-track at-grade crossing. The warning devices consist of flashing lights, bells and gates.

The assessment identified safety deficiencies and recommended seven **short- to medium-term** remedial measures, summarized in Table 13, four of which must be implemented before November 2021. The three additional remedial measures are not required under the new Regulations, but it is strongly encouraged that these changes be made as soon as possible:

Table 13: Princess Margaret Boulevard Rail Crossing Improvements

Remedial Measure		Cost	Responsible Party	Funding Opportunity
Short- to medium-term				
1	Install an Emergency Notification sign on both approaches that is easily identifiable by the public.	\$1,200	Rail Authority	None
2	Relocate the RAILWAY CROSSING AHEAD sign on the westbound approach at a distance of 50 to 150 metres.	\$600	HRM	None
3	Improve the surface conditions of south sidewalk near the crossing to provide a leveled surface to pedestrians.	\$6,000	Rail Authority	None
4	Extend the crossing surface at least 0.5 metres on both sides.	\$3,000	Rail Authority	None
5*	Install double stop bars on each approach as per Manual of Uniform Traffic Control Devices.	\$500	HRM	None
6*	Paint white 'X' markings 10 m past the Railway Crossing Ahead signs.	\$500	HRM	None
7*	Adjust the mounting height of the eastbound RAILWAY CROSSING AHEAD sign to 1.5 metres.	\$250	HRM	None
* Not required under the new Regulations				

12.2 Requirements for Pedestrian and Cycling Crossings

According to the Transport Canada Grade Crossing Standards (2014) the following requirements apply to pedestrian and cycling crossings.

- A sidewalk, path, or trail with its centerline more than 3.6 m from a Railway Crossing sign supporting post beside a road approach for vehicle traffic must have separate rail crossing signs.
- The maximum gradients for road approaches must not exceed the following:
 - 2% within 5 m of the nearest rail at a sidewalk, path or trail and
 - 1% within 5 m of the nearest rail at a sidewalk, path or trail designated by the road authority for use by persons using assistive devices.
- The specifications for a grade crossing for a sidewalk, path or trail where a warning system is required are as follows:
 - The sidewalk, path or trail is outside the island circuit of an adjacent warning system, and
 - The railway design speed is more than 50 mph.
- The specifications for a grade crossing for a sidewalk, path or trail where a warning system with gates is required are as follows:
 - The sidewalk, path or trail is outside the island circuit of an adjacent warning system,
 - The railway design speed is more than 15 mph, and
 - There are two or more lines of railway.

At the existing crossing on Nootka Avenue, there is no existing pedestrian or cycling crossings.

13 Active Transportation

In December 2017, Regional Council Approved Halifax's "Integrated Mobility Plan" (IMP). This plan outlines a strategy to shift the modal split in the municipality towards more sustainable forms of transportation. Shannon Parks falls within the municipality's Regional Centre, where active transportation (including cycling) has a mode share target of at least 37%.

Reliable and convenient active transportation infrastructure is required to make the decision to choose active transportation is more appealing to users and enable this shift. With the appropriate infrastructure in place, active transportation offers an alternative to avoid network congestion and parking challenges.

13.1 Pedestrians

Existing pedestrian infrastructure in the surrounding area includes sidewalks on Windmill Road as well as Princess Margaret Boulevard and Baffin Boulevard (Figure 11). The intersection of Windmill Road and Princess Margaret Boulevard/Yorkshire Avenue is signalized with pedestrian crossings. There are three (3) RA-4 crosswalks located on this section of Windmill Road- one to the south of the project area at the intersection of Fernhill Drive, one at the intersection with Nootka Avenue, and a mid-block crossing located between Nootka Avenue and Princess Margaret Boulevard.

Following the development of the Shannon Park lands, a warrant analysis should be completed of these crosswalks, specifically the one located at Nootka Avenue, for potential upgrade to an RA-5 overhead crosswalk.



Figure 11: HRM Sidewalks Map

13.2 Cycling

The IMP identified routes for a proposed All Ages and Abilities (AAA) bicycle network (Figure 12). The IMP's proposed network does not extend to connect to Shannon Park; however, Windmill Road was identified as a candidate for on-street bike lanes in the 2014-19 Active Transportation Priorities Plan (Figure 13). The on-street bike lanes would offer a connection for confident cyclists but would not be considered comfortable for All Ages and Abilities. The additional demand created by the Shannon Park development may shift the pressures of this area and foster a demand to construct a AAA facility on Windmill Road.

An alternative option to on-street facilities could also be pursued. While it does not appear as a candidate route on any of the municipality's strategic plans, there was previously some high-level discussion about the construction of a multi-use active transportation trail along the harbour following the existing Halifax Water sewer route (similar to the collaboration that currently exists with Halifax Water and the Chain of Lakes Trail).



Figure 12: HRM Proposed Bicycle Network

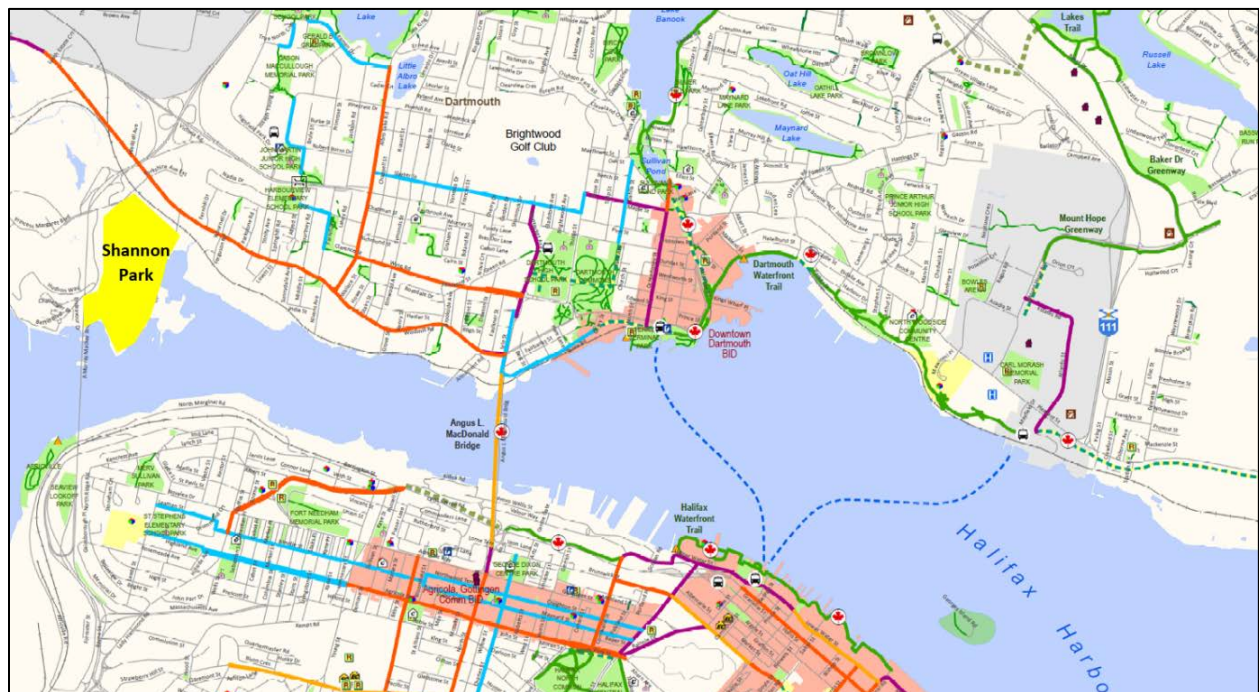


Figure 13: HRM Candidate Bikeway Routes and Greenway Network

13.3 Proposed Active Transportation Route

To encourage cycling as a viable option to access the development, cycling facilities should be provided within the development site. A main route should be identified within the development to serve as the spine that supports active transportation throughout the development. The proposed route is shown in Figure 14, this route also aligns with the proposed transit route through the site. Cycling facilities should be provided along the active transportation route. Cycling connections should be provided to adjacent on-street or off-street facilities. A cycling connection should be provided from the main active transportation route to the waterfront greenspace. Bike storage facilities should be provided throughout the development. Storage facilities should be considered not only in terms of volume but also quality of facility, in a location where users feel comfortable to leave their bikes locked up.

The remainder of the development will be constructed with a focus on providing pedestrian friendly infrastructure, sidewalks are proposed along both sides of each roadway.

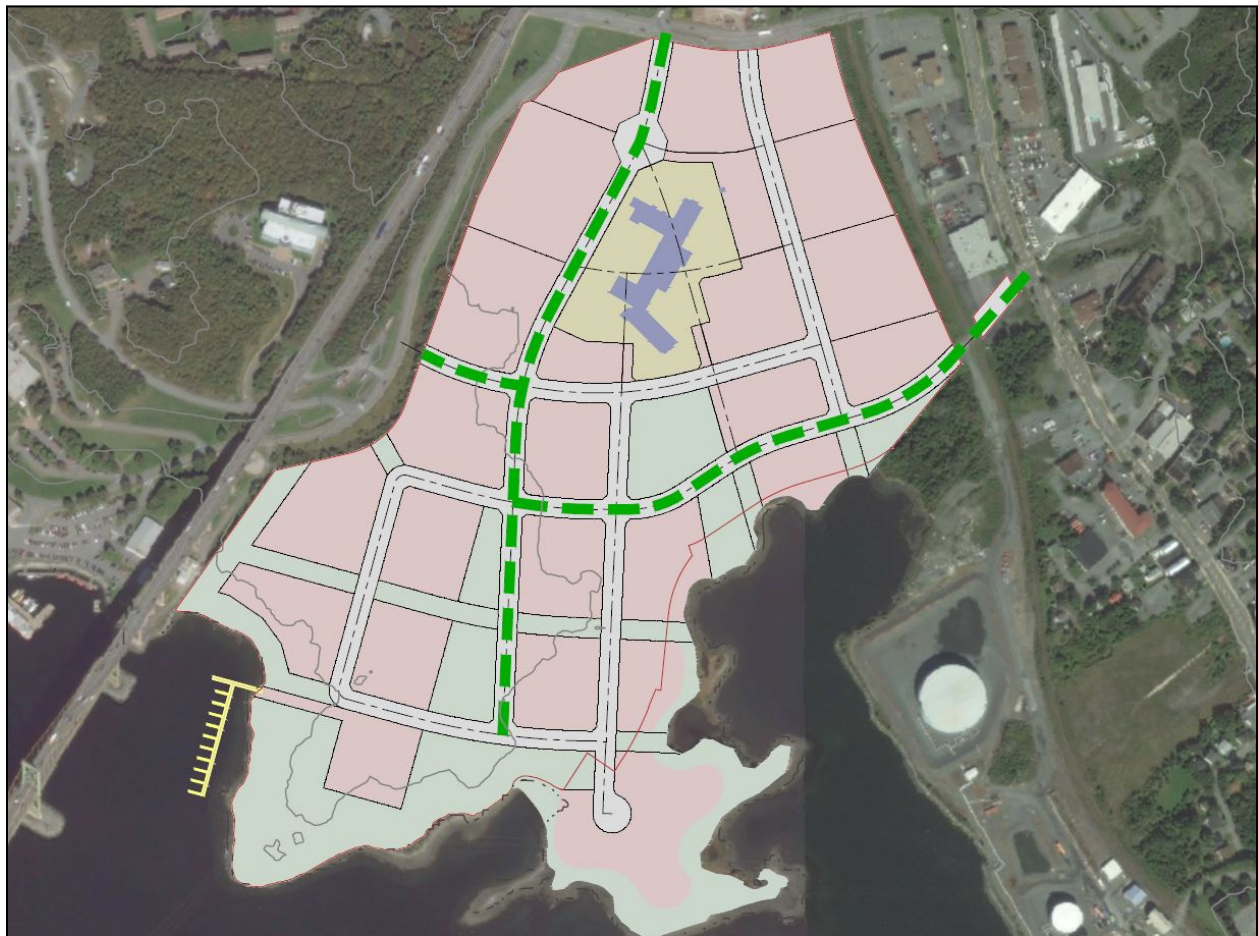


Figure 14: Shannon Park AT Route (shown in green dashed line)

14 Transit

Team members met with Halifax Transit and reviewed the ideas in the “Moving Forward Together” 5-year Halifax Transit Strategic Plan to assess how transit and the re-development of Shannon Park can be best integrated to offer sustainable transportation options for residents both living within the future development and those coming to the area for work or commercial attractions.

The Halifax Transit 5-year strategic plan “Moving Forward Together” looks to overhaul the existing transit network servicing the Municipality. The four principles included in the 5-year strategic plan include: increasing the proportion of resources allocated towards services with high ridership numbers; building a simplified transfer-based system; the investment in quality service and service reliability; and increasing transit priority in the existing and proposed transportation network. The proposed Shannon Park Development is located in the urban transit service boundary, which puts it within the zone that HRM has identified for transit improvements. Currently, this area isn’t a top priority for increased transit service in the plan, but with developments such as Shannon Park on the horizon and its location in the Regional Centre, priority on increased service is likely.

Shannon Park is currently serviced by one local bus route (51 Windmill) which connects to the Bridge Terminal and Burnside. The route currently taken by the 51 Windmill is shown in blue on in Figure 15, with the dashed lines represented the extended service during peak hour.

The increase of density in this area will be supplemented by an improved road network to facilitate a more desirable transit route. In planning transit routes, stops that require a bus to drive in, turn around, and come out the same road are inefficient in terms of reaching the greatest number of people and decreasing the total travel time for all users of the service. The proposed road layout offers a route that buses will be able to loop through the development to pick users up without having to double back on itself. This proposed route is shown in as the green line in Figure 15, and came from discussion with Halifax Transit. This route follows the same route as the main active transportation connection through the site creating connections between these complimentary modes of transportation. Improving pedestrian and bicycle connections to transit services is one of the goals recommended in Halifax Transit’s *Moving Forward Together* plan as it pertains to new developments.

The new access to BIO and the re-development of Shannon Park will also complement each other. Currently, the 51 Windmill stops at the BIO parking lot for a short peak demand period at the beginning and end of the work day. This restricted schedule is due to the configuration of the stop creating a “drive in-drive out” scenario, undesirable for the reasons described above. Halifax Transit has expressed a desire to have this stop on the regular routing of the 51 Windmill if the driveway improvements were to be completed, which would offer a looped route (as shown in yellow in Figure 15). The proposed road network for the Shannon Park re-development creates a smooth and desirable connection with this routing.

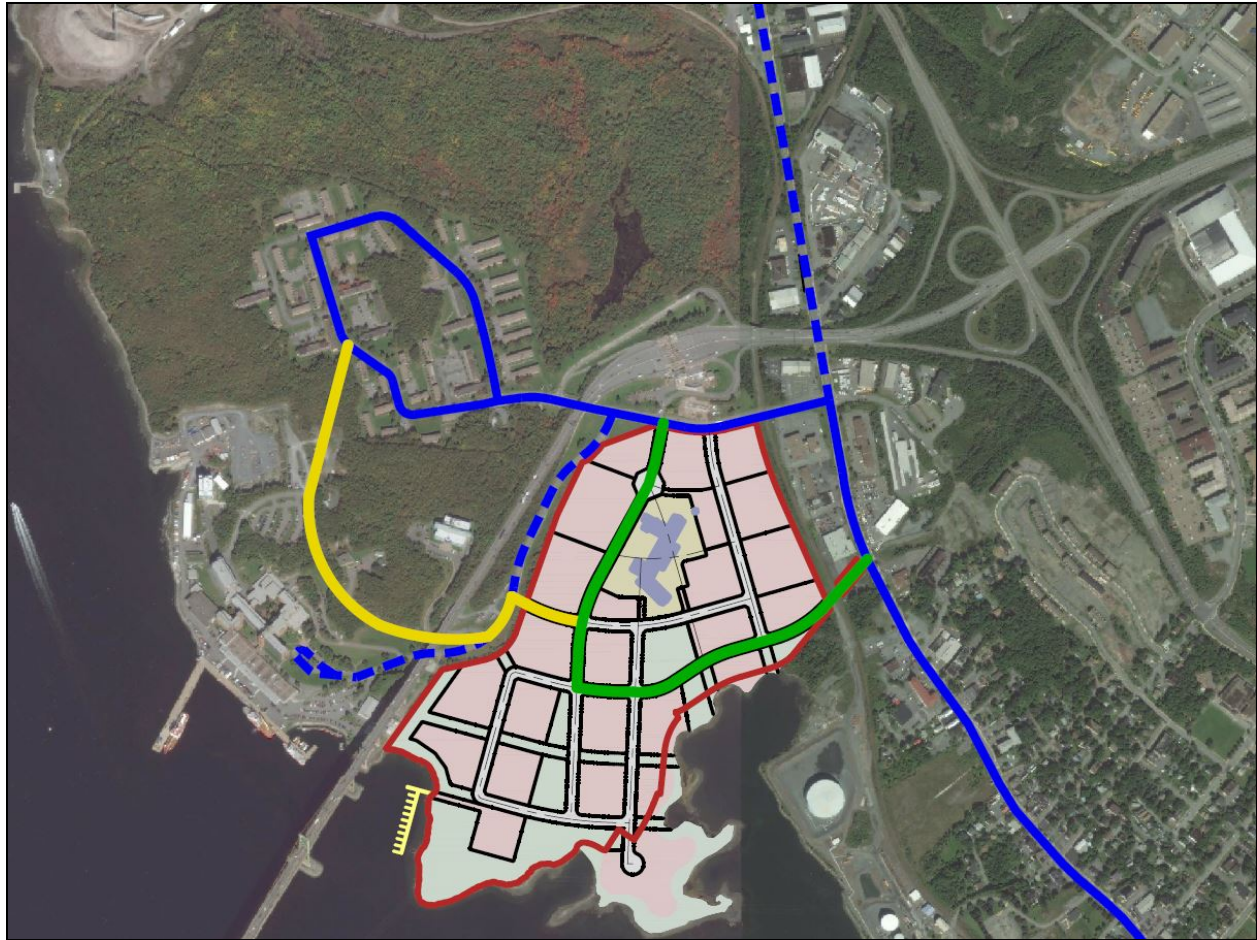


Figure 15: Existing and Proposed Transit Routes

Part of the Moving Forward Together plan includes the construction of a new Wrights Cove Terminal in Burnside. This terminal is tentatively slated for construction in 2020, located on Bancroft Lane near the intersection with Windmill Road. The proximity of this terminal to the Shannon Park lands will create a major transit connection for all residents coming to and from Shannon Park. Along with creating a hub for numerous local routes, the Wrights Cove terminal will also be serviced by four express routes- the 182 First Lake Express, 185 Millwood Express, 183 Springfield Express, and 189 Beaver Bank Express. The short and simple connection to these express routes position Shannon Park as a convenient and desirable working location.

As part of a Transit Priority Measures (TPM) report completed by WSP for HRM in March 2016, a number of intersections within Halifax Transit's network were identified for improvements to establish TPMs and create improved transit routes. This study identified three intersections on Windmill Road, of which two (Windmill Road/Seapoint Road, and Windmill Road/Victoria Road) were ranked highest out of thirteen to prioritize for implementation. These priority measures on Windmill Road will work to improve the transit network surrounding Shannon Park.

15 Shannon Park Ferry Terminal

Halifax Transit is currently reviewing the abutting Millbrook Lands for a future ferry terminal. HRM staff have requested that the potential ferry terminal be accounted in in the traffic study. An additional scenario was completed to evaluate the impacts of the ferry terminal on the development and confirm that vehicle trips to the ferry terminal can be accommodated with the proposed infrastructure improvements.

The Rapid Transit Strategy adopted in May 2020 is HRM’s plan to build Rapid Transit System by 2030. The strategy proposes three new ferry routes, including a new route from Shannon Park, each connecting a new terminal to the Halifax Ferry Terminal in downtown Halifax.

The Shannon Park Route would include a connection from a new ferry terminal on the Millbrook Lands abutting the Shannon Park development to the Halifax Ferry Terminal. The ferry route would have an approximate travel time of 10 minutes and provide 15-minute service at peak hours. The ferry route would provide commuters with a significant reduction in travel time when compared to private vehicle and local transit as shown in Figure 16.

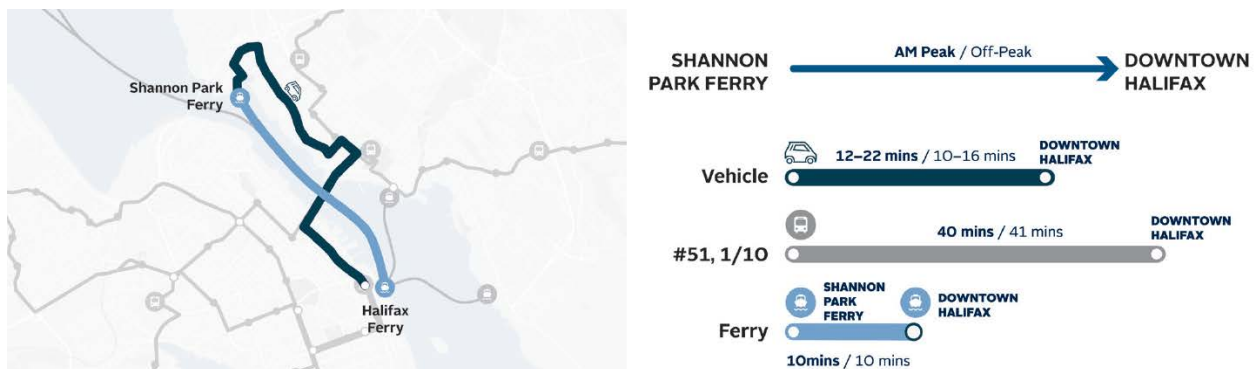


Figure 16: Ferry Travel Time Comparison (Source: Rapid Transit Strategy)

The Strategy indicates that active transportation and transit connections to the ferry terminal will be prioritized to provide access to the ferry. While Park & Ride options will be considered at ferry terminals where there is space, the priority will be to encourage ridership through transit-oriented development and connections to transit routes and active transportation.

15.1 Ferry Assumptions

Assumptions for the Shannon Park Ferry were developed based on information from the Rapid Transit Strategy and ridership data from existing ferry routes. The ferry assumptions were reviewed and accepted by HRM and Traffic Management prior to completing the analysis.

Ridership

The Rapid Transit Strategy indicates the new ferry route could have ridership similar to that of Halifax Transit’s existing ferry service, with an anticipated daily ridership between 2,200 and 3,500 boardings per day. The boardings for the existing ferry service at Alderney and Woodside in 2019 (representing pre-Covid levels) summarized in Table 14, indicate average weekday morning and afternoon peak hour ridership ranging from 382 to 519 boardings per hour.

Table 14: Average Weekday Peak Hour Boardings

2019 Average Boardings per Hour		Weekday AM Peak Hour	Weekday PM Peak Hour
Alderney Ferry	Alderney to Halifax	308	147
	Halifax to Alderney	74	370
	Total	382	517
Woodside Ferry	Woodside to Halifax	440	62
	Halifax to Woodside	79	403
	Total	519	465

An average of the two existing routes was assumed for the Shannon Park ferry's anticipated weekday morning and afternoon peak hour ridership. The ridership assumptions are summarized in Table 15.

Table 15: Shannon Park Ferry Ridership

Anticipated Boardings per Hour		Weekday AM Peak Hour	Weekday PM Peak Hour
Shannon Park Ferry	Shannon Park to Halifax	374	105
	Halifax to Shannon Park	77	387
	Total	451	492

Ferry Trip Generation

With the Strategy's goal of creating a transit-oriented development around the Shannon Park ferry terminal, it would be reasonable to assume that the majority of the ferry trips will consist of trips to/from the Shannon Park development and connections through transit routes.

However, since the ferry terminal will be located on undeveloped land there is potential space to provide Park & Ride options. Based on a review of existing Park & Ride facilities at the Alderney Ferry Terminal and Woodside Ferry Terminal (Table 16), it was assumed that a Park & Ride facility of approximately 110 parking spaces would be provided to account for potential external vehicle trips to/from the ferry terminal.

Table 16: Existing Ferry Park & Ride Facilities

Park & Ride Location	Parking Spaces
Alderney Ferry Terminal	110
Woodside Ferry Terminal	515

Based on the average of the two existing routes, weekday peak hour boardings represent approximately 68 percent of the total peak period boardings during the morning peak and approximately 62 percent during the afternoon peak. For a Park & Ride facility with 110 parking spaces and assuming a vehicle occupancy of 1.0 to remain conservative, this translates into approximately 74 vehicle trips during the morning peak hour and 68 vehicle trips during the afternoon peak hour.

The remaining ferry trips will consist of trips to/from the Shannon Park development and connections through transit routes. It was assumed that 80 percent of remaining trips are to/from the Shannon Park development and made through active transportation modes and 20 percent are made through transit connections. The ferry trip generation by mode is summarized in Table 17.

Table 17: Ferry Trip Generation

Ferry Trip Generation by Mode	Weekday AM Peak Hour			Weekday PM Peak Hour		
	Total	Shannon Park to Halifax	Halifax to Shannon Park	Total	Shannon Park to Halifax	Halifax to Shannon Park
Vehicle (Park & Ride Trips)	74	61	13	68	16	52
Active Transportation (Shannon Park Trips)	301	250	51	339	71	268
Transit	76	63	13	85	18	67
Total	451	374	77	492	105	387

Park & Ride Trip Distribution

On a typical weekday, the ferry terminal's Park & Ride facility is expected to generate 74 vehicle trips during the morning peak hour (61 entering, 13 exiting) and 68 vehicle trips during the afternoon peak hour (16 entering, 52 exiting). Trips associated with the Park & Ride facility were distributed to the study area road network using the following trip distribution:

- 10% to/from Bedford and areas to the north via Windmill Road;
- 75% to/from Dartmouth and areas south via Windmill Road; and
- 15% to/from the rest of the metro area via Highway 111.

The trip distribution was developed based on engineering judgement. It was assumed that most of the non-Shannon Park vehicle trips to this facility would come from the area north of Woodland Avenue in north end Dartmouth, including Highfield Park and the Tufts Cove area. It was assumed that little traffic on Highway 111 would be diverted to this ferry, for the following reasons:

- Drivers are taking the MacKay Bridge because their destination is not downtown Halifax; and
- Most drivers travelling on Highway 111 would be backtracking to get to the Shannon Park ferry. If they wanted to take a ferry, Alderney or Woodside would be more convenient options.

The distribution and assignment of the vehicle trip estimates associated with the Park & Ride facility at the study intersections are shown diagrammatically in Appendix I.

Impact on Shannon Park Development Mode Share

Without the presence of a ferry terminal, the traffic impact study assumes a non-auto mode share of 15.5 percent (10 percent for transit and 5.5 percent for active transportation) for the Shannon Park development (Section 2.1). While the Shannon Park development is located in the Regional Centre where there is a non-auto mode share of 50 percent, according to the Integrated Mobility Plan (IMP), the site is located in an area serviced by only one transit route (51 – Windmill) and with limited connections to active transportation corridors. Therefore, a high non-auto mode share was not considered be feasible in Shannon Park without significant improvements to transit and active transportation infrastructure in the area.

The Rapid Transit Strategy recognizes that the development of Shannon Park into a mixed-used development will increase density in the area and provides the opportunity to create a transit-oriented development. The Strategy indicates that active transportation and transit connections to the ferry

terminal will be prioritized to provide access to the ferry. While Park & Ride options will be considered at ferry terminals where there is space, the priority will be to encourage ridership through transit-oriented development and connections to transit routes and active transportation.

The ferry service and additional transit and active transportation connections are expected to significantly increase the non-auto mode share for the Shannon Park development. With the presence of a ferry terminal, a non-auto mode share (including ferry, transit and active transportation trips) of 50 percent was assumed for the Shannon Park development, consistent with the IMP's non-auto mode share for the Regional Centre. Ferry trips are expected to account for approximately half of the non-auto trips. The changes to the non-auto trip reductions for the Shannon Park development are summarized in Table 18.

Table 18: Change in Non-Auto Trip Reductions

Non-Auto Trips	Weekday AM Peak Hour			Weekday PM Peak Hour		
	Total	In	Out	Total	In	Out
Without ferry terminal (15.5 percent)	222	78	144	253	155	98
With ferry terminal (50 percent)	718	252	466	816	500	316
Non-Auto Trip Difference	496	174	322	563	345	218

The weekday morning and afternoon peak hour trip generation estimates and adjustments for the Shannon Park development with the ferry terminal are summarized in Table 19. On a typical weekday, the Shannon Park development is expected to generate 717 vehicle trips (252 entering/465 exiting) during the morning peak hour and 815 vehicle trips (499 entering/316 exiting) during the afternoon peak hour.

The ferry terminal is expected to generate 74 vehicle trips (61 entering/13 exiting) during the morning peak hour and 68 vehicle trips (16 entering/52 exiting) during the afternoon peak hour. The combined trip generation of the development and the ferry terminal is 791 vehicle trips (313 entering/478 exiting) during the morning peak hour and 883 vehicle trips (525 entering/368 exiting) during the afternoon peak hour.

Trips associated with the Shannon Park development and adjacent developments were distributed to the study area road network using the trip distribution outlined in Section 6.2. The distribution and assignment of the vehicle trip estimates associated with the Shannon Park development at the study intersections are shown diagrammatically in Appendix I.

Table 19: Shannon Park Development with Ferry Terminal Trip Generation Estimates

Land Use	Units		AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
221 - Multifamily Housing (Mid-Rise)	380	Units	138	36	102	169	104	65
222 - Multifamily Housing (High-Rise)	2,620	Units	814	195	619	944	576	368
715 - General Office Building	23.50	1000 ft ²	27	23	4	27	4	23
814 - Variety Store	34.00	1000 ft ²	109	63	46	233	121	112
851 - Convenience Market	3.00	1000 ft ²	188	94	94	147	75	72
899 - Liquor Store	6.00	1000 ft ²	0	0	0	98	49	49
911 - Walk-In Bank	5.00	1000 ft ²	0	0	0	61	27	34
918 - Hair Salon	11.00	1000 ft ²	13	7	6	16	3	13
925 - Drinking Place	5.50	1000 ft ²	0	0	0	62	41	21
930 - Fast Casual Restaurant	6.00	1000 ft ²	12	8	4	84	46	38
931 - Quality Restaurant	19.00	1000 ft ²	0	0	0	148	99	49
931 - Quality Restaurant	20.00	1000 ft ²	14	8	6	156	104	52
932 - High-Turnover (Sit-Down) Restaurant	5.00	1000 ft ²	50	28	22	49	30	19
933 - Fast-Food Restaurant w/o DT	3.00	1000 ft ²	0	0	0	85	43	42
933 - Fast-Food Restaurant w/o DT	2.00	1000 ft ²	50	30	20	57	29	28
936 - Coffee/Donut Shop w/o DT	2.00	1000 ft ²	202	103	99	73	37	36
Total Trips Generated			1617	595	1022	2409	1388	1021
Internal Trips			182	91	91	778	389	389
External Trips			1435	504	931	1631	999	632
Reduction for non-auto modes including ferry (50 percent)			718	252	466	816	500	316
Adjusted Vehicle Trips			717	252	465	815	499	316
Pass-by Trips			60	30	30	66	33	33
Primary Trips			657	222	435	749	466	283
Ferry Park & Ride Trips			74	61	13	68	16	52
Total Vehicle Trips with Ferry Terminal			791	313	478	883	525	368

15.2 Scenario 6 – Five-Year Timeframe after Shannon Park Development (2032) with Ferry Terminal on Millbrook Lands

Scenario 6 is an analysis of future conditions throughout the study area five years after the full build-out of the Shannon Park development with the potential Shannon Park Ferry Terminal on Millbrook Lands. The traffic volumes for this scenario reflect the future background traffic volumes and the projected traffic volumes associated with the Shannon Park development with the higher mode share reduction factored using a growth rate of 1.0 percent per year over five years (2027-2032) to account for background traffic growth. The road network reflects the proposed improvements from Scenario 4.

The AM and PM traffic volumes used in this scenario and the Synchro level of service conditions are shown diagrammatically in Figure 17. A summary of the MOE results including delay, level of service, volume-to-capacity ratio and 95th percentile queue lengths and the detailed Synchro and SimTraffic reports can be found in Appendix J.

The reduced vehicle trips from the Shannon Park development will outweigh new vehicles trips generated by the ferry terminal's Park & Ride facility, resulting in lower traffic volumes throughout the study area and slightly improved operations at most intersections when compared to the same scenario without the ferry terminal (Scenario 5 - Five-year Timeframe after Shannon Park Development).

The impacts of the ferry terminal on operations at each of the study intersections are described below:

- **Princess Margaret Boulevard & BIO Access:** The unsignalized intersection will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service. Operations at the unsignalized intersection will not be significantly impacted (average delay per vehicle at the intersection reduced by less than 0.5 seconds).
- **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach. With the ferry terminal, average delay per vehicle at the intersection will be reduced by approximately 1.0 seconds during the morning peak hour and approximately 0.5 seconds during the afternoon peak hour.
- **Princess Margaret Boulevard & Baffin Boulevard:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service. Operations at the unsignalized intersection will not be significantly impacted during the morning peak hour (average delay per vehicle at the intersection reduced by less than 0.5 seconds).

The intersection will experience very light congestion (LOS B) during the afternoon peak hour. The reduction in traffic volumes on Princess Margaret Boulevard will improve operations for the northbound right movement (Baffin Boulevard), the movement will operate at LOS E in Synchro (improvement from LOS F in Scenario 5 without the ferry terminal) and will no longer be over

capacity with a v/c ratio of 0.85 (improvement from 1.05 in Scenario 5 without the ferry terminal) during the afternoon peak hour. With the ferry terminal, average delay per vehicle for the northbound right movement (Baffin Boulevard) will be reduced by approximately 51.0 seconds, with average delay per vehicle at the overall intersection reduced by approximately 10.0 seconds during the afternoon peak hour.

- **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/“Main Street”:** The roundabout will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service with 95th percentile queues lengths under 25 metres on the MacKay Bridge approach. With the ferry terminal, average delay per vehicle at the intersection will be reduced by approximately 2.0 seconds during the morning peak hour and approximately 3.0 seconds during the afternoon peak hour. The intersections will also experience a significant reduction in queues on the eastbound approach during the afternoon peak hour, with 95th percentile queues lengths under 20 metres on Princess Margaret Boulevard.
- **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** The unsignalized intersection will experience no congestion (LOS A) during the morning and afternoon peak hours; all movements will continue to operate at acceptable levels of service. Operations at the unsignalized intersection will not be significantly impacted (average delay per vehicle at the intersection reduced by less than 0.5 seconds).
- **Windmill Road & Victoria Road:** The signalized intersection will experience noticeable congestion (LOS D) during the morning peak hour; the eastbound through movement and the northbound movements will continue to operate at LOS E. The intersection will experience light congestion (LOS C) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service.

With the ferry terminal, average delay per vehicle at the intersection will be reduced by approximately 1.5 seconds during the morning peak hour and approximately 1.0 seconds during the afternoon peak hour.

- **Windmill Road & Princess Margaret Boulevard:** The signalized intersection will experience very light congestion (LOS B) during the morning and afternoon peak hour; all movements will continue to operate at acceptable levels of service. The 95th percentile queue lengths on the Princess Margaret eastbound approach continue to indicate that intersection queues will not impact the at-grade CN rail crossing.

With the ferry terminal, average delay per vehicle at the intersection will be reduced by approximately 1.0 seconds during the morning peak hour and approximately 2.0 seconds during the afternoon peak hour.

- **Windmill Road & Nootka Avenue:** The unsignalized intersection will experience no congestion (LOS A) during the morning peak hour. The eastbound left movement (Nootka Avenue) will continue to operate at LOS F in Synchro. The SimTraffic analysis continues to indicate that the movement will operate at an acceptable level of service.

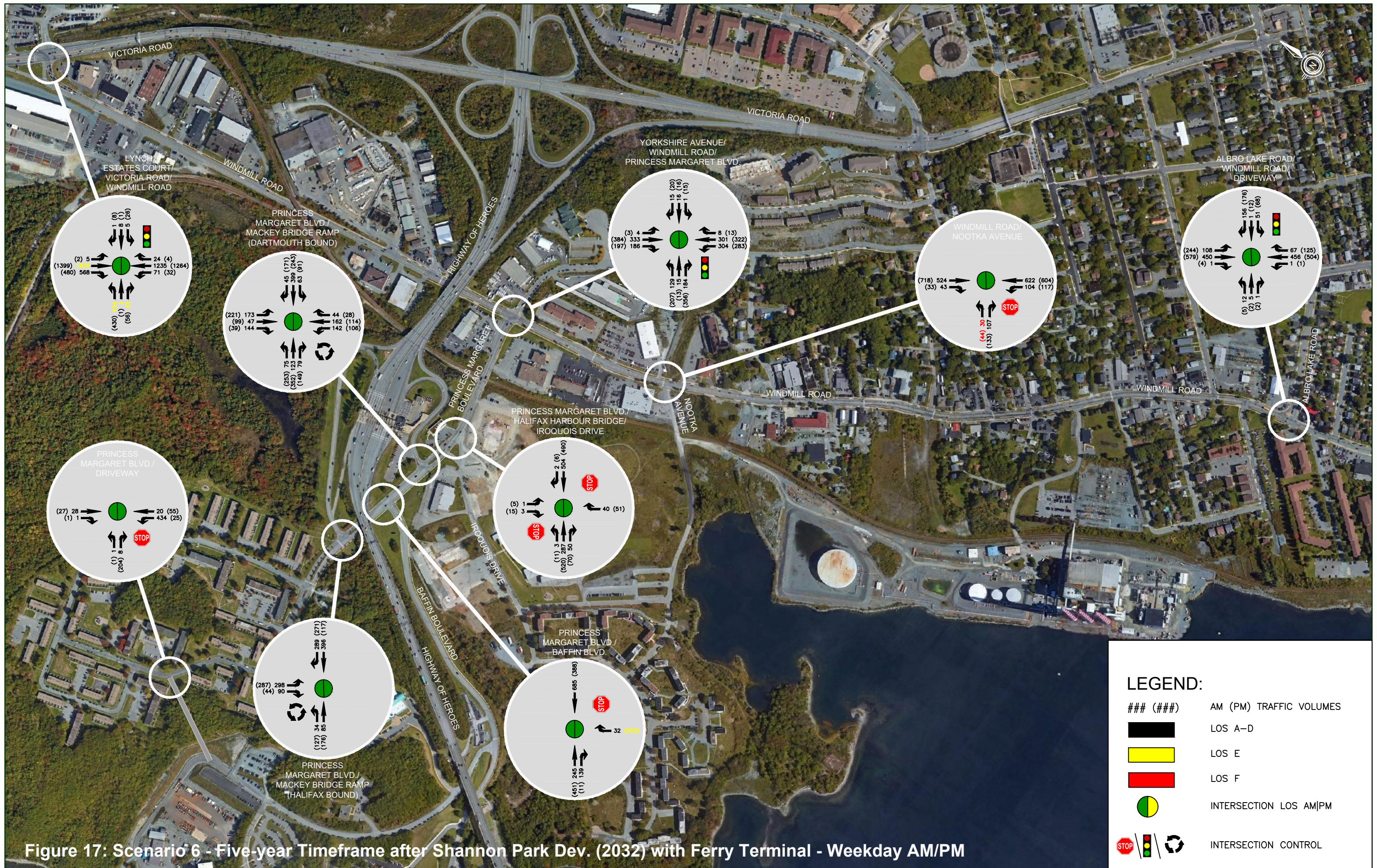
The unsignalized intersection will experience no congestion (LOS A) during the afternoon peak hour. The eastbound left movement (Nootka Avenue) will continue to operate at LOS F in Synchro. The SimTraffic analysis indicates that the movement will operate at LOS E (improvement from LOS F in Scenario 5 without the ferry terminal). The 95th percentile queue lengths on the Nootka Avenue approach continue to indicate that intersection queues will not impact the at-grade CN rail crossing.

The reduction in traffic volumes from the development will improve operations for the eastbound left movement (Nootka Avenue). With the ferry terminal, average delay per vehicle for the northbound right movement (Baffin Boulevard) will be reduced by approximately 11.5 seconds during the morning peak hour and approximately 101.5 seconds during the afternoon peak hour. Average delay per vehicle at the overall intersection will be reduced by approximately 1.5 seconds during the morning peak hour and approximately 3.0 seconds during the afternoon peak hour.

- **Windmill Road & Albro Lake Road:** The signalized intersection will experience no congestion (LOS A) during the morning peak hour; all movements will continue to operate at acceptable levels of service. Operations at the signalized intersection will not be significantly impacted during the morning peak hour (average delay per vehicle at the intersection reduced by less than 0.5 seconds).

The intersection will experience very light congestion (LOS B) during the afternoon peak hour; all movements will continue to operate at acceptable levels of service in Synchro. The SimTraffic analysis indicates that the southbound left movement (Windmill Road) will operate at LOS D (improvement from LOS E in Scenario 5 without the ferry terminal). With the ferry terminal, average delay per vehicle at the intersection will be reduced by approximately 1.0 seconds during the afternoon peak hour.

The results of the analysis indicate that the proposed road network improvements are still required to accommodate the development and will be sufficient to accommodate the ferry terminal during the weekday peak hours. No additional roadway infrastructure improvements are required.



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16 Conclusions and Recommendations

16.1 Conclusions

The Canada Lands Company (CLC) has plans to redevelop Shannon Park to include a mixed use residential and commercial development. The redevelopment scenario includes approximately 3,000 residential units and 150,000 square feet of commercial space.

The traffic impact study was completed to investigate the impacts of the development scenario for Shannon Park. The study evaluates the impact of the development scenario during the weekday morning and afternoon peak hours of traffic.

Shannon Park is located south of Princess Margaret Boulevard in Dartmouth, Nova Scotia. Shannon Park is uniquely located with established transportation network connections to multiple key corridors in HRM including the MacKay Bridge, Highway 111, and Windmill Road. The study area for the traffic impact study, includes Windmill Road between Victoria Road and Albro Lake Road and Princess Margaret Boulevard. Nine intersections within the study area were included in the analysis, the study intersections include:

- Princess Margaret Boulevard & BIO Access
- Princess Margaret Boulevard & MacKay Bridge (Halifax-bound)
- Princess Margaret Boulevard & Baffin Boulevard
- Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)
- Princess Margaret Boulevard & Iroquois Drive
- Windmill Road & Victoria Road
- Windmill Road & Princess Margaret Boulevard
- Windmill Road & Nootka Avenue
- Windmill Road & Albro Lake Road

Traffic volumes gathered in 2016 and updated counts at 6 study area intersections collected in 2019 were used to develop the base traffic volumes for the analysis. Background traffic forecast were developed using a growth rate of 1.0 percent per year and trip estimates for adjacent proposed developments including the anticipated growth at the Bedford Institute of Oceanography and the redevelopment of the Ship Victory site on Windmill Road.

Transportation Demand Projections: Demand projections were developed for the weekday morning and afternoon peak hours of adjacent street traffic. The weekday peak hour trip generation estimates for the residential and commercial land uses were quantified using trip generation rates from the Trip Generation Manual (10th edition) published by the Institute of Transportation Engineers (ITE).

The trip generation estimates were adjusted to account for internal trips, modal split, and pass-by trips. On a typical weekday the Shannon Park development is expected to generate 1111 vehicle trips (375 entering/736 exiting) during the AM peak hour and 1268 vehicle trips (789 entering/479 exiting) during the PM peak hour; all of which would be considered new or primary trips.

Trips associated with the Shannon Park development and adjacent developments were distributed to the study area road network using the following trip distribution:

- 25% to/from Halifax via the MacKay Bridge,
- 15% to/from Bedford and areas to the north via Windmill Road,
- 25% to/from Dartmouth and areas south via Windmill Road, and
- 35% to/from the rest of the metro area via Highway 111.

Weekday Peak Hour Analysis: The performance of the study intersections during the weekday morning and afternoon peak hours was evaluated under five scenarios to quantify the impact of the proposed development on the study area road network. The assessment scenarios included:

- Scenario 1 – Existing Conditions (2019): A scenario reflecting the existing conditions in the study area. This scenario provides an assessment of current operations based on existing traffic volumes, lane configurations and signal timing plans.
- Scenario 2 – Background Growth and Adjacent Developments (2027): A projection of normal traffic growth to the year 2027 and the projected traffic volumes associated adjacent developments. This scenario provides an assessment of future operations without the proposed development.
- Scenario 3 – Shannon Park Development (2027): A projection of background traffic volumes (from Scenario 2) and the projected traffic volumes associated with the Shannon Park development. This scenario provides an assessment of future operations with the proposed development in place which is used to identify if improvements are required to accommodate the proposed development.
- Scenario 4 – Future Development Conditions with Improvements (2027): A projection of future background and development traffic volumes (from Scenario 3) with the proposed improvements. This scenario provides an assessment of future operations with the proposed improvements.
- Scenario 5 – Five-Year timeframe after Shannon Park Development (2032): A projection of normal traffic growth five-years after full build out of the Shannon Park development.

Under existing and background conditions, there are operational issues at the intersections of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) and Windmill Road & Victoria Road during the peak hours.

The Shannon Park development will contribute to the deterioration of existing operational problems or create operational problems with individual movements at all study intersections with the exception of Princess Margaret Boulevard & BIO Access and Windmill Road & Albro Lake Road.

Road Network Improvements: Based on the weekday peak hour intersection analysis, a number of road network improvements are required to mitigate the impact of the Shannon Park development during the weekday peak hours. The improvements include:

1. **Princess Margaret Boulevard & MacKay Bridge (Halifax-bound):** The intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) should be upgraded to a single lane roundabout.

2. **Princess Margaret Boulevard & Baffin Boulevard:** Access to Baffin Boulevard should be restricted to right-in, right-out only by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp. Speed tables will be required on Princess Margaret Boulevard between the Mackay Bridge (Halifax—bound) ramp and Hudson Way to reduce the impacts of the increase in volumes travelling through the residential area as a result of the turning restrictions at Baffin Boulevard.
3. **Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound)/ “Main Street”:** The intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) should be upgraded to a single lane roundabout. The single lane roundabout will require a right turn by-pass on the eastbound approach (Princess Margaret Boulevard) to accommodate the right turn movement into the Shannon Park development.

Improvements to the intersection are required to improve existing and future background operations at the intersection and to accommodate the main access to the Shannon Park development. The roundabout will need to be constructed on both the CLC lands and HRM property.
4. **Princess Margaret Boulevard & “Collector B” (formerly Iroquois Drive):** Access to “Collector B” should be restricted to right-in, right-out only with no restrictions on the HHB driveway
5. **Windmill Road & Princess Margaret Boulevard:** The intersection should be widened to accommodate new lane configurations on the eastbound (Princess Margaret Boulevard) and southbound (Windmill Road) approaches. The existing right turn storage lane should be extended (50 metres) and a left turn storage lane (75 metres) should be provided on the eastbound approach. A right turn storage lane (40 metres) should be provided on the southbound approach. The existing left turn storage lane should be extended (75 metres) on the northbound approach.
7. **Windmill Road & Nootka Avenue:** A left turn storage lane (25 metres) should be provided on the westbound approach (Nootka Avenue). The existing crosswalk should be upgraded to an RRFB to provide appropriate pedestrian crossing control based on future traffic volumes.

The total cost of the roadway infrastructure improvements is estimated at \$4,875,000. The cost estimates do not include allowances for engineering, property acquisitions, utility relocations or harmonized sales tax (HST).

Princess Margaret Boulevard Corridor Analysis: The intersection performance analysis identified a number of road network improvements required along Princess Margaret Boulevard to mitigate the impact of the Shannon Park development. Under existing conditions, traffic flows freely along the entire length of the Princess Margaret Boulevard corridor until the signalized intersection at Windmill Road. The proposed improvements include changes to intersection controls along the corridor which will introduce delay and queues along the corridor.

The intersections along Princess Margaret Boulevard are closely spaced making it important to identify interactions between adjacent intersections. Different types of software were used to model the

intersections based on the type of intersection control. While the queue length results from the various analyses are a good indicator of intersections between adjacent intersections, a supplemental corridor analysis was completed along Princess Margaret Boulevard using PTV Vissim software to confirm the results of the intersection performance analysis.

The study area for the corridor analysis was limited to the section of Princess Margaret Boulevard from the ramps to the MacKay Bridge toll plaza to Windmill Road, the section includes five study intersections. The performance of the study intersections during the weekday morning and afternoon peak hours was reevaluated under two of the previous scenarios: Scenario 1 – Existing Conditions (2019) and Scenario 5 – Five-Year timeframe after Shannon Park Development (2032).

The results of the Vissim analysis are consistent with the intersection performance analysis results. The corridor analysis confirms that the proposed road network improvements will be sufficient to accommodate the proposed development during the weekday peak hours and confirms that the Shannon Park development will not impact the MacKay Bridge toll plaza or the CN rail crossing.

Shannon Park Ferry Terminal: Halifax Transit is currently reviewing the abutting Millbrook Lands for a future ferry terminal. HRM staff have requested that the potential ferry terminal be accounted in in the traffic study. The Shannon Park Route, identified in the Rapid Transit Strategy, would include a connection from a new ferry terminal on the Millbrook Lands abutting the Shannon Park development to the Halifax Ferry Terminal.

The performance of the study intersections during the weekday morning and afternoon peak hours was evaluated under an additional scenario to quantify the impact of the proposed development with the presence of a ferry terminal on the study area road network:

- Scenario 6 – Five-Year timeframe after Shannon Park Development (2032) with Ferry Terminal on Millbrook Lands: A projection of normal traffic growth five-years after full build out of the Shannon Park development, where the projected traffic volumes associated with the Shannon Park development assume a higher mode share reduction and the additional vehicle trips generated by the ferry terminal's Park & Ride facility. This scenario includes the proposed improvements identified in Scenario 4 that required to accommodate the Shannon Park Development.

The reduced vehicle trips from the Shannon Park development will outweigh new vehicles trips generated by the ferry terminal's Park & Ride facility, resulting in lower traffic volumes throughout the study area and slightly improved operations at most intersections when compared to the same scenario without the ferry terminal (Scenario 5 - Five-year Timeframe after Shannon Park Development). The results of the analysis indicate that the proposed road network improvements proposed improvements are still required to accommodate the development and will be sufficient to accommodate the ferry terminal during the weekday peak hours.

16.2 Recommendations

Based on the findings of this study, it is recommended that:

- The intersection of Princess Margaret Boulevard & MacKay Bridge (Dartmouth-bound) be upgraded to a single lane roundabout with a right turn by-pass on the eastbound approach (Princess Margaret Boulevard).
- The intersection of Princess Margaret Boulevard & MacKay Bridge (Halifax-bound) be upgraded to a single lane roundabout.
- Access to Baffin Boulevard be restricted to right-in, right-out only by providing a continuous raised concrete median on Princess Margaret Boulevard between the proposed roundabouts at Mackay Bridge (Halifax—bound) ramp and the MacKay Bridge (Dartmouth-bound) ramp.
- Traffic calming measures (vertical deflections) be installed on Princess Margaret Boulevard between the Mackay Bridge (Halifax—bound) ramp and Hudson Way.
- Access to “Collector B” be restricted to right-in, right-out only. Detailed design should consider the feasibility of further access management at this intersection such as extending the continuous concrete median on Princess Margaret Boulevard and relocating the HHB driveway to maintain fully directional access.
- A left turn storage lane be provided on the Nootka Avenue approach.
- The existing crosswalk at Windmill Road & Nootka Avenue be upgraded to an RRFB.
- The intersection of Windmill Road & Princess Margaret Boulevard be widened to extend the existing eastbound (Princess Margaret Boulevard) right turn storage lane and provide an eastbound left turn storage lane, extend the existing northbound (Windmill Road) left turn storage lane, and provide a southbound (Windmill Road) right turn lane.
- Traffic calming measures (vertical deflections) be installed adjacent to the school.
- HRM implement the recommendations previously identified in the at-grade crossing assessment completed in 2018 for the Princess Margaret Boulevard crossing.
- Roadway infrastructure improvements be implemented based on the phasing of the development as outlined in the implementation plan and a monitoring plan be implemented to ensure regular monitoring of the intersections as development occurs to ensure the improvements are implemented earlier if traffic patterns indicate operational issues on MacKay Bridge ramps or Princess Margaret Boulevard.
- The requirements of the internal road network intersections (control type, lane configuration, storage lane requirements) be determined during detailed design.