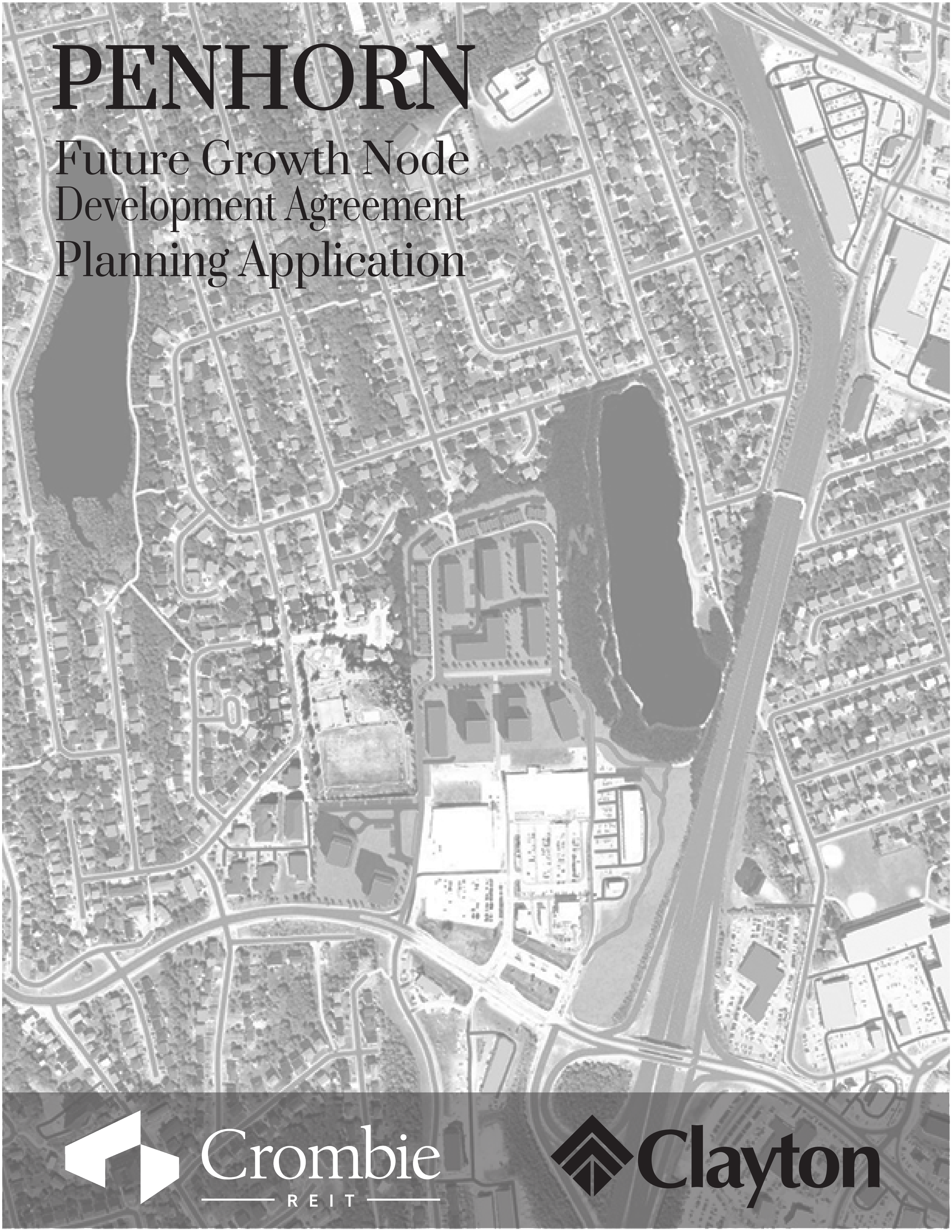
PENHORN

Future Growth Node
Development Agreement
Planning Application



Crombie REIT

Clayton

December 8, 2020

Mr. Carl Purvis
Planning Applications Program Manager
Planning and Development
HALIFAX

Dear Mr. Purvis,

Re: Penhorn Application for Development Agreement PIDs 00222844 & 41331281

Clayton Developments Limited and Crombie REIT have formed a partnership to develop the Penhorn Property. We are pleased to submit the following package in support of our application for development agreement.

Attachment A: Concept Plan & Massing Model images
Attachment B: Centre Plan, Map 12 Comparison
Attachment C: Parks and Open Space Plan
Attachment D: Active Transportation Network Plan
Attachment E: Street Network Plan & Cross Sections
Attachment F: Site Servicing Brief & Plans
Attachment G: Traffic Impact Study
Attachment H: Stormwater Management Plan and Report
Attachment I: Shadow Study
Attachment J: Landscape Plan and Summary
Attachment K: Retracement Plan

1. Background

The Penhorn Future Growth Node presents a brownfield redevelopment opportunity in HRM's Regional Centre with significant access to transit, parkland, and commercial amenities. A former shopping centre, the site is now partially vacant, with the rest having been redeveloped as a retail and office complex adjacent Portland Street. The recently developed commercial area is active and well used, with the newest building having been constructed within the last year, and with many long term leases held by successful businesses. Therefore, the retail and office complex area is expected to remain in place, and maintain development rights that exist today, until such a time as it is ready to be redeveloped. The future redevelopment of this area should be planned in greater detail at a later date than the currently vacant lands which demand immediate attention. These vacant areas provide a near-term development opportunity of approximately 25.2 acres, to be reimagined into a residential development.

In October 2009, a Community Vision for the Penhorn site was approved in principle by Regional Council as a mixed-use area clustered around the transit terminal on Portland Street. The approval came following a significant community consultation process, which generated a community vision including pedestrian and transit-oriented spaces and corridors, as well as a range of medium to high density housing choices.

This community vision was integrated into the Regional Centre Secondary Municipal Planning Strategy (SMPS), enabling future development at the site through a development agreement process. Development agreement applications are to be reviewed, assessed, and approved in accordance with Future Growth Node Policies 3.35 and 3.32. At a high level, these policies require:

1. Site and building design to support a compact, mixed-use neighbourhood
2. Environmental protection and water quality protection
3. A range of parks and open spaces to serve the densely populated community
4. A transportation network that prioritizes walking, the easy use of mobility devices, cycling, and transit.

2. Development Brief

The proposed new development of the Penhorn lands incorporates a decidedly urban feel with focus on important pedestrian connections to existing parkland (Brownlow Park and Penhorn Lake), commercial, and transit amenities. The near-term concept plan is shown on Attachment 2 – Concept Plan with designed building footprints, and is rationalized into eight multi-residential development blocks bounded by 45 sixteen-foot-wide townhomes as a transition to the existing low-rise neighbourhood of Manor Park. Future, long term, development blocks I through M are shown as mixed use—incorporating commercial and office uses at the ground floors, with residential above.

The recently adopted Regional Centre SMPS supports a density figure of 3,500 – 4,000 people for this Future Growth Node of 42 acres, which equate to between 83 and 95 people per acre. In the near-term approximately 25 of the 42 acres are proposed to be developed. The remaining 17 acres is existing retail and office and is intended to remain in its current state indefinitely, with the exception of proposed upgrades to the road network, pedestrian connections and AT connections.

The near-term development plan includes 905 units within the approximate 25 acre area where new residential development is proposed. This equates to a total of 2086 people and a population density of 83 PPA, and sits within the policy's target. A population of 1912 is allocated to the future redevelopment of the 17-acres of active commercial lands. As the development agreement process progresses, the plans will be fine-tuned. The unit yield may vary as the most effective layout is agreed upon to fulfill the intent of all Future Growth Node policies.

The absorption rate for the multi-residential units are expected to be strong with all blocks being sold within a four to five year time horizon following the first year of infrastructure development. Vacancy rates in HRM hit an all-time low in 2019 falling below 2%, while fill rates of newly constructed buildings have averaged between 10-12 months per 100 units completed.

The pedestrian environment is a priority of this development. Enhanced streetscapes, ornamental street lighting, decorative plantings, and general site landscaping are significant elements of the plan to ensure a fine grained, attractive look and feel to the neighbourhood.

Efficient and creative use of infrastructure is important to the success of the development. The proposed road cross sections coupled with storm water management techniques will innovatively cater to the needs of the site. The selective use of hardscaping and narrower travel ways will contribute to pedestrian safety and traffic calming. Performance based road design will link seamlessly with the existing and proposed land use patterns to ensure minimal disruption to existing tenants within the commercial district of Penhorn. These, and other strategic environmental and infrastructure approaches, will contribute to the end objective of developing this community to its greatest potential, in a manner that is attractive and complete.

3. Applicable SMPS Policies

This section will address the applicable policies. SMPS text will be italicized for clarity.

3.1 Objectives

The Regional Centre SMPS includes several objectives within section 3.8, for the future development of lands designated 'Future Growth Node', which includes the Penhorn lands.

F1 Provide for diverse and inclusive opportunities for public engagement during the comprehensive planning process;
F2 Preserve and recognize significant environmental and cultural aspects and provide for a variety of open space uses;
F3 Comprehensively plan and develop each Future Growth Node for a mixed-use neighbourhood with a range of housing opportunities, places of employment and services where daily needs of residents can be met;
F4 Design a transportation network that includes transit services and facilities, prioritizes pedestrians, cyclists, and public transit over auto-oriented uses, and is connected to other communities;
F5 Effectively integrate new developments with surrounding neighbourhoods;
F6 Design and build attractive, pedestrian-oriented healthy places, which consider human scale design, food security, urban agriculture, and the use and conservation of energy;
F7 Design to mitigate flooding, including coastal flooding, and to manage stormwater on-site; and
F8 Create a safe, attractive and accessible public realm for people of all ages and abilities.

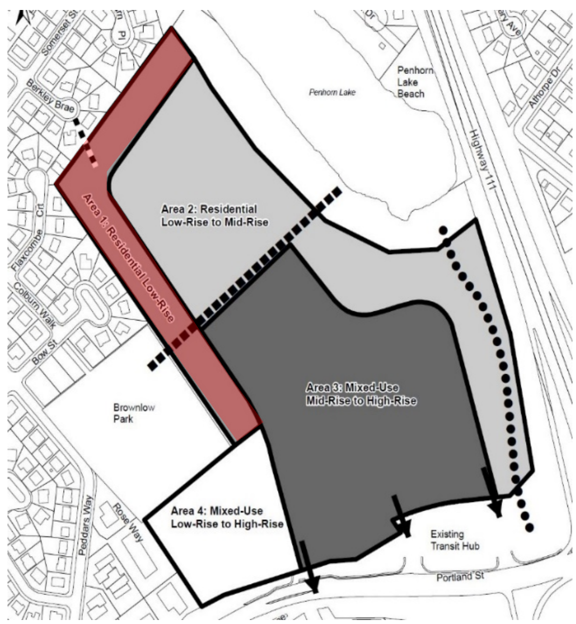
The proposed development includes a variety of private open spaces and enhanced connections to public open spaces abutting the development site. The concept includes a mix of land uses, housing choices and built forms, creating an environment where residents have direct, convenient, walkable connections to private and public amenities and services such as public transit. The proposed transportation network prioritizes active transportation users through enhanced streetscaping, traffic calming design elements, and multi-use trails. Land uses and built forms transition appropriately to surrounding neighbourhoods in accordance with provisions of Policy 3.67 and Map 12 of the SMPS, as seen in Attachment B. Objectives F1 – F8 above are acknowledged throughout this proposal, within the attachments, and will be specifically addressed in response to policies particular to the Penhorn Site, in section 3.8.3.2 of the SMPS.

3.2 Four Areas of the Penhorn Future Growth Node

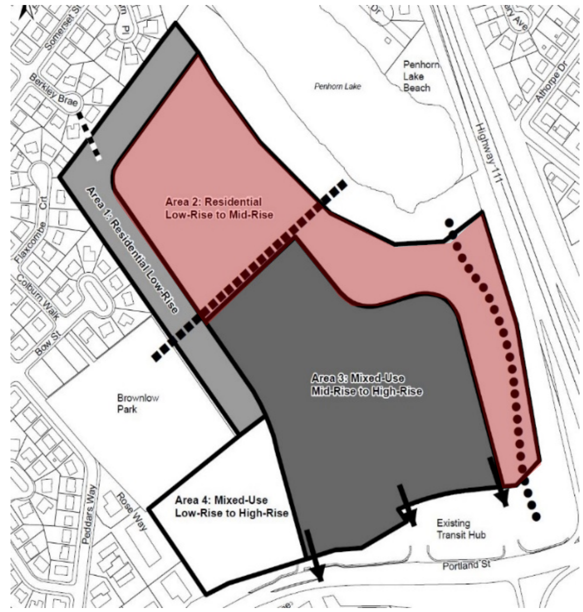
The Regional Centre SMPS, including Map 12, outline four separate ‘Areas’ for the Penhorn Lands within Section 3.8.3.2.

Area 1: this area abuts the Manor Park Neighbourhood and Penhorn Lake Park and Brownlow Park. Future development will maintain and enhance the existing vegetative buffer. Low-rise residential buildings are supported in this area due to its proximity to an existing low-rise residential neighbourhood.

As shown on Attachment A: Concept Plan and massing model imagery, there is an existing vegetative buffer along the outer edge of this area where it abuts the Manor Park Neighbourhood and Brownlow Park. Low-rise residential townhouses are proposed within this area, providing an appropriate scale and form of residential development in proximity to the abutting low-rise neighbourhood.

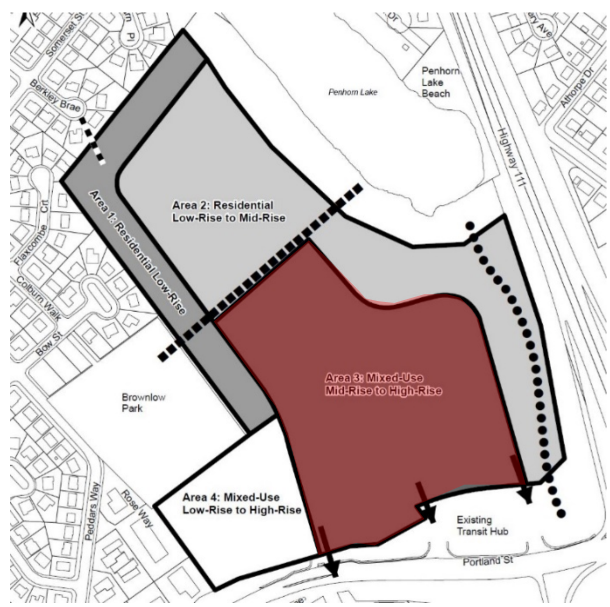


Area 2: this area abuts Area 1 and the Penhorn Lake Parkland. Future development will maintain and enhance the existing vegetative buffer. Predominantly residential low-rise buildings and mid-rise buildings will be established in this area to provide transition between the low-rise residential of Area 1, and the more dense and mixed-use Area 3. Part of this area also abuts the Circumferential Highway where a multi-use trail is to connect the transit facility to Area 3, and Penhorn Lake Park.



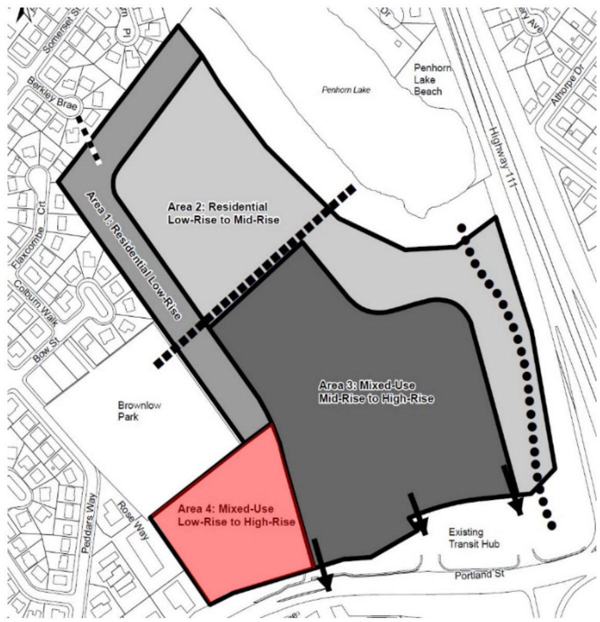
The proposed development includes mid-rise, multi-unit residential development ranging from 4-6 storeys within the portion of Area 2 adjacent to Area 1 and Penhorn Lake. These mid-rise building forms provide an appropriate transition between the established and planned low-rise residential areas, and the denser, high rise forms in Areas 3 and 4. A multi-use trail and parkland is proposed adjacent to the Circumferential Highway, connecting the transit terminal to Area's 3, 2 and Penhorn Lake.

Area 3: this area is intended to be the mixed-use centre of the Penhorn Future Growth Node. Mid-rise buildings, tall-mid-rise buildings and high-rise buildings in a transit-oriented development is supported in this area. A main-street pedestrian-oriented development is envisioned for this area, providing a focal point for commercial activity and supporting public amenities for this dense community. A multi-modal active transportation greenway connects and provides a transition between this area, and Area 2 and connects the two key parks which exist on the site.



The majority of Area 3 is currently occupied by recently developed retail and office uses, with the northern portion of the area being vacant. The proposed concept plan includes mid-rise to high-rise residential development in this vacant portion, adjacent to Area 2. A multi-model greenway is proposed to connect Penhorn Lake parkland to Brownlow Park, as detailed in Attachment C. The lands which are currently developed will need to maintain their existing development rights, as per the Centre Plan CDD zone, for the foreseeable future (30+ years). As such, the redevelopment of this area cannot be planned in great detail at this point in time, but is identified on the concept plan as mixed use with a grid block structure to support a future, pedestrian oriented development patter. The population of this area is intended to be approximately 1912 people, varying with the finalization of detailed plans for the currently vacant area. This population is intended to be distributed amongst commercial lands and multiple residential units.

Area 4: this area is nestled between Manor Park low-rise residential area, Brownlow Park, low-rise Area 1, and the mixed-use centre of Area 1. This area is facing Portland Street and is in close proximity to the transit facility. This area may develop into low-rise to high-rise mixed-use development, and additional park space adjacent to Brownlow Park may also be considered for this area.



The proposed concept for Area 4 includes high-rise residential development and open space to create appropriate transition and compatibility with Brownlow Park. The design also proposes an expansion of Brownlow park through the inclusion of a dedicated parking area. Residential development is oriented towards Portland Street, within proximity to the transit terminal.

3.3 Penhorn Future Growth Node Policies

Policy 3.67 - When considering a development agreement for the Penhorn Lands Future Growth Node, Council shall consider Policy 3.64, and:

a) *That the general location of proposed land uses, road network connections, parks, and multi-use trails is reasonably consistent with Map 12;*

As outlined in section 3.2 of this letter and shown in Attachment B, the proposed land uses and building forms within the development concept are reasonably consistent with the four areas identified on Map 12. The concept proposes two separate public street connections to Portland Street, a multi-use trail along the Circumferential Highway connecting Penhorn Lake to the Transit Terminal, a multi-use trail connecting Penhorn Lake to Brownlow Park and a walkway connecting Area 1 of the development to the existing low-rise neighbourhood to the north. All of these details within the concept plan are consistent with the elements of Map 12.

b) *That site and building design supports a compact, mixed-use neighbourhood by:*

i. *planning for a mix of low-rise buildings, mid-rise buildings, tall mid-rise buildings and high-rise buildings as illustrated on Map 12;*

The development concept includes a mix of low-rise, mid-rise and high-rise buildings that are distributed across the site in a manner that is consistent with Map 12. Please refer to the concept plan and massing model imagery (Attachment A).

ii. *planning for low-rise residential buildings in Area 1; low-rise to mid-rise buildings predominantly residential forms in Area 2; mixed-use mid-rise, tall mid-rise and high-rise buildings in Area 3; and low-rise to mid-rise buildings and open space in Area 4;*

As outlined in section 3.2 of this letter, and in Attachments A and B, the proposed land building forms within the development concept are consistent with the four areas. The existing retail commercial area encompasses the majority of Area 3 and this application is seeking to enable the continuation of these uses. In the long term, mixed use development will be developed within Area 3 in a manner consistent with applicable SMPS policies.

iii. *transitioning new development down to existing low-rise residential buildings, and to municipal parks,*

The development concept maintains a vegetative buffer along the outer edge of Area 1 that abuts the Manor Park Neighbourhood and Brownlow Park. The Low-rise residential townhouses proposed along this edge provide an appropriate scale and form of residential development in proximity to the abutting low-rise neighbourhood and Brownlow Park. Mid-rise building forms are proposed adjacent to Penhorn Lake, however they are located on the opposite side of a public street providing appropriate separation and transition to the municipal parkland. Area 4 includes high-rise residential development and a significant amount of open space to create appropriate transition and compatibility with Brownlow Park. Residential development is oriented towards Portland Street to create separation and appropriate transition from the existing low-to-mid-rise multiple unit dwellings to the west.

iv. *locating commercial and institutional uses within mixed use buildings up to the third floor, and primarily along the ground floor of pedestrian-oriented commercial streets;*

The majority of Area 3 is currently occupied by a recently developed retail and office complex that includes a variety of commercial amenities within short walking distance of the proposed residential developments. Further development of Area 3 may occur in the future, at which time mixed use buildings will be considered that contain commercial and institutional uses within the ground-oriented levels.

v. *providing pedestrian-oriented building facades and designs;*

The proposed residential developments places the buildings close to the street, with human scaled streetwalls that include ground oriented residential units and variation in design elements. The majority of vehicular parking areas are proposed to be located underground with landscaped podiums at grade, with a limited amount of surface parking located away from public streets. The concept strikes an appropriate balance of high density, human scaled residential development and landscaped open space within the public realm. The balance of these elements aims to create a walkable, pedestrian-oriented environment.

vi. *prohibiting new drive-through facilities;*

No new drive-through facilities are proposed within the development

vii. *providing substantial landscaping around the perimeter of the site, and adjacent to all buildings; and*

The proposed development includes landscaped vegetative buffers along the outer edges of the site, abutting existing low-rise neighbourhoods and municipal parks. Enhanced streetscapes, ornamental street lighting, planter boxes, and general site landscaping are provided throughout the development concept. Please refer to Attachment J: Landscape Plan and Summary statement

viii. *providing a mix of units, including ground orientated units.*

The concept includes 45 ground oriented (16' wide) townhouses, with rear lane access, along the northwestern edge of the site adjacent to the low-rise residential neighbourhood of Manor Park. The total number of residential units is proposed to range between 800 and 905, and will include a variety of unit sizes and types within the low, medium and high rise structures.

c) *That environmental protection, water quality and Urban Forest Master Plan objectives are supported by:*

i. *designing on-site stormwater management that emphasizes low impact development measures as a means to maintain water quality in Penhorn Lake, with consideration given to the Analysis of Regional Lakes Water Quality Data (2006- 2011) prepared by Stantec in 2012*

The Master Storm Water Management Plan found in Attachment H demonstrates that the site is balanced and gives consideration to the referenced Stantec Data. Site pre and post development balancing of storm water is achieved by the application of a wide range of Low Impact Development strategies and Best Management Practices as outlined Conceptual Stormwater Plan within Attachment H.

ii. *considering a water quality monitoring program during and following development to ensure that the water quality objectives of the Regional Plan are satisfied;*

As the development strategy progresses, a water quality monitoring program will be established in collaboration with Halifax Regional Municipality in order to ensure that the water quality objectives of the Regional Plan are satisfied.

iii. *preparing a landscaping and vegetation plan as part of site development to support the canopy target for the Manor Park Neighbourhood as referenced in the Urban Forest Masterplan.*

The initial Landscape Plan can be found in Attachment J, along with a summary document which explains how the plan supports the canopy targets of the Urban Forest Masterplan.

d) *Parks and open spaces provide the full range of recreation and open spaces needed to serve the dense community by:*

i. *locating public amenity spaces near the transit terminal on Portland Street,*

Land directly to the north-east of the transit terminal will be developed as public parkland. This corridor of land provides amenity space near the transit services, and also offers connectivity to further recreation opportunities. The corridor continues behind the existing commercial uses adjacent to the Circumferential Highway and connects the transit terminal to Penhorn Lake Beach and the existing trail around the West side of Penhorn Lake with a multi-use trail.

ii. *retaining, and where feasible, enhancing vegetative buffers around Penhorn Lake,*

The existing vegetative buffer surrounding Penhorn Lake ranges between 40m and 60 m in width, and will be maintained in its entirety. An additional linear portion of land, ranging from 4m to 24 metres wide, will be added to the existing buffer area between the proposed development and Penhorn Lake.

iii. *establishing setbacks from municipally-owned lands around Penhorn Lake,*

In addition to expanding the existing municipally-owned lands, development will not occur on the North-east side of the road (the same side as Penhorn Lake) to ensure that setbacks are maintained, and provide visibility and ease of access to the parklands.

iv. *providing that only pervious landscaping surfaces or materials are permitted within the setbacks from municipally-owned lands around Penhorn Lake, and*

The landscaping materials within the setbacks from municipally-owned lands are intended be grass or will remain as existing natural vegetation.

v. *planning for a public park or parks to be aligned with, and to be visible from existing parks and the multi-modal pathway linking Penhorn Lake area and Brownlow Park; and*

The plan establishes a multi-modal linear park aligned to connect Brownlow Park and the Penhorn Lake area. The linear park is 18 m in width and continues the full 147m length of the residential block. A direct and legible connection is made across the public street, to the existing parks on either end.

The Parkland Plan, found in Attachment C, provides detail on the vision for this space. The linear park is intended to be used as both an active and a passive recreational area; providing a means of moving between existing parks, as well as a place to linger. A 3m wide multi-use trail provides a direct route through the park for bikers and joggers, while a meandering adjacent pathway and landscaped area is suitable for more leisurely movement. Seating will be available throughout the linear park, with a set of landscaped steps that overlook the central connection towards the commercial area. These steps will be a key view terminus from the commercial area, and will draw shoppers to this activated space, where they can enjoy a snack from a nearby shop, rest, or people watch, at their leisure.

e) That the transportation network prioritizes walking, the easy use of mobility devices, cycling, and transit use by:

i. providing a minimum of two street accesses to Portland Street as illustrated on Map 12;

The proposed concept plans includes two separate street accesses to Portland Street at existing controlled intersections, as illustrated on Map 12.

ii. planning for a multi-modal greenway that links Penhorn Lake area and Brownlow Park, is hard surfaced and no less than 3 metres wide to accommodate public spaces, trees and an off-road active transportation route;

The concept plan includes a hard surfaced, tree lined, 3m wide multi-modal path for off-road active transportation through the centre of the development. This is shown in detail in Attachment C.

iii. designing wide pathways to access the back half of the site and intersect with the greenway to give priority to pedestrians and active transportation,

A central, active transportation-only pathway connects the commercial area to the North-west portion of the site, as shown in Attachment D. The path begins at the edge of the existing commercial area, and passes through an 18m wide corridor between residential blocks. The pathway comes to an end as it intersects with the multi-modal linear park. This pathway provides a direct connection to the amenities at the back of the site. While pedestrians and bikes can access the back half of the site by way of sidewalks, this direct route provides a more pedestrian friendly option, as it is not accessible to motorized vehicles. Landscaping details and an attractive view terminus towards the multi modal linear park will incite a natural movement towards the back half of the site.

iv. designing pedestrian pathways to connect the transit facility, existing neighbourhoods, Brownlow Park, Penhorn Park, and the proposed Penhorn Lake trails, and

The Active Transportation Plan (Attachments D) and the Street Network Plan (Attachment E) depict the variety of connections and pathways. In addition to the trail connecting the transit terminal to the Penhorn Lake, the multi-modal linear park area, and the connector pathway, which have been described above, the site design also provides various other connection and enhancements to complement the existing pedestrian network, including:

- The maintenance and improvement of the existing connection from the site to the Manor Park Neighbourhood through Berkley Brae
- 1.8m wide sidewalk along the entirety of Local Road 1 which provides pedestrian connectivity throughout Areas 1 and 2
- 3m wide asphalt trail along Local Road 3 which solidifies the link between the multi-modal linear park and Brownlow Park, as well as providing pedestrian connectivity between Areas 1, 3 and 4, and out towards Portland street
- The design ensures that Penhorn Lake is accessible from throughout the neighbourhood, offering a trail connection from the back, midpoint and front of the site.

v. *planning for pedestrian pathways and open spaces.*

The site has been designed to have high internal pedestrian permeability and to access surrounding areas by direct and convenient pathways. The longest pedestrian connection across the site is a route of approximately 670 metres from the transit terminal on Portland Street, to the most distant townhouses within Area 1. This distance is within norms for walkable access to public transit.

In addition to providing pedestrian pathways to access open spaces, and providing the multi-modal linear park area, this plan also provides enhancements and expansions of existing parkland.

Brownlow Park is a well-used existing recreational area, however it lacks dedicated parking. Users currently park along the adjacent public residential street, and the park is primarily accessed from Peddars Way. This plan proposes a direct means of access from Portland Street, and provides 40 off-street parking stalls dedicated for park use.

Penhorn Lake's trails and beach area are also primarily accessed from the adjacent residential street. This plan proposes the development of a 20-stall parking area for beach and trail users. Combined with the new trails surrounding the lake, as shown on the concept and pedestrian network plans, this parking lot will greatly increase usability and access to the green space and beach area of Penhorn Lake.

In total, this plan includes 5.4 acres of new parkland area, which support and connect the existing network, and provide upgraded accessibility. These 5.4 Acres represents 12% of the entire project area. The plan also proposes upgrades, including 950 m of crusher dust trails, and 633 m of 3 m wide asphalt multi use trail. The multi modal linear park will include a variety of enhancements, such as sitting steps, hammocks, bike racks, and plantings.

<u>3.4 General Development Agreement & Land Use By-Law Amendment Policies</u>

Policy 3.64 The Maximum Building Height Precincts illustrated on Map 6 shall not apply to a development agreement within a CDD zone. In considering development agreement for any lands zoned CDD, Council shall consider the following:

a) the Urban Design Manual contained in Appendix 2 of this Plan;

Please see Section 4 of this letter, which provides the Urban Design Manual Rationale.

b) the applicable site specific CDD requirements set out in Section 3.8.3 of this Plan;

Please see Section 3.2 and 3.3 of this letter, which respond to specific policies applicable to the Penhorn Mall Site.

c) all applicable policies of the Regional Plan and of this Plan;

The Regional Plan identifies this area as a Regional Local Growth Centre. The Plan outlines future characteristics of these growth centres:

- Includes a mix of medium to high density developments with pedestrian oriented facades
- Transit service availability with connections to developments through enhanced pedestrian linkages
- High quality streetscaping and interconnected private and public open spaces.

The characteristics are translated into policy within the Regional Centre SMPS, which guided the creation of the proposed development concept for the Penhorn lands. The proposed development includes a mix of housing types and built forms with pedestrian oriented facades and streetscaping design. Private development lots include significant landscape open spaces to further enhance the public realm. A variety of direct pedestrian connections are proposed, connecting new developments to the existing transit terminal.

d) the subdivision of land;

The proposed development includes a variety of building types and building forms. New residential buildings are proposed to be located on their own individual lots, some of which may have interconnected parking structures below grade. As the development agreement process progresses, the requirements for subdividing the land will be contemplated in greater detail.

e) *the phasing of infrastructure;*

The proposed development will be broken up into eight phases. Development will begin along Portland Street and will progress along Local Road 1, towards the middle of the site and then along Local Road 2. The order will be, Block H, B, A, and C-G will be divided into two parts and represent the final two phases of the near-term development. The existing commercial redevelopment will follow in the distant future, in four final phases.

f) *the proposed road network and the location of transit facilities;*

The proposed concept plan includes a road network that is consistent with the land use concept in Map 12. The network of streets and multi-use trails provide a variety of direct pedestrian connections to the existing transit terminal.

g) *the provision of open space that meets the objectives of this Plan and the requirements of Regional Subdivision By-law;*

The proposed development concept includes a variety of open spaces which are, in aggregate, equivalent to 12% of the development, as well as additional upgrades described above. These spaces are integrated seamlessly with the existing municipal parks (Brownlow Park and Penhorn Lake), and enhanced with multi-use trails that connect to the existing transit terminal and commercial amenities.

h) *the proposed built form and land use requirements reference the appropriate zones and sections of Land Use By-law with limited variations considered as needed to meet Urban Design Manual;*

i) *the agreement may identify Pedestrian-Oriented Commercial Streets, View Corridors, and View Terminus Sites;*

The sitting steps located in the centre of the multi-modal linear park will act as a view terminus from the pedestrian connection from the commercial area to the back portion of the site. The right of ways through the existing commercial areas will be enhanced based on feedback received from staff, committees, and the community. Over time, as the existing commercial area becomes beneficial to redevelop as a mixed use node, the opportunity will be taken to explore the integration of pedestrian-oriented commercial designs.

j) *provisions to comply with the Pedestrian Wind Impact Assessment Protocol and Performance Standards, and the Shadow Impact Assessment Protocol and Performance Standards of the Land Use By-law;*

Please refer to Attachment I: Shadow Study regarding shadow impacts. With regards to Pedestrian Wind Impact Assessment Protocol, we proposed to include a clause within the development agreement that requires proposed buildings adhere to the provisions of Appendix 1 of the Regional Centre Land Use By-law. We propose the development of future buildings to be subject to the same standards and protocols.

k) *provisions for incentive or bonus zoning;*

We proposed to include a clause within the development agreement that requires proposed buildings adhere to the provisions of Part XII of the Regional Centre Land Use By-law.

l) *impacts to Municipal infrastructure and the need, if any, to concurrently approve by-laws to pay for growth related municipal infrastructure; and*

Please refer to Attachments E through I, including the Traffic Impact Study, Street Network Plan, Site Servicing Brief and Plans, and Storm Water Management Plans and Concepts, which collectively provide a summary of how municipal infrastructure is proposed to be integrated into the development.

m) *the agreement to enable the agreement to be discharged when all terms and obligations are fulfilled.*

The proposed development approach will enable the development agreement to be discharged when all terms and obligations are fulfilled. The creation of private lots with frontage on public right of ways allows a typical zoning model and built form provisions to be incorporated within the existing land use by-law.

4. Urban Design Manual Rationale

The Regional Centre Urban Design Manual contains urban design criteria which represent objectives for how projects can best achieve the urban design goals of Regional Centre SMPS, and best practices for creating a positive relationship between proposed buildings and the open spaces, communities and neighbourhoods. The document is divided into four categories: Site Context, Site Planning and Design, Open Space Design, and Building Design.

Site Context: The proposed development concept for the Penhorn lands was created to support community identity and enable a complete community. In the past, these lands have primarily served as a commercial node for surrounding residential neighbourhoods. This function of the lands, in combination with highly accessible transit node, is preserved and enhanced within the proposed development. Built form patterns, such as street layout, sidewalks, pathways, bike routes, block structure and building massing are deigned to preserve and enhance the context of the site while enabling more residents to live within this area of the city. Community assets surrounding the site, such as Brownlow Park and Penhorn Lake are preserved with enhanced connections to the existing surrounding neighbourhoods and newly proposed developments within the site.

Site Planning and Design: The proposed development organizes new building massing, open spaces and uses to emphasize and enhance the pedestrian environment. Buildings will have ground oriented units and private landscaped open spaces. An active streetwall will be achieved by locating buildings close to street lines, occupying the majority of street frontages, strategically locating open spaces to break up large lots and providing a fine grained block pattern. The development also proposes mobility connections within the site that support a pedestrian friendly environment and promote interconnectivity between residences, private open spaces, public open spaces, commercial amenities, and public transit services. Parking and utility aspects of private developments are located underground or within the rear yards and interior portions on private development lots in order to minimize the impact on the public realm.

Open Space Design: The proposed development includes a network of public and private open spaces that were strategically located to provide positive experiences for people and support a pedestrian friendly and human-scaled public realm. These spaces are planned to be designed with accessibility in mind by including barrier free access points, careful surface material selection and appropriate seating. Enhanced streetscapes, ornamental street lighting, planter boxes, and general site landscaping are significant elements of the concept plan that are compatible and consistent with open spaces abutting the site and within surrounding neighbourhoods.

Building Design: The proposed development includes a variety of building types and forms that are strategically sited in order to provide appropriate transition to surrounding neighbourhoods. The building designs will support a pedestrian-friendly and human-scaled public realm through the following:

- Designing buildings that are taller than wide, with human scaled streetwalls
- Providing breaks in streetwalls to emphasize fine-grained neighbourhood character
- Including multiple entrances and grade-related units to enhance the streetscape and pedestrian experience
- Locating parking away from the streetline, either underground, inside, or to the rear of the building with access doors not visible from the public realm

5. Closing

We trust that the enclosed materials satisfy the application requirements, and look forward to working with staff, the community, committees, and council throughout the application process. Please do not hesitate to contact the undersigned at any time.

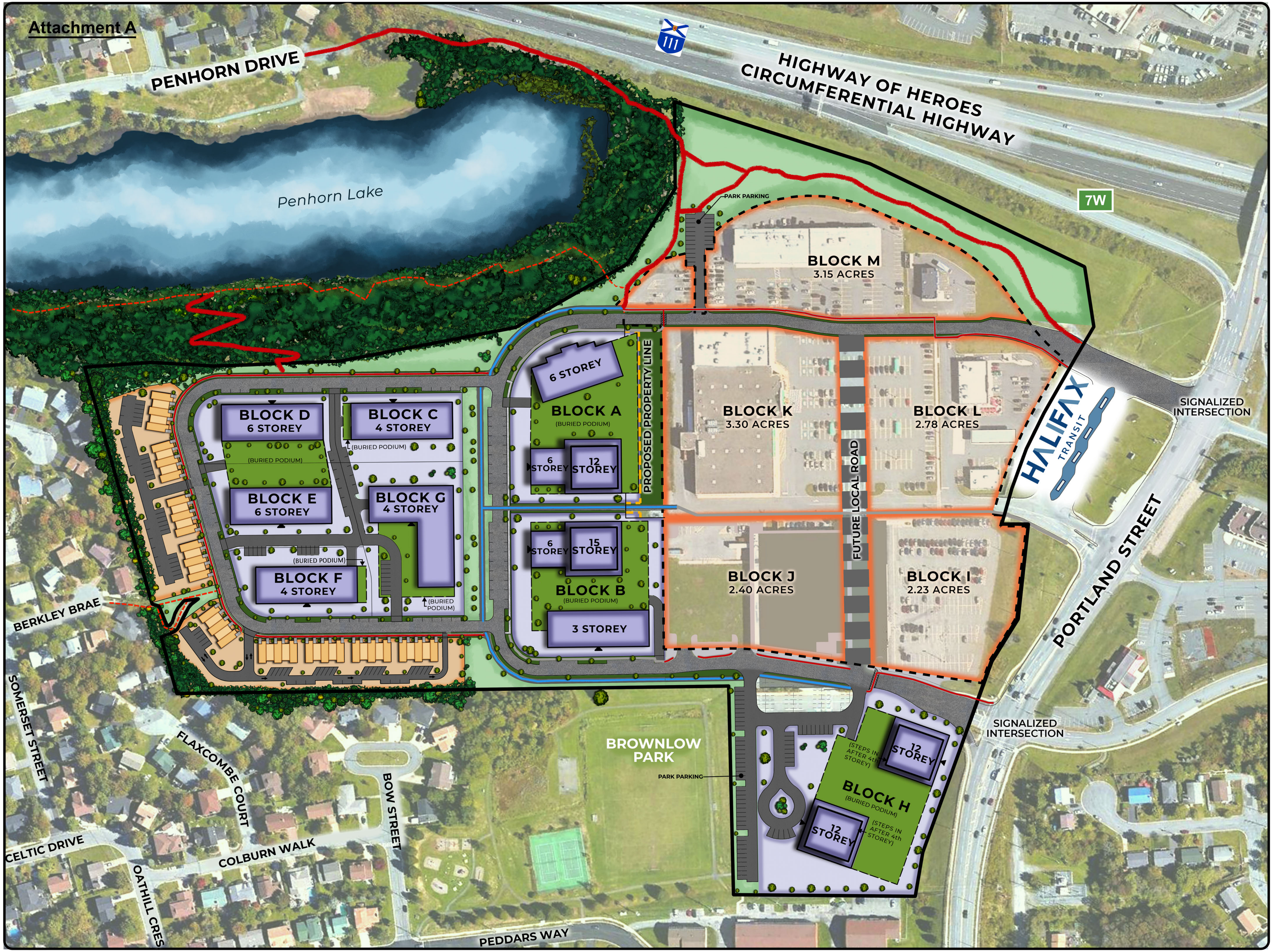
Yours truly,

Clayton Developments Limited

Original Signed   Original Signed

Kevin Neatt, MA (GEOG)
Vice President of Planning and Development

Stephanie Mah, BSc, MES Planning, MCIP, LPP
Planner, Urban Designer



CONCEPTUAL PLAN

PENHORN

LEGEND

- High Density (Multiple Residential/ Podium)
- Medium Density (Rental Townhouses)
- Mixed Use
- Project Boundary (42.0 ACRES)
- Potential Future Development
- Sidewalk
- Asphalt Multi-Use Path
- Crusher Dust Trail
- Existing Trail/ Footpath
- Park/ Open Space
- Planted/ Existing Vegetation

DATE
DECEMBER 2020

SCALE
NTS
0 10 20 40 80
METRES

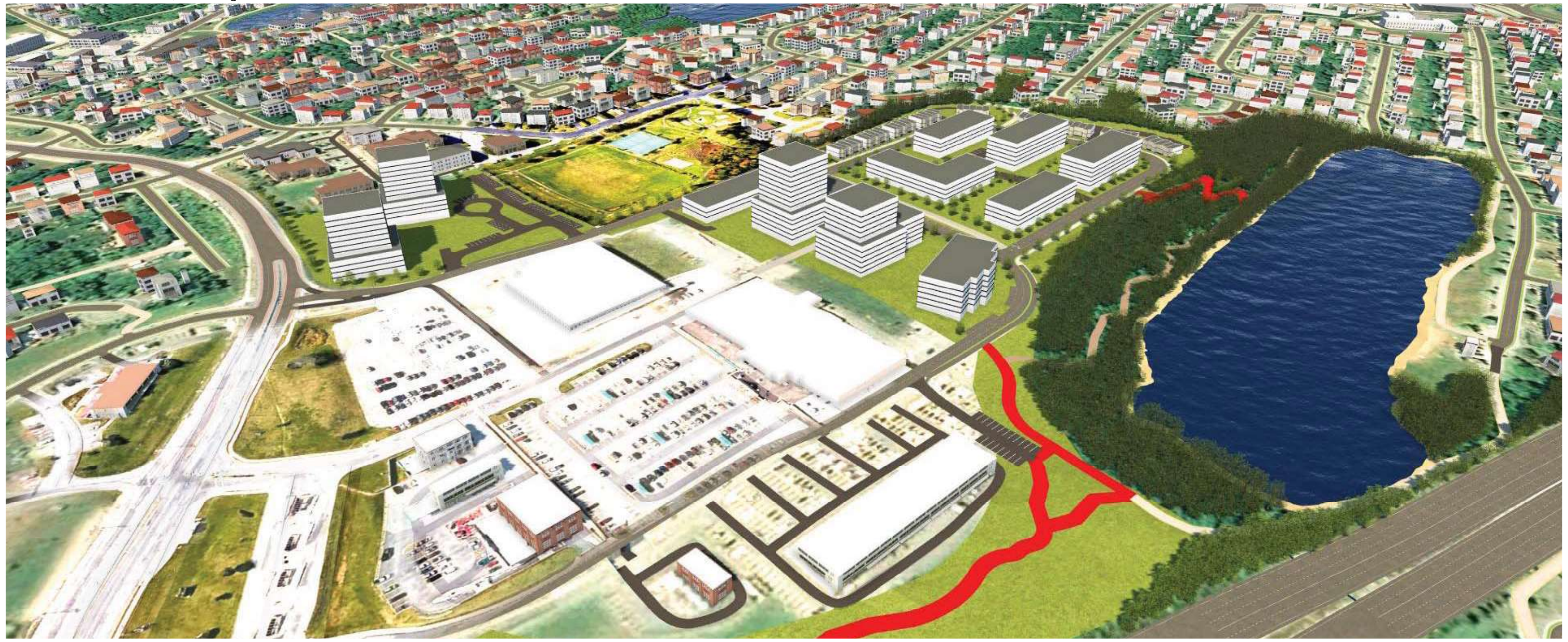
N


View of Penhorn Site, looking Eastward

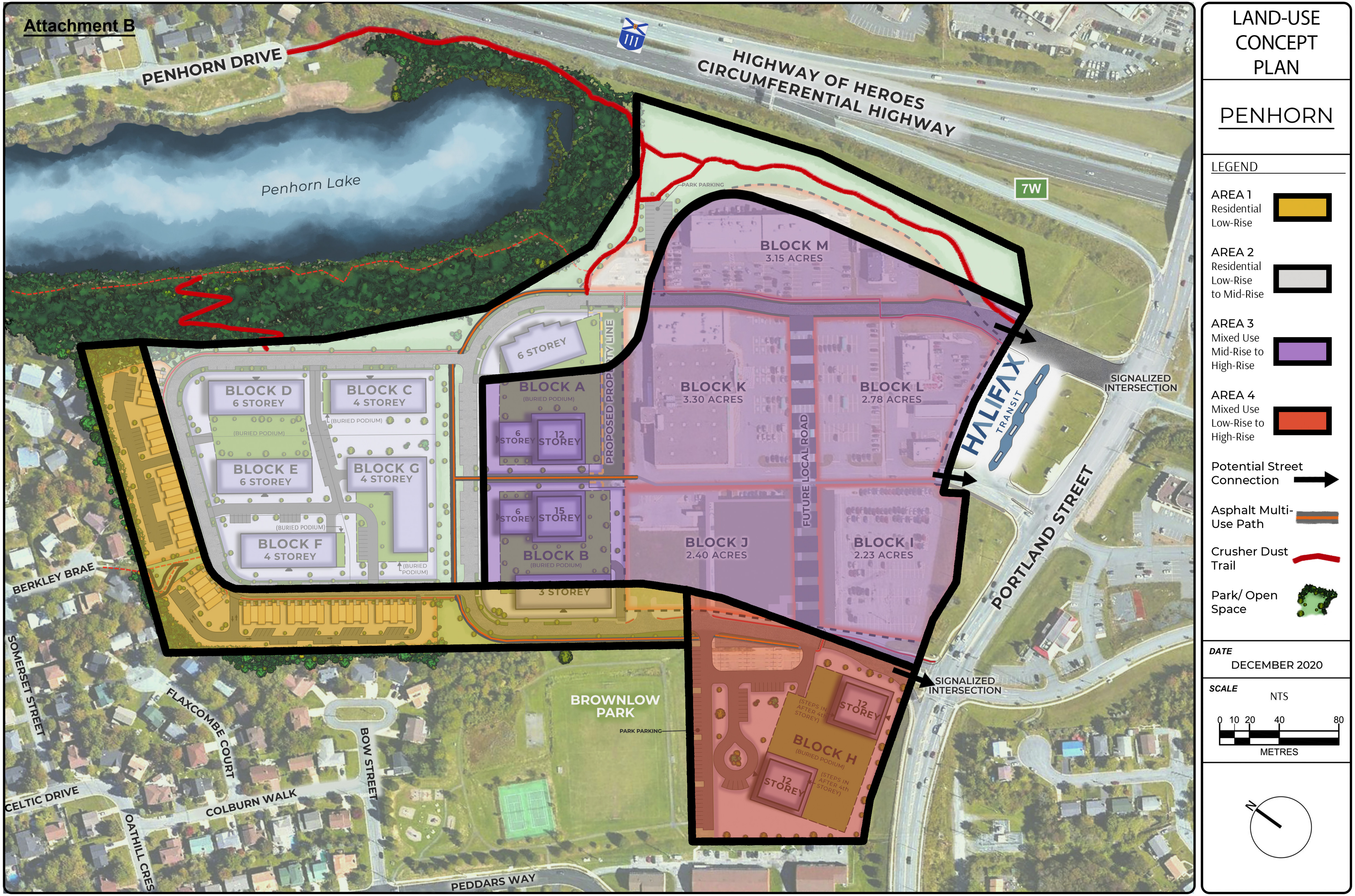

Aerial view of Penhorn Site


View of Penhorn Site, looking North


View of Penhorn site looking South, showing relationship to existing community


View of Penhorn Site, looking West


View of Penhorn Site as seen from existing Penhorn Lake Beach


Attachment B
PENHORN DRIVE
HIGHWAY OF HEROES
CIRCUMFERENTIAL HIGHWAY
111
7W
Penhorn Lake
PARK PARKING
BLOCK M
3.15 ACRES
6 STOREY
BLOCK A
(BURIED PODIUM)
6 STOREY
12 STOREY
PROPOSED PROPERTY LINE
BLOCK K
3.30 ACRES
BLOCK L
2.78 ACRES
FUTURE LOCAL ROAD
HALIFAX TRANSIT
SIGNALIZED INTERSECTION
BLOCK D
6 STOREY
BLOCK C
4 STOREY
(BURIED PODIUM)
BLOCK E
6 STOREY
BLOCK G
4 STOREY
BLOCK F
4 STOREY
6 STOREY
15 STOREY
BLOCK B
(BURIED PODIUM)
3 STOREY
BLOCK J
2.40 ACRES
BLOCK I
2.23 ACRES
PORTLAND STREET
BERKLEY BRAE
SOMERSET STREET
FLAXCOMBE COURT
BOW STREET
BROWNLOW PARK
PARK PARKING
SIGNALIZED INTERSECTION
12 STOREY
BLOCK H
(BURIED PODIUM)
(STEPS IN AFTER 4th STOREY)
12 STOREY
CELTIC DRIVE
COLBURN WALK
OATHILL CRES
PEDDARS WAY
LAND-USE CONCEPT PLAN
PENHORN
LEGEND
AREA 1
Residential Low-Rise
AREA 2
Residential Low-Rise to Mid-Rise
AREA 3
Mixed Use Mid-Rise to High-Rise
AREA 4
Mixed Use Low-Rise to High-Rise
Potential Street Connection
Asphalt Multi-Use Path
Crusher Dust Trail
Park/ Open Space
DATE
DECEMBER 2020
SCALE
NTS
0 10 20 40 80
METRES
N

Attachment J

Penhorn Development

Landscape Plan

30 June, 2020

fathom

01

Landscape Plan Description

Penhorn Development is situated north and east of Manor Park residential areas and south of the Circumferential Highway (NS-111). The old Penhorn Mall property was primarily asphalt and buildings for much of the site for over 40 years and has been sitting idle since much of Penhorn Mall was closed over a decade ago. This property has been identified in the Urban Forest Master Plan as a high potential site for revegetation.

A mixed Acadian Forest strip located on the north-eastern edge of the property provides a natural buffer between the development and Penhorn Lake, which has public beach access on its north side. The lake is stocked with Trout every year and though is heavily urbanized, it still provides good habitat for many native species of flora and fauna.

The 2013 HRM Urban Forest Master Plan identified the Penhorn Mall site as containing no trees onsite and zero percent canopy cover. Additionally, the site has a high degree of impervious surfaces which, for the most part, all drain into the Penhorn Lake catchment. The Manor Park neighbourhood was identified in the plan as an area that was a considerable revegetation challenge for the municipality.

The Urban Forest Master Plan outlines goals to increase native tree species diversity, distribution, canopy cover and provide additional habitat across the municipality. In Pehnorn, the report highlighted the need to increase species biodiveristy and forest cover from 0% to 20% on site when a new development was implemented (Figures 1 & 2).

The landscape plan for Penhorn Development responds to the call from the HRM Urban Master Plan by substantially increasing tree, shrub and ground cover planting across the site. Street trees have been added to all streets with a spacing of at least 1 tree every 10-15m using the recommended tree species outlined in the Urban Forest Plan. Each townhouse lot would include 3 trees per lot and each multi-unit site would include at least 10 trees per building. The plan shows over 1.1km of new road so that will be over 100 caliper sized street trees, and hundreds of trees on private lots. The northeastern buffer would be supplemented with new plantings as well to increase the density and width of the buffer between the new development. The plan anticipates at least 20% canopy cover within 30-50 years of implementing the plan to reach the Urban Forest milestone.

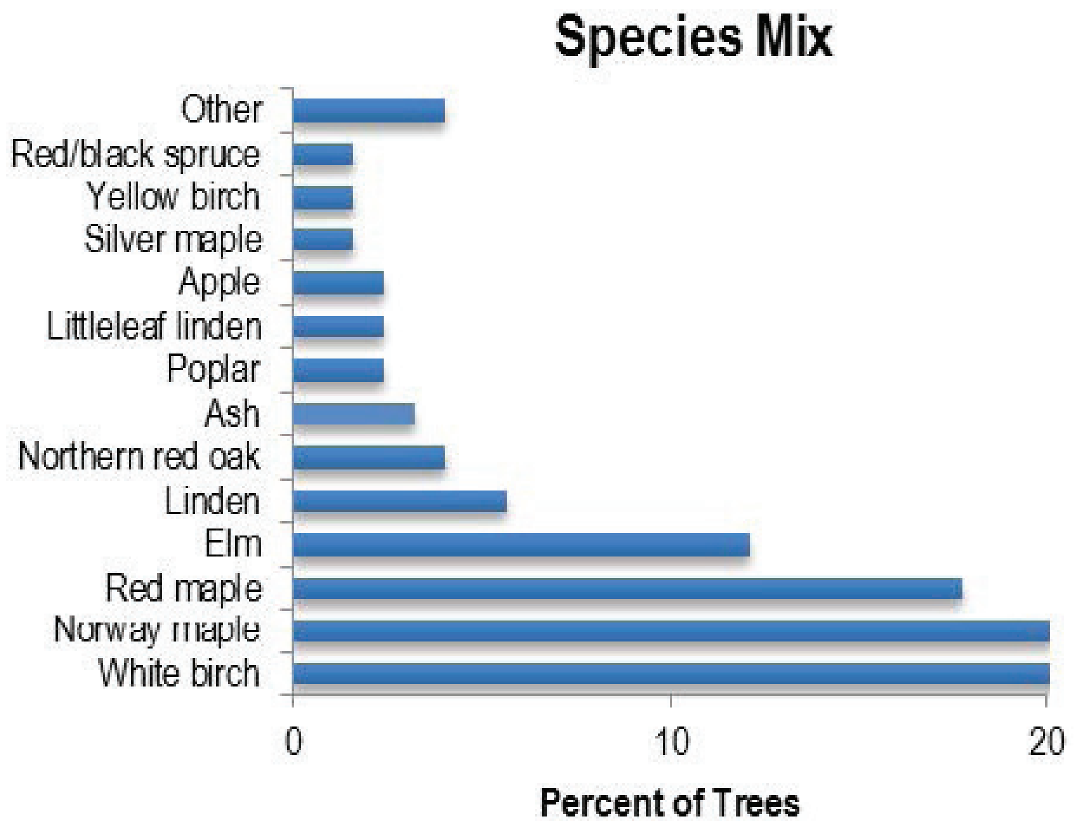


Figure 1. Percentage of Tree Species in Manor Park Residential Area (Source HRM Urban Forest Master Plan 2013)

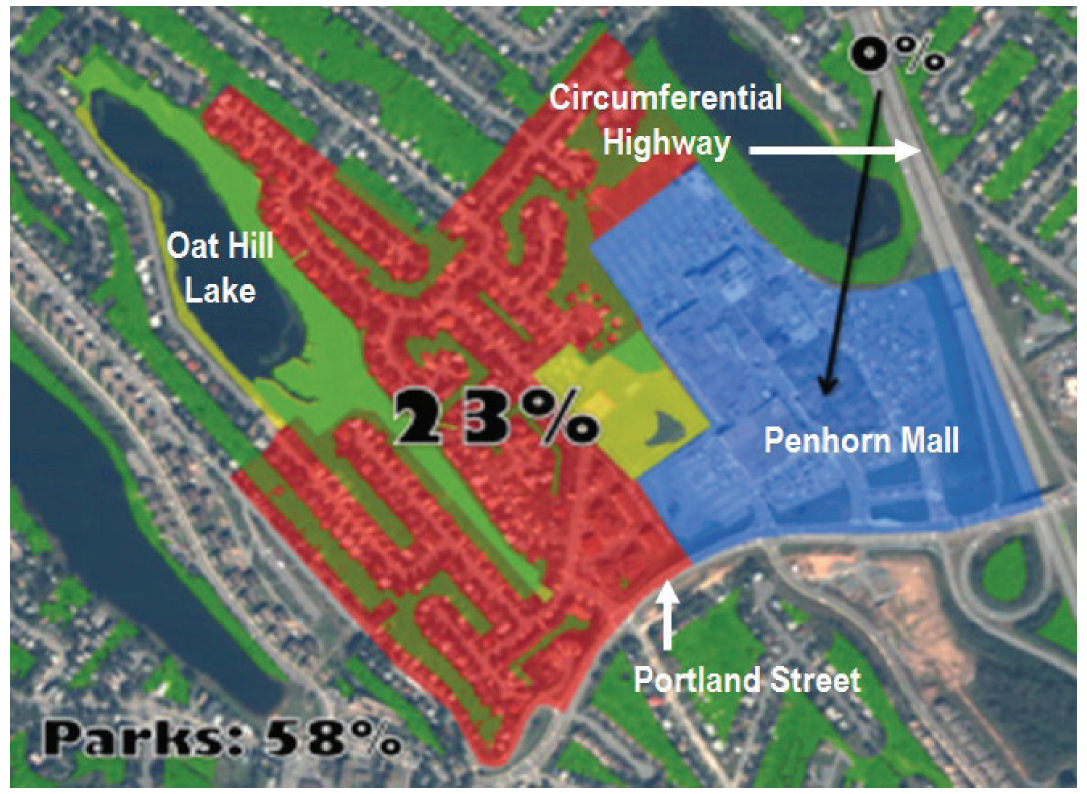


Figure 2. Percentage of Canopy Cove in Manor Park Residential Area (23%) & surrounding parks (58%) (Source HRM Urban Forest Master Plan 2013)

Tree Species Selection	
Scientific Name	**Common Name**
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Betula alleghaniensis	Yellow Birch
Liquidambar styraciflua	American Sweetgum
Liriodendron tulipifera	Tulip Tree
Maidenhair tree	Ginkgo
Quercus macrocarpa	Bur Oak
Quercus palustris	Pin Oak
Quercus rubra	Northern Red Oak
Tilia americana	American Basswood
Ulmus americana	American Elm
Picea mariana	Black Spruce
Picea rubens	Red Spruce
Pinus strobus	White Pine
Pinus resinosa	Red Pine
Thuja occidentalis	Eastern White Cedar

The landscape plan for Penhorn development introduces turf lawns, planting beds, trees and stormwater wetlands and stormwater gardens surrounding the site. Most of the parking for the buildings has been located below the multi-unit buildings minimizing the coverage of onsite parking. In some places, parking podiums are located beyond the building footprint. In these areas, there would be at least 18" of cover for growing turf and any trees would be done in raised planters. The podium cover will be appropriate for lawns and shrub beds.

Stormwater gardens have been added to some of the curb bumpout areas around many of the new streets. These gardens would be depressed below the road surface allowing direct drainage into a bed of wetland plants and flood resistant trees. A standpip would capture and direct overflows to the stormwater drainage network. We anticipate at least 3-4" of roof storage as well on all multi-unit buildings.

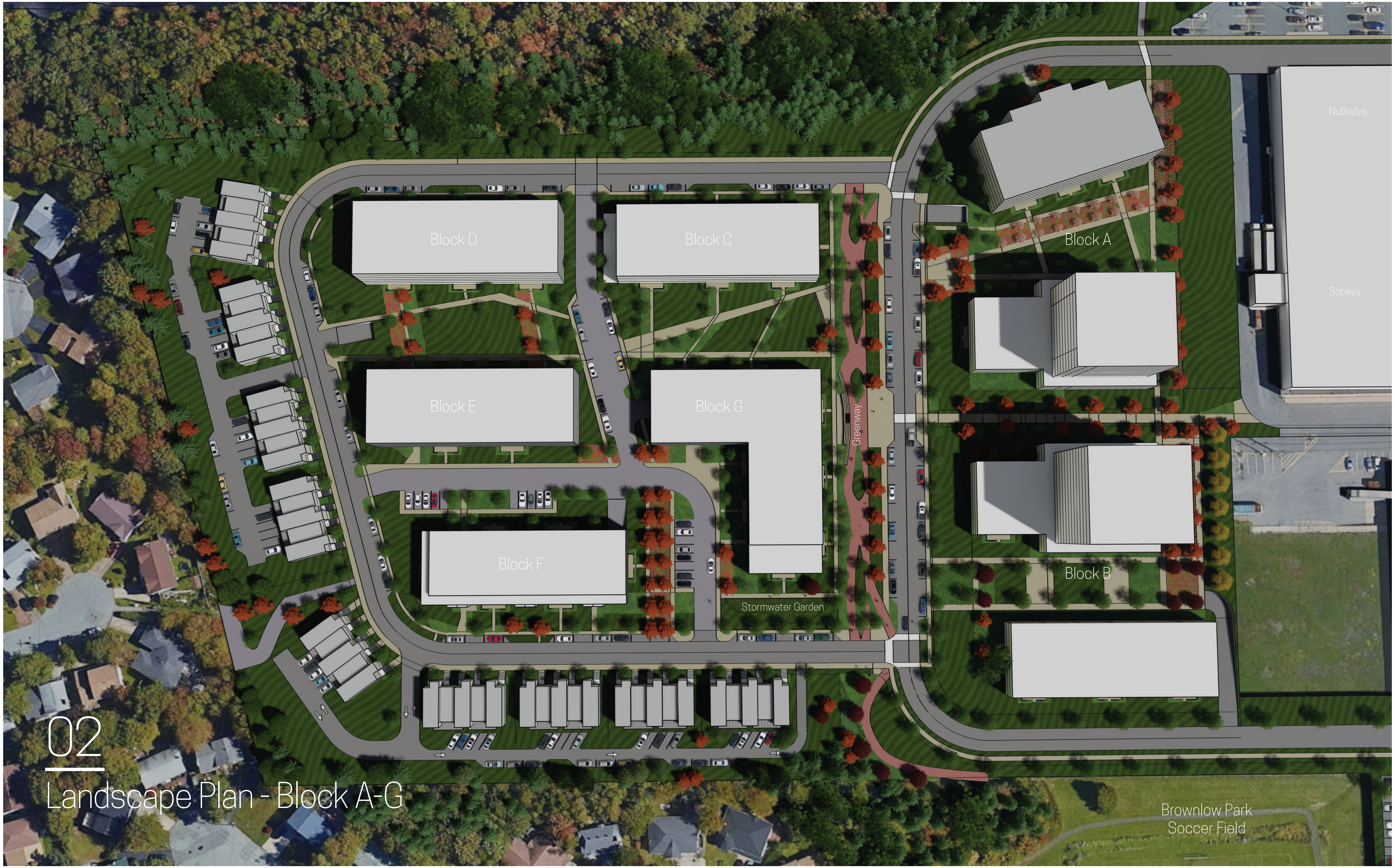
The AT greenway, located east of Blocks C and G, is made up of two weaving pathways that intersect, with planting beds in between, and runs north-south across the site connecting the Brownlow Park Soccer Field to the South to the Penhorn Lake Greenway to the east. Another main pedestrian connector would link the new development to the Metro Transit terminal at Penhorn. This pathway would include gardens and a tree lined canopy along its length.

A parking lot has been provided for access to Penhorn Lake on the east side of the site. The woodlot buffer adjacent to Penhorn lake north of the site is left intact with additional trees planted on the bordering edge of the site.

Depending on the final street cross section, we may include soil cells in the right-of-way to ensure the health of the street trees and provide a greater rooting medium for growing trees. The Penhorn Development Landscape Plan provides a wide range of urban street trees which are included in the urban forest master plan, with the overall goal of reaching the 20% cover within a few decades of the project being implemented.

fathom

01 Landscape Plan



02

Landscape Plan - Block A-G

fathom

03

Landscape Plan - Block H

fathom

fathom

04

Landscape Plan - Block G

05

Landscape Plan - Greenway

fathom

06

Landscape Plan - Block H

fathom

07

Landscape Plan - Block A-G

08

Landscape Plan - Block A-G

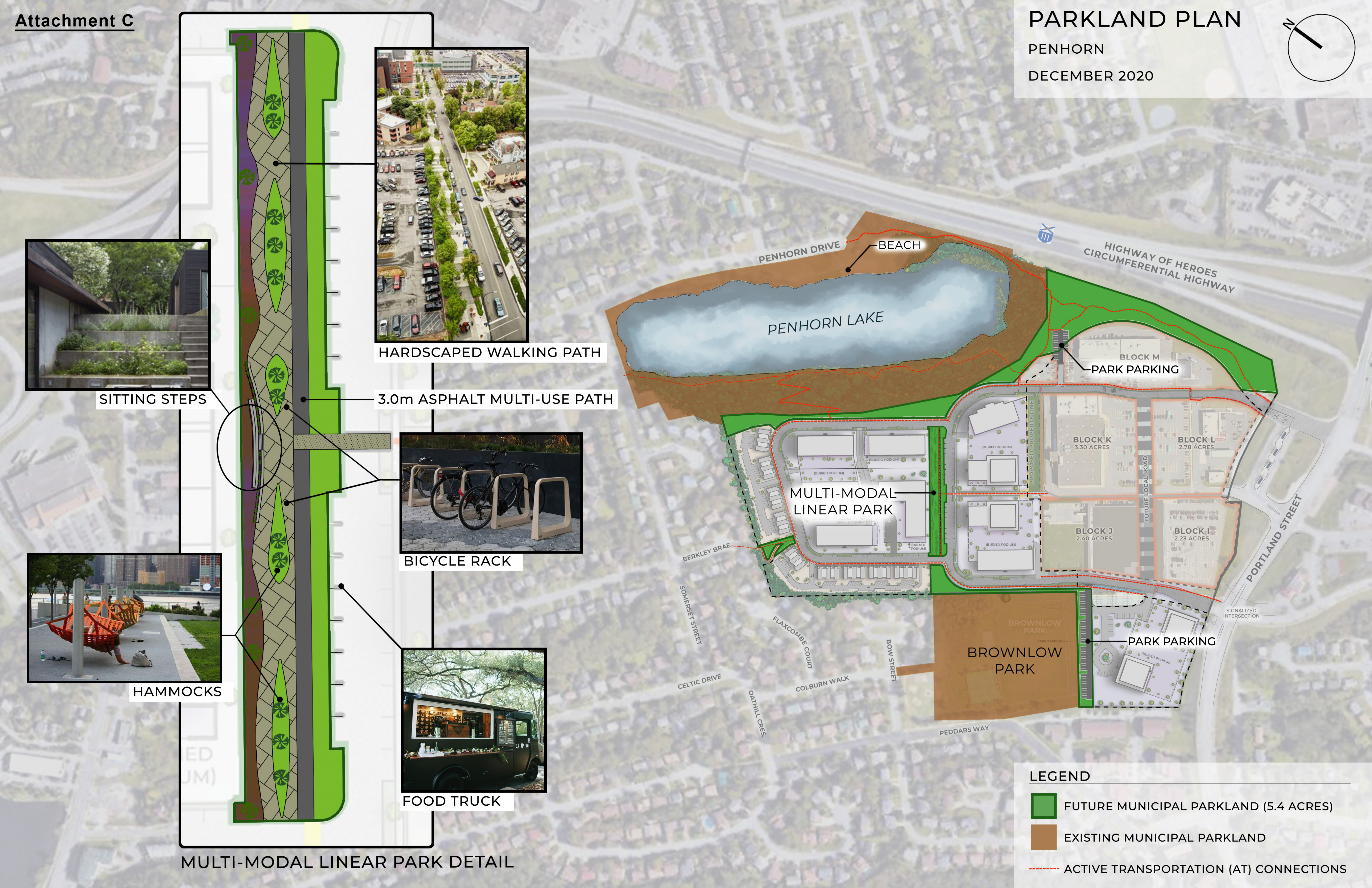
fathom

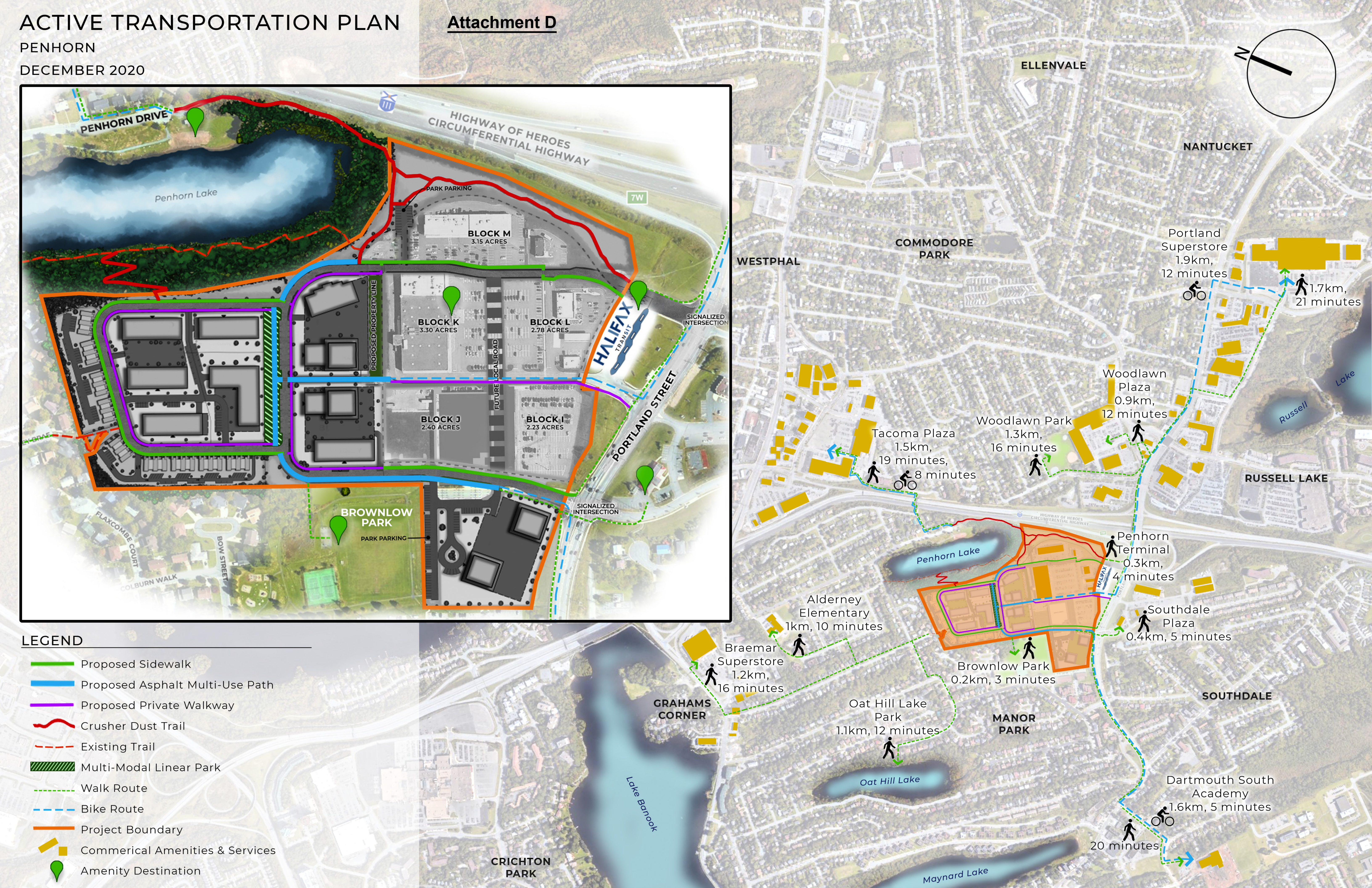
09

Landscape Plan - Entry

fathom

Attachment C




ACTIVE TRANSPORTATION PLAN
PENHORN
DECEMBER 2020
Attachment D
PENHORN DRIVE
HIGHWAY OF HEROES
CIRCUMFERENTIAL HIGHWAY
7W
Penhorn Lake
PARK PARKING
BLOCK M
3.15 ACRES
BLOCK K
3.30 ACRES
BLOCK L
2.78 ACRES
BLOCK J
2.40 ACRES
BLOCK I
2.23 ACRES
PROPOSED PROPERTY LINE
FUTURE LOCAL ROAD
HALIFAX TRANSIT
SIGNALIZED INTERSECTION
PORTLAND STREET
SIGNALIZED INTERSECTION
BROWNLOW PARK
PARK PARKING
FLAXCOMBE COURT
BOW STREET
COLBURN WALK
ELLENVALE
NANTUCKET
WESTPHAL
COMMODORE PARK
Portland Superstore
1.9km,
12 minutes
1.7km,
21 minutes
Woodlawn Plaza
0.9km,
12 minutes
Woodlawn Park
1.3km,
16 minutes
Tacoma Plaza
1.5km,
19 minutes,
8 minutes
Russell Lake
RUSSELL LAKE
Penhorn Terminal
0.3km,
4 minutes
Penhorn Lake
Alderney Elementary
1km, 10 minutes
Southdale Plaza
0.4km, 5 minutes
Braemar Superstore
1.2km,
16 minutes
Brownlow Park
0.2km, 3 minutes
GRAHAMS CORNER
Oat Hill Lake Park
1.1km, 12 minutes
MANOR PARK
SOUTHDALE
Oat Hill Lake
Lake Banook
Dartmouth South Academy
1.6km, 5 minutes
20 minutes
CRICHTON PARK
Maynard Lake
LEGEND
Proposed Sidewalk
Proposed Asphalt Multi-Use Path
Proposed Private Walkway
Crusher Dust Trail
Existing Trail
Multi-Modal Linear Park
Walk Route
Bike Route
Project Boundary
Commerical Amenities & Services
Amenity Destination

Attachment F

September 4, 2020

Mr. Scott MacCallum, P.Eng, M.B.A.
Director of Operations
Clayton Developments Limited
255 Lacewood Drive, Suite 100C
Halifax, NS B3M 4G2

Dear Mr. MacCallum,

Re: Municipal Servicing Brief
Penhorn Mall Site Residential Development, Dartmouth, NS

INTRODUCTION AND BACKGROUND

The following letter outlines the preliminary review of municipal servicing issues for the above-noted development. Further information on the stormwater management approach for this development can be found in the Master Stormwater Management Plan (MSWMP) prepared by Strum Consulting.

In accordance to the Halifax Regional Centre Plan (Package A), "A Community Vision for the Penhorn Mall site was approved in principle by Regional Council in October of 2009 as a mixed-use area clustered around the transit terminal on Portland Street. The redevelopment concept includes pedestrian and transit oriented spaces and corridors, a range of medium to high density housing choices. Public amenity spaces including Penhorn Lake and Brownlow Park will support the development of this community, and additional open spaces and open space connections will be provided."

The Penhorn residential development being considered will consist of a combination of multi-unit apartment buildings and single-family townhouse units with public open space and walking trails. The Penhorn development is to be fully serviced with water, wastewater, and stormwater systems connected to existing local municipal systems.

The subject site is a property located at 535 Portland Street, Dartmouth, NS (PID 00222844). The site is an approximately 12.53 hectare (31 acre) property bounded by Penhorn Lake to the north, Highway 111 to the east, Portland Street to the south, and parkland and residential development to the west. The subject site is currently owned by Crombie Penhorn Mall (2011) Limited. The site contains an existing approximately 7,200 m^2 commercial building which was constructed in 1982 and underwent a major renovation in 2009 when a large section of the former mall was demolished. The existing building underwent further redevelopment, transitioning to a primarily office building in 2018.

The subject site borders a commercial property owned by Penhorn Plaza Holdings Limited (PID 41331281). This neighbouring commercial property was subdivided from the subject site in 2010 and contains multiple commercial units including a Sobeys grocery store, Sobeys gas bar, and commercial strip plaza buildings. The subject site is also bordered by a forested municipal property (PID 00222851) and Penhorn Lake to the north.

STORMWATER

Further, detailed information on the stormwater management approach for this development is contained in the MSWMP report, completed by Strum Consulting. This development will utilize progressive best management practices and low impact design methodology in the management of stormwater. This approach is anticipated to include the use of a combination of the following best management practices, which are described in greater detail in the MSWMP:

- Rain Barrels
- Perforated Stormwater Piping
- Infiltration Trenches
- Rain Gardens
- Bio Swales
- Filter Strips
- Permeable Pavers
- CDS Units

The usage of these BMP's is focussed on mitigating the impact of this development during rainfall events, with a focus on stormwater quantity (volume, peak flow), and quality (TSS, TP, and temperature).

Runoff from the newly developed areas will be discharged to the existing stormwater management system at the following locations:

- Existing outfall into Penhorn Lake
- Existing piped system across Highway 111 to Athorpe Drive
- Existing piped system on Pedder's Way.

Strum has evaluated the existing peak stormwater flows reaching these three locations under existing conditions, and under full development. Through the use of on-site stormwater storage and the BMP's noted above, the post development flows have been attenuated to be within 10% of the predevelopment flows. Strum has also reviewed the local receiving stormwater infrastructure and has confirmed that the existing infrastructure is adequately sized to accept the anticipated flows.

Public stormwater infrastructure will be constructed within public road right of ways and public easements. Stormwater laterals will be constructed to provide service to individual lots. Stormwater retention will be provided both on individual lots and within the public road ROW through innovative road cross section design.

WATER

Water service for this site is provided from connection to the existing municipal water system. The existing water system in this area is primarily fed through a large 600 mm diameter transmission main that runs along Portland Street adjacent to this site. The existing water system is located within the Dartmouth Intermediate East pressure zone, with a reported hydraulic grade line of 101 m to 107 m. This portion of the Halifax Water distribution system is fed from the Lake Major Treatment facility, with the closest water storage tank being the Mount Edward Water Reservoir on Mount Edward Road (PID 00196360).

Water service throughout this development will be provided via a series of publicly owned watermains located in public right of ways or easements. Individual laterals will be provided to each property and sized in consideration of the individual demands. It is anticipated that the majority of buildings located within this development will be serviced with both sprinkler and domestic water service. Based on water modelling completed by Strum, it is anticipated that 300 mm diameter pubic watermains will be required to provide adequate fire flows in accordance with Halifax Water Standards. Laterals to each property will be provided as 300 mm diameter, with a possible reduction in lateral sizing once building use and size are finalized.

WASTEWATER

Wastewater servicing for this development will also be provided through a series of publicly owned wastewater mains and laterals to each lot. Wastewater mains will be located within public street right of ways or easements. Wastewater main sizing has been completed using Halifax Water Standards and the Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal. Three potential discharge locations for connections to the existing municipal wasterwater system have been identified:

1. Peddars Way, through Cranston Avenue to Prince Albert Road.
2. Across Highway 111, through Virginia Avenue and Bowser Avenue to Oakwood Court.
3. Berkley Brae, through Somerset Street and Celtic Drive to Prince Albert Road.

A review of these routes for capacity constraints was completed in accordance with Halifax Water Standards, and using zoning information from HRM to determine tributary flows to each portion of the wastewater system. This analysis identified the following available capacities within the existing wastewater system:

1. Peddars Way – Available Capacity = 21.8 L/sec
2. Highway 111 – Available Capacity = 45.0 L/sec
3. Berkley Brae – Available Capacity = 58.7 L/sec

The current design for this site contemplates connections to the municipal system a Peddars Way and Highway 111 only, with no connection being proposed for Berkley Brae. Based on the current site plan, peak design flows from this site will not exceed available capacity, with the following peak design flows being anticipated:

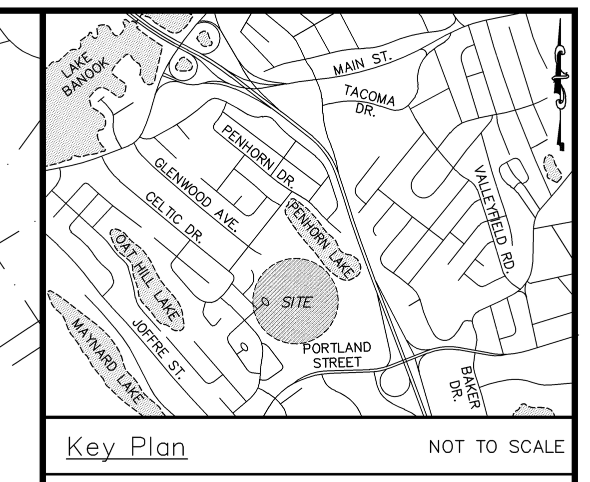
1. Peddars Way – Design Flow = 20.7 L/sec
2. Highway 111 – Design Flow = 15.2 L/sec
3. Berkley Brae – Design Flow = 0.0 L/sec

We trust that this letter meets with your current requirements. If you have any questions, please contact us.

Thank you,

[redacted]

Chris Boudreau, P.Eng.
Manager, Engineering
cboudreau@strum.com



Key Plan — NOT TO SCALE

LEGEND

- SANITARY M.H. & SEWER
- GRAVITY PIPE FLOW DIRECTION
- FORCEMAIN FLOW DIRECTION
- RIGHT OF WAY
- PROPERTY BOUNDARY
- EXISTING PROPERTY BOUNDARY
- FUTURE ASPHALT
- FUTURE HIGHWAY
- EXISTING BUILDING
- PROPOSED BUILDING
- EXISTING WATERCOURSE
- 1 IN 20 YEAR FLOODPLAIN LIMIT
- 1 IN 100 YEAR FLOODPLAIN LIMIT

NOTES:

1. Contour interval is 1.0 metre, based on LRIS mapping blended with actual field data provided by Servant, Dunbrack, McKenzie & MacDonald Ltd.
2. All sanitary pipes modelled as PVC DR35.
3. I&I tributary areas do not include undeveloped lands that do not naturally drain towards the streets.
4. Commercial sanitary flows based on equivalent population of 75 people per hectare.

No	Description	Date	By
0.	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXX

Revision or Issue

Strum CONSULTING

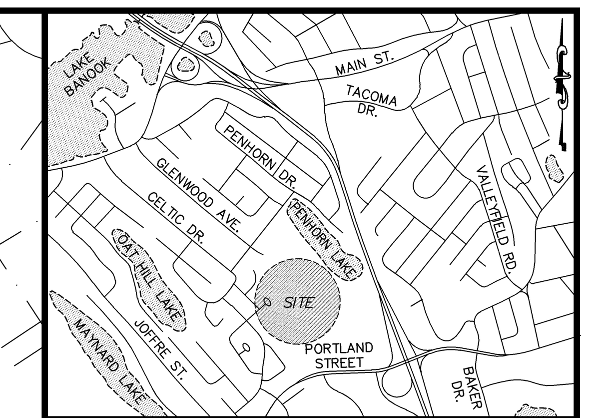
Project: PENHORN PLAZA, DARTMOUTH, NOVA SCOTIA

Drawing: SANITARY SYSTEM MASTER PLAN

Scale 1:1250

Date		Drawn
XXXX-XX-XX		MMH
Design: CTP	Check: CNB	Approv.: CNB
Project No.: 20-7306		Sheet: 1 Of 3
Drawing No.: A01		Rev.: 0

DRAFT NOT FOR CONSTRUCTION PRINTED JUN-12-20



Key Plan NOT TO SCALE

LEGEND

- STORM M.H. & SEWER
- GRAVITY PIPE FLOW DIRECTION
- FLOW DIRECTION ARROW
- PUBLIC CULVERT
- PRIVATE OUTFALL
- RIGHT OF WAY
- PROPERTY BOUNDARY
- EXISTING PROPERTY BOUNDARY
- FUTURE ASPHALT
- FUTURE HIGHWAY
- EXISTING BUILDING
- PROPOSED BUILDING
- EXISTING WETLAND
- PROPOSED EASEMENT
- 1 IN 20 YEAR FLOODPLAIN LIMIT
- 1 IN 100 YEAR FLOODPLAIN LIMIT

NOTES:

1. Contour interval is 1.0 metre, based on LRIS mapping blended with actual field data provided by Servant, Dunbrack, McKenzie & MacDonald Ltd.
2. All proposed storm pipes to be confirmed at time of site design.

No	Description	Date	By
0.	XXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXX

Revision or Issue

Strum CONSULTING

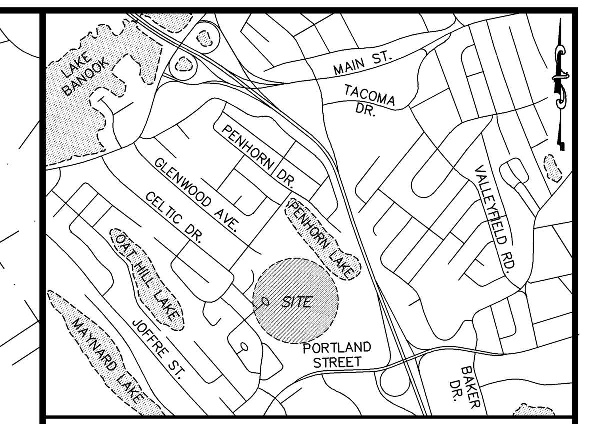
Project
PENHORN PLAZA
DARTMOUTH
NOVA SCOTIA

Drawing
STORM SYSTEM
MASTER PLAN

Scale 1:1250

Date XXXX-XX-XX		Drawn MMH
Design CTP	Check CNB	Approv. CNB
Project No. 20-7306		Sheet 2 Of 3
Drawing No. A02		Rev. 0

DRAFT NOT FOR CONSTRUCTION PRINTED JUN-12-20



Key Plan NOT TO SCALE

LEGEND

- GATE VALVE & WATERMAIN
- HYDRANT
- RIGHT OF WAY
- PROPERTY BOUNDARY
- EXISTING PROPERTY BOUNDARY
- FUTURE ASPHALT
- FUTURE HIGHWAY
- EXISTING BUILDING
- PROPOSED BUILDING
- EXISTING WATERCOURSE
- 1 IN 20 YEAR FLOODPLAIN LIMIT
- 1 IN 100 YEAR FLOODPLAIN LIMIT

NOTES:

1. Contour interval is 0.5 metre, based on LRIS mapping blended with actual field data provided by Servant, Dunbrack, McKenzie & MacDonald Ltd.

2. Domestic and fire flow modelled in accordance with Halifax Water (HW) Standards. Model was constructed and updated based on MEH's existing WaterCAD system model and Reference Manual dated July 25, 2008.

3. All water lines modelled as PVC DR18 with a Hazen Williams roughness coefficient, C, of 130.

4. Water Model utilizes the following assumptions:
- Normal low tank level: 61.26m (201')
- Normal high tank level: 64.31m (211')
- Domestic demand is based on the following:
  - 2008 MEH historical records where available.
  - Residential population density based on Halifax Water Standards
  - ICI population density based on MEH Standards (45 people/hectare).
  - Average Day/Max. Day/Max. Hour/Min. Hour Demands based on MEH Standards.
- Fire flow demand based on HW Standards:
  - Residential: 3300 L/min
  - ICI: 13620 L/min
- Min. Pressure: 40 PSI (Max. Hourly Demand)
- Max. Pressure: 90 PSI (Min. Hourly Demand)
- Min. Pressure: 22 PSI at point of withdrawal, 10 PSI elsewhere (Fire Flow + Max. Day Demand)
- Max. Velocity: 1.4 m/s (Max. Hourly Demand)
- Max. Velocity: 2.4 m/s (Fire Flow + Max. Day)

5. Max Hour and Fire flow analysis completed assuming all tanks are at their normal low operations level 61.26m (201'). Min Hour analysis completed assuming all tanks are at their normal high operations level 64.31m (211').

6. Based on the model results, the existing system has several locations that do not comply with minimum pressure during Max Hour demand (Robert Scott Drive & Kali Lane). This condition is generally unchanged by the addition of the new development.

7. Fire flow for the commercial area of this development is being limited by maximum velocity in pipe P–11 near the existing Lantz water tower. An increased maximum allowable velocity of 2.6m/s is required to provide adequate fire flow to this development in the ultimate build–out.

No	Description	Date	By
0.	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXX

Revision or Issue

Strum CONSULTING

Project
PENHORN PLAZA
DARTMOUTH
NOVA SCOTIA

Drawing
WATER SYSTEM
MASTER PLAN

Scale 1:1250

Date XXXX–XX–XX		Drawn MMH
Design CTP	Check CNB	Approv. CNB
Project No. 20–7306		Sheet 3 Of 3
Drawing No. A03		Rev. 0

DRAFT
NOT FOR CONSTRUCTION
PRINTED JUN–12–20

Attachment I

MNA Inc.
400 - 5540 Kaye Street
Halifax NS | B3K 1Y5

902.455.5522
www.**mnarch**.ca

Re: Penhorn Shadow Analysis

This shadow analysis has been prepared as a component of a Development Agreement application involving the redevelopment of surplus lands at the Penhorn Mall site in Dartmouth. This development will involve adding a residential component to the remaining existing commercial use.

This study follows the procedures and guidelines as described in Appendix 2: *Shadow Impact Assessment Protocol and Performance Standards* of the Halifax Regional Centre Land Use By-Law. The attached diagrams and tables illustrate the extent of the shadows created by the proposed development. They show that building placement within the development has been carefully analyzed to ensure that the impact on the two adjacent parks, Brownlow Park and Penhorn Lake Park, are compliant with the times outlined in Section 4 of the Standards. All calculations utilized latitude and longitude information as provided in Table A2-1. Base mapping was taken from NAD83 coordinate system.

Prepared the 21st day of June, 2020 by Licensed Architect Michael Napier NSAA of the firm Michael Napier Architecture Inc. Contact information is included in letterhead, email is mn@mnarch.ca

LICENSED ARCHITECT
[redacted]
MICHAEL M NAPIER
NOVA SCOTIA ASSOCIATION OF ARCHITECTS

BROWNLOW PARK

TIME OF DAY - September 21 (Atlantic Daylight Time UTC-3:00)

BUILDING	08:00:00	08:15:00	08:30:00	08:45:00	09:00:00	09:15:00	09:30:00	09:45:00	10:00:00	10:15:00	10:30:00	10:45:00	11:00:00	11:15:00	11:30:00	11:45:00	12:00:00	12:15:00	12:30:00	12:45:00	13:00:00	13:15:00	13:30:00	13:45:00	14:00:00	14:15:00	14:30:00	14:45:00	15:00:00	15:15:00	15:30:00	15:45:00	16:00:00	16:15:00	16:30:00	16:45:00	17:00:00	17:15:00	17:30:00	17:45:00	18:00:00	TOTAL TIME IN SHADOW
A																																										
B																																										*0.5 hrs*
C																																										
D																																										
E																																										
F																																										
G																																										
H																																										*4 hrs*

PENHORN LAKE PARK

TIME OF DAY - September 21 (Atlantic Daylight Time UTC-3:00)

BUILDING	08:00:00	08:15:00	08:30:00	08:45:00	09:00:00	09:15:00	09:30:00	09:45:00	10:00:00	10:15:00	10:30:00	10:45:00	11:00:00	11:15:00	11:30:00	11:45:00	12:00:00	12:15:00	12:30:00	12:45:00	13:00:00	13:15:00	13:30:00	13:45:00	14:00:00	14:15:00	14:30:00	14:45:00	15:00:00	15:15:00	15:30:00	15:45:00	16:00:00	16:15:00	16:30:00	16:45:00	17:00:00	17:15:00	17:30:00	17:45:00	18:00:00	TOTAL TIME IN SHADOW
A																																										*2.5 hrs*
B																																										
C																																										*1 hr*
D																																										*2.5 hrs*
E																																										
F																																										
G																																										
H																																										

LEGEND

IN SUN

IN SHADOW

TIME OF DAY *[SHADOW AZIMUTH]*

BUILDING	HEIGHT	08:00:00 *[278.87°]*	09:00:00 *[290.18°]*	10:00:00 *[302.98°]*	11:00:00 *[318.19°]*	12:00:00 *[336.48°]*	13:00:00 *[357.36°]*	14:00:00 *[18.57°]*	15:00:00 *[37.59°]*	16:00:00 *[53.49°]*	17:00:00 *[66.77°]*	18:00:00 *[78.33°]*
A	36.59 m	212.82 m	100.19 m	64.44 m	47.37 m	38.63 m	35.51 m	37.42 m	44.71 m	59.34 m	88.79 m	169.03 m
B	45.73 m	266.03 m	125.24 m	80.55 m	59.21 m	48.29 m	44.39 m	46.78 m	55.88 m	74.17 m	110.99 m	211.29 m
C	12.20 m	70.94 m	33.40 m	21.48 m	15.79 m	12.88 m	11.84 m	12.47 m	14.90 m	19.78 m	29.60 m	56.34 m
D	18.29 m	106.41 m	50.09 m	32.22 m	23.68 m	19.32 m	17.75 m	18.71 m	22.35 m	29.67 m	44.40 m	84.52 m
E	18.29 m	106.41 m	50.09 m	32.22 m	23.68 m	19.32 m	17.75 m	18.71 m	22.35 m	29.67 m	44.40 m	84.52 m
F	12.20 m	70.94 m	33.40 m	21.48 m	15.79 m	12.88 m	11.84 m	12.47 m	14.90 m	19.78 m	29.60 m	56.34 m
G	18.29 m	106.41 m	50.09 m	32.22 m	23.68 m	19.32 m	17.75 m	18.71 m	22.35 m	29.67 m	44.40 m	84.52 m
H	36.59 m	212.82 m	100.19 m	64.44 m	47.37 m	38.63 m	35.51 m	37.42 m	44.71 m	59.34 m	88.79 m	169.03 m

PENHORN
DARTMOUTH, NOVA SCOTIA

NO.	DESCRIPTION	BY	DATE

1. ALL CONSTRUCTION TO MEET ALL APPLICABLE CODES, STANDARDS, BY-LAWS, ETC.
2. DO NOT SCALE THIS DRAWING FOR CONSTRUCTION PURPOSES. USE FIGURED DIMENSIONS AS NOTED.
3. ALL DIMENSIONS AND CONDITIONS TO BE VERIFIED ON SITE. ALL DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT AND AGREED UPON BEFORE PROCEEDING.

MICHAEL NAPIER ARCHITECTURE
www.mnarch.ca • 902.455.5522

ISSUED FOR: INFORMATION

DRAWING: SHADOW STUDY - MATRICES

DATE: 06/11/20

SCALE: N.T.S.

DRAWING NO.: 001

08:00 ADT

08:15 ADT

PENHORN
DARTMOUTH, NOVA SCOTIA

NO.	DESCRIPTION	BY	DATE

1. ALL CONSTRUCTION TO MEET ALL APPLICABLE CODES, STANDARDS, BY-LAWS, ETC.
2. DO NOT SCALE THIS DRAWING FOR CONSTRUCTION PURPOSES. USE FIGURED DIMENSIONS AS NOTED.
3. ALL DIMENSIONS AND CONDITIONS TO BE VERIFIED ON SITE. ALL DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT AND AGREED UPON BEFORE PROCEEDING.

MICHAEL NAPIER ARCHITECTURE
www.mnarch.ca • 902.455.5522

ISSUED FOR: INFORMATION

DRAWING: SHADOW STUDY

DATE: 2020 06 25

SCALE: N.T.S.

DRAWING NO.: 002

08:30 ADT

12:15 ADT

PENHORN
DARTMOUTH, NOVA SCOTIA

NO.	DESCRIPTION	BY	DATE

1. ALL CONSTRUCTION TO MEET ALL APPLICABLE CODES, STANDARDS, BY-LAWS, ETC.
2. DO NOT SCALE THIS DRAWING FOR CONSTRUCTION PURPOSES. USE FIGURED DIMENSIONS AS NOTED.
3. ALL DIMENSIONS AND CONDITIONS TO BE VERIFIED ON SITE. ALL DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT AND AGREED UPON BEFORE PROCEEDING.

MICHAEL NAPIER ARCHITECTURE
www.mnarch.ca • 902.455.5522

ISSUED FOR: INFORMATION

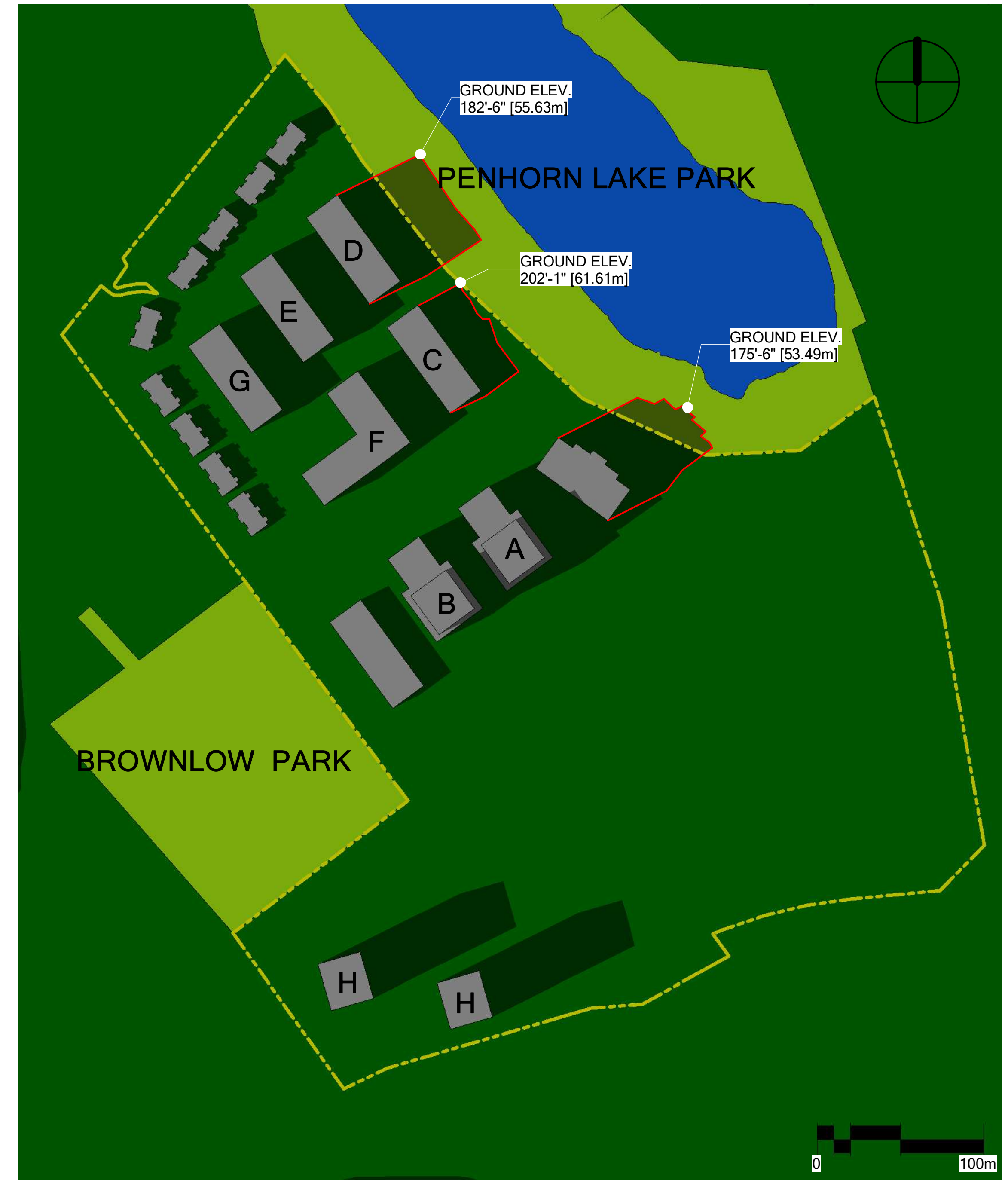
DRAWING: SHADOW STUDY

DATE: 2020 06 25

SCALE: N.T.S.

DRAWING NO.: 003

15:30 ADT



16:45 ADT

PENHORN

DARTMOUTH, NOVA SCOTIA

NO.	DESCRIPTION	BY	DATE

1. ALL CONSTRUCTION TO MEET ALL APPLICABLE CODES, STANDARDS, BY-LAWS, ETC.
2. DO NOT SCALE THIS DRAWING FOR CONSTRUCTION PURPOSES. USE FIGURED DIMENSIONS AS NOTED.
3. ALL DIMENSIONS AND CONDITIONS TO BE VERIFIED ON SITE. ALL DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT AND AGREED UPON BEFORE PROCEEDING.

MICHAEL NAPIER ARCHITECTURE
www.mnarch.ca + 902.455.5522

ISSUED FOR: INFORMATION

DRAWING: SHADOW STUDY

DATE: 2020 06 25

SCALE: N.T.S.

DRAWING NO.: 004

18:00 ADT

NO.	DESCRIPTION	BY	DATE

1. ALL CONSTRUCTION TO MEET ALL APPLICABLE CODES, STANDARDS, BY-LAWS, ETC.
2. DO NOT SCALE THIS DRAWING FOR CONSTRUCTION PURPOSES. USE FIGURED DIMENSIONS AS NOTED.
3. ALL DIMENSIONS AND CONDITIONS TO BE VERIFIED ON SITE. ALL DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT AND AGREED UPON BEFORE PROCEEDING.

MICHAEL NAPIER ARCHITECTURE
www.mnarch.ca + 902.455.5522

PENHORN
DARTMOUTH, NOVA SCOTIA

ISSUED FOR: INFORMATION

DRAWING: SHADOW STUDY

DATE: 2020 06 25

SCALE: N.T.S.

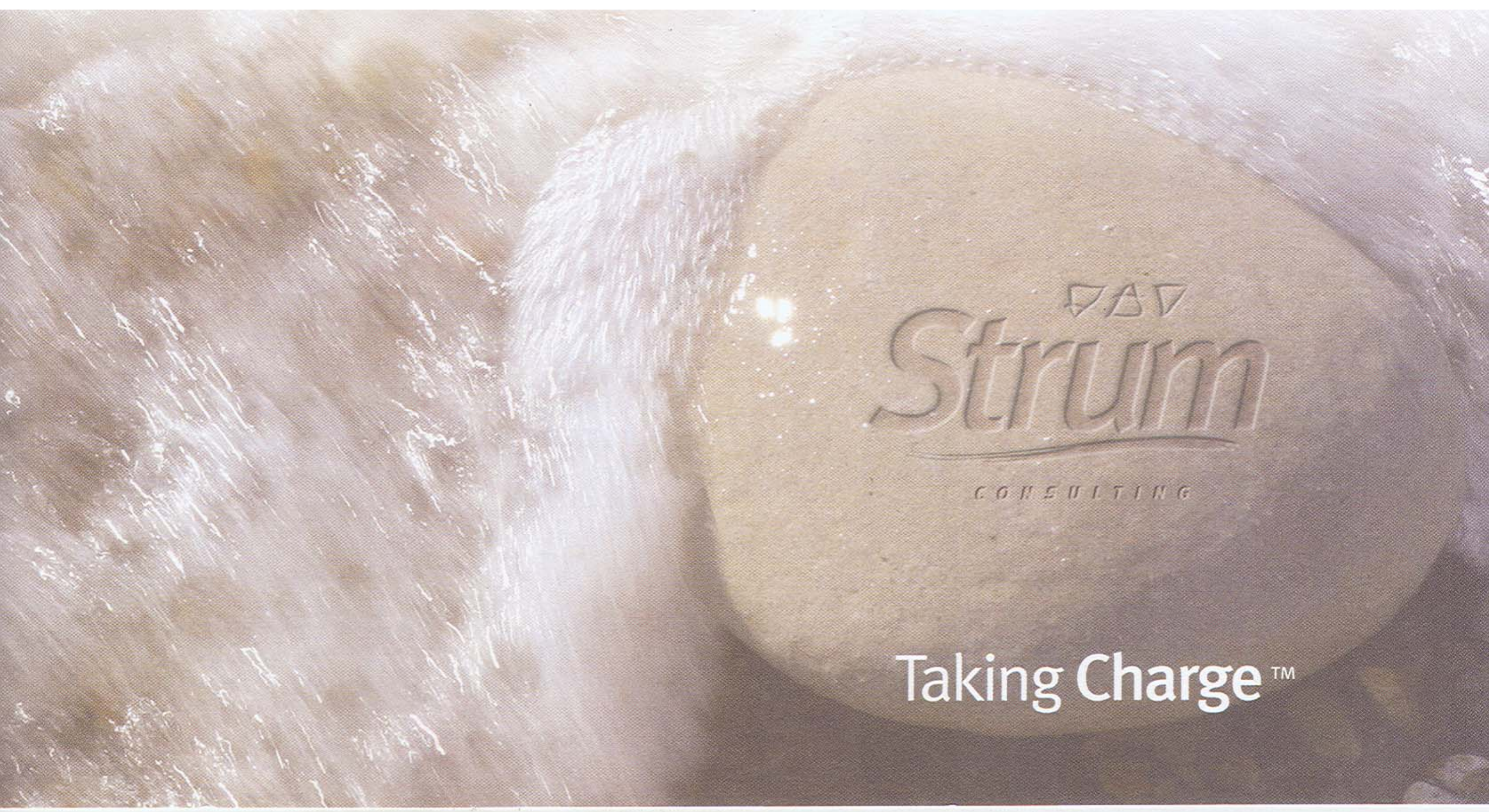
DRAWING NO.: 005

Attachment H

Strum
CONSULTING

MASTER STORMWATER MANAGEMENT PLAN
Penhorn Residential Development

December 8, 2020



December 8, 2020

Crombie REIT Limited & Clayton Developments Limited

Re: Master Stormwater Management Plan
Penhorn Residential Development

Attached is the Master Stormwater Management Plan prepared for the Penhorn Residential Development.

We trust this to be satisfactory at this time. Once you have had an opportunity to review this correspondence, please contact us to address any questions you may have.

Thank you,

Original Signed

Original Signed

Ben Crouse, P.Eng.
Civil Engineer
bcrouse@strum.com

Chris Boudreau, P.Eng.
Manager, Engineering
cboudreau@strum.com

TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

1.0 INTRODUCTION

This Master Stormwater Management Plan (MSWMP) has been prepared by Strum Consulting on behalf of Crombie REIT Limited (Crombie) and Clayton Developments Limited (Clayton), for consideration by Halifax Regional Municipality (HRM) staff. This report presents a stormwater management strategy for the site and demonstrates how it will meet the stormwater management goals and objectives set forth in the Regional Centre Secondary Municipal Planning Strategy (Package A) and Morris-Russell Lake Secondary Planning Strategy as provided by Halifax Regional Municipality (HRM).

This report has also been completed in reference to HRM Stormwater Management Guidelines (Dillon, 2006) and previous MSWMPs for areas with similar sensitivities to stormwater management within the HRM. These areas include West Bedford Sub-Area 2, West Bedford Sub-Areas 7 & 8, and Bedford South.

1.1 Background

In accordance to the Halifax Regional Centre Plan (Package A), "A Community Vision for the Penhorn Mall site was approved in principle by Regional Council in October of 2009 as a mixed-use area clustered around the transit terminal on Portland Street. The redevelopment concept includes pedestrian and transit oriented spaces and corridors, a range of medium to high density housing choices. Public amenity spaces including Penhorn Lake and Brownlow Park will support the development of this community, and additional open spaces and open space connections will be provided. Protection of the water quality of Penhorn Lake is a key goal of future development on this site, and shall be considered during the development and construction of the site."

The Penhorn residential development being considered will consist of a combination of multi-unit apartment buildings and single-family townhouse units. Exterior site development will include public open space and walking trails. The Penhorn development is expected to be fully serviced with water, wastewater, and stormwater systems connected to existing local municipal systems.

The sensitive nature of the natural environment surrounding the proposed development has been documented through previous watershed and water quality studies completed in the area. If not properly maintained, impacts to stormwater variations as a result of the proposed development will be directly transferred downstream to lakes which are already experiencing the effects of urbanization. Areas downstream of the proposed development include sensitive environmental habitats and public use areas, which are at risk of being impacted from both a stormwater quality (nutrient) and quantity (flooding) perspective.

Additionally, Penhorn Lake, a prominent water body adjacent to the proposed development lands, was identified as having significant water quality issues related to previous development and urbanization of the surrounding watershed. Special considerations will be discussed to ensure that further degradation will not occur as a result of the Penhorn residential development. It is anticipated that both temporary construction and permanent on-site stormwater management strategies will be implemented in order to maintain water balance and maintain or improve contaminant and nutrient levels for the benefit of the lake health.

1.2 Goals and Objectives

The purpose of this Master Stormwater Management Plan (MSWMP) is to address the potential effects on water quality and quantity from the proposed development on the surrounding lands and the downstream watershed. All development will generally be governed by HRM planning documents set forth in the Regional Centre Secondary Municipal Planning Strategy (Package A). This document specifically outlines objectives from the development of the Penhorn lands and contains general environmental protection and stormwater objectives, summarized in Section 3.6.3.2, policy 3-35 as follows:

i. Design on-site stormwater management that emphasizes low impact development measures as a means to maintain water quality in Penhorn Lake, with consideration given to the Analysis of Regional Lakes Water Quality Data (2006- 2011) prepared by Stantec in 2012.
ii. Consider a water quality monitoring program during and following development to ensure that the water quality objectives of the Regional Plan are satisfied;
iii. Prepare a landscaping and vegetation plan as part of site development to support the canopy target for the Manor Park Neighbourhood as referenced in the Urban Forest Masterplan.

In addition, Penhorn Lake and a significant portion of the development area is tributary to the Russel-Morris Lake Watershed. This area is generally governed by requirements the Dartmouth Municipal Planning Strategy and specifically, the Morris-Russel Lake Secondary Planning Strategy. HRM has presented objectives for stormwater management for new development in this document, with the relevant contained as policy ML-28 as follows:

> Within the Morris Lake Watershed, as illustrated on Map 9M, where applications are received for the expansion of existing or new commercial, institutional and multiple unit residential buildings, or for proposed grade alterations on such properties, it shall be the intention of Council to require the developer, where possible, to prepare and implement stormwater remediation measures to improve water quality entering the Morris Lake system.

This MSWMP will serve to address and outline the environmental and development objectives related to stormwater outlined in the HRM documents and the requirements for the on-site, low impact stormwater management systems, monitoring, and best management practices to be included in the development with the goal of minimizing impact to the surrounding area and maintaining or improving water quality of the downstream system.

2.0 ENVIRONMENTAL SETTING

2.1 Site Location

The subject site consists of PID 00222844 and 41331281, located on Portland Street, Dartmouth, also known generally as Penhorn Plaza. The site is approximately 17.05 hectares (42 acre), bounded by Penhorn Lake to the north, Highway 111 to the east, Portland Street to the south, and parkland and residential development to the west.

PID 00222844 is currently owned by Crombie Penhorn Mall (2011) Limited. The property contains an existing approximately 7,200 m^2 commercial building which was constructed in 1982 and underwent major renovations in 2009 when a large section of the former mall was demolished. The existing building underwent further redevelopment, transitioning to a primarily office building in 2018. PID 41331281 is a commercial property owned by Penhorn Plaza Holdings Limited. The two properties were subdivided in 2010 and the commercial property now contains multiple commercial units including a Sobeys grocery store, gas bar, and commercial strip plaza buildings. Figure A.1 included in Appendix A identifies the site boundary and current property ownership of the area included in this study.

The proposed Penhorn development is anticipated to consist of a combination of multi-unit residential and townhouse units, along with roadway, parking, and landscaped open space. A rendering of the proposed development layout is included as Figure A.2 in Appendix A.

This MSWMP will primarily focus on the development of the current open space on PID 00222844. There are no current plans on redevelopment of the existing commercial buildings, but future considerations for development and associated stormwater impacts, have been provided in this report.

2.2 Geology and Soil

2.2.1 Land Use and Topography

The subject site has been developed previously and contains large commercial buildings on the southern side of the site. The remainder of the site mainly consists of lands of the previously demolished Penhorn Mall, asphalt parking, and landscaped areas. In accordance to HRM planning documents (Halifax Regional Centre Plan Package A), the subject site is currently planned for mixed-use development.

The grading and sloping of the existing site was analyzed based on the topographic survey in combination with topographic LIDAR of the area. Detailed topographic survey has been completed throughout the subject site by SDMM in 2018 and DesignPoint in 2019.The topography of the site is mainly flat, with the majority of the site consisting of previously leveled pads of the former Penhorn Mall and asphalt parking areas. Steep landscaped and forested slopes, up to 50% grade, are located around the perimeter of previously developed pad areas. These slopes will generally remain undisturbed during development to maintain an essential natural riparian buffer to Penhorn Lake.

Generally, the finished site will be graded to minimize steep sloping to help promote infiltration and groundwater recharge. Existing site grades and sloping are indicated on the Pre-Development Site Drainage Plan, included as Figure A.3 in Appendix A.

2.2.2 Surficial and Bedrock Geology

A geotechnical investigation was completed as part of the preparation of the development of the subject site. Stantec completed an extensive geotechnical test pit program in June 2020 to assess geologic conditions of the subject site. Based on this investigation, subsurface conditions generally consist of a 1.0-4.0m thick layer of silty-sand and gravel fill, overlying silty-clay till and frequent cobbles and boulders. The majority of test pits were terminated upon encountering suspected large boulders, at depths between 2.0 to 6.0 m below the surface. Published Nova Scotia surficial geology data indicates the natural topography of the site area to be generally comprised of a silty till plain (ground moraine), which generally agrees with the data collected by Stantec.

According to the Nova Scotia Geoscience Atlas, the subject site is situated in the Halifax Formation of the Meguma Group. The Halifax Formation consists primarily of slate, siltstone, and minor sandstone. Based on the geotechnical investigations completed by Stantec, bedrock was not confirmed within the test pit depth. Groundwater levels were measured in each of the test pit locations. Groundwater was not encountered in the majority of the test pits, but was encountered in a small percentage of the total test pits with levels as high as 1.5 m below surface elevation. Based on the variation of groundwater elevations measured, there is possible groundwater mounding at the site, causing an apparent groundwater flow divide, to the north and southeast. Generally, deep bedrock elevations and low groundwater table will help to encourage infiltration, groundwater recharge, and be more conducive to the BMP approach and associated use of stormwater BMPs.

Stantec completed subsurface infiltration testing at select test pit locations during the investigation. Based on these tests, a medium to low infiltration rate of 6-8 mm/hour was estimated for the existing fill and till. The soil parameters and conditions outlined above will be used in the stormwater management design for optimal results and will be further assisted by the integration of imported permeable topsoil and fill for increased effectiveness of surface BMPs and infiltration.

2.3 Watershed Overview

Based on topographic data, historical record drawings, and previous watershed analysis completed in the area, it was determined that the Penhorn residential development area is primarily tributary to the Russel-Morris Lake Watershed, with a small portion tributary to the Lake Banook Watershed. The majority of the existing subject site flows directly into Penhorn Lake which is tributary to the Russel/Morris Lake Watershed.

A portion of the existing site flows directly into an existing underground stormwater system to the southeast which eventually drains into Morris Lake. The Morris/Russel watershed is a large watershed consisting of extensive residential development. Refer to Figure A.5 included in Appendix A, for the approximate limits of the Morris/Russel Lake watershed area, taken from HRM's Morris-Russel Lake Secondary Planning Strategy. Clayton Developments has a thorough understanding of the sensitivities around the Morris/Russel watershed, based on extensive previous community development in Russel Lake West.

A small portion of the southwestern site (approximately 15% of the total site area) flows west into the municipal storm system on Peddars Way, which eventually runs into Lake Banook. The Lake Banook watershed consists of a large catchment area which includes significant areas of existing development. This includes areas of previous and ongoing development of residential, commercial, and industrial lands, including a portion of Burnside Industrial Park, Dartmouth Crossing, and downtown Dartmouth. A map of the approximate catchment area for Lake Banook and the contributing land uses is provided as Figure A.6 in Appendix A, taken from the AECOM Hydraulic Modeling and Flood Plain Mapping Report (2013).

In accordance with previous environmental site assessments (Strum Consulting, 2010), the subject site contains no natural wetlands and watercourses within the site boundaries.

2.3.1 Penhorn Lake

Penhorn Lake is an approximately 4.3 hectare lake located just northeast of the subject site and is the primary receiving water body for the proposed Penhorn development. The lake is separated from the subject site by an approximately 50 m wide forested municipal parcel, which will act as a buffer zone. The lake includes an outlet control structure near the crossing of Highway 111 to manage lake discharge to the downstream system to Morris and Russel Lake. The Penhorn Lake watershed has been extensively developed with inflow from surrounding residential housing, commercial, and highway properties. The lake sees frequent public use with ongoing fishing and swimming activity. Preliminary plans for a public beach have been suggested by HRM staff. A new public trail is currently being constructed by HRM on the eastern side of Penhorn Lake.

Concern regarding nutrient levels and trophic status, in relation for natural plant and fish species have been previously expressed by HRM and local community groups such as the Banook Area Residents Association. According to a study provided by the group, emerging anoxic conditions have been identified in the deep water, caused by excessive nutrients and higher temperatures. As a result of these concerns, a solar-powered aerator was installed in 2019, lead primarily by the Association, with partial funding provided by Crombie REIT Limited.

In accordance with the HRM Regional Centre Secondary Municipal Planning Strategy (Package A), protection of the water quality of Penhorn Lake is a key goal of future development on this site, and shall be considered during the development and construction of the site. HRM has identified Penhorn Lake as one of the high-priority lakes in the Regional Plan Centre, in regards to water quality analysis. All planned development (with the possible exception of a public walking trail) will be contained on the subject site and will be constructed to avoid direct disruption to the neighbouring public parcel and lake.

2.4 Water Quality Monitoring

In accordance with general stormwater objectives Regional Centre Secondary Municipal Planning Strategy (Package A), on-site stormwater management systems will be included as a means to maintain water quality in Penhorn Lake, with consideration given to the Analysis of Regional Lakes Water Quality Data (2006- 2011) prepared by Stantec in 2012.
As part of an extensive water quality monitoring program conducted on HRM lakes between 2006 and 2011, Stantec was commissioned to prepare a report to compare measured water quality data to established water quality guidelines and to identify water quality trends within the selected lakes. This report provided Water Quality Index (WQI) and phosphorus-indicative trophic status of each of the water bodies sampled based on Canadian Council of Ministers of the Environment (CCME) Protection of Freshwater Aquatic Life (FAL) guidelines and field measurements.

The CCME WQI analyzes specific water quality parameters against the established CCME guidelines, resulting in a water quality index value ranging from 0 (poor) to 100 (excellent). In accordance with the Stantec report, six parameters were included in the customized WQI program: nitrate, nitrite, phosphorus, pH, ammonia, and chloride.

In accordance with the Stantec report, trophic status can be used in conjunction with WQI as an indicator of water quality in areas where nutrient enrichment has the potential to result from development activities. For determination of the trophic status in water bodies, the CCME Phosphorus Framework outlines the natural phosphorus ranges recommended by the CCME and is based on phosphorus being the limiting nutrient in the aquatic environment. Total Phosphorous (TP) is generally considered the most meaningful measurement of phosphorus in the aquatic environment and therefore is recommended by CCME as a predictor of the trophic state. A lake can be generally classified as being in one of three possible statuses based on concentration of phosphorus in surface water: oligotrophic (<10 μg/L), mesotrophic (10 – 20 μg/L), or eutrophic (>20 μg/L).

Water quality sampling and analysis included the relevant lakes downstream of the proposed development area, including Penhorn Lake, Morris Lake, Russel Lake, and Lake Banook. The results of the sampling and analysis are summarized in the following sections.

2.4.1 Penhorn Lake

Penhorn Lake was sampled seasonally for water quality between 2006 and 2011 at a monitoring station near the outlet at the Highway 111 crossing. In accordance with the 2012 Stantec report, Penhorn Lake was measured to have a CCME WQI rating of 78, or "Fair". The CCME WQI Technical Report (2001) defines "Fair" as follows: "Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels." Penhorn Lake was also measured to have an average TP concentration of 12 μg/L, classifying the lake as Mesotrophic in accordance with the CCME phosphorus framework.

Further sampling and analysis in Penhorn Lake was completed by AECOM in 2017. Based on the AECOM report, measured phosphorus levels ranged between 14 to 25 μg/L, with an

average of 20 µg/L for samples taken in the spring, summer, and fall. These results would suggest that the trophic status of the lake would be on the higher end of the mesotrophic range (10 to 20 µg/L) and into the eutrophic (>20 µg/L) range, however, due to the limited testing period and available results, it is suggested the previous Stantec historical results and classification of the lake would still govern.
Testing of other indicative nutrients were also completed in Penhorn Lake including nitrate, nitrite, phosphorus, pH, ammonia, and chloride. From the 2012 Stantec report, all measured parameters fell below CDWQG PAL and Health Canada guidelines, with the exception of chloride, which exceeded the CDWQG limit of 120 mg/L in 11 out of 16 tests completed. A compilation of the historical water quality testing results for Penhorn Lake from the Stantec analysis is provided as Appendix B. Based on the 2017 AECOM report, CDWQG exceedances for nitrate and pH were observed in the spring, and exceedances for chloride were observed in the spring, summer, and fall.

2.4.2 Russel Lake, Morris Lake, and Lake Banook

In accordance with the 2012 Stantec Water Quality Monitoring Report, Morris Lake, Russel Lake and Lake Banook were sampled seasonally between 2006 and 2011.

Morris Lake was measured to have a CCME WQI rating of 80, or “Good” at both locations. The CCME WQI Technical Report (2001) defines “Good” as follows: “Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.” Morris Lake was also measured to have an average TP concentration of 14 µg/L at the northern monitoring station and 13 µg/L at the southern monitoring station, classifying the lake as Mesotrophic in accordance with the CCME phosphorus framework. Russel Lake was measured to have a CCME WQI rating of 70, or “Fair”. Russel Lake was also measured to have an average TP concentration of 12 µg/L, classifying the lake as Mesotrophic in accordance with the CCME phosphorus framework.

In accordance with the 2012 Stantec report, a TP management threshold has been set at a concentration of 15 µg/L for Morris and Russell Lakes. Through the implementation of on-site LID stormwater management practices on the proposed site, phosphorous contribution to the downstream watershed will be maintained or reduced in an attempt to achieve these requirements.

Lake Banook was measured to have a CCME WQI rating of 70, or “Fair”. Lake Banook was also measured to have an average TP concentration of 11 µg/L, classifying the lake as Mesotrophic in accordance with the CCME phosphorus framework.

In accordance with Water Quality Objectives from the Shubenacadie Lakes Subwatershed Study – Final Report prepared by AECOM in 2013, a TP management threshold has been set at a concentration of 20 µg/L for Lake Banook to maintain its current trophic status. The study also indicated historical high levels of chloride in the lake, which should be considered as part of any new development. It is anticipated that because of the limited portion of the site which flows towards the Lake Banook system (approximately 15% of subject site), and through proper implementation of on-site LID stormwater management practices, phosphorous and chloride contribution to the downstream watershed will be maintained or reduced to achieve these requirements.

2.5 Existing Stormwater Management Facilities

As the subject site has been previously developed, some stormwater management facilities are currently incorporated. In accordance with record drawings and information from the current property managers, facilities on the existing site mainly include traditional stormwater infrastructure, consisting of a combination of roof and catch basin conveyance and traditional underground piped infrastructure. The existing commercial development also contains multiple operational flow stormwater treatment units, which are reportedly maintained on an annual basis.

During the demolition of the existing Penhorn Mall in 2009, much of the surrounding underground stormwater infrastructure was removed, but a portion of it was left in place and/or capped and abandoned. As part of the demolition, surface flow diversion ditches were constructed to direct and disperse runoff off-site. Considerations for the continued maintenance and integration of the existing stormwater treatment units will be critical to the implementation of new stormwater infrastructure and phasing of the new development. Design considerations will be investigated to utilize existing infrastructure, such as remaining ditches or piping, for temporary or long term stormwater management.

Considerations for the potential future redevelopment of the existing commercial lands, and the associated impacts on stormwater management, is further discussed in Section 3.4 of this report.

3.0 CONCEPTUAL STORMWATER MANAGEMENT PLAN FACILITIES

The strategy for the development of the subject site is to provide an integrated approach to stormwater management. This approach has been developed based on a hierarchy of stormwater management practices that begin at the source of runoff and nutrient creation. The hierarchy of stormwater management practices is as follows:

- Re-establishment and integration of natural vegetation;
- Source controls;
- Conveyance controls; and
- End-of-pipe controls.

3.1 Re-establishment and Integration of Natural Vegetation

Reintroducing natural vegetation throughout the development area is a key factor to improving natural water balance. Based on historical land use on the subject site, the majority of the site had been completely hardscaped in the 1970's with very limited green areas and natural vegetation. As a result, water quality in Penhorn Lake and the surrounding watershed has deteriorated through the introduction of increased nutrient levels and increased runoff rates. Native vegetation on the Penhorn lands shall be integrated into the development to act as a natural resource for runoff treatment, tree protection, ecological habitat, and public green space. Careful detailing during the design development phase will be completed to evaluate the capability of treatment and runoff quantity balancing.

Some of the benefits of re-establishing natural vegetation in green spaces are as follows:

- Natural cleansing and filtration of stormwater runoff;
- Promotion of evapotranspiration from trees and natural ground cover;
- Promotion of natural infiltration from undisturbed soils;
- Increased groundwater recharge;
- Preserving native plant communities;
- Providing natural buffers and green space as amenities;
- Maintaining the natural ecology for fish and waterfowl species; and
- Control runoff temperature.

The Integration of natural riparian buffers will provide natural water quality and quantity improvements before discharge to Penhorn Lake. Vegetation will reduce runoff quantities by minimizing stormwater velocities and promoting infiltration and aid in the removal of pollutants such as total suspended solids and phosphorus from the stormwater runoff, and reduce runoff temperature.

After the construction of each phase, guidelines will be utilized to encourage continued efficient nutrient removal within the green areas and stormwater BMPs. To ensure the vegetation will survive without heavy fertilizer applications, a topsoil recommendation specification has been provided as Appendix C, which provides the developers with detailed information on the topsoil requirements to produce healthy and sustainable planting. Using adequate depth and quality topsoil is helpful in promoting healthy lawn and plant growth as it provides a good growing base for root structures and in turn mitigates the need for fertilizer application. Additionally, acceptable plant species will be outlined as to closely resemble pre-development conditions. The use of native planting species encourages sustained growth as it is understood that these species already thrive in their natural habitat, this mitigates the need for fertilizer application and promotes sustained growth.

The Master Stormwater Management Plan intends to fully integrate landscaping design with recommendations in the HRM Urban Forestry Guide along with preserved natural forested areas around the development. Special consideration will be made along the eastern side of the site adjacent to Penhorn Lake, to eliminate significant point source discharge over the steep slopes, through the use of stormwater BMP facilities. All pre/post stormwater flows will be balanced at all critical discharge points to preserve the natural water balance in these areas.

3.2 Proposed BMP Description

Stormwater BMPs are features included in a stormwater system with the goal of improving water quality and quantity. Typically, BMPs are introduced in areas that experience a change in land use and have an increased percentage of impervious area, causing more direct runoff and nutrient transfer to occur. The performance of various BMPs has been monitored in studies across North America and published values for removal efficiency are widely available. Removal efficiency values quantify the BMPs ability to remove nutrients, such as TP and TSS. BMP removal efficiencies used in this study have been compiled from the following sources:

- Halifax Regional Municipality Stormwater Management Guidelines prepared by Dillon Consulting (2006);
- Standard and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems published by Alberta Environment (2013);
- Credit Valley Conservation – Low Impact Development Guidance Documents; and
- New Jersey Stormwater Best Management Practices Manual published (2004)

BMP strategies will be integrated into the stormwater management system throughout the development area to reduce the post-development runoff rates and nutrient loads. BMPs will be implemented in series wherever possible to obtain a higher level of runoff reduction and the highest potential removal rates of nutrients. Stormwater BMPs will be designed to be low-maintenance and be cost comparable over their lifecycle relative to traditional municipal facilities. Specific BMPs as discussed in this section can decrease capital and maintenance costs by reducing or eliminating traditional infrastructure such as asphalt pavement, curbing, and piped infrastructure. Additionally, integrating the functional aspect of BMPs with the development of parks and green spaces can provide major savings for both capital and maintenance costs as well as enhances aesthetics with more natural looking infrastructure. Further detail on specific BMP integration is provided in the following sections.

BMP strategies, as outlined in HRM Stormwater Management Guidelines (2006), can be divided into three primary categories: source controls, conveyance controls, and end-of-pipe controls. The following sections outline the BMP strategies which are being considered in the proposed development area.

3.2.1 Stormwater Source Control

Stormwater source controls are on-site measures which control runoff at the source of generation. This would include all BMP measures utilized to store and treat stormwater before it reaches the conveyance system or downstream BMPs. Source control BMPs can exist within both public and private property. Some general BMPs which will be considered within the private development areas include:

- Minimizing impervious areas (travel ways, driveways, walkways, etc.) and maximizing green space;
- Roof leaders directed to lawns and vegetated areas rather than the street / storm system; and
- Roof and parking lot stormwater storage.

Additional examples of source control BMP’s that can be implemented into public and private development areas are as follows:

Reduced Travel Ways
In accordance with design guidance included in the latest addition of the Transportation Association of Canada (TAC) manual, narrowing drive lanes will naturally result in lower operating speeds and improve pedestrian safety. In addition to traffic calming and safety benefits, reducing the paved travel ways on local roads also has significant benefits to improving stormwater runoff. The increase in permeable green space and decrease in the amount of impermeable area within the right-of way will increase levels of infiltration and filtration.

Historically in HRM, design of roads has been governed by a standard approved cross-section differentiated by road type (i.e. local, collector, arterial etc.) and not the expected traffic volumes they carry. This often results in local roads with little traffic volume to be significantly over-designed. It is recommended that the roads within the subject site be individually designed in consultation with HRM, based on expected road use, traffic volumes, and requirements for parking in the local area.

Brownstone Townhouses
Residential layout alternatives which can function with shared exterior spaces while still maintaining privacy and resident independence. These layout styles encourage social interaction using communal parking, communal green/open spaces, and increased housing proximity.

By providing centralized parking over individual private driveways, the overall impermeable area of this type of development is smaller than traditional residential development. This type of development also allows for narrower travel ways, which decreases impermeable area and associated maintenance and replacement costs that may require public funding.

Green Roofs
Green roofs generally consist of a thin layer of vegetation and growing medium installed on top of a conventional flat or sloped roof. Green roofs provide water quality, water balance, and peak flow control benefits in urban areas where open green space may be limited. Green roofs function by storing rainwater in the growing medium and ponding areas. Excess rainfall enters underdrains and overflow points and is conveyed in the building drainage system. After the storm, a large portion of the stored water is removed through evapotranspiration through the plants, evaporation into the air, or slowly drains away through the medium. The removal of stormwater decreases the demand on the downstream system, and provides natural contaminant removal.

Other benefits of green roofs include improvement of energy efficiency through the insulating properties of the media, reduction of urban heat island effects, and creation of greenspace for passive recreation or aesthetic enjoyment. Green roofs come with some limiting design constraints such as increased structural loads, potential for water damage, and limiting roof sloping and layout of amenities. Green roofs will be considered as a potential stormwater management option for multi-unit residential buildings and be investigated further during the detailed design phase.

Rain Barrels/Rainwater Harvesting

Rainwater harvesting is the process of intercepting, conveying, and storing rainwater for future use. Stormwater is typically gathered on a catchment surface, such as a roof, and is collected into a storage tank or rain barrel. Implementation of rainwater harvesting units or rain barrels can provide benefits of both conserving water for reuse and reducing stormwater runoff rates. With minimal pre-treatment, the captured rainwater can be reused for outdoor non-potable water uses such as irrigation systems, or in the building to flush toilets or urinals. In accordance with the Credit Valley Conservation (CVC) estimates, household municipal water consumption rates can be reduced by up to 55% with full system implementation.

When utilized in irrigation systems, the water is either evapotranspired by vegetation or infiltrated into the soil, which can significantly reduce stormwater runoff rates and pollutant loads. The capture and use of rainwater provides a reliable and renewable source of water to end users, and also helps reduce demand from the municipal water supply. By reducing demand on water resources, rainwater harvesting can result in significant cost savings.

Permeable Pavement and Pavers

Permeable pavement or pavers is an alternative to traditional pavement in urban areas to encourage infiltration and groundwater recharge in locations where open or green space is limited. Permeable pavement allows stormwater to drain through the hardscape structure through gaps or pours, into a stone reservoir where it is infiltrated into the underlying native soil or temporarily detained. Permeable paving allows for filtration, storage, or infiltration of runoff, and can reduce or eliminate surface stormwater flows compared to traditional impervious paving surfaces like concrete and asphalt.

Typical application of permeable pavement is on low traffic roads, parking lots, driveways, pedestrian plazas, and walkways. Permeable pavement types can vary and can include the following:

- Permeable interlocking concrete pavers (i.e., block pavers);
- Plastic or concrete grid systems (i.e., grid pavers);
- Pervious concrete; and
- Porous asphalt.

The permeable pavement system may be designed with no underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain for a no infiltration or detention and filtration only practice. Design consideration will need to include winter snow clearing and salting operations, and maintenance to prevent clogging.

Bio-Infiltration Planters

Surface bio-infiltration units are an emerging surface treatment alternative which can be integrated with natural landscaping and tree plantings. Units typically consist of pre-constructed planter frames, surface tiles, stormwater inlet, filter media, and subsurface drains. Typical application would be in walkway areas adjacent to landscaped or hardscaped areas such as parking lots, used in combination with traditional catch basins.

Bio-infiltration units use a fine-gradation of sand and filter media to treat stormwater runoff at its source to achieve a relatively high infiltration rate and stormwater treatment for small storm events.

3.2.2 Stormwater Conveyance Control

The stormwater conveyance in the development will include both traditional stormwater infrastructure and stormwater BMPs. Where possible, runoff will be directed to vegetated areas to promote infiltration and groundwater recharge. This overland flow conveyance practice serves to reduce peak runoff rates, infiltrate water, and filter nutrients. Conveyance control BMPs which are being considered for the development are as follows:

Permeable Storm Sewer and Soak-Away Structures

Permeable pipes and soak-away structures (manholes, catch basins) can be integrated into grassed medians, landscaped islands, bioswales, and hard-surfaced areas with low traffic volumes. Permeable stormwater infrastructure serves to help infiltrate stormwater into the ground, while still providing conveyance in significant rainfall events. Traditional piped conveyance would only be utilized when overland or underground pathways (i.e. surface swales and piped infiltration) do not provide sufficient capacity to handle the required rain events.

Open bottom or perforated manholes give opportunity for stormwater to infiltrate into the surrounding soils while still conveying a portion of stormwater so as not to flood unwanted areas. Furthermore, placing the conveyance conduit (perforated pipes) at a higher elevation than the bottom (i.e. sump) of the structure, provides an opportunity for additional water storage when stormwater flow exceeds infiltration rates.

Vegetated Swales / Bioswales

Vegetated swales or bioswales are linear landscape features consisting of a drainage channel with gently sloping sides. Underground, they may be filled with engineered soil and/or contain a water storage layer of coarse gravel material. Vegetated swales help to detain runoff, filter sediment and nutrients, and promote infiltration.

Typical applications for vegetated swales will be along the edges of roads and paved areas, replacing conventional curb and gutter configurations. Other applications will include collection systems capturing runoff from yards and conveyance from pipe outfalls to existing wetlands, watercourses, and natural drainage features. Check dams installed in the swale reduce water velocities and are necessary to prevent severe erosion on slopes greater than 4%. Vegetated swales and bioswales are proposed for use throughout the development where applicable. See Figure 3.1 below for an example of a successful bioswale installed in the Parks of West Bedford, Sub-Area 7.

Figure 3.1: Bioswale Outlet, (Parks of West Bedford, Sub-Area 7, 2020)

Infiltration Trenches
Infiltration trenches are underground linear stormwater BMP features typically comprised of a channel of clean permeable stone surrounded by geotextile fabric or sand filter. Trenches can include perforated drainpipes and be integrated with traditional piped stormwater system in certain scenarios. Infiltration trenches help convey and recharge groundwater and help maintain or restore the site's natural hydrology. Infiltration trenches store runoff stormwater in the stone void spaces, and filter as it slowly percolates downward into the subsoil. Infiltration trenches can be constructed as a stormwater conveyance alternative to vegetative swales and bioswales throughout the development area.

3.2.3 End of Pipe Control

CDS Units (Hydro-Dynamic Separators)
Continuous Deflective Separation (CDS) units are treatment units which can be integrated into the underground piped stormwater system for water quality protection. A CDS unit is typically a vertically-oriented separator that removes oil, sediment, and other potential contaminants in urban runoff. A CDS unit typically contains an emergency bypass system that allows runoff in major storm events to directly bypass the lower chamber and prevent the disruption of settled pollutants.

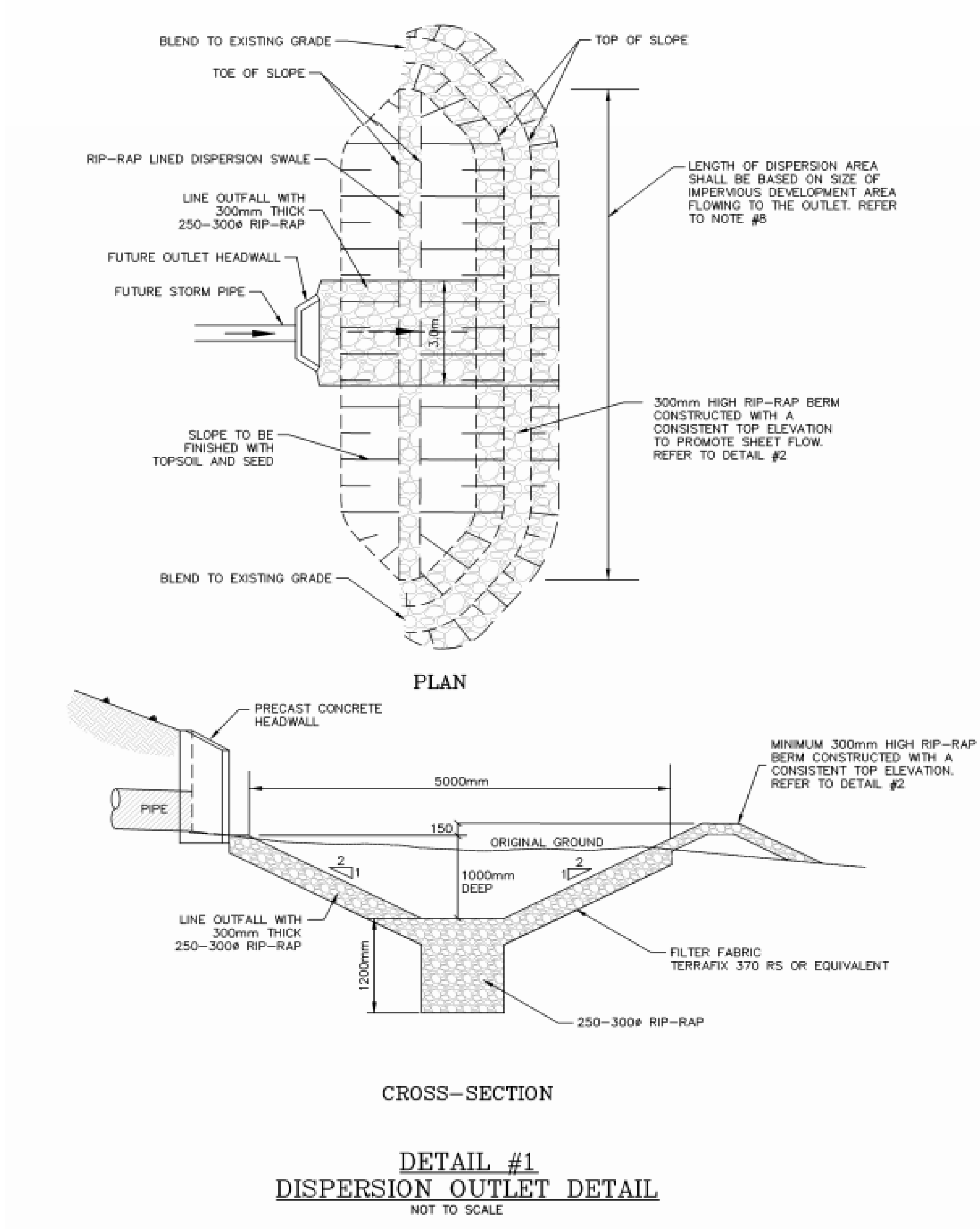
According to the US Environmental Protection Agency Fact sheet on CDS units: The CDS stormwater applications include removal of trash, debris, vegetative material, and coarse sediments prior to discharges to receiving waters and wetlands. Where higher levels of treatment are desired, CDS provides the essential pre-treatment as the initial step in a treatment train that may employ ultra-fine filtration and/or adsorption/absorption for removal of very small particulates, dissolved pollutants and oil/water separators.

Flow Dispersion Outlets / Vegetative Filter Strips

Dispersion features and vegetative filter strips can be constructed at piped outfalls to disperse runoff over a large area and promote sheet flow and infiltration to the downstream area. Vegetated filter strips are gently sloping, vegetated areas that treat runoff as sheet flow from adjacent impervious areas. They function by limiting runoff velocity and filtering out suspended sediment and pollutants, and by providing some infiltration into underlying soils. Vegetation included in filter strips may be comprised of a variety of trees, shrubs, and native plants to add aesthetic value as well as water quality benefits. With proper design and maintenance, filter strips can provide relatively high pollutant removal.

Dispersion outlet structures will consist of a perpendicular trench and berm configuration. Permeable media such as clearstone or rip-rap will be installed below the trench to provide storage and promote infiltration and groundwater recharge. The flow dispersion structures will be individually sized to handle volume from the estimated 95th percentile-24hr annual rainfall event (+/-25mm) within the constructed trench. Any storm event which exceeds this limit will filter through and overtop the rip-rap berm along its length, promoting sheet flow into a vegetative filter strip. Refer to Figure 3.2 below regarding construction detail of the dispersion outlet. Further detailing and sizing of filter strips is indicated on drawing D02, included in Appendix A.

Figure 3.2: Dispersion Outlet Detail



3.3 Stormwater Modeling Results

In accordance with the objectives proposed in the Regional Centre Secondary Municipal Planning Strategy (Package A) and Morris-Russel Lake Secondary Planning Strategy, the primary goal of the MSWMP will be to maintain or improve water quality in the surrounding watersheds and downstream water bodies. This goal will be achieved through implementing on-site stormwater BPM's into the development to maintain or improve post-development stormwater conditions both in terms of stormwater quantity and quality.

3.3.1 Stormwater Quantity Design Criteria

The intent of stormwater quantity control is to manage flood hazards and prevent or reduce damages associated with large, infrequent storm events. Significant increase in water levels, volumes, and flow velocities associated with land development can also directly affect water quality, through the disturbance of sediment and soils surrounding which can lead to increased turbidity, suspended solids, and other harmful nutrients into the water system.

The stormwater objectives outlined in the HRM Regional Centre Secondary Municipal Planning Strategy (Package A), can be supported by typical water quantity objectives from local authorities including HRM Stormwater Management Guidelines (Dillon, 2006), Halifax Regional Water Commission (HRWC) Standard Specifications (2020), and NSE. As per local guidelines, estimated post-development peak flows must be controlled for the 2, 5, 10, 25, 50, and 100-year, 24-hr design storm event, and peak flows at all critical discharge points must be balanced within 10% of the pre-development condition.

3.3.2 Stormwater Quantity Hydrological Model

Water quantity and peak flow rate modeling for the proposed development was completed through a desktop study analysis. The pre-development and post-development sites were modelled in HydroCAD Version 10.00, using the SCS TR-20 Unit Hydrograph runoff method and Dynamic-Storage-Indication reach routing method. This analysis has considered all areas which are tributary to each discharge point from the development area.

Design storms were taken from published storm data provided in the latest edition of the HRWC Standard Specification (2020). Rainfall depths for each design storm is listed in Table 3.1 below.

Table 3.1: Halifax Regional Water Commission – Design Storm Rainfall Depths

Design Storm	24-hr Rainfall Depth
2-yr	83 mm
5-yr	124 mm
10-yr	145 mm
25-yr	169 mm
50-yr	188 mm
100-yr	204 mm

Catchments were delineated using AutoCAD Civil 3D and available LiDAR contour mapping blended with field survey data completed by SDMM and DesignPoint. Multiple catchments areas and outlets points were carefully selected to suit the natural drainage characteristics and conditions (refer to Figure A.3 and A.4 in Appendix A).

Runoff coefficients are used in determining the portion of rainfall that runs off the site during the prescribed storm events. For the SCS model, the runoff coefficient is referred to as an "SCS curve number" or "CN" and is a number between 0 and 100, which approximates the relationship between rainfall and runoff. Further information on the SCS curve numbers utilized in our stormwater analysis can be found on Figure A.3 and A.4 in Appendix A. SCS curve numbers have been selected with careful consideration of the native soil's ability to accept and infiltrate stormwater, based on previous geotechnical studies and analysis of the study area.

3.3.3 Stormwater Quantity Modeling Results

The pre-development modeling results are summarized in Table 3.2 for the Penhorn residential development area. Pre-development catchment areas and critical drainage points in the table are indicated on drawing D01, included in Figure A.3 in Appendix A. The post-development modeling results are summarized in Table 3.3. Post-development catchment areas and critical drainage points in the table are indicated on Figure A.4 in Appendix A.

The post-development runoff results reflect site conditions with some minor typical stormwater management facilities such as rooftop and parking lot storage. Results are generally conservative as integrated stormwater BMPs, which will contribute to additional flow reduction, are not reflected in the model. These BPMs will be further detailed and included at the design development stage.

Table 3.2: Pre-Development Model Results - Stormwater Quantity Summary

POINT	AREA (Hectares)	CN	TC (Min.)	FLOW (cms)					
				2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
A	5.60	84	20	0.365	0.647	0.779	0.942	1.063	1.180
B	0.92	98	7	0.148	0.224	0.261	0.307	0.340	0.375
C	1.87	94	15	0.202	0.310	0.359	0.420	0.465	0.510

Table 3.3: Post-Development Model Results - Stormwater Quantity Summary

POINT	AREA (Hectares)	CN	TC (Min.)	FLOW (cms)					
				2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
A	5.81	87	20	0.364	0.635	0.748	0.881	0.976	1.067
B	1.02	90	7	0.124	0.203	0.242	0.291	0.326	0.362
C	1.93	89	15	0.172	0.277	0.327	0.389	0.434	0.480

Peak-flow balancing was achieved on the subject site through the introduction of additional open green space and design features including cluster-style unit layouts and reduced travel lane widths. For the majority of the site, runoff coefficients (CN) were reduced from the pre-development condition (asphalt parking lot), through the use of landscaping and vegetative site finishes which are more conducive to infiltration. Through the implementation of these BMPs, pre/post peak flow balancing was achieved for each of the design storms as required by local authorities. In addition, flow capacity of the existing piped stormwater system directly downstream of the development area was analysed and confirmed to be acceptable based on the anticipated peak runoff rates from the proposed development.

3.3.4 Stormwater Quality Design Criteria

The primary goal of the stormwater quality management system, in accordance with water quality objectives proposed in the Regional Centre Secondary Municipal Planning Strategy (Package A) and Morris-Russel Lake Secondary Planning Strategy, is to maintain or improve water quality in the surrounding watersheds and downstream water bodies, which include Penhorn Lake, Morris/Russel Lake, and Lake Banook.

The general approach to maintaining or improving water quality will be to maintain or decrease total phosphorus (TP) and total suspended solids (TSS) levels from the development area such that the lakes do not experience an increase in trophic state. This approach is consistent with the general objective of the HRM Regional Planning Strategy, which seeks to “maintain existing trophic status of our lakes and waterways to the extent possible” (HRM, 2014). For the purposes of the development area, the approach of providing no net increase in TP or TSS load from the development area will be utilized to ensure the quality and trophic status of the downstream water bodies remains unchanged.

3.3.5 Stormwater Quality Model

Through the use of desktop modeling processes and empirical data presented in the HRM Stormwater Management Guidelines (2006), a concentration-based mass-balance nutrient loading model was created. This model simulated anticipated TP and TSS transported from the site through stormwater runoff in the 1 in 2, 5, 10, 25, 50, and 100-year storm events. This accepted methodology was previously used in Bedford South and the Parks of West Bedford, with analysis for those projects previously completed by Stantec. Considerations in the model include:

- Accurately identifying ground surface and soil characteristics;
- Assigning TP and TSS nutrient loading values; and
- Nutrient removal rates for a range of different stormwater BMPs.

The majority of nutrient transport occurs in what is known as the first flush. The first flush is identified as the initial stages of a rainfall event, usually when rainfall intensities are low but steady. Nutrients that are situated at the surface are easily removed by the first flush and transported downstream. As the rainfall event increases in intensity it is understood that a large majority of the surface nutrients have already been removed and that the latter parts of the rainfall event only transport a small amount of nutrients downstream. In addition to the first flush, light rains that happen more regularly, with a short duration and lower intensity will transport sediment much in the same way. These storms are referred to as low intensity, high frequency storms and represent approximately 90% of the annual rainfall. Designing stormwater quality measures that consider these storms and encourage infiltration is considered a proactive approach to stormwater management and is one of the fundamental elements of stormwater BMPs.

Similar to proven methodology employed for Bedford South and The Parks of West Bedford, a concentration-based loading mass-balance water quality model has been utilized for this analysis. This model was initially run in the pre-development scenario to determine the base-line, or budget, TP and TSS values. Then, a post-development model was created that ran uncontrolled with no allowance for nutrient loading attenuation features (BMPs). This provided an understanding of how the expected nutrient loading would be affected by a developed site. The equations below were used in calculating the concentration-based nutrient loads.

$$L = (R * \rho) / 1000$$ **Equation 3-1**

Where,
L = Nutrient load (kg)
R = Site runoff volume (m^3)
ρ = Total phosphorus concentration (mg/L)

$$R = A * C * P$$ **Equation 3-2**

Where,
R = Site runoff volume (m^3)
A = Tributary area (m^2)
C = Runoff coefficient (unitless)
P = Depth of precipitation (m)

In accordance with Halifax Regional Municipal Planning Strategy (2006), "Rational C" runoff coefficients were used in the water quality model. The runoff coefficient is essentially a ratio of rainfall to runoff and varies based on land use, soil type, infiltration ability, and land slope. Runoff coefficients are a value between 0 and 1 that can be taken from published tables or used aggregately as a weighted value to represent an area which incorporates multiple land uses.

It is standard practice to increase the rational runoff coefficient during a high intensity, low frequency storm to account for the response to a rainfall of increased intensity. The anticipated percent increase can vary depending on the expected runoff coefficient during lower frequency storm events. The lower the runoff coefficient, the larger the change is expected.

3.3.6 BMP Selection

Throughout the preliminary design process for this development, several stormwater BMPs were selected based on their potential application to the site. The general description of these BMPs are outlined in Section 3.2 of this report. Generally, some combination of the indicated BMP will be required to maintain or improve water quality discharge from the site. Exact layout and location requirements for the BMPs will be finalized during the design development stage and will be required to be considered for each portion of the development.

Table 3.4 below outlines the primary stormwater BMPs selected for this project and their associated TP and TSS removal efficiencies. The values presented below have been compiled from the HRM Stormwater Management Guidelines and alternative resources indicated below. Other BMPs to be included in the development, as indicated in Section 3.2, will have associated removal efficiencies, and will be analyzed in further detail at the design development stage.

Table 3.4: BMPs and Related TP and TSS Removal Efficiencies

Best Management Practice (BMP)	TP Removal Efficiency (%)	TSS Removal Efficiency (%)
Vegetative Grass Swale	40	85
Vegetated Filter Strip	50*	85*
Infiltration Basins and Trenches	70	90
CDS Units	30**	70**
Green Roof	N/A	N/A
Permeable Pavement	Negligible	80
Permeable Storm Sewer and Soak-Away Structures	80***	70***
Bio-infiltration Planters	50****	85****

*Based on New Jersey BMP Manual – 2004

**Based on study by the Cooperative Research Centre for Catchment Hydrology, as noted in the CDS Technologies brochure. Actual removal efficiencies will depend on model chosen.

***Based on average removal rates in combination with additional BMPs (Grass swale or infiltration trench) found in Credit Valley Conservation Low Impact Development Stormwater Management Planning and Design Guide.

****Based on the International BMP Database estimates on similar sand media filters with similar dimensions.

The BMPs listed above are anticipated to be incorporated into the site design and natural topography of the development but require special consideration for placement due to size or soil characteristic requirements (i.e. a vegetated filter strip may require a minimum flow length or maximum slope for effective removal or an infiltration trench may require a minimum soil infiltration rate to achieve the published removal efficiency). Table 3.5 below outlines some special considerations required for each BMP presented above.

Table 3.5: BMPs Design Requirements and Considerations

Best Management Practice (BMP)	Design Considerations
Vegetative Grass Swales	• Contributing drainage <2 ha. • Maximum 2.5:1 interior side slopes. • Minimum depth of 750 mm. • Minimum bottom width of 750 mm. • Use of natural and native vegetation. • Effective for stormwater treatment if length is at least 60 m. • Requires permanent check dams at 60 m spacing. • Longitudinal sloping should range between 0.5-5%. • Requires regular inspection and maintenance of vegetation.
Vegetated Filter Strips	• Contributing drainage <2 ha. • Minimum flow length of 10 m. • Sloping should range between 0.5-5%.

Best Management Practice (BMP)	Design Considerations
Infiltration Basins and Trenches	• Contributing Drainage <2 ha. • Requires pre-treatment to protect groundwater quality (grassed channels, sedimentation basins, ponds, wetlands). Recommended volume of pre-treatment 25% of the design runoff volume. • Soils to have clay content <20%, and silt/clay content <40%. • Slopes less than 15%. • Must have safe overflow facility designed to take flows in excess of the design event. • Requires an observation well. • Soil percolation rate >15 mm/h. • High water table level and bedrock > 1m below trench bottom.
Green Roofs	• Choice of Extensive (thin soil) vs. Intensive (deep soil) Green Roof. • Extensive green roofs are limited in plant species options and are lower maintenance. • Intensive green roofs have a greater weight loading and better insulation properties. • Considerations for waterproofing and maintenance are important.
Permeable Pavement	• Very limited experience in Canada. • Use only in low vehicle traffic areas. • Requires moderately permeable soils, with depth at least 1 m above high water table or bedrock. • Only effective for small drainage areas. • Should not be applied in parking areas where sanding or salting is used in the winter. • Soil permeability >16 mm/hour. • Longitudinal slopes <15%. • Require frequent inspection and maintenance.
Permeable Storm Sewer and Soak-Away Structures	• Pipe diameter >200 mm. • Slope of pipe <0.5% to encourage infiltration. • Implemented in soils >15 mm/h percolation rate. • High water table or bedrock >1 m below pipe. • Geotextile fabric installed between pipe bedding and the native soil. • Pipe bedding using clear stone 50 mm diameter with 40% void ratio.
CDS Units	• Installed in accordance to the manufacturer's specification. • Select model based on design flow rate and level of pollutant removal required. • Requires annual inspection and maintenance. • Typically more effective for low flows, medium and high flows are bypassed.

*Based on data provided in HRM Stormwater Management Guidelines – 2006

3.3.7 Treatment Trains

BMPs can act as stand-alone features that work to remove a defined percentage of waterborne nutrients, but they can also be arranged in a treatment train to increase the overall removal efficiency. When stormwater BMPs are laid out in series, each successive BMP sees water with a greatly reduced nutrient load. The downstream BMP removes its "target" percentage of nutrients from what remains in the water that it receives. Credit Valley Conservation has recommended the use of treatment trains, when combining source, conveyance, and end of pipe control measures to produce a more efficient nutrient removal system. BMPs provided in a train cannot simply have their removal efficiencies added together, but rather they require a specific equation to determine the cumulative, aggregate, removal efficiency. The total removal rate of the BMP treatment train is based on applying the removal rate of the second BMP to what results from the application of the first BMP, and so on. Equation 3-3 below describes this relationship and is used to determine the removal efficiency of BMPs in series:

$$R_{train} = R_a + R_b - (R_a R_b/100) \qquad \textbf{Equation 3-3}$$

Where,
R_{train} = Total aggregate removal rate of train (%)
R_a = Removal rate of the upstream BMP (%)
R_b = Removal rate of the downstream BMP (%)

3.3.8 Stormwater Quality Modeling Results

The water quality model has been completed using a concentration-based loading mass-balance approach that is widely accepted and originally adopted for use in Bedford South and The Parks of West Bedford by Jacques Whitford (Stantec). The concentration-based loading mass-balance approach is used to estimate the proposed development's generation of TP and TSS in kilograms during prescribed storm events. Anticipated TP loading is dependent on the land use of a particular area and the stormwater management design. Land use and corresponding TP concentrations are outlined below and were selected from the HRM Stormwater Management Guidelines and other relevant literature. Using the provided TP and TSS concentrations, a mass of TP and TSS in kilograms was calculated using the estimated rainfall that falls on a given area during the different return period storm events. The anticipated pre-development TP and TSS masses were used as the target values during post-development balancing.

The following land use scenarios were used during analysis:

- Scenario 1: Pre-development conditions
- Scenario 2: Post-development conditions, no BMPs (uncontrolled)
- Scenario 3: Post-development conditions, with BMPs

Pre and post-development land use and corresponding TP and TSS loading concentrations were assigned using the information presented in Table 5-5 of the HRM Stormwater Management Guidelines. Table 3.6 below summarizes the land uses and corresponding TP and TSS loading values utilized throughout the modelling process. Refer to Stormwater Drainage Plans included as Figure A.3 and A.4 in Appendix A for reference.

Table 3.6: Summary of Pre and Post-Development Land Uses

Development Condition	Drainage Area	Land Use	Area (ha)	TP Loading (mg/L)	TSS Loading (mg/L)	Notes
Pre-Development	A	Urban Open	5.81	0.20	20.0	Abandoned mall site/parking area
	B	Urban Open	1.02	0.20	20.0	Abandoned mall site/parking area
	C	Commercial	1.93	0.30	54.2	Parking lot
Post-Development	A	Residential (Medium Density)	1.40	0.20	30.5	Townhouse development
		Residential (High Density)	4.41	0.20	47.7	Multi-unit development
	B	Residential (High Density)	1.02	0.30	47.7	Multi-unit development
	C	Residential (High Density)	1.93	0.30	47.7	Multi-unit development

For consistency with the water quantity analysis (peak flow attenuation), event specific concentration-based loading mass-balance calculations were completed. Tables 3.7 to 3.12 summarize the pre and post-development TP and TSS values as well as the anticipated percent reduction required to provide balanced nutrient loads for the whole project site area.

Table 3.7: TP Loading for Project Site - Pre and Post-Development Drainage Area "A"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	0.606	0.905	1.058	1.233	1.372	2.253
Post-Development (Uncontrolled)	0.638	0.954	1.115	1.300	1.446	2.617
Percent Reduction Required	5.4%	5.4%	5.4%	5.4%	5.4%	16.1%

Table 3.8: TP Loading for Project Site - Pre and Post-Development Drainage Area "B"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	0.116	0.173	0.202	0.236	0.262	0.416
Post-Development (Uncontrolled)	0.114	0.171	0.200	0.262	0.259	0.452
Percent Reduction Required	-1.1%*	-1.1%*	-1.1%*	-1.1%*	-1.1%*	8.7%

*Negative value indicates that reduction in anticipated TP loading has been achieved naturally through change in land use and reduction in impervious area.

Table 3.9: TP Loading for Project Site - Pre and Post-Development Drainage Area "C"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	0.356	0.532	0.623	0.726	0.807	1.180
Post-Development (Uncontrolled)	0.205	0.307	0.359	0.418	0.465	0.855
Percent Reduction Required	-42.3%*	-42.3%*	-42.3%*	-42.3%*	-42.3%*	-27.5%*

*Negative value indicates that reduction in anticipated TP loading has been achieved naturally through change in land use and reduction in impervious area.

Table 3.10: TSS Loading for Project Site - Pre and Post-Development Drainage Area "A"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	60.57	90.49	105.81	123.32	137.19	225.30
Post-Development (Uncontrolled)	100.75	150.52	176.01	205.15	228.21	413.08
Percent Reduction Required	66.4%	66.4%	66.4%	66.4%	66.4%	83.3%

Table 3.11: TSS Loading for Project Site - Pre and Post-Development Drainage Area "B"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	11.57	17.28	20.21	23.56	26.21	41.55
Post-Development (Uncontrolled)	18.20	27.19	31.79	37.05	41.22	71.85
Percent Reduction Required	57.3%	57.3%	57.3%	57.3%	57.3%	72.9%

Table 3.12: TSS Loading for Project Site - Pre and Post-Development Drainage Area "C"

Development Scenario	Total Project Site TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Pre-Development	64.38	96.19	112.48	131.09	145.83	213.11
Post-Development (Uncontrolled)	32.67	48.80	57.07	66.51	73.99	135.97
Percent Reduction Required	-49.3%*	-49.3%*	-49.3%*	-49.3%*	-49.3%*	-36.2%*

*Negative value indicates that reduction in anticipated TSS loading has been achieved naturally through change in land use and reduction in impervious area.

Based on the loading models results, it was determined that integration of on-site stormwater BMPs is required in "Area A" (tributary to Penhorn Lake) and "Area B" (tributary to Morris Lake) in the development in order to achieve no net increase of TP and TSS generation following project completion. Because of the pre-existing conditions (commercial parking lot), development of the "Area C" (tributary to Banook Lake) actually results in a decrease in TP and TSS loading and thus no additional BMPs are required to achieve nutrient balance. A plan indicating preliminary location of all primary BMP facilities is provided as Figure A.7 in Appendix A. To ensure "no net increase" of TP and TSS during construction, proper application of the erosion and sediment control measures, as well as any required modifications, will be monitored and enforced by the Site Engineer.

3.4 Considerations for Potential Future Redevelopment of Existing Commercial Lands

It has been requested by HRM for this MSWMP to include analysis of the potential impacts of redevelopment of the existing commercial units which are part of the subject site. These commercial units include the existing office building owned by Crombie Penhorn Mall (2011) Limited (PID 00222844), and the existing commercial units contained on Penhorn Plaza Holdings Limited (PID 41331281) property, including Sobeys, Mr. Lube, Needs, Starbucks, commercial strip mall, etc. There are no current plans to redevelop these lands, but any future changes to land use and impervious area will have a direct effect on stormwater quantity and quality leaving the site and would need to be considered in the overall impact to the downstream watershed. Clayton Developments Limited has provided a high-level conceptual blocking for this area, which has been used to estimate the potential impact area for the stormwater analysis. Conceptual future blocking is indicated on the proposed development layout included as Figure A.2 in Appendix A.

There are two primary stormwater discharge locations for the existing commercial lands. Discharge locations are indicated as critical point “D” and “E” on drawing D01, included in Figure A.3 in Appendix A. Critical point “D” discharges into the ditch system adjacent to Portland Street and Highway 111. Critical point “E” discharges into the municipal storm sewer system which crosses Highway 111. Both of these discharge points are believed to be tributary to the Russel/Morris Lake watershed.

3.4.1 Existing Commercial Stormwater Quantity Analysis

Stormwater quantity design criteria has been outlined in Section 3.3.1 of this report. As per local guidelines, estimated peak flows must be controlled for the 2, 5, 10, 25, 50, and 100-year, 24-hr design storm event, and peak flows at all critical discharge points must be balanced within 10% of the pre-development condition. For the purposes of analysing the existing commercial development area, the approach of achieving flow balance at critical discharge points will be utilized, based on the current development conditions.

Based on a review of record drawings, there is limited on-site stormwater retention currently being utilized on the existing commercial lands. Stormwater runoff is generally conveyed through traditional stormwater infrastructure directly into the municipal stormwater piped system. Stormwater hydraulic analysis was completed on the existing commercial lands as outlined in Section 3.3.2 of this report. Estimated existing peak flow rates for the critical discharge points have been calculated as per Table 3.13 below based on the current land use.

Table 3.13: Existing Commercial Model Results - Stormwater Quantity Summary

POINT	AREA (Hectares)	CN	TC (Min.)	PEAK FLOW (cm)					
				2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
D	3.57	93	7.0	0.514	0.818	0.966	1.151	1.281	1.418
E	3.20	96	7.0	0.498	0.765	0.895	1.059	1.173	1.295

As per local guidelines, and to provide a “no net increase” in stormwater flow, it is recommended that for any future redevelopment of the existing commercial lands, the peak design flow shall not exceed these quantities. Any future redevelopment planning should consider the requirements of adhering to the stormwater quantity targets above.

3.4.2 Existing Commercial Stormwater Quality Analysis

Stormwater quality design criteria has been outlined in Section 3.3.4 of this report. The general approach for maintaining or improving water quality will be to maintain or decrease total phosphorus (TP) and total suspended solids (TSS) levels from the development area such that the downstream lakes do not experience an increase in trophic state. For the purposes of analysing the existing commercial development area, the approach of providing no net increase in TP or TSS load based on the current development will be utilized to ensure the quality and trophic status of the downstream water bodies remains unchanged.

Based on compiled record drawings from the existing commercial properties, some nutrient/sediment mitigation strategies have been implemented into the existing stormwater management system. Several stormwater treatment units have been identified to be operating on the commercial lands, covering approximately 2.7 hectares of developed area. Treatment coverage includes portions of buildings and paved areas surrounding Sobeys (2008), commercial strip mall (2009), Needs (2012), Mr. Lube (2013), and Starbucks (2014).

Stormwater treatment units are reportedly a combination of traditional CDS, Stormceptor, and oil separator units, but the exact make and models are unknown. For the purposes of this water quality analysis, it is assumed that the existing stormwater treatment units have an average removal efficiency of 30% for TP and 70% for TSS as outlined in Table 3.4 of this report. Known locations of existing stormwater treatment units are indicated on drawing D01, included in Figure A.3 in Appendix A.

Stormwater quality analysis was completed for the existing commercial lands as outlined in Section 3.3.5 of this report. Pre-development TP and TSS loading rates for the critical discharge points have been calculated as per Table 3.14 and Table 3.15 below based on the current land use, and currently installed treatment units.

Table 3.14: TP Loading for Existing Commercial Site

Critical Drainage Point	TP Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
D	0.619	0.925	1.081	1.260	1.402	2.090
E	0.493	0.737	0.861	1.004	1.117	1.528

Table 3.15: TSS Loading for Existing Commercial Site

Critical Drainage Point	TSS Loading (kg)					
	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
D	105.40	157.46	184.13	214.60	238.73	355.39
E	54.07	80.78	94.46	110.09	122.47	172.56

As per local guidelines, and to provide a “no net increase” in nutrient loading, it is recommended that for any future redevelopment of the existing commercial lands, estimated TSS and TP loadings shall not exceed these quantities. Any future redevelopment planning should consider the requirements of adhering to the storm water quality targets above.

4.0 PROTECTION MEASURES DURING AND AFTER SITE DEVELOPMENT

Temporary and long-term effect of sedimentation and erosion can be minimized by appropriate prevention and control measures. All development will comply with applicable environmental laws, regulations, standards and practices, permits, approvals, and requirements of federal, provincial, and municipal authorities. All land developers involved will have established guidelines that are enforced through the tender/contract period. Appendix D of this report includes a detailed Sedimentation and Erosion Minimization Plan that will be utilized during construction for the Penhorn lands. All developers within the project area will be required to adopt similar on-site procedures. Clear and concise guidelines and site-specific erosion control plans must be provided to all contractors.

The geology of the site consists mainly of silt and granular fill, which, if exposed, would potentially be susceptible to erosion. Imported material will generally be limited to gravels and topsoil needed for landscaping. Standard erosion and sedimentation control measures will be employed for all erodible soils. In addition, site-specific salt and snow management plans will be developed in collaboration with HRM at the time of development application.

4.1 Temporary Protection Measures

Temporary erosion and sedimentation protection measures used during construction will generally include:

- Phased construction approach, limiting amount of exposed soil at any one time;
- Utilizing existing diversion ditches as management and dispersion features;
- Silt fences installed downstream of impacted areas before construction;
- Clean run-on water controlled/diverted by installation of channels, berms, and grading;
- Rip-rap rumble strips installed at all construction entrances to prevent tracking of sediment and fines;
- Silt sacs installed in all surrounding catch basins to prevent migration of fines into stormwater system;
- Exposed soil minimized via rapid cover by mulch, gravel, hay, etc.;
- Controlled exposure relative to forecasted weather conditions;
- Conscious site grading to minimize steep slopes;
- Continuous site monitoring and inspection of temporary sedimentation and erosion control measures; and,
- Limited transportation and testing of materials off-site.

4.2 Permanent Protection Measures

The erosion and sedimentation control plan for permanent stabilization should include:

- Immediate stabilization of all disturbed surfaces during and after construction;
- Periodic inspection and maintenance of erosion and sedimentation control measures to ensure continued effectiveness;

- Provide vegetative buffers between all development and natural wetlands and watercourses; and
- Installation of permanent dispersion features to disrupt concentrated point source discharge.

4.3 Ongoing Protection Measures

There are a variety of other “soft” protection measures that will be adopted by the community to further aid in stormwater quality and quantity management. The Halifax Regional Municipality Bedford West Master Planning Study (HRM, 2006) provides the following suggestions, which will also be applied to the Penhorn development area:

- Public education. Educate individuals in the development about the effects of poor stormwater management and the methods by which they can minimize their impact (e.g. the protection measures listed in the following bullets). Methods of education can include billing inserts, school and community programs, pamphlets, etc.
- Litter control and recycling programs. Litter control and recycling programs reduce the potential for clogging of stormwater management facilities and can be implemented through the use of no-littering bylaws.
- Animal waste control. Clean-up and proper disposal of household pet waste through the use of bylaws reduces the release of nutrients and pathogenic bacteria to downstream receiving waters.
- Spill response plans. The implementation of emergency spill response plans can help limit pollutants and hazardous chemicals from entering downstream receiving waters.
- Proper storage and use of chemicals, fertilizers, and pesticides. The decreased use and proper application of fertilizers can greatly decrease the nutrient and chemical loading to downstream watercourses. Common control measures include applying fertilizers to minimize potential for runoff and hand-weeding as opposed to controlling weeds with chemicals.
- Vacant lot clean-up. Lot clean-up can prevent the accumulation of debris and other material which may pollute downstream watercourses.
- Identification and prohibition of illegal/illicit storm drain connections and discharges. This is another way to minimize pollutant load to receiving waters.
- Street sweeping and catch basin cleaning. Street sweeping and catch basin cleaning can reduce oil and grease runoff as well as decrease the potential for clogging of stormwater management facilities.
- Road salt management. Properly managed road salt application programs minimize the load of salt and sediment in stormwater runoff.
- Pollution prevention lawn care. Utilization of proper fertilizer and pesticide application will reduce the release of nutrients and chemicals that typically contribute to downstream receiving water impairments. Also, guidelines will require a minimum of 6” of topsoil on lawn areas prior to seeding and/or sodding.

To address the issues outlined in the HRM study, Clayton will prepare a Home Owner’s Guide to address Lawn Care Best Management Practices. A reference guide, which was provided in the Parks of West Bedford, is provided as Appendix E. The document outlines the developer's environmental commitment for the development as well as the management practices that the homeowner can undertake to contribute to that commitment.

5.0 STORMWATER FACILITY MAINTENANCE

Stormwater BMPs will be designed to be low-maintenance and be cost-comparable to traditional municipal stormwater facilities. Specific BMPs as discussed in this section can decrease capital and maintenance costs by reducing or eliminating traditional infrastructure such as asphalt pavement, curbing, and underground piped infrastructure.

5.1 Stormwater BMP Maintenance

In order to provide BMPs that maintain their optimal TP and TSS removal potential throughout their lifespans, it is important that regular maintenance be completed. For natural BMPs such as vegetated filter strips and enhanced grass swales, making sure they are free of debris and excess sediment will help them operate at their full potential. Ultimately, maintenance schedules are the responsibility of the owner but it is imperative that regular maintenance be performed to ensure peak operational efficiency of any BMP implemented.

Credit Valley Conservation (CVC) in Ontario, Canada has published literature on typical maintenance and inspection activities for BMPs. Table 5.1, 5.2, and 5.3 presents typical recommendations below.

Table 5.1: Typical Maintenance Activities for Vegetative Filter Strips and Grass Swales (Source: Credit Valley Conservation)

Activity	Schedule
• Inspect for vegetation density (at least 80% coverage), damaged by foot or vehicular traffic, channelization, accumulation of debris, trash and sediment, and structural damage to pre-treatment devices.	After every major storm event (>25 mm) in the first year, quarterly for the first two years, and twice annually thereafter.
• Regular watering may be required during the first two years while vegetation is becoming established. • Mow grass to maintain height between 75 to 150 mm. • Remove trash and debris from pre-treatment devices, the swale surface and inlet and outlets.	At least twice annually. More frequently if desired for aesthetic reasons.
• Remove accumulated sediment from pre-treatment devices, inlets and outlets. • Replace dead vegetation, remove invasive growth, dethatch, remove thatching and aerate (PDEP, 2006). • Repair eroded or sparsely vegetated areas. • Replace mulch in spring. • Trim trees and shrubs. • Remove accumulated sediment on the swale surface when dry and exceeds 25 mm depth (PDEP, 2006). • If gullies or pools of standing water are observed along the swale, regrading and revegetating may be required.	Annually or as needed.

Table 5.2: Typical Maintenance Activities for Permeable Storm Sewer and Soak-Away Structures (Source: Credit Valley Conservation)

Activity	Schedule
• Inspection via manholes should be performed to ensure the facility drains within the maximum acceptable length of time (typically 72 hours)	After every major storm event (>25 mm) in the first year, and at least annually.
• Cleaning out leaves, debris and accumulated sediment caught in pre-treatment devices	Annually or as needed.

Table 5.3: Typical Maintenance Activities Green Roofs (Source: Credit Valley Conservation)

Activity	Schedule
• Irrigation and/or watering • Leak Detection: Electronic leak detection is recommended with particular attention should be paid in the first few months following installation.	Regularly as needed
• Weeding and removal of volunteer seedlings of trees and shrubs. • Remove debris and dead vegetation. In particular, the overflow conveyance system should be kept clear	At least twice per year

Table 5.4: Typical Maintenance Activities CDS Units (Source: CDS Technologies)

Activity	Schedule
• Visual inspection - ensure that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. • Inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. • Inspect level of discoloration of the sorbent material, if, used.	At least twice per year
• Cleaning - when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. • Cleaning shall be completed with vacuum truck or other approved method. • If absorbent material is used, it should be replaced when significant discoloration has occurred.	As needed as determined by inspection

5.2 Erosion and Sedimentation Control Maintenance

The maintenance program to ensure the effectiveness of the erosion and sedimentation control plan will generally include:

- Daily (and during precipitation events) inspection of temporary erosion and sedimentation control measures to check for damage. Damaged structures will be repaired.
- Maintenance of environmental protection structures (including removal of silt material) until disturbed areas have been completely stabilized. Following

stabilization of disturbance areas, environmental protection structures will be removed and the area will be re-graded and stabilized.

Further maintenance measures are outlined in the Sedimentation and Erosion Minimization Plan that will be utilized during construction for the Penhorn development is included as Appendix D.

6.0 STORMWATER MANAGEMENT SUMMARY

All critical aspects of the proposed development, existing site constraints and site features have been considered in the management of stormwater. A stormwater management design, through the implementation and integration of on-site BMP features has been adopted that focuses on achieving the stormwater objectives for new development contained within the Regional Centre Secondary Municipal Planning Strategy (Package A) and Morris-Russell Lake Secondary Planning Strategy provided by HRM.

The design of the proposed development was thoughtfully prepared to minimize development impact and utilize Stormwater BMP strategies where possible. Stormwater quantity and quality balancing have been jointly achieved through the measures outlined in this document. Based on the data presented in this report, it is anticipated that stormwater BMPs are required to be incorporated throughout the site design to achieve stormwater quantity (peak flow) and quality (TSS and TP) balance as required by HRM documents. It is anticipated that BMP treatment trains will be utilized to achieve water balance and will likely include a combination of green roofs, permeable pavers, rain barrels, vegetative grass swales, bio-infiltration planters, permeable stormwater infrastructure, filter strips, and CDS treatment units. Detailed design and selection of specific units will be further detailed during the design development stage.

Stormwater peak flow management for this project will be achieved through the use of increased green space to aid in attenuating the anticipated peak runoff from the developed area along with traditional flow management and green stormwater BMP features. A balanced peak-flow site is anticipated to be achieved as required as per local authorities. In addition, flow capacity of the existing piped stormwater system directly downstream of the development area was analysed and confirmed to be acceptable based on the anticipated peak runoff rates from the proposed development.

Both private and publicly owned BMPs and erosion and sediment control measures outlined will been designed to achieve a negligible impact on the existing surface flows from the development to any receiving watercourses or bodies of water. This is to be accomplished through the re-establishment and integration of natural vegetation, maintaining appropriate riparian buffers to existing water features, and providing flow dispersion BMP’s at all outfalls to eliminate concentrated point discharge. Proposed sedimentation and erosion control measures have been provided to outline all measures to be completed before, during, and after construction to mitigate possible disturbances to the surrounding area.

The development will intend to integrate and re-establish native natural vegetation throughout the site. Landscaping design will focus on integrating local native plantings and will generally seek opportunities to implement measures outlined in the HRM Urban Forestry Plan.

The trophic status of the primary receiving body, Penhorn Lake, and additional receiving bodies, Lake Banook and Morris/Russel Lake, have been reviewed through historical testing compiled by Stantec and AECOM. It is anticipated that, through the measures outlined in this report, the current trophic status of the Lakes will be maintained by achieving the water quality/quantity balance of the developed site and managing any potential disturbance of sediment in and around Penhorn Lake during and after construction.

Hydraulic stormwater and nutrient loading analysis was also completed for the existing commercial lands to evaluate potential impacts of redevelopment. Estimated peak flow and nutrient loading rates were determined at critical discharge points, and are recommended for use as stormwater targets for any future redevelopment activities. Any future redevelopment planning should consider the requirements of adhering to the storm water quantity and quality targets as indicated.

Chloride levels, which were identified as being a concern for the receiving lakes, will be managed by implementing specific BMP features near roads and parking areas and by implementing snow and salt management strategies which are to be developed with consultation with HRM throughout the development application process. The Developers involved in this project would be generally prepared to enhance the existing water quality monitoring program for Penhorn Lake and would be open to working with HRM for the potential development of a public beach on Penhorn Lake.

7.0 STATEMENT OF QUALIFICATIONS AND LIMITATIONS

This Report (the "Report") has been prepared by Strum Consulting ("Consultant") for the benefit of Crombie REIT Limited and Clayton Developments Limited ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations, and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental, or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental, or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed in writing by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss, or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations forms part of the Report and any use of the Report is subject to the terms hereof.

Should additional information become available, Strum requests that this information be brought to our attention immediately so that we can re-assess the conclusions presented in this report. This report was prepared by Ben Crouse, P.Eng., Civil Engineer, and was reviewed by Chris Boudreau, P.Eng., Manager Engineering.

8.0 REFERENCES

AECOM (2017). Surface Water Quality Monitoring – 2017 Final Report. Prepared for Halifax Regional Municipality. Halifax, NS.

AECOM (2013). *Final Report - Hydraulic Modeling and Flood Plain Mapping of Lake Charles, Lake Micmac, Lake Banook, Red Bridge Pond, and Sullivan's Pond.* Prepared for Halifax Regional Municipality and Halifax Regional Water Commission. Halifax, NS.

AECOM (2013). *Shubenacadie Lake Sub-watershed Study – Final Report.* Prepared for Halifax Regional Municipality. Halifax, NS.

Alberta Government. (2013). Part 5: Stormwater management guidelines. *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems.* Retrieved from https://open.alberta.ca/dataset/f57fec02-7de8-4985-b948-dcf5e2664aee/resource/aa3ba3a4-e415-4d85-ad66-496f98c9bc8e/download/part5-stormwatermanagementguidelines-2013.pdf

Banook Area Residents Association. *Penhorn Lake Aerator – Reversal of Anoxic Conditions.* Prepared for Crombie Penhorn Mall (2011) Limited. August 7, 2017. Dartmouth, NS.

Credit Valley Conservation & Toronto and Region Conservation for the Living City. (2010). *Low impact development stormwater management planning and design guide.* Retrieved from: https://cvc.ca/wp-content/uploads/2014/04/LID-SWM-Guide-v1.0_2010_1_no-appendices.pdf

Dillon Consulting Ltd. (2013). *Russel Lake Nutrient Source Desktop Assessment - Final.* Prepared for the Halifax Regional Municipality. Halifax, NS.

Dillon Consulting Ltd. (2006). *Stormwater Management Guidelines.* Prepared for the Halifax Regional Municipality. Halifax, NS.

Griffiths Muecke Associates (1998). *Morris Lake Watershed Management Plan – Final Report.* Prepared for the Halifax Regional Municipality. Halifax, NS.

Halifax Regional Municipality (2019). *Regional Centre Secondary Municipal Planning Strategy (Package A). Retrieved from https://www.halifax.ca/sites/default/files/documents/ about-the-city/regional-communityplanning/Centre_Plan_Package_A_Ministerial_Approved_Version_Nov_22_2019_ONLINE.pdf*

Halifax Regional Municipality (2019). *Municipal Planning Strategy Dartmouth.* Retrieved from: https://www.halifax.ca/sites/default/files/documents/about-the-city/regional-community-planning/Dartmouth-MPS-Eff-19Nov30-RegionalCentrePlan-PackageA-TOCLinked_0.pdf

Halifax Regional Municipality. (2016). *Municipal planning strategy: Planning districts 14/17 (Shubenacadie lakes).* Retrieved from https://www.halifax.ca/sites/default/files/documents/about-the-city/regional-community-planning/PlanningDistricts14and17-MPS-Eff-16Apr02-Cases01192and20150-TOCLinked.pdf

Jacques Whitford NAWE, Inc. (2008). *Master Stormwater Management Plan for The Parks of West Bedford Sub Area 2.* Bedford, NS

Jacques Whitford NAWE, Inc. (2008). *Master Stormwater Management Plan for Bedford South*. Bedford, NS

Jacques Whitford NAWE, Inc. (2004). *Morris Lake Stormwater Management Plan*. Prepared for the Halifax Regional Municipality. Halifax, NS.

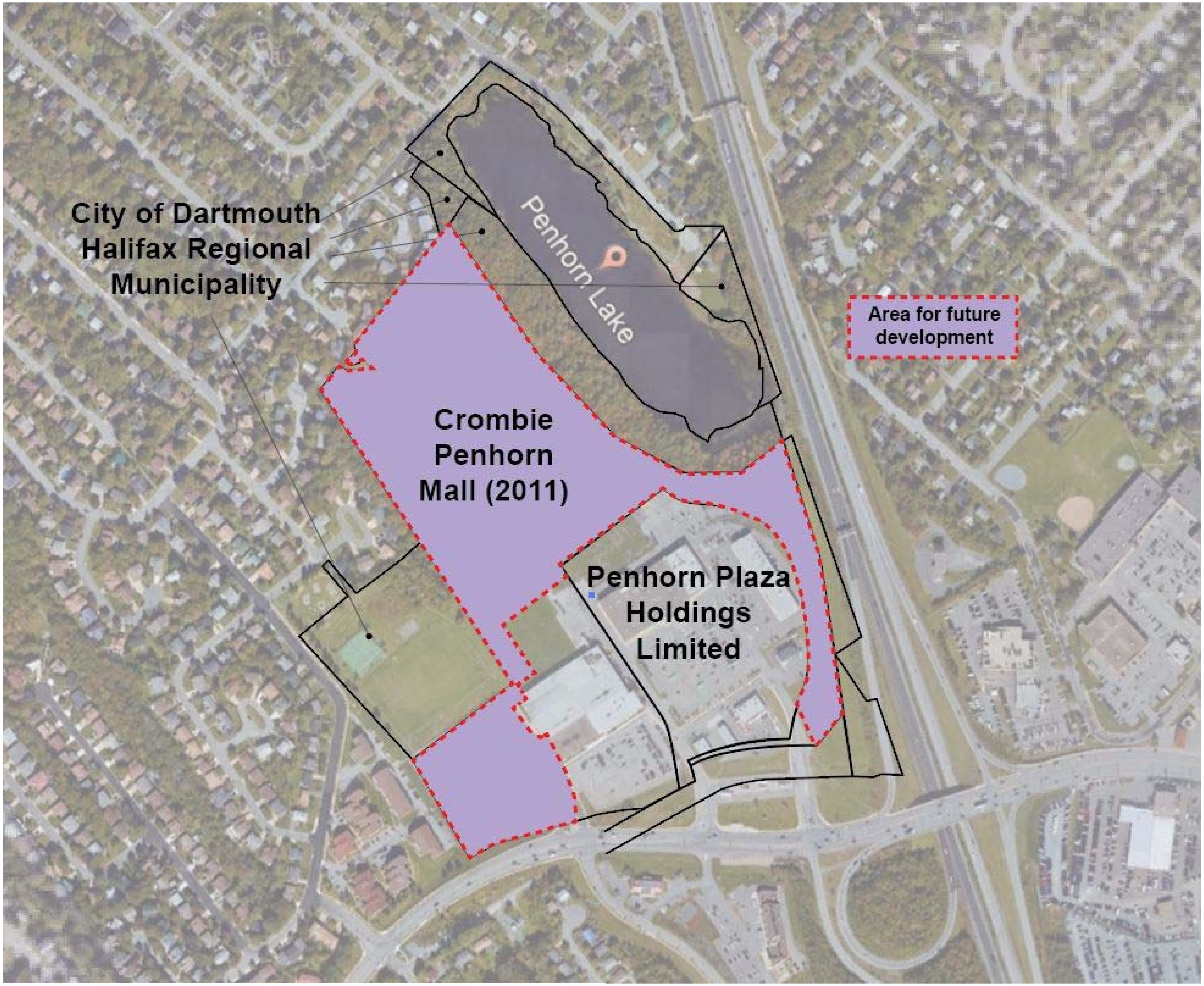
LVM Maritime Testing Inc. (2013). *Master Stormwater Management Plan. West Bedford Areas 7 & 8.* Halifax, NS.

Stantec Consulting Ltd. (2020). *Geotechnical Test Pit Logs, Penhorn Plaza - June 5, 2020.* Dartmouth, NS.

Stantec Consulting Ltd. (2012).*An Analysis of the HRM Lakes Water Quality Monitoring Program Data (2006-2011) – Final Report*. Halifax, NS.

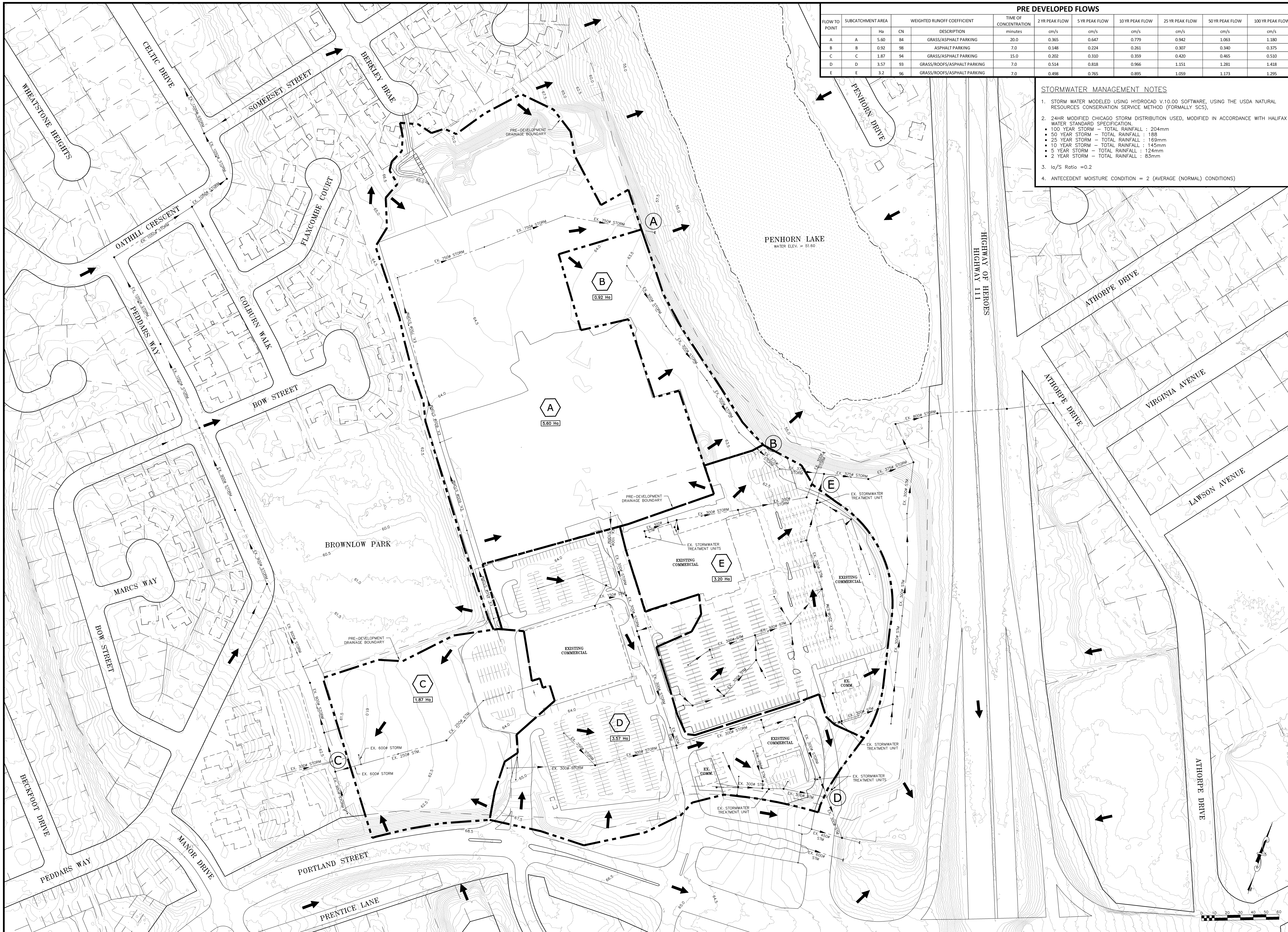
Strum Consulting Ltd. (2010) *Phase 1 Environmental Site Assessment – 535 Portland Street (Penhorn Mall). Dartmouth, NS.*

APPENDIX A
SITE MAP FIGURES



A.1 – Penhorn Property Ownership Map

A.2 - Penhorn Residential Concept Plan



PRE DEVELOPED FLOWS

FLOW TO POINT	SUBCATCHMENT AREA		WEIGHTED RUNOFF COEFFICIENT		TIME OF CONCENTRATION	2 YR PEAK FLOW	5 YR PEAK FLOW	10 YR PEAK FLOW	25 YR PEAK FLOW	50 YR PEAK FLOW	100 YR PEAK FLOW
		Ha	CN	DESCRIPTION	minutes	cm/s	cm/s	cm/s	cm/s	cm/s	cm/s
A	A	5.60	84	GRASS/ASPHALT PARKING	20.0	0.365	0.647	0.779	0.942	1.063	1.180
B	B	0.92	98	ASPHALT PARKING	7.0	0.148	0.224	0.261	0.307	0.340	0.375
C	C	1.87	94	GRASS/ASPHALT PARKING	15.0	0.202	0.310	0.359	0.420	0.465	0.510
D	D	3.57	93	GRASS/ROOFS/ASPHALT PARKING	7.0	0.514	0.818	0.966	1.151	1.281	1.418
E	E	3.2	96	GRASS/ROOFS/ASPHALT PARKING	7.0	0.498	0.765	0.895	1.059	1.173	1.295

STORMWATER MANAGEMENT NOTES

1. STORM WATER MODELED USING HYDROCAD V.10.00 SOFTWARE, USING THE USDA NATURAL RESOURCES CONSERVATION SERVICE METHOD (FORMALLY SCS),
2. 24HR MODIFIED CHICAGO STORM DISTRIBUTION USED, MODIFIED IN ACCORDANCE WITH HALIFAX WATER STANDARD SPECIFICATION.
   - 100 YEAR STORM – TOTAL RAINFALL : 204mm
   - 50 YEAR STORM – TOTAL RAINFALL : 188
   - 25 YEAR STORM – TOTAL RAINFALL : 169mm
   - 10 YEAR STORM – TOTAL RAINFALL : 145mm
   - 5 YEAR STORM – TOTAL RAINFALL : 124mm
   - 2 YEAR STORM – TOTAL RAINFALL : 83mm
3. Ia/S Ratio =0.2
4. ANTECEDENT MOISTURE CONDITION = 2 (AVERAGE (NORMAL) CONDITIONS)

Key Plan — NOT TO SCALE

LEGEND

- DRAINAGE AREA IDENTIFIER
- CRITICAL CALCULATION POINT
- OVERLAND FLOW DIRECTION
- DRAINAGE BOUNDARY
- WLX — WETLAND IDENTIFIER
- XX.XX Ha — DRAINAGE AREA VOLUME IDENTIFIER
- S## — VOLUME RATE IDENTIFIER
- STORMWATER MANAGEMENT AREA
- BODY OF WATER
- EXISTING LOTS
- EXISTING ROW
- LOW POINT — LOW POINT IN ROADWAY
- HIGH POINT — HIGH POINT IN ROADWAY
- PROPOSED LOTS
- PROPOSED ROW
- SILT FENCE

NOTES:

1. Contour interval is 0.5 Metre, based on LRIS mapping blended with actual field data provided by Servant Dunbrack Limited.
2. For storm drainage calculations refer to Strum Consulting storm drainage calculation sheets.
3. Peak flows for critical discharge point "D" and "E" have been indicated for the purposes of setting maximum flow targets for the potential future redevelopment of these existing commercial lands.

No	Description	Date	By
0.	XXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXX

Revision or Issue

Strum CONSULTING

Project: PENHORN PLAZA, DARTMOUTH, NOVA SCOTIA

Drawing: PRE-DEVELOPMENT DRAINAGE CONDITIONS

Scale 1:1250

Date XXXX-XX-XX		Drawn MMH
Design CTP	Check CNB	Approv. CNB
Project No. 20-7306		Sheet 1 Of 1
Drawing No. D01		Rev. 0

DRAFT NOT FOR CONSTRUCTION PRINTED JUN 30/20

A.3 - Pre-Development Site Drainage Plan

POST DEVELOPED FLOWS

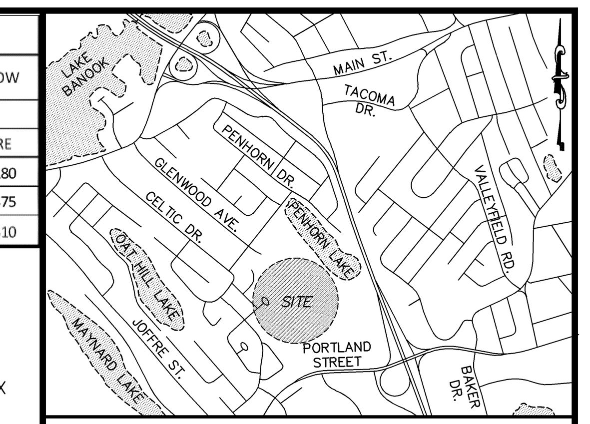
FLOW TO POINT	SUBCATCHMENT AREA		WEIGHTED RUNOFF COEFFICIENT		TIME OF CONCENTRATION	2 YR PEAK FLOW		5 YR PEAK FLOW		10 YR PEAK FLOW		25 YR PEAK FLOW		50 YR PEAK FLOW		100 YR PEAK FLOW	
						cm/s		cm/s		cm/s		cm/s		cm/s		cm/s	
		Ha	CN	DESCRIPTION	minutes	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE
A	A	5.81	87	TOWNHOUSE AND APARTMENT	20.0	0.364	0.365	0.635	0.647	0.748	0.779	0.881	0.942	0.976	1.063	1.067	1.180
B	B	1.02	90	APARTMENT	7.0	0.124	0.148	0.203	0.224	0.242	0.261	0.291	0.307	0.326	0.340	0.362	0.375
C	C	1.93	89	APARTMENT	15.0	0.172	0.202	0.277	0.310	0.327	0.359	0.389	0.420	0.434	0.465	0.480	0.510

STORMWATER MANAGEMENT NOTES

1. STORM WATER MODELED USING HYDROCAD V.10.00 SOFTWARE, USING THE USDA NATURAL RESOURCES CONSERVATION SERVICE METHOD (FORMALLY SCS),
2. 24HR MODIFIED CHICAGO STORM DISTRIBUTION USED, MODIFIED IN ACCORDANCE WITH HALIFAX WATER STANDARD SPECIFICATION.
   - 100 YEAR STORM – TOTAL RAINFALL : 204mm
   - 50 YEAR STORM – TOTAL RAINFALL : 188
   - 25 YEAR STORM – TOTAL RAINFALL : 169mm
   - 10 YEAR STORM – TOTAL RAINFALL : 145mm
   - 5 YEAR STORM – TOTAL RAINFALL : 124mm
   - 2 YEAR STORM – TOTAL RAINFALL : 83mm
3. Ia/S Ratio =0.2
4. ANTECEDENT MOISTURE CONDITION = 2 (AVERAGE (NORMAL) CONDITIONS)

RELEASE RATES (L/s)

BLOCK	2YR	5YR	10YR	25YR	50YR	100YR
BLOCK A	91	136	157	184	203	223
BLOCK B	52	93	107	122	132	141
BLOCK C	21	37	40	48	52	56
BLOCK D	22	40	46	52	56	60
BLOCK E	27	48	56	64	69	73
BLOCK F	21	38	44	50	54	58
BLOCK G	38	67	77	88	95	101
BLOCK H	172	277	327	389	434	480



Key Plan — NOT TO SCALE

LEGEND

- DRAINAGE AREA IDENTIFIER
- CRITICAL CALCULATION POINT
- OVERLAND FLOW DIRECTION
- DRAINAGE BOUNDARY
- WLX — WETLAND IDENTIFIER
- XX.XX Ha — DRAINAGE AREA VOLUME IDENTIFIER
- S## — VOLUME RATE IDENTIFIER
- STORMWATER MANAGEMENT AREA
- BODY OF WATER
- EXISTING LOTS
- EXISTING ROW
- LOW POINT — LOW POINT IN ROADWAY
- HIGH POINT — HIGH POINT IN ROADWAY
- PROPOSED LOTS
- PROPOSED ROW
- SILT FENCE

NOTES:

1. Contour interval is 0.5 Metre, based on LRIS mapping blended with actual field data provided by Servant Dunbrack Limited.
2. For storm drainage calculations refer to Strum Consulting storm drainage calculation sheets.
3. All post developed flows are based on Release Rates shown in the table.

No	Description	Date	By
0.	XXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXX

Revision or Issue

Strum CONSULTING

Project: PENHORN PLAZA, DARTMOUTH, NOVA SCOTIA

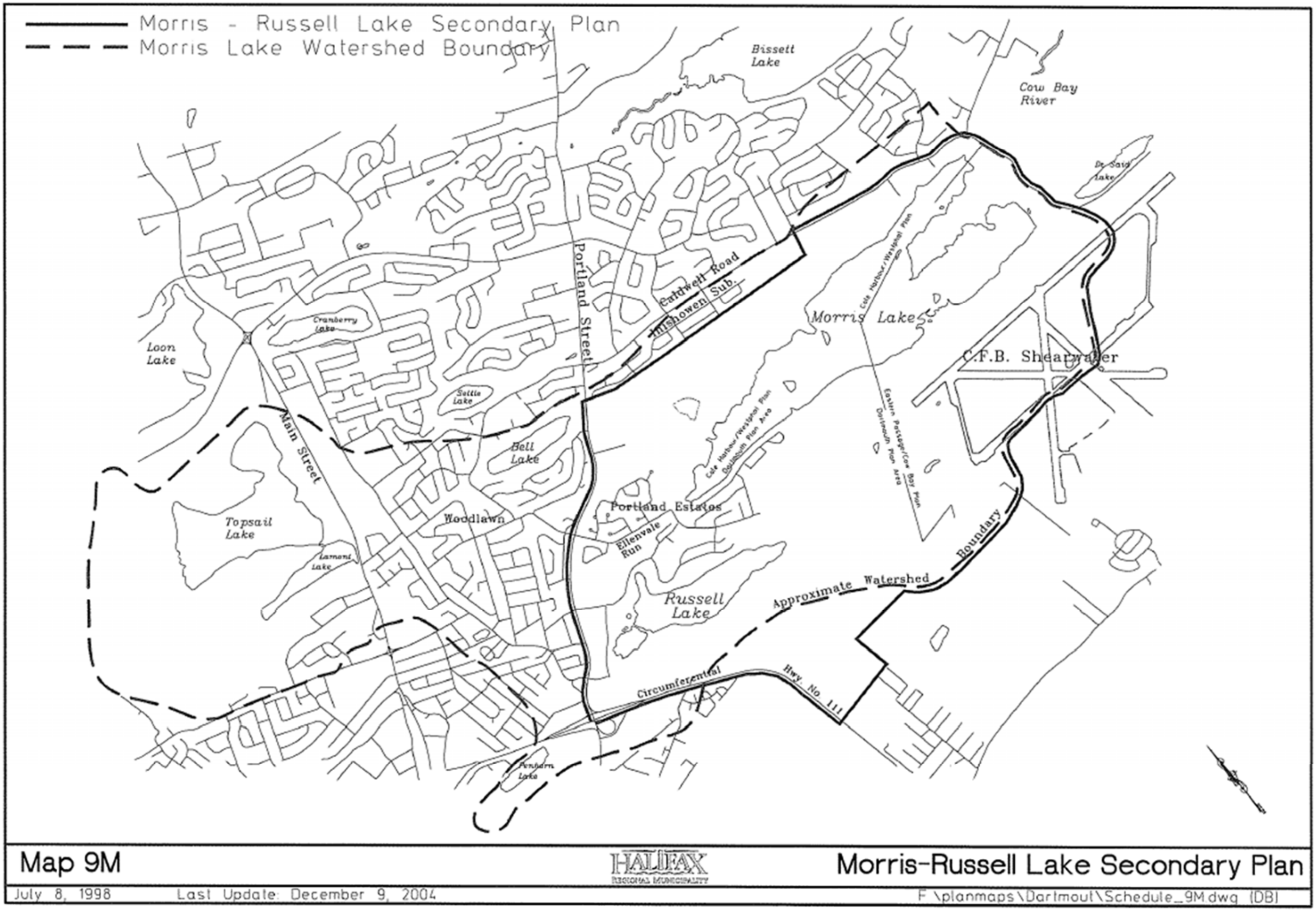
Drawing: POST–DEVELOPMENT DRAINAGE CONDITIONS

Scale 1:1250

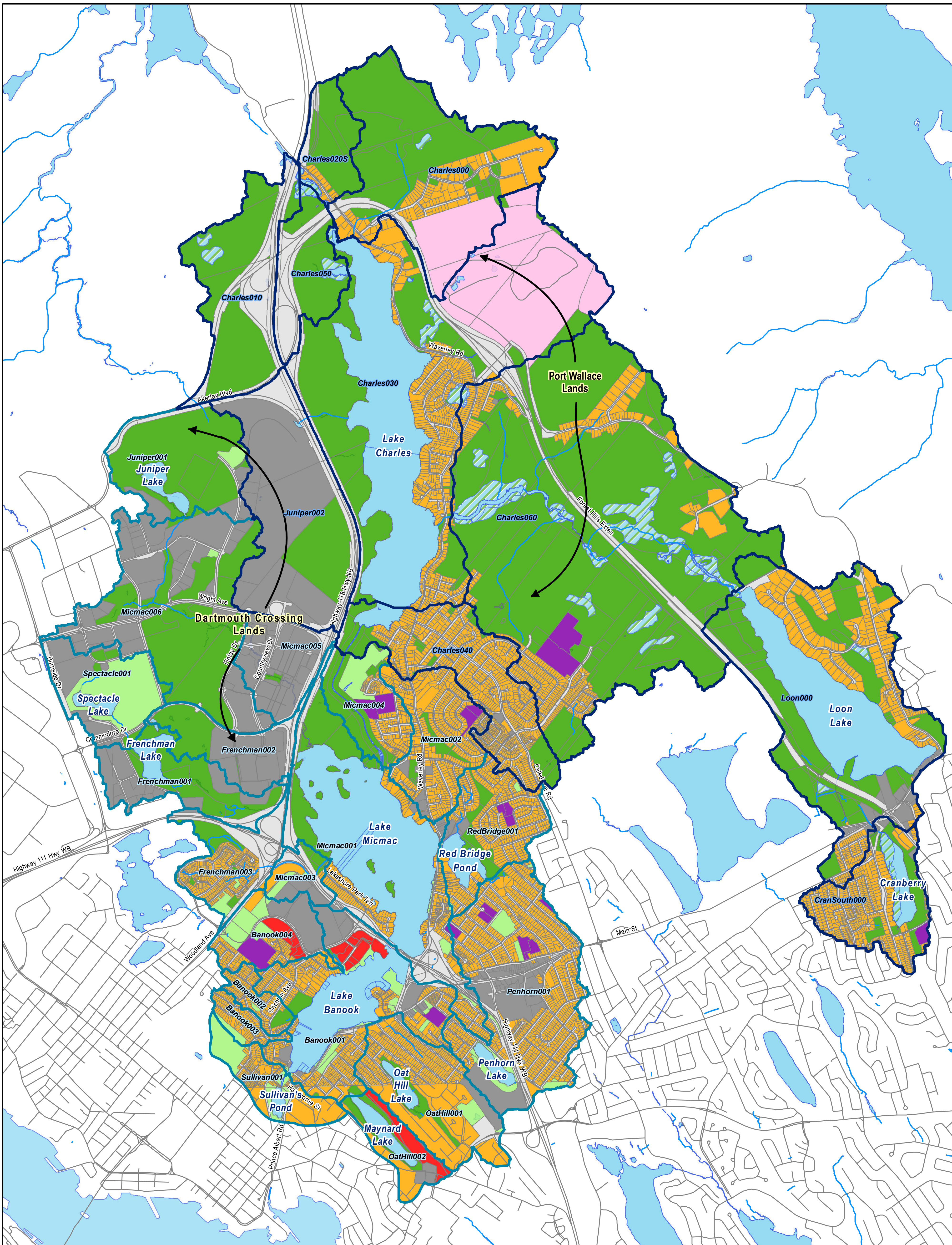
Date		Drawn
XXXX–XX–XX		MMH
Design: CTP	Check: CNB	Approv.: CNB
Project No.: 20–7306		Sheet: 1 Of 1
Drawing No.: D02		Rev.: 0

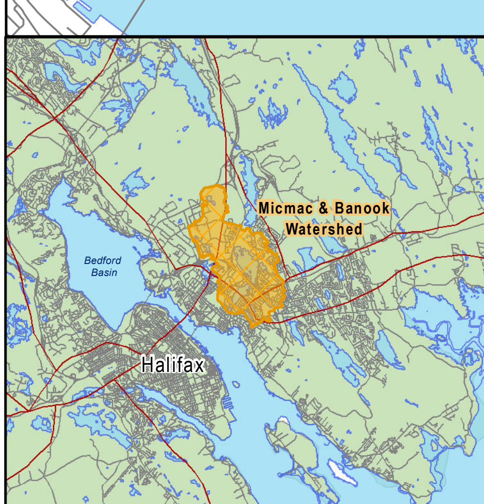
DRAFT NOT FOR CONSTRUCTION PRINTED Jun-30-20

A.4 - Post-Development Site Drainage Plan



A.5 – Morris-Russell Lake Watershed





Legend

Existing Land Use

- High Density Residential
- Medium Density Residential
- Commercial
- Industrial
- Institutional
- Roadway
- Forest
- Open Space
- Wetland
- Water

- Watercourses
- Roads
- Lakes
- Lake Charles Subwatershed and Subcatchment Boundaries
  - *Charles010* : Subcatchment name
- Micmac & Banook Subwatershed and Subcatchment Boundaries
  - *Banook002* : Subcatchment name

N

Hydraulic Modeling & Flood Plain Mapping of Lake Micmac, Lake Banook, Red Bridge Pond & Sullivans Pond

Existing Land Use and Hydrologic Subcatchment Boundaries

August 2013	1:30,000	Datum: ATS 1977 MTM 5 NS Source: HRM
P#: 60299928	V#: 001	

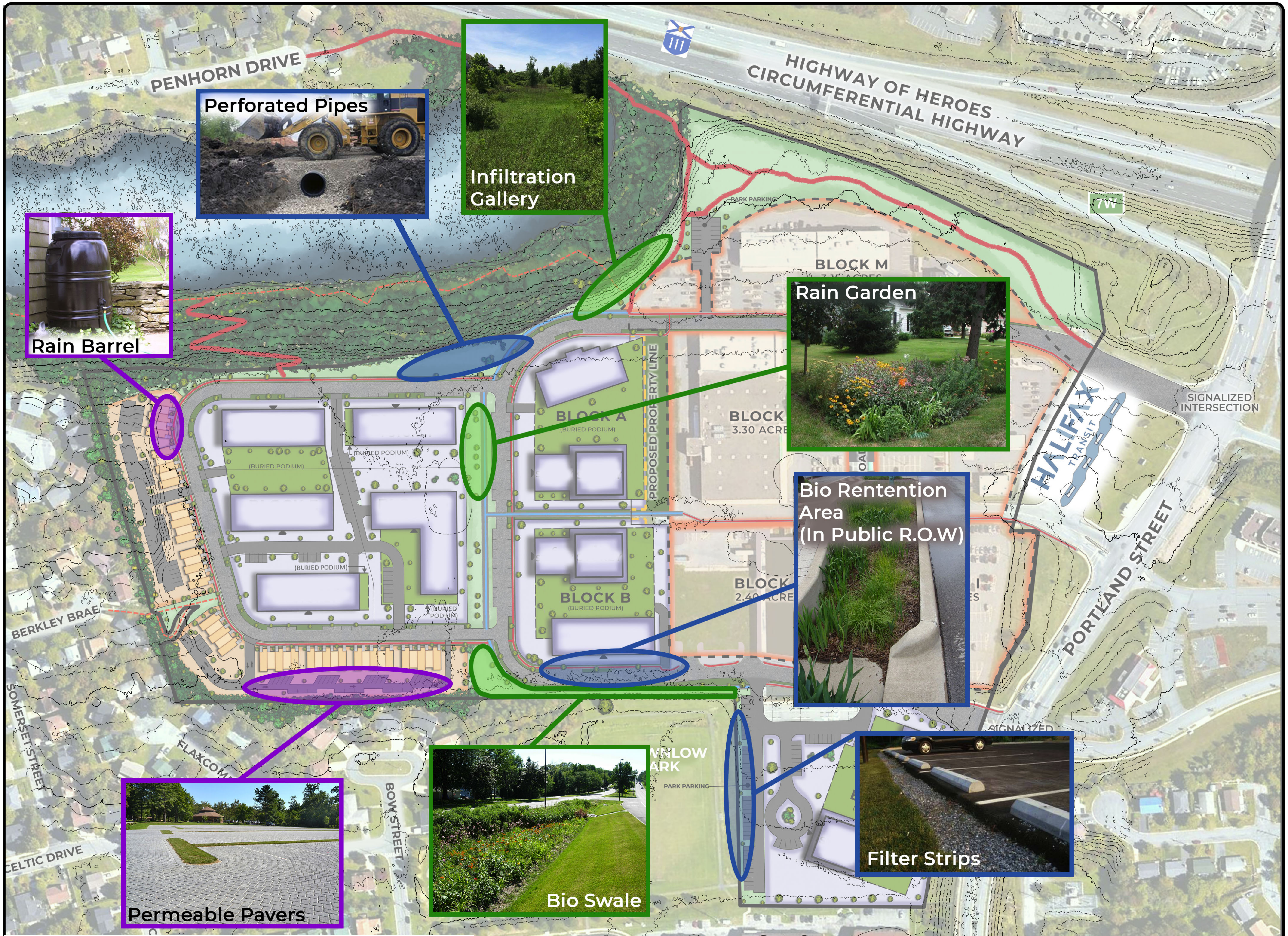
AECOM

Figure 2

0 0.5 1 2
Kilometers

Map Location: P:\60299928 Sullivan's Pond\900-CAD-GIS\920 GIS-Graphics\Design\Report Figures

A.6 - Lake Banook Watershed



A.7 - Prenhorn Residential Conceptual BMP Plan

STORMWATER MANAGEMENT PLAN

PENHORN

LEGEND

- Natural Installations
- Residential Installations
- Public Installations
- Contours

DATE: DECEMBER 2020

SCALE: NTS

0 10 20 40 80 METRES

N

APPENDIX B
PENHORN LAKE WATER QUALITY TESTING RESULTS

Penhorn Lake

WATER QUALITY ANALYSES - HRM LAKE SAMPLING PROGRAM

See NOTES below

	Units	RDL	Spring 2006	Fall 2006	Spring 2007	Summer 2007	Fall 2007	Spring 2008	Summer 2008	Fall 2008	Spring 2009	Summer 2009	Fall 2009	Spring 2010	Summer 2010	Fall 2010	Spring 2011	Summer 2011	Fall 2011
Community			Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth	Dartmouth
Sampling Date & Time	DD/MM/YYY Y 24hr time		5/17/2006 0:00	10/11/2006 0:00	5/8/2007 9:40	8/14/2007 11:14	10/24/2007 9:02	5/6/2008 10:31	8/13/2008 10:35	10/20/2008 11:40	6/1/2009 8:35	7/27/2009 10:35	10/20/2009 11:20	5/10/2010 10:25	8/10/2010 11:00	10/19/2010 11:50	4/7/2011 0:00	8/7/2011 11:40	11/14/2011 12:10
FIELD DATA																			
Secchi Depth	Meters	N/A	3.8	2.5	5.5 (bottom)	3	2.25	4.6	3.7	2.4	2.3	2	1.8	4.7	4.9	3.9	--	4.4	--
Temp	Celsius	N/A	14.35	15.19	10.33	22.08	14.97	12.67	22.03	11.29	16	22.04	9.24	13.27	22.62	11.4	--	21.99	9.14
Dissolved Oxygen	mg/L	0.2	10.34	8.99	10.57	8.04	9.29	11.65	8.22	9.76	11.28	8.63	10.44	11.3	8.65	10.74	--	8.75	10.66
pH (Field)	pH	N/A	7.51	7.41	7.17	7.3	7.07	7.52	7.92	8.03	6.93	7.07	7.71	7.77	7.13	7.56	--	7.4	7.43
Specific Conductance	mS/cm	0.001	0.446	0.385	0.606	1.04	0.417	0.781	0.666	0.649	0.941	0.835	0.749	0.693	0.616	0.627	--	0.531	0.401
TDS	g/L	0.01	--	--	0.394	0.676	0.271	0.508	0.433	0.422	0.612	0.543	0.487	0.45	0.401	0.407	--	0.345	0.261
Salinity	ppt	0.01	--	--	0.3	0.51	0.2	0.39	0.32	0.32	0.47	0.41	0.37	0.34	0.3	0.31	--	0.26	0.19
INORGANICS																			
Total Alkalinity (Total as CaCO3)	mg/L	5	--	--	25	--	26	24	26	30	27	30	29	29	30	31	25.1	35	33
Dissolved Chloride (Cl)	mg/L	1	110	90	160	--	100	200	170	170	260	246	218	308	168	166	159.1	134	91
Colour	TCU	5	--	6	5	ND	9	ND	9	7	16	52	9	ND	6	5	11	ND	16
Total Kjeldahl Nitrogen (TKN)	mg/L	0.4	0.2	0.3	0.3	--	2.8	ND	0.4	0.3	ND	1.1	0.9	ND	ND	0.4	--	ND	1
Nitrate + Nitrite	mg/L	0.05	--	--	2.1	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	--	ND	ND
Nitrate (N)	mg/L	0.05	<0.05	ND	--	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.2	0.04	ND	ND
Nitrite (N)	mg/L	0.05	<0.01	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	ND	--	ND	ND	ND	0.06	ND	0.06	ND	0.05	ND	ND	0	ND	0.21
Total Organic Carbon (C)	mg/L	0.5	--	--	1.8	--	2.9	2	2	2.2	3.2	7.7	4.5	4.3	3.6	3	--	3.9	5.3
Orthophosphate (P)	mg/L	0.01	--	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	0.01
pH (Lab)	pH	N/A	--	--	7.35	--	7.65	7.56	7.43	7.47	7.9	7.8	7.7	7.8	7.8	7.7	7.8	8	7.8
Total Phosphorus (1M depth)	mg/L	0.001	0.002	ND	0.007	0.004	0.018	0.006	0.012	0.021	0.011	0.019	0.005	0.025	0.021	0.02	0.006	0.009	0.019
Total Phosphorus (Deep)	mg/L	0.001	--	--	--	0.012	--	--	--	--	--	0.004	--	--	--	--	--	0.012	--
Reactive Silica (SiO2)	mg/L	0.5	--	--	ND	--	2.5	ND	1.4	2.6	ND	1	2	ND	1	1.9	--	0.7	1.7
Total Suspended Solids	mg/L	5	<2	ND	ND	1	2	1	1	2	ND	ND	ND	ND	ND	ND	--	ND	ND
Dissolved Sulphate (SO4)	mg/L	2	--	--	14	--	9	18	14	13	19	15	14	14	11	11	14.6	13	13
Turbidity	NTU	0.1	0.9	0.9	0.6	0.9	2.3	0.5	1	1	1.6	1.5	3.2	0.9	0.7	1.4	--	0.9	13.3
Conductivity	uS/cm	1	--	--	560	--	420	770	650	650	1030	855	797	688	630	607	654	505	385
Calculated Parameters																			
Anion Sum	me/L	N/A	--	--	5.38	--	3.58	6.61	5.7	5.76	8.27	7.84	7.01	5.63	5.56	5.55	5.29	4.75	3.49
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1	--	--	25	--	26	24	26	30	27	30	29	29	30	31	--	35	33
Calculated TDS	mg/L	1	--	--	310	--	214	395	339	341	450	501	1200	1015	990	324	--	301	200
Carb. Alkalinity (calc. as CaCO3)	mg/L	1	--	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND
Cation Sum	me/L	N/A	--	--	55	--	3.85	7.07	6.01	5.97	6.86	10.12	6.93	5.7	7.25	5.69	5.22	5.93	3.5
Hardness (CaCO3)	mg/L	1	--	--	5.13	--	43	58	53	54	49	157	55	55	59	55.3	--	48	50
Ion Balance (% Difference)	%	N/A	--	--	2.38	--	3.63	3.36	2.65	1.79	9.4	12.7	0.6	0.6	13.2	1.3	--	11.1	0.1
Langelier Index (@ 20C)	N/A	N/A	--	--	-1.4	--	-1.17	-1.2	-1.33	-1.22	-1.1	-0.63	-1.26	-1.14	-1.1	-1.17	--	-0.89	-1.06
Langelier Index (@ 4C)	N/A	N/A	--	--	-1.65	--	-1.42	-1.45	-1.58	-1.47	-1.42	-0.95	-1.58	-1.46	-1.42	-1.49	--	-1.21	-1.38
Saturation pH (@ 20C)	N/A	N/A	--	--	8.75	--	8.82	8.76	8.76	8.69	9	8.43	8.96	8.94	8.9	8.87	--	8.89	8.86
Saturation pH (@ 4C)	N/A	N/A	--	--	9	--	9.07	9.01	9.01	8.94	9.32	8.75	9.28	9.26	9.22	9.19	--	9.21	9.18
METALS (ICP-MS)																			
Total Aluminum (Al)	ug/L	5	--	--	17	--	--	13	ND	ND	--	--	72	--	31	--	34	17	--
Total Antimony (Sb)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Arsenic (As)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Barium (Ba)	ug/L	5	--	--	26	--	--	28	34	35	--	--	40	--	30	--	--	29	--
Total Beryllium (Be)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Bismuth (Bi)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Boron (B)	ug/L	5	--	--	7	--	--	6	7	7	--	--	9	--	8	--	--	8	--
Total Cadmium (Cd)	ug/L	0.017	--	--	ND	--	--	ND	ND	ND			ND	--	ND	--	--	0.051	--
Total Calcium (Ca)	mg/L	0.1	--	--	19	--	15	20	18	19	16.5	60.5	18.9	19.2	20.6	19	18.8	15.8	17.3
Total Chromium (Cr)	ug/L	1	--	--	ND	--	--	ND	ND	ND	--	--	3	--	ND	--	--	ND	--
Total Cobalt (Co)	ug/L	1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Copper (Cu)	µg/L	2	--	--	ND	--	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	--	ND	2
Total Iron (Fe)	µg/L	50	--	--	ND	--	0.04	ND	ND	60	130	160	180	81	73	115	--	59	611
Total Lead (Pb)	ug/L	0.5	--	--	0.6	--	--	ND	ND	ND	--	--	ND	--	1.2			ND	
Total Magnesium (Mg)	mg/L	0.1	--	--	1.9	--	1.5	1.8	1.8	1.8	2	4.2	1.8	1.8	1.9	1.9	1.7	2.1	1.7
Total Manganese (Mn)	µg/L	2	--	--	32	--	0.22	75	91	190	123	127	319	87	52	73	--	67	38
Total Molybdenum (Mo)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Nickel (Ni)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Phosphorus (P)	mg/L	0.1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Potassium (K)	mg/L	0.1	--	--	1.2	--	1.2	1.2	1.2	1.2	2.9	3	2.8	2.3	1.9	2.1	2	1.7	2.1
Total Selenium (Se)	ug/L	1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Silver (Ag)	ug/L	0.1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Sodium (Na)	mg/L	0.1	--	--	92	--	68	140	110	110	133	158	132	104	138	104	93.8	113	52.8
Total Strontium (Sr)	ug/L	5	--	--	52	--	--	60	59	62	--	--	65	--	63	--	--	59	--
Total Thallium (Tl)	ug/L	0.1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Tin (Sn)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Titanium (Ti)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Uranium (U)	ug/L	0.1	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Vanadium (V)	ug/L	2	--	--	ND	--	--	ND	ND	ND	--	--	ND	--	ND	--	--	ND	--
Total Zinc (Zn)	µg/L	5	--	--	13	--	ND	7	ND	9	13	751	ND	ND	46	ND	--	ND	ND
MICROBIOLOGICAL																			
Total Coliform Lake	MPN/100mL	2	--	--	--	--	--	--	--	--	--	--	387	52	1961	613	--	--	--
Total Coliform Outlet	MPN/100mL	2	--	--	--	--	--	--	--	--	--	--	--	--	259	517	36	--	--
E. Coli Lake	MPN/100mL	2	--	ND	--	--	--	--	--	--	--	--	4	13	6	27	--	10	39
E. Coli Outlet	MPN/100mL	2	--		--	--	--	--	--	--	--	--	--	--	10	25	4	17	34
Fecal coliform Lake	CFU/100mL	2	72	2	13	240	260	2	1300	40	8	32	36	--	--	--	--	--	--
Fecal coliform Outlet	CFU/100mL	2	--	--	40	570	340	9	140	47	PRESENT	20	--	--	--	--	--	--	--
Fecal coliform Inlet	CFU/100mL	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	N/A	0.63	5.92	0.42	4.64	43.23	2.06	1.48	3.72	8.62	3.59	7.44	1.23	2.37	11.41	3.5	3.83	3.59
Chlorophyll A - Welschmeyer method	µg/L	N/A	--	--	0.41	4.14	44.8	2.13	1.58	3.71	8.35	3.72	7.75	1.1	2.29	9.95	--	3.64	3.42

Notes:

-- Not Analysed
NC Not Calculable
ND Not Detected
N/A Not Applicable
MPN Most Probable Number
RDL Reportable Detection Limit
ug Micrograms
mg Milligrams
L Litre
† Recreational Water Quality Guidelines
1 Taken from South East end of Lake
2 Taken from South West end of Lake

CCME - Canadian Council of Ministers of Environment Guidelines for the Protection of Aquatic Life
Fecal Coliform Guideline: for Contact Recreation
Dissolved Oxygen Guideline: lowest acceptable level depending on temperature and life stage
Bacterial level of concern for swimming
Bacterial level unsuitable for swimming

APPENDIX C
TOPSOIL RECOMMENDATION SPECIFICATION – JACQUES WHITFORD NAWE, INC.

Memo

Jacques Whitford NAWE, Inc
4444 Centerville Road, Suite 140 • White Bear Lake, MN • 55127
Phone: 651-255-5050 • Fax: 651-255-5060 • www.nawe-pa.com

To: Scott MacCallum

From: Shane Sparks

Date: July 31st, 2008

Re: Topsoil Recommendations

Scott,

Good quality topsoil is critical to the establishment of a low maintenance landscape. If the topsoil has sufficient amounts of air, water, and nutrients, it will reduce the need for maintenance activities such as aeration, irrigation, and fertilizer application. The purpose of this memo is to provide guidelines for the selection and installation of topsoil for future developments. Recommendations are divided into chemical and physical characteristics of the recommended topsoil.

Physical Characteristics:

1. *Texture* - Ideal topsoil contains a mixture of sand, silt, and clay. Acceptable soil textures are loam, sandy loams and loamy sands. These soil types have good permeability to prevent saturation, but also hold a significant amount of moisture to supply to the landscape.
2. *Organic Matter* – High quality topsoil typically has a minimum of 4% organic matter. Higher percentages are preferred for the soil as the organic matter supplies critical nutrients to the landscape above.
3. *Structure/Consistency* – Soil should crush/crumble easily when pressure is applied.
4. *Topsoil Thickness* – The minimum thickness for topsoil is 10 centimeters (cm). However, a range of 15-20 cm is ideal as all topsoil will compact following installation to approximately 50% of its original thickness

Chemical Characteristics:

1. *Salts* – High levels of salt, as measured by soil electrical conductivity (EC), can cause toxic effects on lawn vegetation. Sodium and chloride levels below 100 mg/kg of soil are recommended.
2. *pH* – Turfgrass tends to grow in slightly more acidic soils. Therefore, a pH of 6.3-6.8 is recommended for the topsoil.

3. *Nutrients* – Several nutrients are critical to reduce the need for fertilizer addition to lawn topsoil. Any potential topsoil sources should be tested by a certified soils lab before application to ensure that they meet the following nutrient requirements:
    a. Nitrogen: greater than 30 mg N/kg of soil (more organic matter = more nitrogen)
    b. Phosphorus: greater than 30 mg P/kg of soil
    c. Potassium: 120 to 250 mg K/kg of soil
    d. Calcium: 2,000 to 4,000 mg Ca/kg of soil
    e. Magnesium: 150 to 300 mg Mg/kg of soil
    f. Trace Elements: boron, cobalt, iron, copper, molybdenum, sulfur, manganese and zinc should be present in trace amounts

High quality topsoil is well balanced, rich in microbial life, and high in the essential nutrients for basic plant nutrition. The application of the guidelines above will result in the installation of high quality topsoil that is critical to a low maintenance landscape. If you have any questions regarding this document, or would like more information, please contact Shane Sparks at 651-255-5045.

Sincerely,

Original Signed

Shane Sparks
Hydrogeologist/Soil Scientist

APPENDIX D
SEDIMENTATION AND EROSION MINIMIZATION PLAN

Sedimentation and Erosion Minimization Plan
Penhorn Residential Development Area

1.0 INTRODUCTION

This Sedimentation and Erosion Minimization Plan for the Penhorn Residential Development Area has been prepared by Strum Consulting on behalf of Crombie REIT Limited and Clayton Developments Limited, for consideration by Halifax Regional Municipality (HRM) staff. This Plan has been developed to provide a general summary of the runoff, erosion, and sedimentation controls that are anticipated to be implemented before, during, and after construction activities.

This Plan does not serve to meet the formal requirements for an Erosion and Sedimentation Control Plan (ESCP) for any particular construction activity or work phase on the site. All development will be required to comply with all applicable environmental laws, regulations, standards, and practices, permits, approvals, and requirements of federal, provincial, and municipal authorities. This Plan presented will be provided to all land developers involved and will establish guidelines that will be enforced through all stages of development. This Plan will be based on the following principles:

- Prevent runoff and migration of sediment from disturbed areas to adjacent undisturbed areas through the installation of perimeter controls prior to commencement of work.
- Intercept and divert clean surface runoff away from the work site to prevent it from mixing with sediment laden water resulting from ongoing construction activities.
- Prevent concentrated point discharge by installing flow dispersion features at the outlet of work areas.
- Dewater excavation by pumping sediment laden water to highly controlled areas.
- Stabilize areas of exposed soil as soon as final grade is achieved.
- Maintain control measures until the site is stabilized.

1.1 Background

The subject site is a property located at 535 Portland Street, Dartmouth, NS (PID 00222844). The site is an approximately 12.53 hectare (31 acre) property bounded by Penhorn Lake to the north, Highway 111 to the east, Portland Street to the south, and parkland and residential development to the west. The subject site is currently owned by Crombie Penhorn Mall (2011) Limited. The site contains an existing approximately 7,200m2 commercial building which was constructed in 1982 and underwent a major renovations in 2009 when a large section of the former mall was demolished. The existing building underwent further redevelopment, transitioning to primarily office building in 2018.

The Penhorn residential development being considered will consist of a combination of multi-unit apartment buildings and single-family townhouse units with public open space and walking trails. The Penhorn development is to be fully serviced with water, wastewater, and stormwater systems connected to existing local municipal systems. The sensitive nature of the natural environment surrounding the proposed development has been documented through previous watershed and water quality studies completed in the area. If not properly maintained, impacts to stormwater variations as a result of the proposed development will be directly transferred downstream to lakes which are already experiencing the effects of urbanization. Areas downstream of the proposed development include sensitive environmental habitats and public use areas, which are at risk of being impacted from both a stormwater quality (nutrient) and quantity (flooding) perspective.

Additionally, Penhorn Lake, a prominent water body adjacent to the proposed development lands, was identified as having significant water quality issues related to previous development and urbanization of the surrounding watershed. Special considerations will be discussed to ensure that further degradation will not occur as a result of the Penhorn residential development. It is anticipated that both temporary construction and permanent on-site stormwater management strategies will be implemented in order to maintain water balance and maintain or improve contaminant and nutrient levels for the benefit of the lake health.

The surface/subsurface conditions at test pit locations generally subsurface conditions generally consists of a 1.0-4.0m thick layer of silty-sand and gravel fill, overlying silty-clay till and frequent cobbles and boulders. The geology of the site is such that, if exposed, has to potential to be susceptible to erosion.

As part of each Penhorn development phase, a specific Erosion & Sediment Control Plan shall be developed to ensure that any sensitive areas are considered. Special efforts are anticipated to be required around Penhorn Lake to ensure that the currently stable sediment layers are maintained. A key focus shall be the minimization of point source discharges to sensitive areas coupled with an emphasis on not creating any turbidity within Penhorn Lake

2.0 GENERIC REQUIREMENTS

1. The controls included in this plan are anticipated to be the most effective approach during the execution of work on this project, based on background review of the site and measures completed for similar projects. Site conditions encountered during construction may require that controls be modified. It may be necessary for additional controls to be implemented.
2. All controls must be installed in compliance with specifications and manufacturer’s instructions.
3. All work shall be in accordance with the latest revision of the Nova Scotia Environment's Erosion and Sedimentation Control Handbook for Construction Sites.
4. All temporary environmental controls must be maintained until the site has been stabilized.
5. The amount of exposed soil areas in this development must always remain at a minimum.

6. The release of sediment to watercourses, wetlands, and land adjacent to the development area must be prevented.
7. All necessary precautions shall be taken to prevent or minimize the spillage, misplacement or loss of fuels and other hazardous materials. All Acts and Regulations pertaining to controlled products shall be followed.
8. The delivery, storage, use, and disposal of hazardous materials shall only be undertaken by trained personnel in accordance with provincial and federal laws and regulations.
9. The Contractor shall always keep an emergency spill containment kit on site. Any spilled fuel or lubricants shall be promptly reported and cleaned up and disposed of in accordance with NSE regulations.
10. Fuelling, storage, and servicing of vehicles and construction equipment is not allowed within 30 m of a watercourse, wetland, drainage ditch, and areas with a high-water table or exposed or shallow bedrock.
11. All equipment used on the development site shall be mechanically sound with no oil or gas leaks. Frequent inspections shall be carried out on all equipment and repairs to leaks shall be immediately addressed.

3.0 BEST MANAGEMENT PRACTICES

For construction projects, there are generally three categories of erosion and sediment control measures: water controls, erosion controls, and sediment controls. Water controls limit or contain soil movement from the construction site, minimizing rainfall impact on the soil and reducing runoff volume and runoff velocities. Erosion controls are implemented to reduce or eliminate the detachment of soil particles by rainfall or to resist sheet or channel flow. Sediment controls work to capture detached sediment and prevent mitigation to the surrounding undisturbed areas. Details regarding specific controls which will be implemented is provided below.

3.1 Water Controls

3.1.1 Diversion Ditches

Temporary Diversion Ditches shall be used to intercept and direct any surface runoff away from the work site. Diversion ditches may be used in combination with Sandbag Berms and Check Dams if conditions warrant.

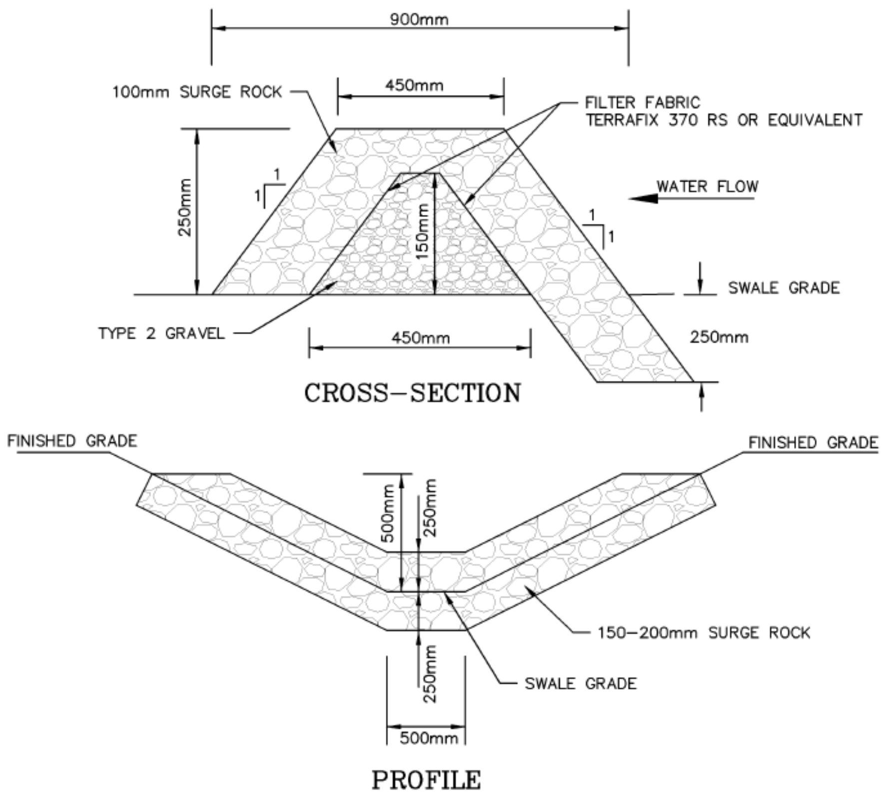
- Install upstream of work areas to prevent clean runoff from entering the work area.
- If the material in the diversion ditches is erodible then ditch shall be lined with Riprap or Clear Stone as specified by the Project Engineer.

3.1.2 Check Dams

Check Dams shall be installed in temporary or permanent ditches or stormwater conveyance features to reduce the velocity of surface runoff and promote the deposition of suspended sediment.

- Rock Flow checks shall be constructed with Clear Stone or Surge Rock in compliance with Division 3, Section 4 of NSTIR's Standard Specification or a directed by the Project Engineer.
- The Contractor shall maintain a quantity of Clear Stone and/or surge rock on site at all times.
- Rock check dams shall be installed at intervals such that the top of the next dam is less than 100 mm below the bottom of the previous dam.
- Refer to Figure 3.1 below for details on Rock Flow Check Dam construction

Figure 3.1: Check Dam Detail



3.1.3 Sandbag Dams and Barriers

Temporary Sandbag Dams shall be used to block or divert flow so that work within water features can be completed in dry conditions. Sandbag Berms shall be used to divert surface runoff to vegetated areas or be used as a barrier around salvaged and stockpiled material.

- Dams will be installed prior to any soil disturbance and will consist of sandbags of approximate dimensions 150 mm x 150 mm x 450 mm.
- Sandbags to be filled with sand or pea gravel, containing no silt or clay material.
- Sandbags to be installed in rows, tightly abutted against one another.
- The sandbags in each layer shall uniformly overlap the layer below.

- The sandbag dam shall be constructed of sufficient height and width to handle a 2-year rainfall event.

3.1.4 Dewatering
Dewatering during construction on the site will include pumping and discharging of sediment-laden water through the following options:

- Discharge to a Filter Bag placed on a 300 mm layer of Clear Stone. The dimensions of the filter bag shall be based on the size of the discharge pump. The Filter Bag shall be located more than 30 m from any watercourse, wetland, or drainage ditch and be in an area of dense vegetation.
- Discharge to constructed temporary settling ponds. Pond shall be maintained throughout the period of use (including drainage of 'clean water' and accumulated sediments: water outlets should be protected with 200 mm-250 mm stone or other protective cover). Take special care prior to storm events to avoid over-filling the pond (flocculants and pumping maybe required to direct to other storage areas or via tanker to an off-site location).
- Dewatering discharge points should be routinely monitored and maintained. Concentrated flow discharge should be avoided through the use of dispersion method approved by the Project Engineer.

3.2 Erosion Controls

3.2.1 Rip-rap Lining
Rip-rap protection shall be installed in locations where erosion may be caused by surface runoff or subsurface seepage. This may include steep slopes, stream, or ditch banks. Rip-rap lining shall also be used to dissipate concentrated flow and prevent downstream erosion in culvert outfalls/inlets and drainage channels.

- Rip-rap stone should be blocky, angular shape, and by sized of a mixed gradation so that smaller stones fill the voids between the larger ones.
- A layer of filter stone or fabric may be required depending on the nature of the underlying soil the size of protective riprap above.
- Riprap should be sized by the Project Engineer, to resist the erosive forces, based on the volume and velocity of anticipated flow.
- Riprap should be applied at a thickness of at least 1.5 times the maximum stone size and not less than 300 mm thick.
- Riprap should be placed as not to restrict the design width of the ditch or channel.
- The Contractor should maintain a quantity of riprap on site at all times as part of his Contingency Plan.

3.2.2 Vegetative Lining
Vegetative lining shall be installed, once grading operations have completed, to achieve natural, self-regenerating cover, for protection of exposed sediment from erosive action of

runoff (overland flow and open channel flow). This can be achieved using suitable soil or imported topsoil with a combination of seed, sod, and/or other approved plantings.

- Imported topsoil shall be minimum 150 mm thick as directed and approved by the Design Engineer.
- Seed mixture to be approved by the Design Engineer and in accordance with Government of Canada "Seeds Act" and "Seeds Regulations".
- Sod to be approved by the Design Engineer and nursery grow and free of diseased plants, pest infestations and noxious or invasive species as listed in the Nova Scotia Weed Control Act.
- Fertilizers type and application in accordance with Canada "Fertilizers Act" and "Fertilizers Regulations" and approved by Design Engineer.
- Seeding shall be completed in conjunction with dry mulching for temporary stabilization if required.

3.2.3 Dry Mulching

Application of Dry Mulching will consist of the spreading of locally procured straw or hay mulch by hand or blower on areas of exposed soil or stockpiled material.

- Dry mulching shall be applied at a rate of 4,000 kg/ha ± 10% (20 kg/100 m2) as a temporary measure prior to a precipitation event or if permanent stabilization is delayed.
- The Contractor should maintain a quantity of straw/hay bales on site at all times as part of his Contingency Plan.

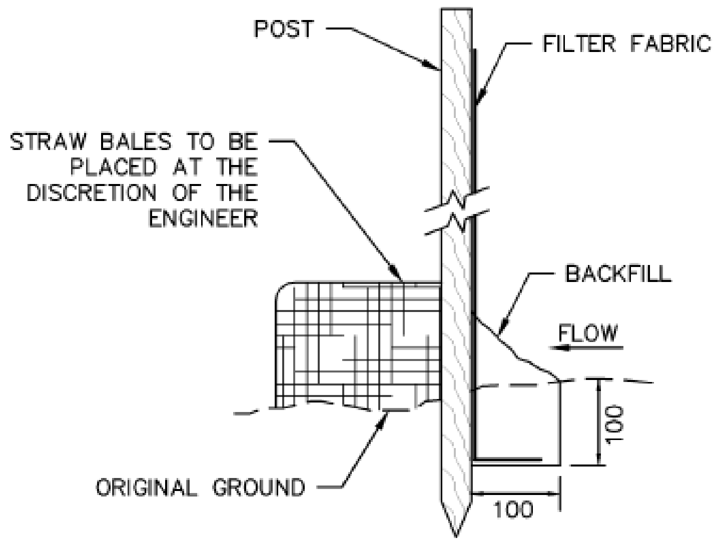
3.3 Sediment Controls

3.3.1 Silt Fence

Silt Fence shall be used as a perimeter control around selected excavated stockpiled material or toe of embankment to prevent the release of sediment from the work site. Silt fence must be erected prior to clearing and grubbing operations and remain in place until site stabilization is achieved.

- Silt fence shall be erected along the entire down-gradient perimeter of the work areas and of stockpiles.
- A backhoe working from the edge of the road may have to gently pull organic material back to displace a corridor so that the silt fence can be installed.
- Sandbags shall be used to toe in the bottom of the fence fabric.
- Refer to Figure 3.2 below for construction detail of the Silt Fence.

Figure 3.2: Silt Fence Detail



3.3.2 Construction Entrances, Access Roads, and Work Platforms

A stable, clean surface material shall be used applied and maintained in the work area to mitigate sedimentation of fine material throughout construction operations.

- Construction driveways and entrances to work areas are to be maintained with clean rock, applied periodically to cover muddied areas. Rip-rap or stone to be a minimum thickness of 150 mm. If necessary, filter fabric will be laid under the rock if fines are encountered. This surface will be maintained during construction.
- Cleaning of adjacent Public Streets is to be performed as needed in accordance with Streets By-Law S-300 Section 43, as directed by the Project Engineer and/or local authority.
- Rock Fill shall be used to construct access roads and work platforms for equipment working around watercourses and wetlands.
- Rock Fill shall be in compliance with Division 4, Section 9 of NSTIR's Standard Specification, or as specified by the Project Engineer.

3.3.3 Silt Sac and Filters

Silt bags shall be installed in all existing nearby catch basins before starting construction, as well as new catch basins as soon as possible.

- Silt bags to be maintained/cleaned as needed throughout construction.
- Fabric material shall be approved by Project Engineer.

4.0 SEQUENCING OF WORK

4.1 Clearing and Grubbing

Clearing and grubbing activities can cause the disturbance of soils and sediment within the work area which can cause the land to become susceptible to sedimentation and erosion. Additionally, clearing and grubbing activities near water features and wetlands can cause disturbance of the protective vegetative buffer or riparian zones and could lead to erosion of the bank slopes and sedimentation and obstruction of the water feature. The following Best Management Practice will be required to be implemented prior to the start of construction.

- Clearing limits, easements, setbacks, sensitive/critical areas and their buffers, trees and drainage courses will be delineated with flagging tape prior to any clearing or grubbing operations.
- No clearing or grubbing will occur within the protective green/belts/protected sensitive areas as identified on the development plans.
- Crop residues, plants, and rough soil surfaces shall be installed to help control velocity of runoff and promote sheet flow.
- Silt fencing shall be erected along the entire down-gradient perimeter of the work areas and around stockpiles as directed by the Project Engineer.
- Diversion berms and channels shall be installed on slopes to intercept sheet flow on exposed surfaces and to reroute clean flow into undisturbed areas. Locations shall be directed by the Project Engineer.
- Check dams shall be constructed in drainage ditches and swales to control the flow velocity.
- The work site will not be cleared or grubbed prior to commencement of construction and implementation of all required control features.
- Cleared and graded areas will be limited to minimize the area of exposed soil.
- Minimal amount of natural vegetation and topsoil will be removed at each construction site
- Mulches consisting of hay, wood chips or stone will be used to limit erosion on exposed areas.
- Non-mercantile timber may be chipped on site and used as temporary protective cover over exposed and disturbed areas.
- Grubbed material, will be properly managed and reused on site where possible. Disposal off-site will be limited and be in accordance with Nova Scotia Environment legislation and Halifax Regional Municipal Bylaws.
- The contractor and developer will maintain a stockpile of erosion control materials onsite.

4.2 Leveling and Grading

Grading and leveling requirements will be extensive in the development area to accommodate the construction of lots and roads. Grading and leveling will include the disturbance of soil and sediment, which must be managed and limited within the work area.

Site contouring and sloping will be completed, which can be particularly susceptible to erosion and sedimentation.
Soil loss from slopes may occur even with the implementation of erosion and runoff control measures. If this soil can enter a waterbody, mitigative measures will be required to intercept it. Methods used to trap sediment include installation of vegetated filter strips, silt fencing, filter berms, and sediment traps.

- Construction will be sequenced such that each stage of the development is to be completed and stabilized before proceeding to the next stage unless overlapping work is approved by the Project Engineer.
- Work along the public streets will not exceed 500 m. The contractor will work continuously until the streets are completed. If work is halted for 5 days, temporary stabilization structures and material will be installed.
- A clean rock construction entrance will be installed to prevent tracking of mud off-site and through the new and adjacent areas.
- Construction driveway entrances will be limited to a select number of locations, especially along Waverley Road, to prevent migration of sediment off-site.
- Lot grading will initially involve construction of the lot driveway with clear stone or gravel to a thickness of 75 mm to 150 mm. If necessary, filter fabric will be laid under the stone if fines are encountered. This surface will be maintained during construction.
- Vehicular travel to the lot will be restricted to the driveway. Access to each lot will be restricted to one driveway.
- Once the house pad is graded, the exposed pad, unless prepared from rock fill, will be graveled with clear stone. All exposed soil or unworked home sites will be stabilized no more than 5 days upon completion of the construction.
- No mud, debris, or other excavation material will be placed on the street. Fill material will not be stored next to the curb. Fill will be piled within the perimeter of the cleared lot (no more than 3 m around the house pad) until needed for cut lots or landscaping.
- Imported fill material will be assessed to ensure that material is not composed of high percentage of fines.
- All stockpiled fill material will be covered with tarps or other material, which are secure, to protect it from rainfall.
- Diversion features will be constructed at the top of each fill slope at the end of each workday, as needed. Diversions will be located at least 0.6 m uphill from the tope edge of each fill. The outlet of diversions, if free of sediment, will be located on undisturbed or stabilized areas when possible. Otherwise, sediment laden runoff must be diverted to a sediment retention structure.

4.3 Post Construction and Long-term Control Management

The final restoration phase is critical for minimizing the long-term impacts to water features and the surrounding area. The developer will incorporate all appropriate mitigative measures to ensure proper restoration of the development area. Implementation of permanent protection measures into a stormwater management plan will minimize the impact to the sensitive downstream area.

- The work site will be stabilized immediately to limit sustained erosion.
- Wood chips, vegetative growth, or rock facing (riprap) on steep slopes and exposed sediment will be installed.
- Establishment of vegetation will reduce the need for costly remedial measures caused by erosion damage to slopes.
- The targets to minimize and reduce contaminant input into the Penhorn Lake system will be achieved through implementation of BMP facilities. The strategy recommended for this site is to provide an integrated approach to stormwater management that is premised on controlling surface runoff and pollution at the source. An integrated series or treatment train, of stormwater management practices may include:
    - Source Controls: Rain barrels, green roofs, rain gardens, reduced travel ways, permeable pavers, grass alternatives, etc.
    - Conveyance Controls: Green ROW cross sections, permeable storm systems, vegetative swales, infiltration trenches, etc.
    - End-of-Pipe Controls: Flow dispersion outlets, vegetative filter strips, CDS units, selective native plantings, etc.

5.0 CONTROL MONITORING AND MAINTENANCE

Routine maintenance of all temporary and permanent erosion and sediment control measures will be enforced to ensure the integrity of surrounding area. Effective monitoring, including frequent inspections of environmental control measures, is critical to demonstrating due diligence and for managing the consequences of the project. All maintenance and monitoring is to be completed to the satisfaction of the Project Engineer, HRM, and Environmental Inspectors.

- The effectiveness of control measures will be inspected and monitored during rain events and maintained and upgraded as necessary or as directed by the Project Engineer or Environmental Inspectors.
- The Contractor and Project Engineer will incorporate a routine end-of-day check to ensure the integrity of the protection measures.
- Monitoring of meteorological conditions and forecasts will be conducted to minimize the potential for erosion. Weather forecasts should be consulted daily during site preparation. In the event of a forecasted precipitation event ≥ 25 mm, environmental controls should be inspected in the field and preventative maintenance carried out in advance of the storm.
- Control structures require maintenance (removal of sediment) when the deposition reaches a height of one-half of the effective height of the control or a depth of 300 mm immediately upstream of the control device.

- Environmental control measures will be reviewed during construction and any deficiencies will be corrected as soon as possible. If the environmental controls included in the ESCP must be replaced or adapted, the process should be recorded in a written addendum to the ESCP.

6.0 CONTINGENCY PLAN AND DOCUMENTATION

Extreme storm events can result in extensive erosion and sedimentation due to heavy rainfall impact and the associated stormwater runoff. Excessive runoff can be mitigated or controlled using additional diversion berms, straw-bale check dams, sediment fences, sediment traps, and/or sandbag barriers. The Contractor will ensure that equipment, personnel, and required materials will be available for application as required. A Contingency Plan will be required to be developed by the Contractor and should include the following information:

- Quantity and location of stored erosion and sediment control materials on site.
- Instructions on how construction equipment can be made available on short notice (including owner/operator details).
- Plan for preventing the offsite discharge of sediment-laden runoff from the site.
- A plan for emergency shutdown of the site, including the sequence of activities.

Following extreme storm events, Environmental Inspectors, will conduct environmental monitoring in those area deemed at risk. Recommendations regarding erosion control will be made by the Environmental Inspectors as required. To establish due diligence in the event of the release on sediment-laden runoff during extreme events, it is important to demonstrate that all reasonable actions have been undertaken to prevent such an occurrence. All ESCP activities will be recorded to demonstrate that a process was followed. Copies of these documents will be kept on site for reference by the Contractor. This documentation should include:

- The original ESCP;
- Any revisions to the ESCP;
- Regular inspection and maintenance reports;
- ESCP related incident reports; and
- ESCP decommissioning report.

7.0 DECOMMISSIONING

Temporary sediment controls are to be maintained throughout construction and only be removed when appropriate and with approval of the Project Engineer and HRM Site Supervisor. Controls will only be removed after site inspection has concluded that areas are sufficiently stabilized and that downstream controls are no longer required. This will be determined when:

- The disturbed area is sufficiently stabilized;
- No areas of active erosion are observed; and
- Control monitoring indicates stable conditions;

8.0 SUMMARY

This Erosion and Sedimentation Minimization Plan is based on the current assessment of the site and the anticipated requirements necessary to best minimize offsite impacts during construction activities on this site. This Plan does not serve to meet the requirements for a formal ESCP for any particular construction activity on the site. All development will be required to comply with applicable environmental laws, regulations, standards, and practices, permits, approvals, and requirements of federal, provincial, and municipal authorities.

APPENDIX E
LAWN CARE BEST MANAGEMENT PRACTICES – HOME OWNERS GUIDE

The Parks of West Bedford

Lawn Care Best Management Practices

Home Owners' Guide

THE PARKS
OF WEST BEDFORD

West Bedford Holdings Limited

THE PARKS
OF WEST BEDFORD

EMBRACING NATURE. ENJOYING LIFE

West Bedford Holdings Limited – Our Commitment

West Bedford Holdings Limited is dedicated to developing residential communities that are sensitive to low impact and sustainable development. Our goal is to not only plan and design residential communities that are responsible, sustainable and functional, but to inspire our homeowners in the Community to learn from their decisions and to develop a greater appreciation for the environment and its resources. For this reason we challenge you the homeowner to better understand your environmental responsibility within the Papermill Lake watershed.

The following Homeowner's Best Management Guideline will serve as a critical educational tool that each family should review and understand in order to preserve and enhance our most precious natural resource....Water!

Stop Runoff

Use a Rain Barrel

Rain barrel usage can be important to the overall success of the stormwater management system. The benefits of using a rain barrel include:

- Stormwater that washes off rooftops and into downspouts is caught and retained.
- Homeowners use the water in the rain barrel as needed during the growing season.
- Water can be reused as needed in the garden or lawn landscape.
- Reduces stormwater runoff and pollution by providing treatment to the "first flush" of contaminants.
- Easy Installation – suitable for all property types.
- Reduces water bills by not using potable water for irrigation.
- Water generated is very soft (low in minerals), which is good for plant growth.

The proper design, siting and maintenance practices are necessary to ensure that the rain barrel is functioning appropriately and not becoming a nuisance or mosquito breeding ground in the development. The following guidance is intended to provide the proper siting, mosquito control and maintenance practices for your rain barrel.

Finding the best location for your rain barrel

To find the best location for your rain barrel, the following techniques are recommended:

- Place rain barrel on a hard, level, and pervious surface. Concrete blocks, bricks, decorative blocks, or flagstones work well as a base.
- Locate rain barrel at downspout nearest to the garden you want to irrigate.
- Rain barrels work using gravity to drain – The garden to be irrigated should be lower in elevation that the rain barrel.
- Ensure that the rain barrel overflow location directs water towards your yard and not your neighbors.

What about those pesky mosquitoes?

Many homeowners worry that rain barrels will create a breeding ground for mosquitoes. The following is a list of tried and trusted techniques that can be employed to control mosquitoes:

- Ensure that the mosquito proof screen on the rain barrel is installed and functioning correctly.
- Ensure that the base is pervious, so overflow does not collect and leave standing water for mosquito breeding.
- Inspect rain barrel weekly – ensure that the lid is securely closed and the water is free of organic material.
- Mosquito larvae require 6-9 days to hatch. Completely drain the barrel once per week and clean if necessary to prevent the formation of stagnant water.

When properly encased with a mosquito proof screen, rainbarrels will keep out any mosquitoes from breeding.

How do I take care of my rain barrel?

To properly care for your rain barrel, the following techniques are recommended:

- Keep spigot closed when not using water.
- Routinely inspect gutters, downspouts, rain barrel intake and mosquito screens for debris.
- Keep lid secured and screens clear of debris. Make sure the overflow tube and hose are functioning correctly.
- If odours develop, drain the rain barrel and spray with a hose until clean.
- Completely drain rain barrel before winter – leave spigot open during the cold months so water does not accumulate and freeze.
- Ensure that the overflow is draining properly and not causing erosion of the rain barrel base. An example overflow valve is shown in the above figure.
- Rain barrel water is not potable – *do not drink the water.*

Go-Toxic Free

Lawn Fertilizer

There are many natural ways to fertilize a lawn before reaching for a store-bought fertilizer. Compost and grass clippings are a cost-effective and environmentally friendly way to provide your lawn with nutrients. If you feel the need to purchase a fertilizer to care for your lawn, use organic fertilizers or slow release fertilizers.

- Clean Nova Scotia indicates that generally a 4:1:2 (the ratio of nitrogen to phosphorous to potassium) fertilizer applied at rate of 1 kilogram nitrogen per 100 square metres (2 pounds per 1000 square feet) provides the proper balance of nutrients.
- Combine the fertilizer with organic material (a mixture of good-quality soil, sand and a source of humus) and add this to your lawn's surface.
- Use a slow release or organic fertilizer before a rain (follow labels). If rain is not expected, water the lawn prior to fertilizing.
- Know your nutrient needs by understanding your soil and lawn conditions (most people apply too much fertilizer and this impacts water quality as well as lawn health).
- Go natural! Forget chemical fertilizers and replace your lawn with native plantings. There are over 1,500 to choose from for our region!

Organic fertilizers are often overlooked as an effective method for lawn care and maintenance.

Create Rain Gardens

A rain garden is a landscaping feature you can build to manage runoff. A rain garden will collect rain water and slowly filter water into the ground. They are usually a constructed depression (10-20 cm deep) that is designed to look like a natural area, but it will accept, infiltrate and clean stormwater. The rain garden will typically fill up with a few inches of water after a storm and within 1-2 days, the water will slowly filter into the ground. It is planted with wet and dry tolerant plants to absorb rain water. This technique encourages the recharge of the groundwater aquifer and uses the soil filters out any pollutants before the infiltrating water reaches the local groundwater table. When combined with a disconnected roof leader (downspout), the stormwater can be conveyed into the rain garden via a vegetated swale creating a high value natural landscape.

Rain gardens serve both a practical and aesthetic purpose; to clean and manage water run off, while creating a more beautiful landscape.

Keep it Green

Lawn Irrigation

One of the key ways you can help to keep lawn care more sustainable is by thinking about how you keep your lawn irrigated. Turf grasses and other plants in a native landscape need water for growth and development. By implementing proper irrigation practices, lawn quality and aesthetics will be improved, while at the same time, lowering water bills. By watering infrequently and deeply you can help improve the health of your lawn. The following techniques will put you on the path to proper lawn irrigation practices and prevent over watering:

- A typical turfgrass requires 2.5 cm of water per week (through rainfall or irrigation), which will soak the upper 10 cm of soil.
- Monitor your irrigation by placing a can in path of sprinkler flow and stop irrigation once 2.5 cm of water has accumulated in the can.
- Ideal irrigation times are when temperatures are cooler in the early morning or early evening and when wind speeds are low.
- Let lawn completely dry out between irrigation intervals. The soil should be difficult to penetrate before irrigation.
- Lawns require water when the grass turns light-green to brown in colour and the stalks remain bent over after being walked on.
- Stop irrigation when puddling or runoff occurs. Excessive moisture can potentially cause fungal disease in grasses and also prevents grasses from extending deep roots.
- Where possible, reuse collected stormwater from rain barrels for irrigation of gardens or smaller areas.
- Use sprinklers with uniform water application patterns. Do not aim sprinklers in a pattern that will water sidewalks, driveways, or the sides of homes.
- Without watering, most lawn grasses will go dormant over the hot summer months. This should not be a concern and the grasses will begin growing again during the cool season months.

Pet Clean-Up

Pet waste is a health hazard and a pollutant as it contains excess phosphorus and harmful bacteria which can harm lake water quality. The following guidelines will provide for the proper cleanup of pet waste and the elimination of any health concerns due to contact concerns:

- Clean up all animal waste whether on your lot or on trails or other places in the community.
- During walks, bring a bag and dispose of the waste in the toilet, garbage, or a designated pet compost area.
- In your yard, encourage pets to use one location. This will make clean-up easier and this area can be isolated from the rest of yard, which can prevent accidental contact with the pet waste.
- Do not feed Geese - It encourages them to frequent your yard and generate waste in your yard, driveway, or sidewalks.
- Pick up after pets before cleaning patios, sidewalks or driveways. Do not spray waste onto streets or into gutters.

Pesticide Use

Pesticides should be applied only as a last resort, or not at all. The major source of pesticides in urban streams is home applications to kill insects and weeds in the lawn and garden. If you need pesticides, certain pesticides may be permitted. Visit the HRM website, http://www.halifax.ca/pesticides/rules.html for more information.

Naturalize

Use Native Species

Many native species are suited to growing in a wide range of ecological conditions and they are usually best suited to the Nova Scotia climate. Because of this, once they are established they usually require less care and are a key element in creating a low maintenance and sustainable landscape. The species listed below are considered to be the types of species that would most usually found in the Parks of West Bedford area, however, use of other native species may also be appropriate. Final planting decisions should be made based on specific site conditions, species availability, and advice from landscape specialists.

Native Trees & shrubs best suited for certain site conditions:

- Dry/Poor Sites: Black Spruce, Balsam Fir, White Pine, Red Pine, White Birch, Grey Birch, Red Oak, Trembling Aspen, and Largetooth Aspen.
- Moist/Poor Sites: Black Spruce, Red Maple, Eastern Larch, and Balsam Fir.
- Average Sites: Red Spruce, White Spruce, Eastern Hemlock, White Pine, White Birch, Yellow Birch, Red Oak, Red Maple, and Sugar Maple.
- Moist/Rich Sites: Red Spruce, White Spruce, Eastern Hemlock, Yellow Birch, Red Maple, Sugar Maple, White Ash, and Ironwood.
- Native Shrubs: Wild Raisin, Serviceberry, False Holly, Canada Holly, Velvetleaf Blueberry, Lowbush Blueberry, Lambkill, Bush Honey Suckle, Huckleberry, Witch Hazel, Speckled Alder, Labrador Tea, Rhodora, Mountain Ash, Teaberry, Spirea, Striped Maple, Mountain Maple, and Beaked Hazelnut.

Lawn Mowing

The frequency, height, pattern and condition of a lawn mower can impact the quality and sustainability of a lawn landscape. The following items provide a recommendation for maintaining your lawn through proper lawn mowing practices:

- Always use a sharp blade – A dull blade will damage the remaining grass blades, potentially stunting future growth.
- Always mow when the grass is dry
- Mow at regular intervals (every 5-7 days).
- Cut grasses to a height of 6-8 cm. Higher cut grass will shade out weeds and encourages deep root growth.
- Never mow more than 1/3 of the grass blade – This puts additional stress on the grass, potentially stunting growth.
- Use a mulching lawn mower and leave grass clippings on yard. The cut grass will contribute nitrogen to the soil and reduce fertilizer use on the yard.
- Avoid mowing when turf is under heat and drought stress.
- Alter the pattern with each mowing event to reduce wear on the grass surface.
- Wear appropriate safety gear, which includes long pants and shirt and eye/ear protection.
- Use a low emission lawn mower. According to Canada's **Clean Air Foundation**, a standard gas mower will emit the same amount of air pollutants in one hour as driving a new car for over 550 kilometers.

Keep it Green

Dethatching

Thatch is a layer of living and dead organic material that lies on top of the soil that can be a home to insects and fungus spores as well as prevent water, fertilizer and air from reaching the soil. The information below provides information how to avoid thatch formation and the removal of thatch should it become a problem:

- Avoid over fertilization and excess pesticide application. Thatch buildup is typically due to excess nitrogen and pesticide in the growing zone.
- Mulching lawnmowers do not cause thatch buildup. If thatch buildup becomes a problem, maintenance will be required on a yearly basis. The following options are available for thatch removal/control:
  - Aeration - Mechanical aeration equipment will break up the thatch, allowing air to penetrate the soil and enhance thatch decomposition.
  - Heavy Raking- A manual removal method for thin thatch layers.

Regular ground aeration is vital for a long-lasting and healthy lawn.

Manage your downspouts

Roof leaders (downspouts) at the Parks of West Bedford where ever possible are directed to lawns and vegetated areas to recharge groundwater. The installation of a downspout diverter can help you to direct water to certain areas on your lot. Benefits of this technique include:

- Low cost alternative that directly reduces stormwater runoff.
- Allow management/use of stormwater on the property.
- Reduce water bills by using stormwater to irrigate lawns and gardens.
- Reduce the volume of stormwater runoff to end of pipe facilities.

Downspouts should drain the water away from any impervious areas, such as the foundation or driveway, and into vegetated zones.

Get with the Program

Get to know your site

Getting to know your site is critical in helping you to create a more sustainable landscape. Consider the following options in caring for your land:

- Be sure you are not removing desirable native plants that are already well adapted to your site.
- Consider how much sunlight your site gets over the course of a day.
- Know your soil type! Does your soil hold moisture? How quickly does it drain? This can help you in choosing the right species and stormwater management techniques.
- Plant a diverse mix of native species and understand how your chosen plants might 'creep' into adjacent areas.
- Over time, the cost of using native plants for landscaping is less than non-native plants. Think of our plants as long-term investments that can be phased in as your budget allows.
- Make sure plants are not dug from the wild. This depletes the resource and many species do not thrive after transplanting.
- Consider interseeding (no till) or plugging plants into existing vegetation in places such as thin lawns, or sparsely vegetated old fields. This can result in fewer new weeds.
- Consider using shade trees to screen your home from the sun. They help keep you comfortable, and save money on air conditioning.

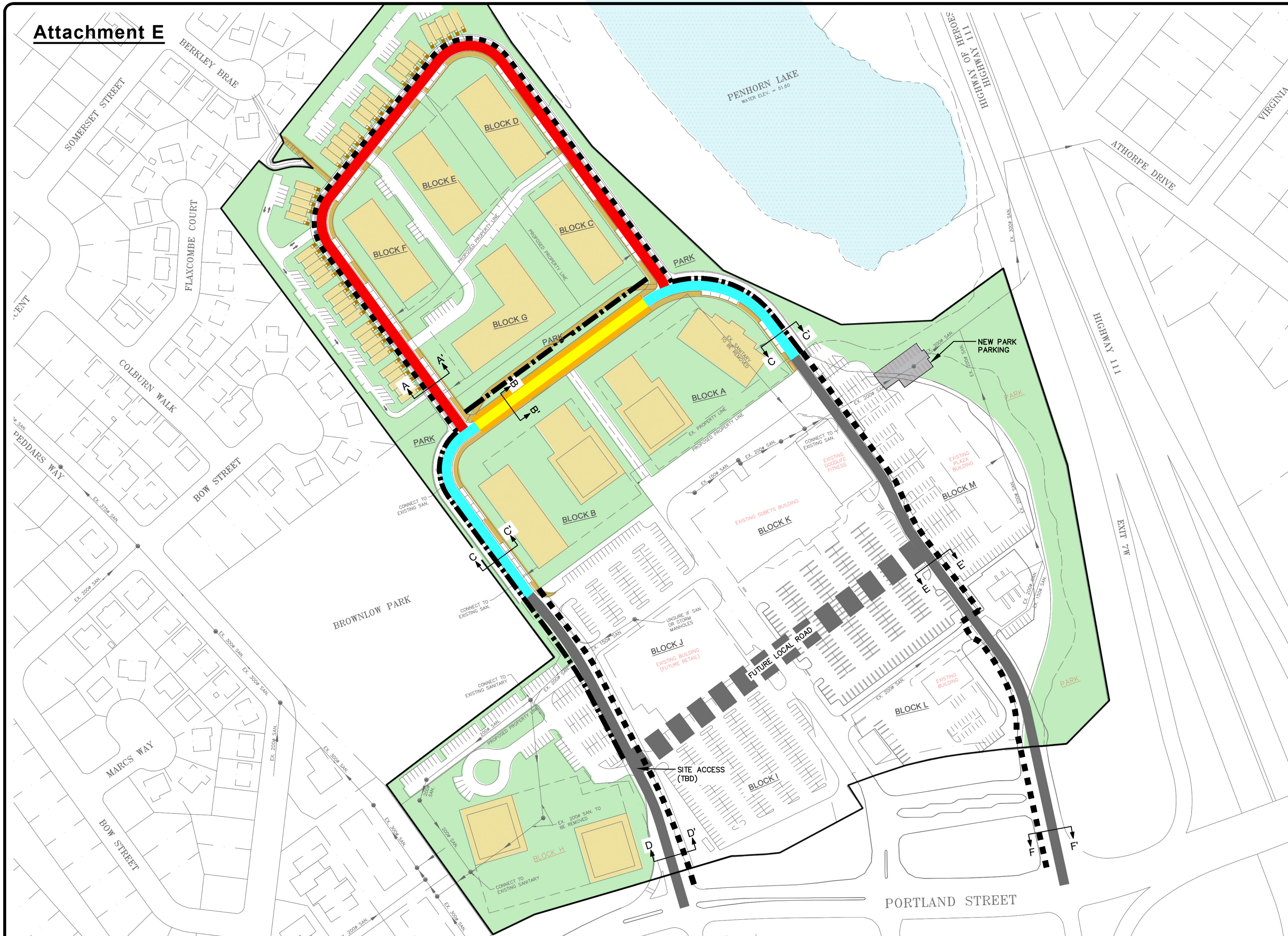
Green Bin Composting

We are lucky in HRM to have an advanced recycling program than can help us in managing our waste. Significant accumulations of grass clippings, leaves, pruned branches, and other vegetative material are typically produced during the growing season. The following guidelines outline the proper handling of these materials to help sustain a low maintenance landscape:

- Use your green bin for leaves & brush, and house & garden plant waste.
- Excess leaf & yard material can be placed alongside the cart using orange or clear plastic bags or heavy paper bags - 20 bag limit, 25 kg (55 lb) maximum weight per bag.
- Branches should be tied in armload - sized bundles - maximum 5 bundles. Each bundle not exceeding 34 kg (75 lb) and no individual piece in the bundle more than 4 feet long (1.2 m) or larger than 8 inches (0.2m) in diameter.
- Create your own compost for your landscape needs. Learn more from HRM at http://www.halifax.ca/wrms/backyardcompost.html or the Resource Recovery Fund Board at www.putwasteinitsplace.ca
- Leave grass clippings on the grass. If possible, use a mulching mower, which will spread the grass clippings through the grass and put nutrients back into the soil.
- If a mulching mower is not available, dispose of grass clippings in your green bin or compost, or spread clippings in a vegetable or flower garden, as a mulch under bushes or add to the soil.
- Rake leaves, seeds, and grass clippings out of the street and gutter.
- Do not dispose of organic debris by dumping it in or near water bodies or sewers.

THE PARKS
OF WEST BEDFORD
EMBRACING NATURE ENJOYING LIFE

Attachment E



PENHORN STREET NETWORK PLAN

LEGEND:

- LOCAL #1 (A-A')
- LOCAL #2 (B-B')
- LOCAL #3 (C-C')
- EXISTING DRIVEWAY, TO BE CONVEYED AS PUBLIC R.O.W.
- 3.0m ASPHALT MULTI-USE PATH
- SIDEWALK
- DUAL ON-STREET PARKING
- PROJECT BOUNDARY

NOTES:

1. SECTION E-E' DEPICTS A PROPOSED APPROACH TO MODIFY THE EXISTING DRIVEWAY TOWARDS LOCAL #3.

N

DATE

DECEMBER 4, 2020

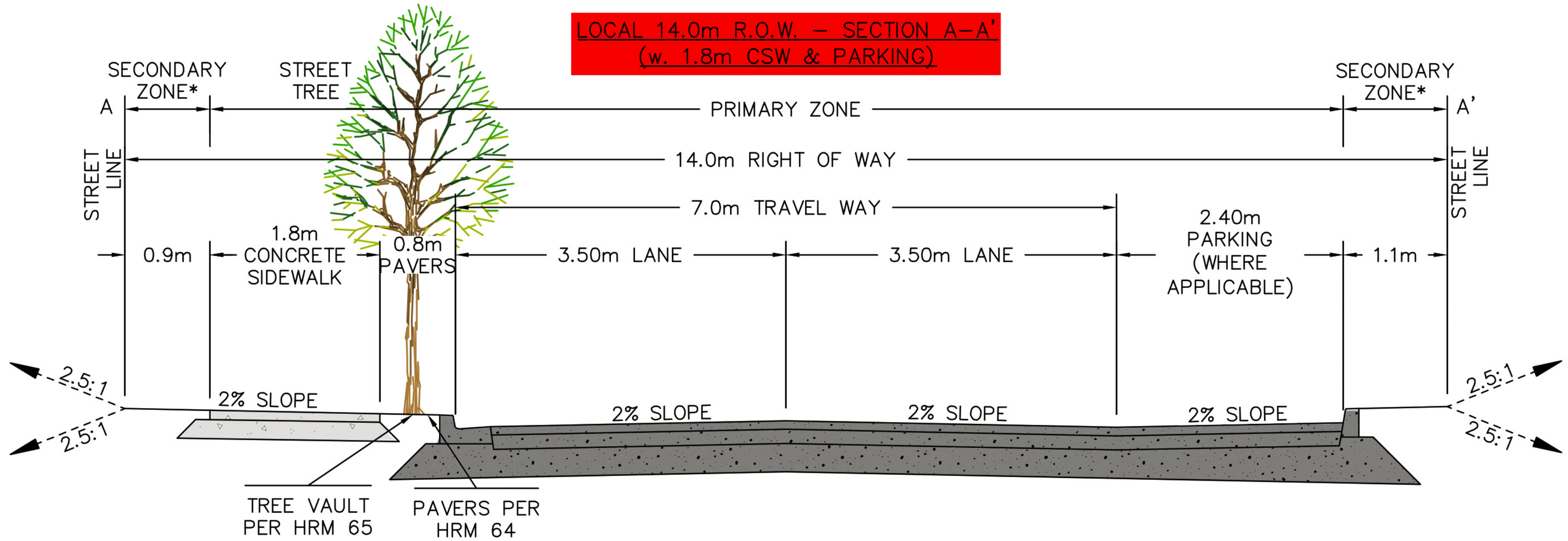
SCALE

NTS

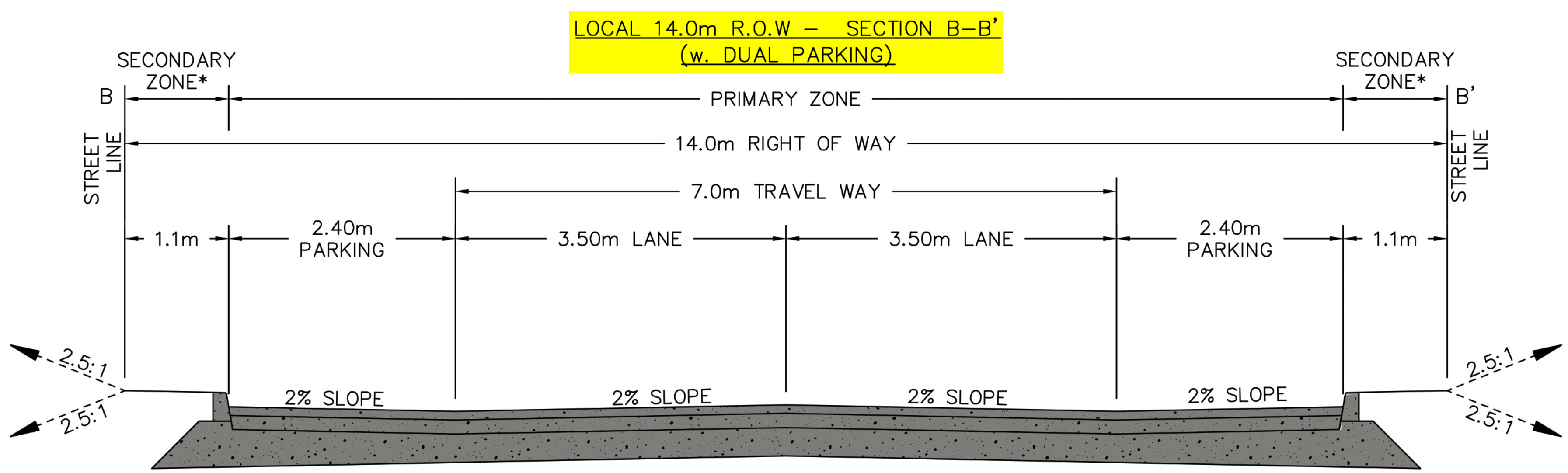
0 25 50 100

METRES

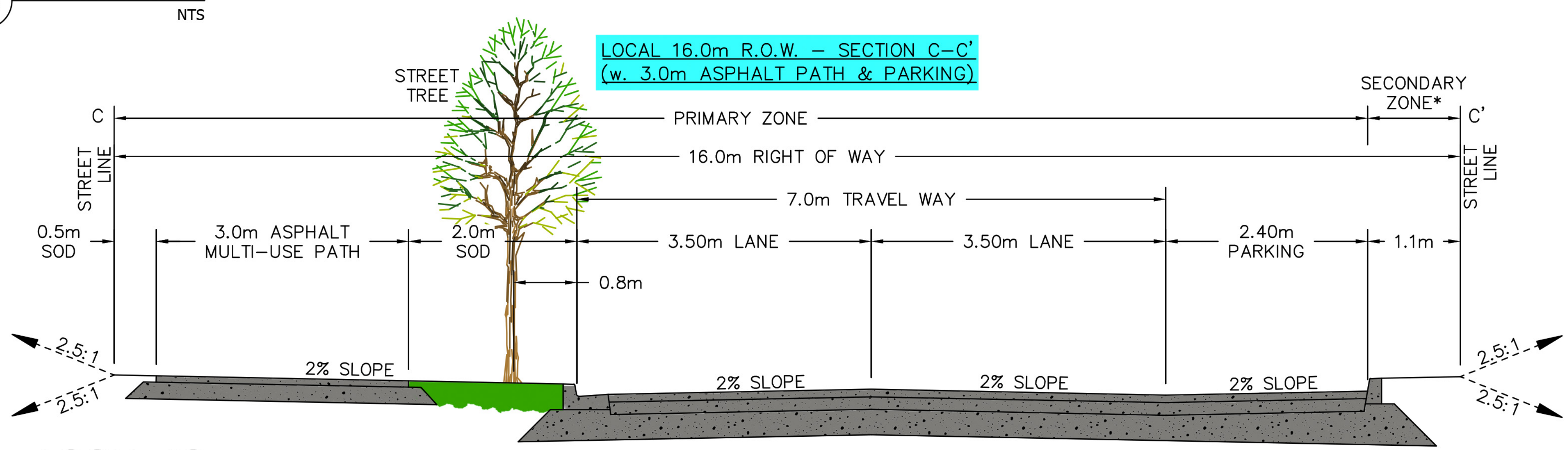
CLAYTON DEVELOPMENTS LTD



A-A' **LOCAL #1**
NTS



B-B' **LOCAL #2**
NTS



C-C' **LOCAL #3**
NTS

PENHORN ROAD CROSS SECTIONS

NOTES:

SECONDARY ZONE*

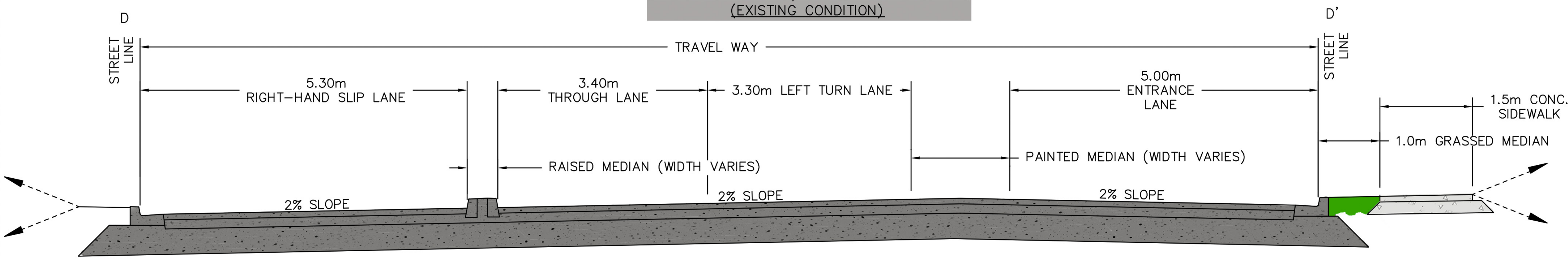
- SECONDARY SERVICES TO BE COMPLETED AT TIME OF BUILDING CONSTRUCTION.
- SURFACE TREATMENT TO BE AS PER MASTER LANDSCAPE PLAN.

DATE
DECEMBER 4, 2020

SCALE
NTS

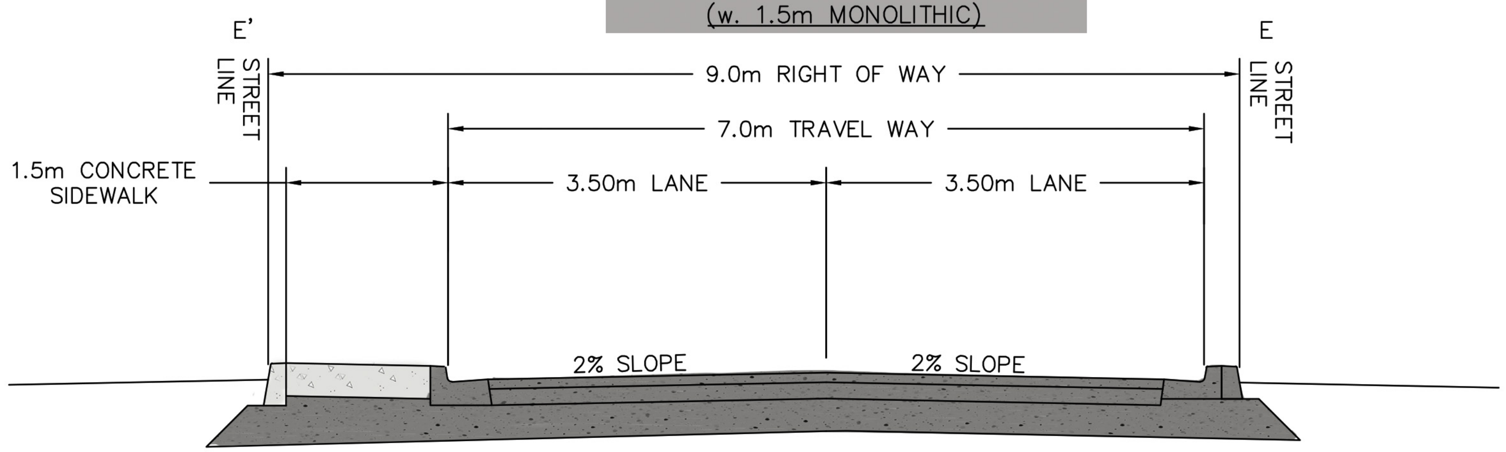
CLAYTON DEVELOPMENTS LTD

WESTERN ENTRANCE/EXIT – SECTION D–D'
(EXISTING CONDITION)



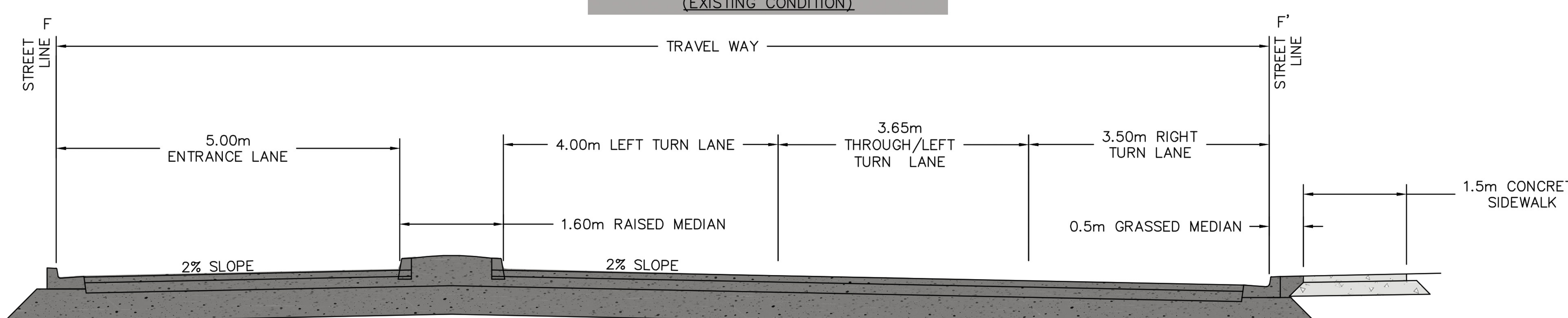
D-D' WESTERN ENTRANCE/EXIT - EXISTING
NTS

LOCAL 9.0m R.O.W. – SECTION E–E'
(w. 1.5m MONOLITHIC)



E-E' MODIFIED FROM EXISTING
NTS

EASTERN ENTRANCE/EXIT – SECTION F–F'
(EXISTING CONDITION)



F-F' EASTERN ENTRANCE/EXIT - EXISTING
NTS

PENHORN ROAD CROSS SECTIONS 2

DATE
DECEMBER 4, 2020

SCALE
NTS

CLAYTON DEVELOPMENTS LTD

Attachment G

TRAFFIC IMPACT STUDY
PENHORN DEVELOPMENT

PREPARED FOR:
CLAYTON DEVELOPMENTS

Project No. 201-04486

JUNE 2020

TABLE OF CONTENTS

APPENDICES

Original Signed

1 INTRODUCTION

Background

Plans are being prepared for a residential development adjacent to the existing Penhorn Plaza site in Dartmouth, Nova Scotia (see Figure 1). Over time Penhorn Plaza has evolved from a large regional shopping center to a smaller-scale retail destination supplemented with a transit terminal. There is currently a significant portion of the Penhorn Plaza site that remains unused and ready for redevelopment.

WSP Canada Inc. has been retained to complete a Traffic Impact Study (TIS) for the proposed residential development concept shown in Figure 2.

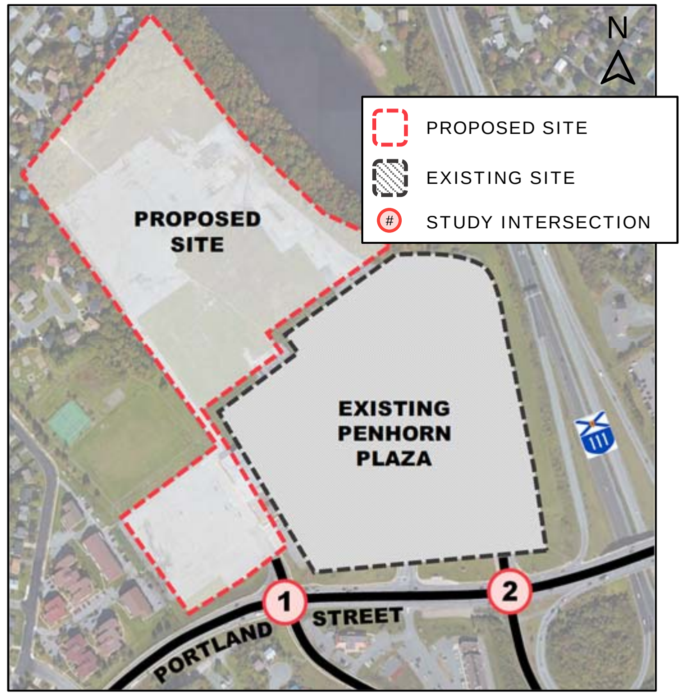


Figure 1 – Study Area

A Traffic Impact Study Usually Considers Four Questions

A TIS usually consists of determining answers for the following questions:

1. **What is the existing transportation situation** adjacent to the study site? How have volumes changed historically?
2. **What transportation changes are expected** at key Study Area locations? How many vehicle and active mode trips are expected to be generated by the proposed development during weekday peak hours? What routes are the trips expected to use to travel within and through the Study Area?
3. **What transportation impacts will occur** on Study Area roads, sidewalks, and intersections?
4. **What transportation improvements are required** to mitigate project impacts on Study Area travel? Are there transportation modifications that should be made to improve the travel experience for all users?

Study Objectives

1. Develop projected 2030 background weekday AM and PM peak hourly volumes for Study Intersection that do not include trips generated by the proposed site.
2. Estimate the number of weekday AM and PM peak hour trips that will be generated by the proposed development.
3. Distribute and assign site generated trips to Study Intersections to project 2030 peak hourly volumes that include site generated trips.
4. Evaluate impacts of site generated traffic on the performance of Study Intersections.
5. Complete warrant analyses, as necessary, for Study Intersections and recommend improvements that may be needed at study intersections to mitigate the impacts of site development.

Figure 2 - Site Plan

CONCEPTUAL PLAN

PENHORN REDEVELOPMENT

NOTES:

- CONCEPTUAL LAYOUT ONLY.
- GRADING IS NOT FINALIZED; WALL HEIGHTS AND ELEVATIONS ARE SUBJECT TO CHANGE.
- FINAL GRADING TO BE IN ACCORDANCE WITH HRM ENGINEERING SPECIFICATIONS & WBHL DESIGN GUIDELINES.
- FINAL PLANS TO BE IN ACCORDANCE WITH THE DEVELOPMENT AGREEMENT AND APPLICABLE LAND USE BY-LAW.

DATE

APRIL 15, 2020

SCALE

1:2500

N

2 STUDY AREA DESCRIPTIONS

Description of Proposed Development

The proposed residential development is expected to be constructed in the demolished lands north of the existing Penhorn Plaza in Dartmouth, Nova Scotia. The proposed development is expected to be made up of a combination of mid-rise and high-rise apartment buildings, totalling 875 apartment units, as well as 45 single family dwellings. Full occupancy of the development is anticipated by 2030.

Proposed Site Access

It is expected that vehicular access to the proposed site will be provided via the existing signalized intersections (Site Access #1 and Site Access #2) that provide access to Penhorn Plaza (see Figure 3). It is not anticipated that trips generated by the proposed development will access the site through the existing unsignalized intersection due to its inopportune location and traffic control.

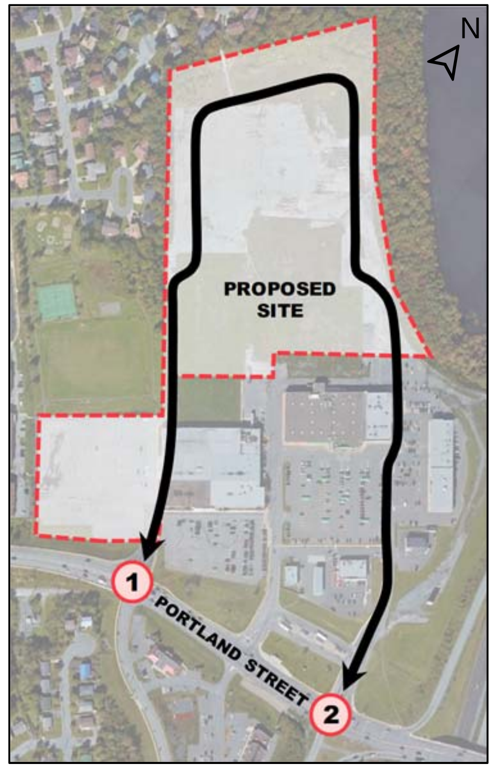


Figure 3 – Site Access

Existing Road Descriptions

Portland Street, otherwise known as NS Route 207, is an arterial road that runs east-west approximately 5.7 km between Alderney Drive (Downtown Dartmouth) and Caldwell Road. In the Study Area, Portland Street consists of a changing cross section with alternating turning lanes, divided by a median. There is sidewalk on the both sides of the roadway and parking is prohibited. The posted speed limit is 50 km/h in the Study Area.

Existing Intersection Descriptions

Intersection 1 – Portland Street and Site Access #1/Green Village Lane is a 4-leg signalized intersection with pedestrian crosswalks on the north, south and west legs (see Photo 1). The eastbound and westbound approaches consists of a left-turn lane, a through lane and a shared through/right-turn lane. The northbound approach (Green Village Lane) consists of a through/left-turn lane and a right turn lane. The southbound approach (Site Access #1) consists of a left-turn lane, a through lane and a channelized right turn lane.

Photo 1 – Portland Street and Site Access #1/Green Village Lane

Existing Intersection Descriptions (Continued)

Intersection 2 – Portland Street and Site Access #2/NS Highway 111 Southbound Onramp is a 4-leg signalized intersection with pedestrian crosswalks on the north and west legs (see Photo 2). The eastbound approach consists of a left-turn lane, a through lane and a shared through/right-turn lane. The westbound approach consists of a left-turn lane, two (2) through lanes and a shared through/right-turn lane. The southbound approach (Site Access #2) consists of a left-turn lane, a through/left-turn lane and a right-turn lane. The south leg is a southbound onramp for NS Highway 111.

Photo 2 – Portland Street and Site Access #2/NS Highway 111 Southbound Onramp

Turning Movement Counts

Turning movement counts were obtained from HRM Traffic Management for morning, midday and evening peak periods at the Study Intersections. The turning movement counts for Portland Street at Site Access #1 were collected by HRM on November 22, 2018. The turning movement counts for Portland Street at Site Access #2 were collected by HRM on August 23, 2017. The turning movement counts have been tabulated in Tables A-1 and A-2, Appendix A, with peak hour volumes indicated by shaded areas.

Background Traffic

When the traffic counts were completed the former Sears building was unoccupied, as shown outlined in Figure 4. Since then, the building has been modified to include approximately 32,000 ft^2 of office space, 5,000 ft^2 of restaurant and 5,000 ft^2 of retail establishments.

Figure 4 – Location of Background Development

Annual Growth

The peak hour volumes on Portland Street and the NS Highway 111 onramp have been increased by an annual growth rate of 1.5% to project background traffic volumes. This growth rate was determined based on historical background volume information and is considered typical for this area. The annual growth rate was not applied to turning movements to/from Green Village Lane because no additional growth is expected in this residential neighbourhood (i.e. fully occupied). Similarly, the annual growth rate was not applied to turning movements to/from Penhorn Plaza because the background development was taken into consideration.

Projected 2020 Traffic Volumes

The projected 2020 AM and PM peak hour volumes represent estimates of the current traffic volumes and are shown diagrammatically in Figure A-1, Appendix A.

Existing and Planned Active Transportation and Transit

The proposed site has good accessibility for pedestrians. There are sidewalks on both sides of Portland Street and marked crosswalks at the Study Intersections, therefore, pedestrians can easily access the site from the south. In addition, there are walking trails throughout the Manor Park neighbourhood and near Penhorn Lake and Brownlow Park, which pedestrians may use to access the site form the north.

The Halifax *Integrated Mobility Plan* (IMP) has proposed an all ages and abilities bicycle network throughout the regional centre of Halifax by 2022. An active transportation greenway is planned near to the proposed site (see Figure 5). A trail is currently being constructed around Penhorn Lake that will ultimately connect to these lands to the proposed development and Penhorn Transit Terminal.

Figure 5 – Active Transportation (IMP, 2017)

The Penhorn Transit Terminal is currently located on Penhorn Plaza site, fronting Portland Street. HRM Transit currently operates Routes 57, 58, 59, 61, 62, 66, 68 and 159 through the Penhorn Transit Terminal (see Figure 7).

The IMP has identified Portland Street as a Transit Priority Corridor (see Figure 7). It is expected that physical or policy-related interventions will be implemented in an effort to reduce the impact of traffic congestion on transit vehicles.

Figure 6 – HRM Transit Routes

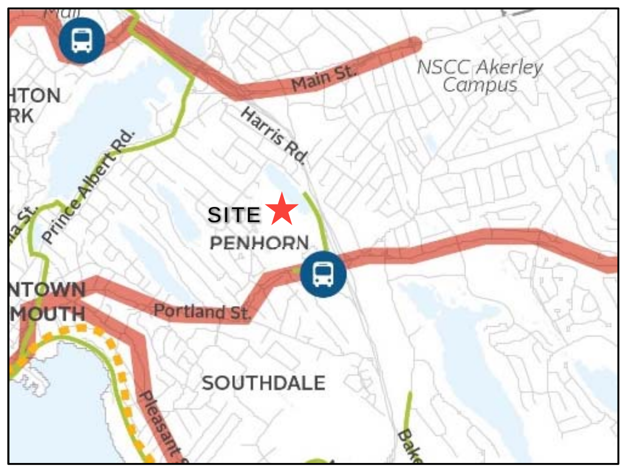


Figure 7 – Transit Priority (IMP, 2017)

3 TRIP GENERATION, DISTRIBUTION, AND ASSIGNMENT

Anticipated Land Use for Proposed Development

The proposed residential development is planned to include a combination of mid-rise (3-10 storeys) and high-rise (more than 10 storeys) apartment buildings as well as single family homes. The site is expected to consist of 427 Mid-Rise Apartment units, 448 High-Rise Apartment units and 45 Single Family Dwellings.

Anticipated Land Use for Background Development

The mixed-use background development is planned to include 32,000 ft^2 of General Office, 5,000 ft^2 of High-Turnover (Sit-Down) Restaurant and 5,000 ft^2 of Specialty Retail.

Estimation of Site Generated Trips (Background Development and Proposed Site)

When using the published rates in *Trip Generation Manual* (Institute of Transportation Engineers), the transportation engineer's objective should be to provide a realistic estimate of the number of trips that will be generated.

Trips generated by Single Family Dwellings (Land Use 210), Mid-Rise Apartment Units (Land Use 221) and High-Rise Apartment Units (Land Use 222) are estimated for the AM and PM peak hours of traffic by the number of units. Trip generated by General Office (Land Use 710), Speciality Retail (Land Use 826) and High-Turnover (Sit-Down) Restaurant (Land Use 932) are estimated for the AM and PM peak hours of traffic by the leasable square footage available.

Trip generation estimates for Single Family Dwellings, Mid-Rise Apartment Units, High-Rise Apartment Units, General Office and High-Turnover (Sit-Down) Restaurant were prepared using published rates from *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, Washington, 2017), and estimates for Specialty Retail were prepared using published rates from *Trip Generation Manual, 9th Edition* (Institute of Transportation Engineers, Washington, 2012). Speciality Retail is no longer listed as a potential land usage in the 10th Edition, instead more specific retail descriptions are provided (e.g. supermarket, apparel store, pet supply store, etc.). Detailed breakdowns of the commercial space within the proposed mixed-use development was unavailable, therefore, more general scenarios were explored.

Two types of trips are included in the external trips that will be generated by the background and proposed development:

- ***Pass-by trips*** are those which are made as 'intervening opportunity' stops to commercial and retail land uses by vehicle trips already passing by the site. Although these trips will be included in the site access volumes to the site, they will not increase the overall traffic volumes on Study Area roads. Diverted link and pass-by rates were determined using *Trip Generation Handbook, 3rd Edition* (Institute of Transportation Engineers, 2017) and local knowledge of the area.
- ***Primary trips*** for this study include all external site generated trips that are not considered pass-by trips.

Reductions to Trip Generation Estimates

In Halifax approximately 12% of commuting trips were made by transit in 2017 (Page 99, IMP, 2017). The Penhorn Transit Terminal is located on-site (Routes 57, 58, 59, 61, 62, 66, 68 and 159), therefore, the transit-ridership expected to be slightly higher in the Study Area. In addition, there are good pedestrian connections (sidewalks and crosswalks) to the surrounding residential neighbourhoods and adjacent commercial properties.

Reductions to Trip Generation Estimates (Continued)

In addition, it is expected that there will be on-site synergies for trips between the proposed and background developments. These are customers that make one trip to the site and make use of more than one service available.

Halifax has a 60% target for non-auto trips within the Regional Centre by 2031 (Page 40, IMP, 2017). Within the 2030 timeframe, the background and proposed developments are expected to be fully occupied, therefore, a conservative reduction at 30% was used, which accounts for all non-auto trips (transit, cycling and walking trips) and on-site synergies.

Trip Generation Estimates for Background Development

Trip generation estimates for the background development are summarized in Table 1.

During the AM peak hour, it is estimated that background development will generate:

- 43 two-way primary vehicle trips (33 entering and 10 exiting); and,
- 22 two-way pass-by vehicle trips (11 entering and 11 exiting).

During the PM peak hour, it is estimated that that background development will generate:

- 44 two-way primary vehicle trips (16 entering and 28 exiting); and,
- 26 two-way pass-by vehicle trips (13 entering and 13 exiting).

Trip Generation Estimates for Proposed Development

Trip generation estimates for the proposed development are summarized in Table 2. It is estimated that the residential development will generate:

- 179 two-way trips (46 entering and 133 exiting) during the AM peak hour; and,
- 227 two-way trips (140 entering and 87 exiting) during the PM peak hour.

Table 1 – Trip Generation Estimates for the Background Development

Land Use[1]	Units[2]	Trip Generation Rates[3]				Trip Generation Estimates[4]			
		AM Peak		PM Peak		AM Peak		PM Peak	
		In	Out	In	Out	In	Out	In	Out
Background Development									
General Office (Land Use 710)	32.0 KGLA	1.00	0.16	0.18	0.97	32	5	6	31
High-Turnover (Sit-Down) Restaurant (Land Use 932)	5.0 KGLA	5.47	4.47	6.06	3.71	27	22	30	19
Specialty Retail[5] (Land Use 826)[6]	5.0 KGLA	0.76	0.60	1.19	1.52	4	3	6	8
Trip Generation Estimate for Bakground Development						63	30	42	58
30% Reduction for Non-Auto Trips[7]						19	9	13	17
40% Reduction for Commercial Pass-By Trips[8]						11	11	13	13
Total Primary Trip Estimate for Background Development						**33**	**10**	**16**	**28**

NOTES:

1. Land Use Code 710 and 932 is from Trip Generation, 10th Edition, (Institute of Transportation Engineers, Washington, 2017) and Land Use Code 826 is from Trip Generation, 9th Edition, (Institute of Transportation Engineers, Washington, 2012).
2. 'Gross Leasable Area x 1000 SF' for General Office, High-Turnover (Sit-Down) Restaurant and Specialty Retail.
3. Trip generation rates are 'vehicles per hour per unit'.
4. Trips generated are 'vehicles per hour' for AM and PM peak hours.
5. Retail uses have yet to be identified, therefore, the commercial space was assumed to be Specialty Retail.
6. The Specialty Retail (ITE Land Use 826) rate for 'Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 PM' has been used. Since there is no published rate for the AM peak hour of adjacent street traffic for this land use, and since AM peak hour trips to specialty retail are generally low, AM trip rates have been assumed to be 50% of the PM rate with reversal of the directional split.
7. A 30% reduction for non-auto trips has been used to account for transit, cycling and walking trips as well as on-site synergies.
8. Trip Generation Handbook, 3rd Edition, (Institute of Transportation Engineers, Washington, 2017) indicates an average of 34% pass-by trips for a Variety Store (Land Use 814) during the PM peak hour and there is no published rate for the AM peak hour, therefore, a 35% reduction for Specialty Retail trips was considered for the AM and PM peak hour. It also indicates 43% pass-by trips for High-Turnover (Sit-Down) Restaurant (Land Use 932) during the PM peak hour and there is no published rate for the AM peak hour. A weighted average of the associated pass-by rates was calculated to be 41%, therefore, a 40% reduction in commercial trips was used, which accounts for pass-by trips on Portland Street.

Table 2 – Trip Generation Estimates for the Proposed Development

Land Use[1]	Units[2]	Trip Generation Rates[3]				Trip Generation Estimates[4]			
		AM Peak		PM Peak		AM Peak		PM Peak	
		In	Out	In	Out	In	Out	In	Out
Penhorn Residential Development									
Single Family Housing (Land Use 210)	45 Units	0.19	0.55	0.62	0.37	9	25	28	16
Mid-Rise Apartments (Land Use 221)	427 Units	Equations from Pages 74 and 75 (Residential - Land Uses 200 - 299)				37	105	109	69
High-Rise Apartments (Land Use 222)	433 Units	Equations from Pages 153 and 154 (Residential - Land Uses 200 - 299)				32	102	95	61
Trip Generation Estimate for Proposed Site						78	232	232	146
30% Reduction for Non-Auto Trips[5]						23	70	70	44
Total Primary Trip Estimate for Proposed Site						**55**	**162**	**162**	**102**

NOTES:
1. Trip generation rates and equations are from Trip Generation, 10th Edition, (Institute of Transportation Engineers, Washington, 2017).
2. 'Number of Residential Units' for Single Family Housing and Mid-Rise and High-Rise Apartment Buildings.
3. Trip generation rates are 'vehicles per hour per unit'.
4. Trips generated are 'vehicles per hour' for AM and PM peak hours.
5. A 30% reduction for non-auto trips has been used to account for transit, cycling and walking trips as well as on-site synergies.

Trip Distribution and Assignment

External trips generated by the proposed development were assigned to the roadway network based on review of past studies and WSP's local knowledge of the area considering major trip origins and destinations in the region.

North	45%	(Burnside, Dartmouth Crossing, Bayers Lake, Bedford, Airport)
East	15%	(Adjacent Shopping Centers, Cole Harbour)
South	10%	(Woodside Industrial Park, Woodside Ferry Terminal, Shearwater)
West	30%	(Downtown Dartmouth, Downtown Halifax, Alderney Ferry Terminal)

Pass-by trips generated by the proposed development were assigned to the roadway based on the turning movement counts available.

It is estimated that of the vehicular traffic generated to/from the north, east and south, 80% will enter/exit the site using Site Access #1 and 20% will enter/exit the site using Site Access #2. It is estimated that trips to/from the west will use Site Access #1. In addition, it is estimated that all trips generated by the background development will enter/exit the site using Site Access #1 due to the location of the background development site. The configuration of the proposed site discourages vehicular traffic from traversing through the Penhorn Plaza site to/from the existing unsignalized driveway. It is not expected that new trips generated by the developments will access the site via the existing unsignalized driveway.

Projected 2030 Background Traffic Volumes

The projected 2030 AM and PM peak hour background volumes are shown diagrammatically in Figure A-2, Appendix A. It should be noted that the volumes have been rounded to the nearest multiple of 5.

Projected 2030 Traffic Volumes with Site Generated Trips

Trips generated by the proposed site (Figure A-3, Appendix A) have been added to the 2030 traffic volumes with the background developments (Figure A-2, Appendix A) to provide projected 2030 AM and PM peak hourly volumes that include site generated trips. The 2030 traffic volumes with the site generated trips are illustrated diagrammatically in Figure A-4, Appendix A.

4 INTERSECTION OPERATIONAL ANALYSIS

Intersection Capacity Analysis

Intersection capacity analysis was completed to estimate how the Study Intersections are currently performing and how they may be expected to operate in the future without and with site generated trips.

Synchro 10.0 software was used to evaluate the performance of the Study Intersections for the following scenarios:

A. Existing 2020 AM and PM peak hour volumes (with background development);
B. Projected 2030 AM and PM peak hour volumes without site development; and,
C. Projected 2030 AM and PM peak hour volumes with site development.

Detailed results of the analyses are included in Appendix B.

Intersection Capacity Analysis Results

Intersection 1 – Portland Street and Site Access #1/Green Village Lane (Table 3) – The existing intersection is expected to operate within available capacity during the AM and PM peak hours. Without site development, the intersection is expected to continue operating at a satisfactory performance during the peak hours. With site development, a surplus of residual capacity is expected and minimal changes to seconds of delay per vehicle are projected. This intersection is expected to operate within HRM guidelines with development of the proposed site.

Intersection 2 – Portland Street and Site Access #2/NS Highway 111 Southbound Onramp (Table 4) – The existing intersection is expected to operate within available capacity during the morning and evening peak periods. Without site development, the intersection is expected to continue operating at an acceptable performance during the peak hours. With site development, a surplus of residual capacity is expected and negligible changes to seconds of delay per vehicle are projected. This intersection is expected to operate within HRM guidelines with development of the proposed site.

Table 3 – Intersection Capacity Analysis for Portland Street at Site Access #1/Green Village Lane

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement									Overall Intersection
	Portland Street				Green Village Lane		Site Access #1			
	EB-L	EB-TR	WB-L	WB-TR	NB-LT	NB-R	SB-L	SB-T	SB-R	Delay
2020 AM Peak Hour with **Existing Conditions** (Page B-1)										
Delay	6.3	5.3	2.2	5.9	41.8	1.2	38.6	0.0	0.1	6.2
v/c	0.08	0.22	0.10	0.33	0.21	0.13	0.09	0.00	0.03	
Queue	5.9	29.8	5.0	47.7	12.7	0.0	7.0	0.0	0.0	
2020 PM Peak Hour with **Existing Conditions** (Page B-3)										
Delay	6.6	6.6	2.6	6.2	42.8	0.9	39.2	0.0	0.2	7.0
v/c	0.05	0.37	0.15	0.32	0.26	0.10	0.13	0.00	0.05	
Queue	4.6	59.6	5.3	49.1	14.6	0.0	8.9	0.0	0.0	
2030 AM Peak Hour **without** Proposed Site (Page B-5)										
Delay	6.6	5.4	2.2	6.3	41.8	1.2	38.6	0.0	0.1	6.4
v/c	0.09	0.25	0.11	0.38	0.21	0.13	0.09	0.00	0.03	
Queue	6.1	34.5	5.0	56.7	12.7	0.0	7.0	0.0	0.0	
2030 PM Peak Hour **without** Proposed Site (Page B-7)										
Delay	6.7	7.0	2.8	6.5	42.8	0.9	38.2	0.0	0.2	7.3
v/c	0.06	0.42	0.17	0.36	0.26	0.10	0.13	0.00	0.05	
Queue	4.7	70.7	5.3	57.6	14.6	0.0	8.9	0.0	0.0	
2030 AM Peak Hour **with** Proposed Site (Page B-9)										
Delay	11.6	8.9	4.2	10.4	33.5	0.6	47.4	0.0	0.4	11.6
v/c	0.17	0.28	0.12	0.44	0.14	0.09	0.58	0.00	0.11	
Queue	12.2	46.1	8.0	79.2	11.3	0.0	33.8	0.0	0.0	
2030 PM Peak Hour **with** Proposed Site (Page B-11)										
Delay	11.8	9.7	4.1	9.3	37.0	0.7	46.1	0.0	0.3	10.6
v/c	0.25	0.46	0.18	0.44	0.20	0.08	0.48	0.00	0.10	
Queue	16.8	82.0	7.0	75.8	13.7	0.0	26.4	0.0	0.0	

Table 4 – Intersection Capacity Analysis for Portland Street at Site Access #2/NS Highway 111 Southbound Onramp

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement							Overall Intersection
	Portland Street				Site Access #2			
	EB-L	EB-TR	WB-L	WB-TR	SB-L	SB-T	SB-R	Delay
2020 AM Peak Hour with **Existing Conditions** (Page B-2)								
Delay	2.8	5.5	14.3	4.8	43.8	43.7	0.4	9.0
v/c	0.05	0.25	0.57	0.25	0.40	0.40	0.05	
Queue	2.8	38.0	80.4	32.0	25.6	26.1	0.0	
2020 PM Peak Hour with **Existing Conditions** (Page B-4)								
Delay	3.0	7.2	12.3	5.7	44.2	43.7	0.9	9.5
v/c	0.08	0.36	0.40	0.24	0.43	0.42	0.11	
Queue	4.1	56.3	33.7	30.6	28.1	28.0	0.0	
2030 AM Peak Hour **without** Proposed Site (Page B-6)								
Delay	2.9	5.7	24.5	5.1	43.8	43.7	0.4	10.5
v/c	0.06	0.30	0.75	0.28	0.40	0.40	0.05	
Queue	2.8	46.0	117.6	38.2	25.6	26.1	0.0	
2030 PM Peak Hour **without** Proposed Site (Page B-8)								
Delay	3.1	7.9	21.2	6.1	44.2	43.7	0.9	10.2
v/c	0.09	0.43	0.58	0.28	0.43	0.42	0.11	
Queue	4.1	72.9	61.1	37.3	28.1	28.0	0.0	
2030 AM Peak Hour **with** Proposed Site (Page B-10)								
Delay	3.1	6.3	36.5	5.5	44.4	44.1	0.3	12.6
v/c	0.06	0.34	0.85	0.30	0.45	0.44	0.04	
Queue	3.0	55.0	127.3	41.3	29.1	29.1	0.0	
2030 PM Peak Hour **with** Proposed Site (Page B-12)								
Delay	3.4	8.4	26.1	6.5	44.5	44.2	0.8	10.9
v/c	0.10	0.46	0.64	0.32	0.46	0.45	0.11	
Queue	4.2	80.1	65.6	43.6	29.8	30.2	0.0	

5 SUMMARY AND CONCLUSIONS

5.1 SUMMARY

Description of the Proposed Development

1. Plans are being prepared for a residential development adjacent to the existing Penhorn Plaza site in Dartmouth, Nova Scotia. The proposed development is expected to consist of 427 Mid-Rise Apartment units, 448 High-Rise Apartment units and 45 Single Family Dwellings. Full occupancy of this development is anticipated by 2030.

Description of the Background Development

2. A background development was taken into consideration in order to project background traffic volumes resulting from redevelopment of the former Sears building. This mixed-use background development includes 32,000 ft^2 of General Office, 5,000 ft^2 of High-Turnover (Sit-Down) Restaurant and 5,000 ft^2 of Specialty Retail when fully occupied.

Proposed Site Access

3. It is expected that vehicular access to the proposed site will be provided via the existing signalized intersections that currently provide access to Penhorn Plaza.

Estimation of Site Generated Trips

4. Trip generation estimates were prepared using rates published in *Trip Generation, 10th Edition* (Institute of Transportation Engineers, Washington, 2017) as well as *Trip Generation Manual, 9th Edition (*Institute of Transportation Engineers, Washington, 2012).

   It is estimated that the site will generate:
   - 179 two-way trips (46 entering and 133 exiting) during the AM peak hour; and,
   - 227 two-way trips (140 entering and 87 exiting) during the PM peak hour.

Trip Distribution and Assignment

5. External trips generated by the proposed development were assigned to the roadway network based on review of past studies and WSP's local knowledge of the area considering major trip origins and destinations in the region. Trips were distributed to the north (45%), east (15%), south (10%) and west (30%).

Summary – Intersection Capacity Analysis

6. ***Intersection 1 – Portland Street and Site Access #1/Green Village Lane –*** This intersection is expected to operate within HRM acceptable limits in 2030 with site development.

   Intersection 2 – Portland Street and Site Access #2/NS Highway 111 Southbound Onramp – This intersection is expected to operate within HRM acceptable limits in 2030 with site development.

5.2 CONCLUSIONS

Impacts to Vehicular Traffic

7. Since the access intersections for this redevelopment site have been constructed to accommodate traffic volumes for a large regional shopping center, there remains residual capacity on the driveway approaches. With added trips generated by the proposed development, the access intersections are projected to operate within HRM guidelines at full occupancy.

APPENDIX

A

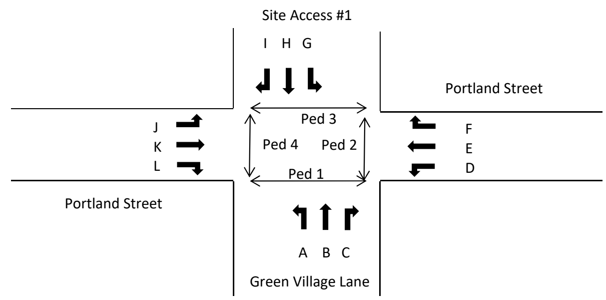
TRAFFIC VOLUME DATA

Table A-1

Portland Street @ Green Village Lane/Site Access #1

Dartmouth, NS

Thursday, November 22, 2018



AM Peak Period Volume Data

Time		Green Village Lane Northbound Approach			Portland Street Westbound Approach			Site Access #1 Southbound Approach			Portland Street Eastbound Approach			Total Vehicles
		A	B	C	D	E	F	G	H	I	J	K	L	
07:00	07:15	5	0	7	9	168	0	0	0	0	0	86	1	276
07:15	07:30	5	0	12	15	187	0	0	1	1	0	120	0	341
07:30	07:45	6	0	9	6	193	2	1	0	0	0	161	2	380
07:45	08:00	6	0	11	11	234	1	1	0	0	0	161	1	426
08:00	08:15	4	0	0	16	214	2	0	0	0	0	142	2	380
08:15	08:30	8	0	10	21	192	1	1	0	0	0	130	6	369
08:30	08:45	7	1	5	21	210	3	1	0	0	0	137	3	388
08:45	09:00	5	0	2	12	199	1	0	0	0	1	126	5	351
AM Peak Hour		**25**	**1**	**26**	**69**	**850**	**7**	**3**	**0**	**0**	**0**	**570**	**12**	**1563**
07:00	**08:00**	**22**	**0**	**39**	**41**	**782**	**3**	**2**	**1**	**1**	**0**	**528**	**4**	**1423**
08:00	**09:00**	**24**	**1**	**17**	**70**	**815**	**7**	**2**	**0**	**0**	**1**	**535**	**16**	**1488**
		Ped 1			**Ped 2**			**Ped 3**			**Ped 4**			**Total Peds**
07:00	**08:00**	**0**			**1**			**14**			**11**			**26**
08:00	**09:00**	**3**			**0**			**7**			**4**			**14**

Midday Peak Period Volume Data

Time		Green Village Lane Northbound Approach			Portland Street Westbound Approach			Site Access #1 Southbound Approach			Portland Street Eastbound Approach			Total Vehicles
		A	B	C	D	E	F	G	H	I	J	K	L	
11:00	11:15	3	0	8	6	130	3	1	0	0	0	111	3	265
11:15	11:30	1	0	9	11	179	0	2	0	0	1	143	1	347
11:30	11:45	2	0	4	10	163	0	0	0	0	1	169	4	353
11:45	12:00	2	0	7	15	131	0	1	0	0	1	170	1	328
12:00	12:15	2	0	2	5	161	0	1	0	0	2	151	4	328
12:15	12:30	2	0	2	14	152	1	1	0	0	1	189	3	365
12:30	12:45	2	0	3	6	176	1	1	1	0	3	170	2	365
12:45	13:00	2	0	11	8	165	1	0	0	0	1	150	2	340
Midday Peak Hour		**8**	**0**	**18**	**33**	**654**	**3**	**3**	**1**	**0**	**7**	**660**	**11**	**1398**
11:00	**12:00**	**8**	**0**	**28**	**42**	**603**	**3**	**4**	**0**	**0**	**3**	**593**	**9**	**1293**
12:00	**13:00**	**8**	**0**	**18**	**33**	**654**	**3**	**3**	**1**	**0**	**7**	**660**	**11**	**1398**
		Ped 1			**Ped 2**			**Ped 3**			**Ped 4**			**Total Peds**
11:00	**12:00**	**3**			**0**			**5**			**5**			**13**
12:00	**13:00**	**0**			**0**			**6**			**5**			**11**

PM Peak Period Volume Data

Time		Green Village Lane Northbound Approach			Portland Street Westbound Approach			Site Access #1 Southbound Approach			Portland Street Eastbound Approach			Total Vehicles
		A	B	C	D	E	F	G	H	I	J	K	L	
16:00	16:15	4	0	7	17	171	0	2	1	0	1	201	4	408
16:15	16:30	1	1	11	13	185	1	3	0	0	2	213	7	437
16:30	16:45	12	0	4	21	176	0	1	0	0	1	222	4	441
16:45	17:00	8	0	4	12	232	1	0	1	0	0	264	5	527
17:00	17:15	9	0	8	25	210	1	0	0	0	0	194	9	456
17:15	17:30	8	0	3	13	189	0	0	0	0	0	267	4	484
17:30	17:45	3	0	4	19	197	1	0	0	0	1	234	2	461
17:45	18:00	5	0	6	18	180	0	1	0	0	1	172	1	384
PM Peak Hour		**28**	**0**	**19**	**69**	**828**	**3**	**0**	**1**	**0**	**1**	**959**	**20**	**1928**
16:00	**17:00**	**25**	**1**	**26**	**63**	**764**	**2**	**6**	**2**	**0**	**4**	**900**	**20**	**1813**
17:00	**18:00**	**25**	**0**	**21**	**75**	**776**	**2**	**1**	**0**	**0**	**2**	**867**	**16**	**1785**
		Ped 1			**Ped 2**			**Ped 3**			**Ped 4**			**Total Peds**
16:00	**17:00**	**0**			**0**			**1**			**3**			**4**
17:00	**18:00**	**0**			**0**			**7**			**6**			**13**

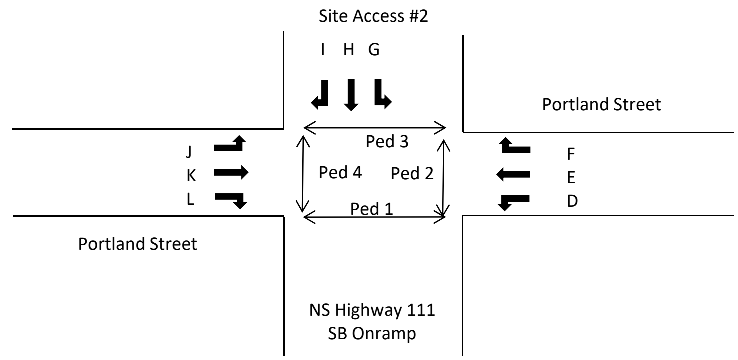
* Count *not* completed by WSP

Table A-2

Portland Street
@
Site Access #2/
NS Highway 111 SB Onramp

Dartmouth, NS

Wednesday, August 23, 2017



AM Peak Period Volume Data

Time		Portland Street Westbound Approach D	E	F	Site Access #2 Southbound Approach G	H	I	Portland Street Eastbound Approach J	K	L	Total Vehicles
07:00	07:15	62	153	20	13	10	2	3	118	7	388
07:15	07:30	76	167	31	21	11	1	6	133	11	457
07:30	07:45	83	191	34	15	7	1	5	141	8	485
07:45	08:00	78	188	36	40	5	0	5	147	10	509
08:00	08:15	77	168	45	36	2	3	8	157	11	507
08:15	08:30	60	166	44	24	1	6	7	161	6	475
08:30	08:45	59	171	37	26	2	3	8	159	8	473
08:45	09:00	64	188	33	23	4	2	5	166	8	493
AM Peak Hour		**298**	**713**	**159**	**115**	**15**	**10**	**25**	**606**	**35**	**1976**
07:00	**08:00**	**299**	**699**	**121**	**89**	**33**	**4**	**19**	**539**	**36**	**1839**
08:00	**09:00**	**260**	**693**	**159**	**109**	**9**	**14**	**28**	**643**	**33**	**1948**

Time		Ped 2	Ped 3	Ped 4	Total Peds
07:00	**08:00**	**0**	**7**	**0**	**7**
08:00	**09:00**	**0**	**9**	**0**	**9**

Midday Peak Period Volume Data

Time		Portland Street Westbound Approach D	E	F	Site Access #2 Southbound Approach G	H	I	Portland Street Eastbound Approach J	K	L	Total Vehicles
11:00	11:15	25	163	44	38	7	3	11	198	21	510
11:15	11:30	32	140	43	38	4	2	9	171	14	453
11:30	11:45	34	138	43	40	8	4	9	182	19	477
11:45	12:00	32	162	47	33	5	2	12	184	18	495
12:00	12:15	34	148	25	41	7	3	9	193	22	482
12:15	12:30	41	154	31	48	6	2	9	196	20	507
12:30	12:45	30	147	37	39	9	1	11	199	26	499
12:45	13:00	27	259	38	32	5	3	8	197	21	590
Midday Peak Hour		**132**	**708**	**131**	**160**	**27**	**9**	**37**	**785**	**89**	**2078**
11:00	**12:00**	**123**	**603**	**177**	**149**	**24**	**11**	**41**	**735**	**72**	**1935**
12:00	**13:00**	**132**	**708**	**131**	**160**	**27**	**9**	**37**	**785**	**89**	**2078**

Time		Ped 2	Ped 3	Ped 4	Total Peds
11:00	**12:00**	**0**	**7**	**0**	**7**
12:00	**13:00**	**0**	**9**	**0**	**9**

PM Peak Period Volume Data

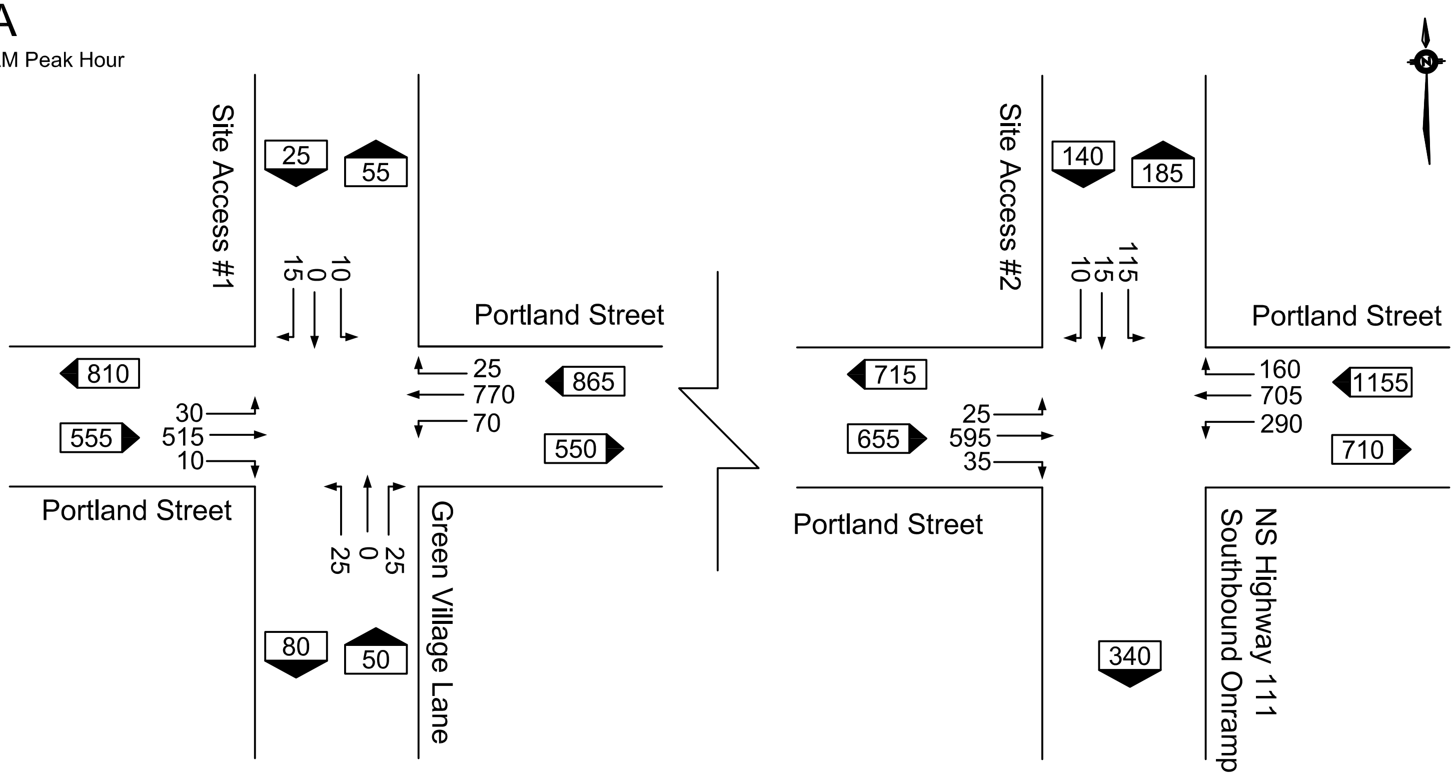
Time		Portland Street Westbound Approach D	E	F	Site Access #2 Southbound Approach G	H	I	Portland Street Eastbound Approach J	K	L	Total Vehicles
16:00	16:15	17	154	51	35	2	1	5	223	11	499
16:15	16:30	50	162	26	25	5	5	8	219	12	512
16:30	16:45	41	176	29	33	6	5	10	204	13	517
16:45	17:00	31	183	45	31	10	8	9	211	11	539
17:00	17:15	28	174	43	24	8	5	13	216	9	520
17:15	17:30	22	169	35	27	6	4	9	207	8	487
17:30	17:45	26	158	27	29	11	3	9	201	10	474
17:45	18:00	18	157	25	21	7	3	6	194	8	439
PM Peak Hour		**150**	**695**	**143**	**113**	**29**	**23**	**40**	**850**	**45**	**2088**
16:00	**17:00**	**139**	**675**	**151**	**124**	**23**	**19**	**32**	**857**	**47**	**2067**
17:00	**18:00**	**94**	**658**	**130**	**101**	**32**	**15**	**37**	**818**	**35**	**1920**

Time		Ped 2	Ped 3	Ped 4	Total Peds
16:00	**17:00**	**0**	**10**	**0**	**10**
17:00	**18:00**	**0**	**11**	**0**	**11**

* Count *not* completed by WSP

A

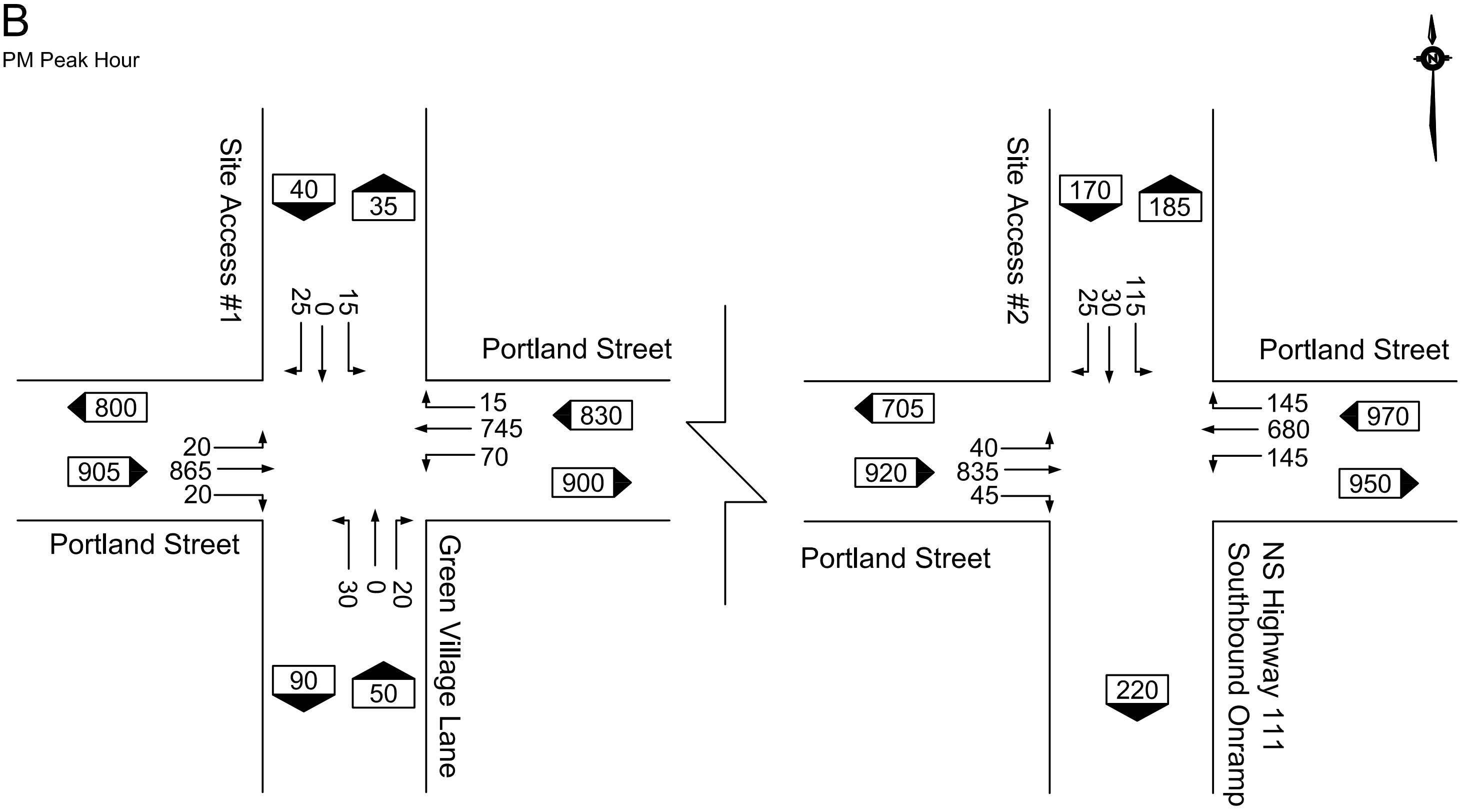
AM Peak Hour



NOT TO SCALE

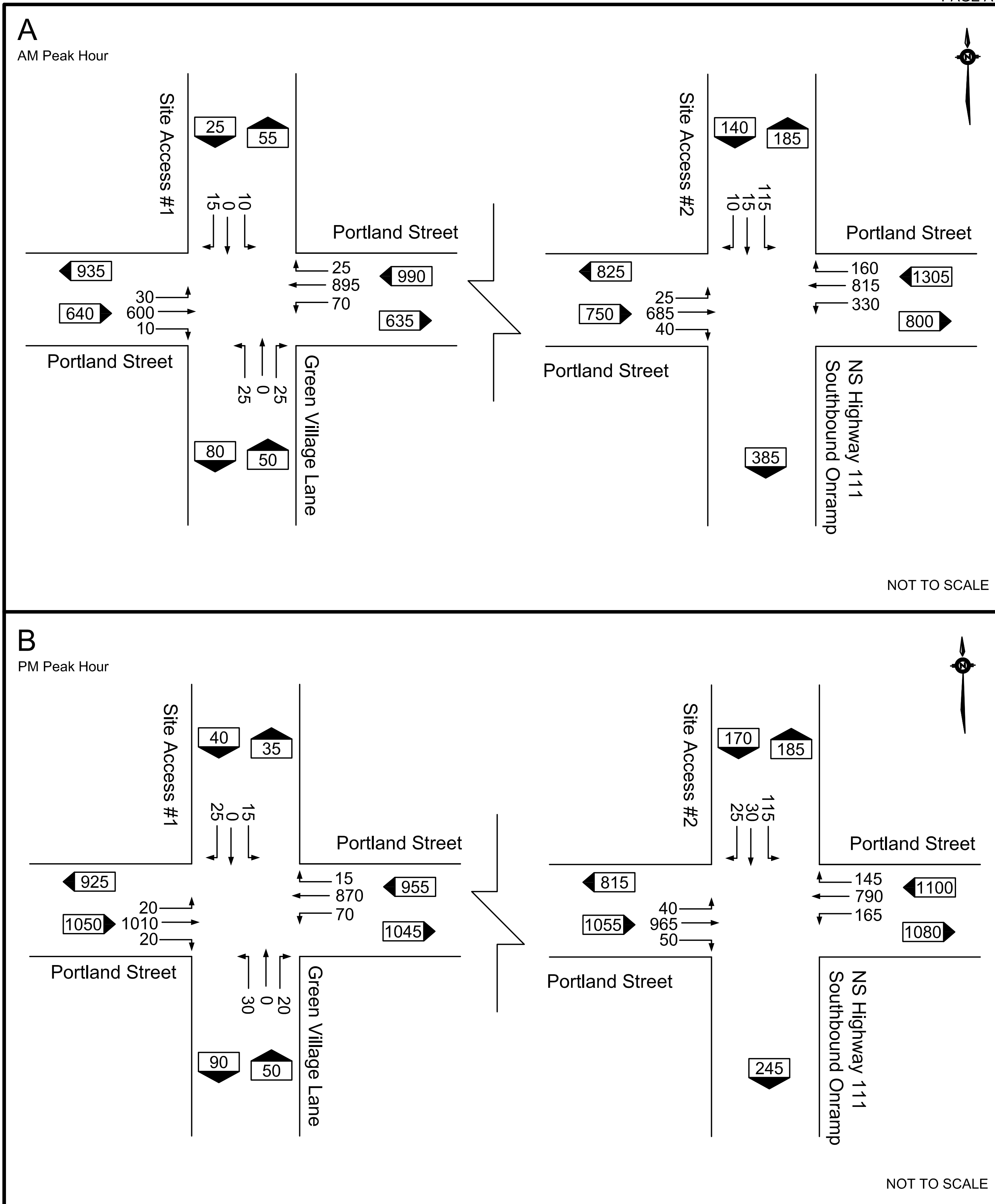
B

PM Peak Hour



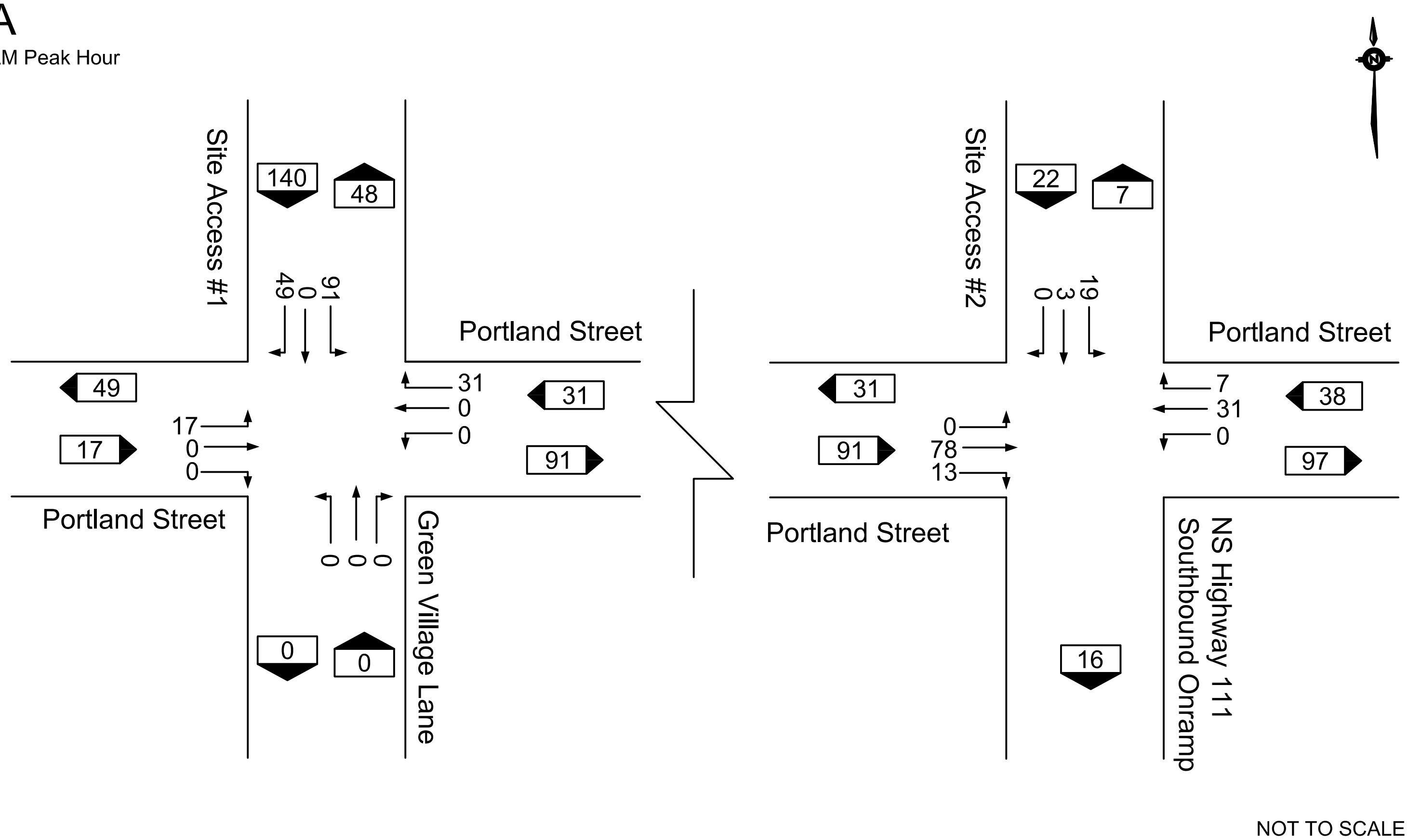
NOT TO SCALE

wsp	Traffic Impact Study - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-1
	2020 Weekday AM and PM Peak Hour Without Site Development	June 2020

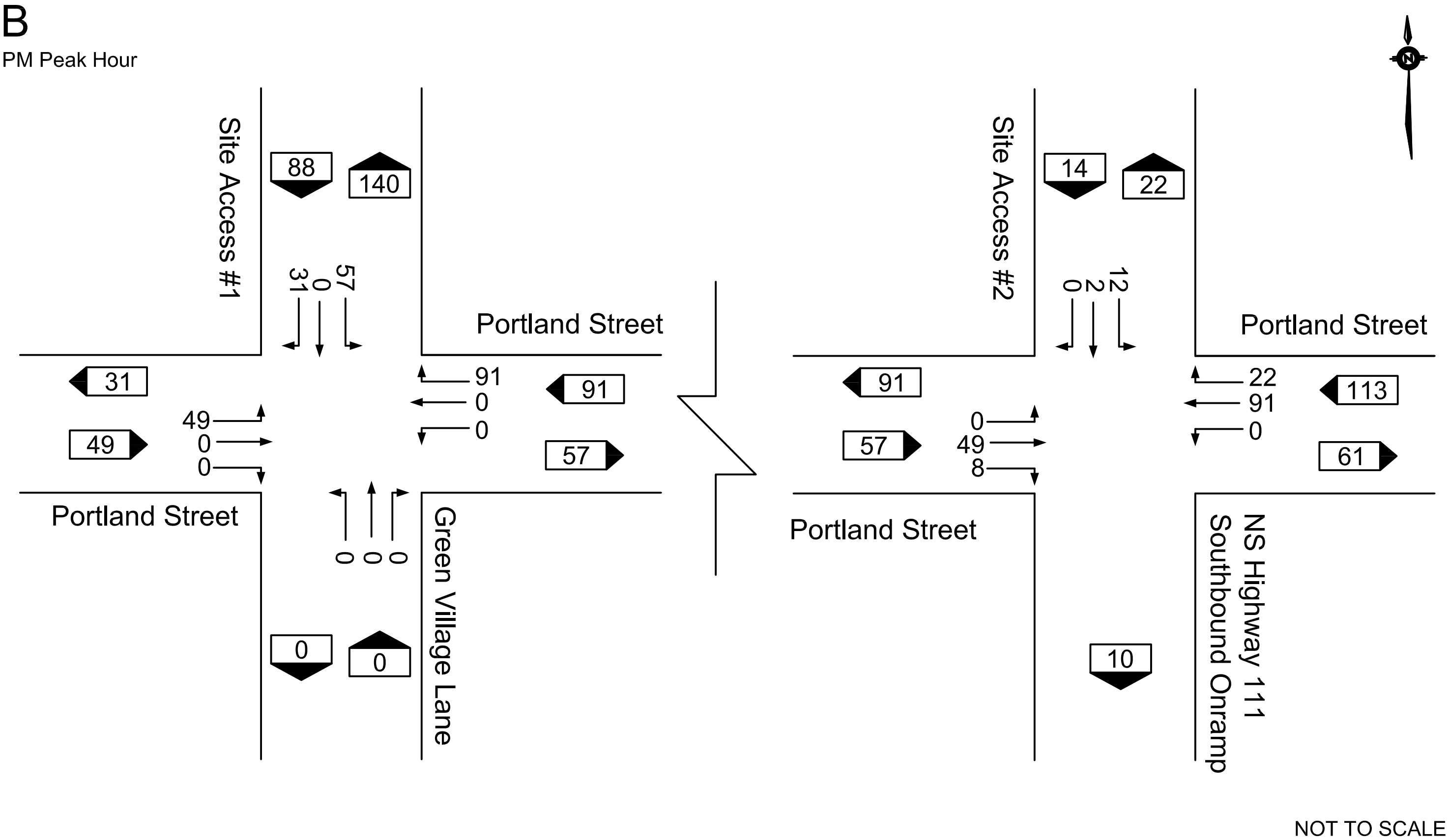


wsp	Traffic Impact Study - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-2
	2030 Weekday AM and PM Peak Hour Without Site Development	June 2020

A
AM Peak Hour

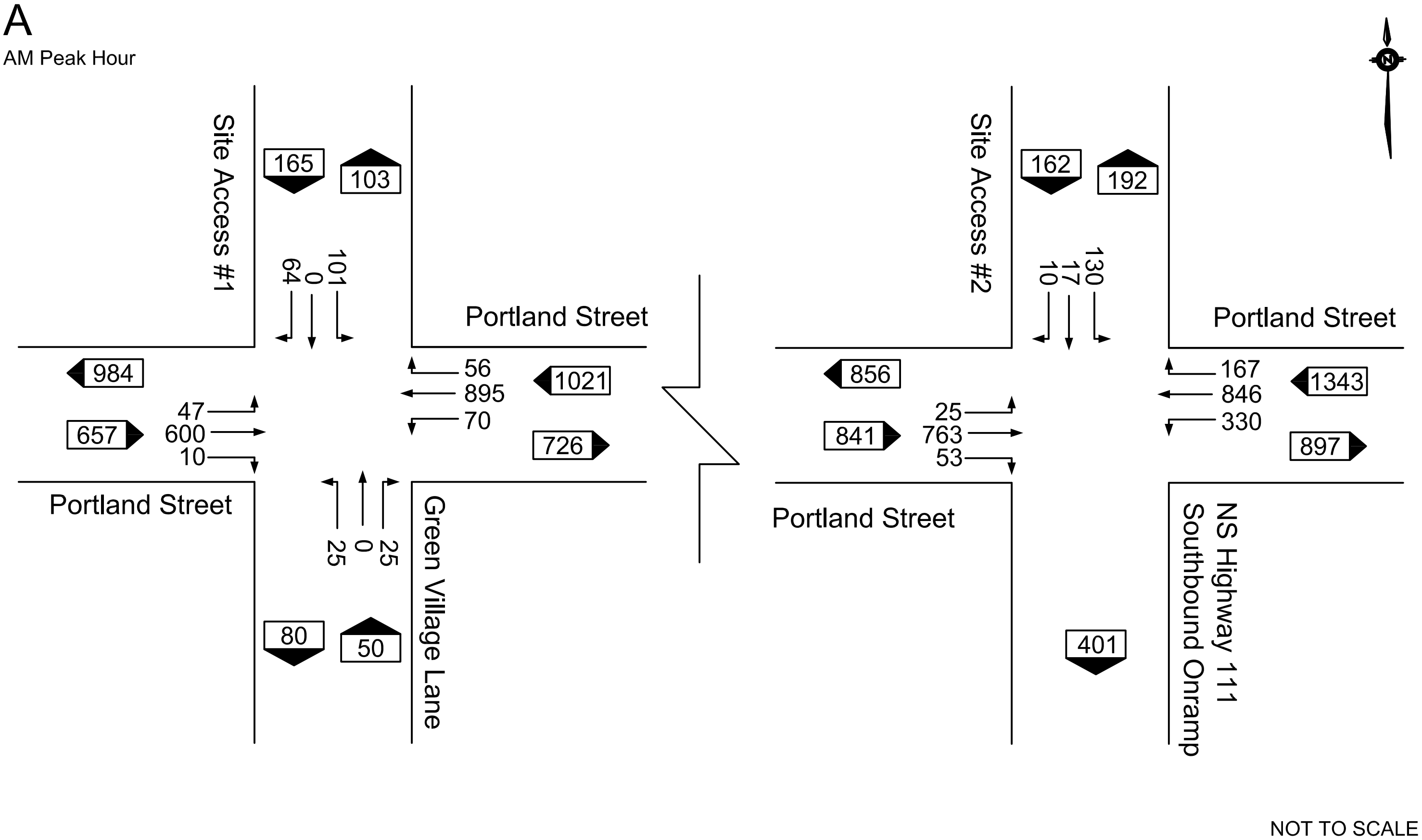


B
PM Peak Hour

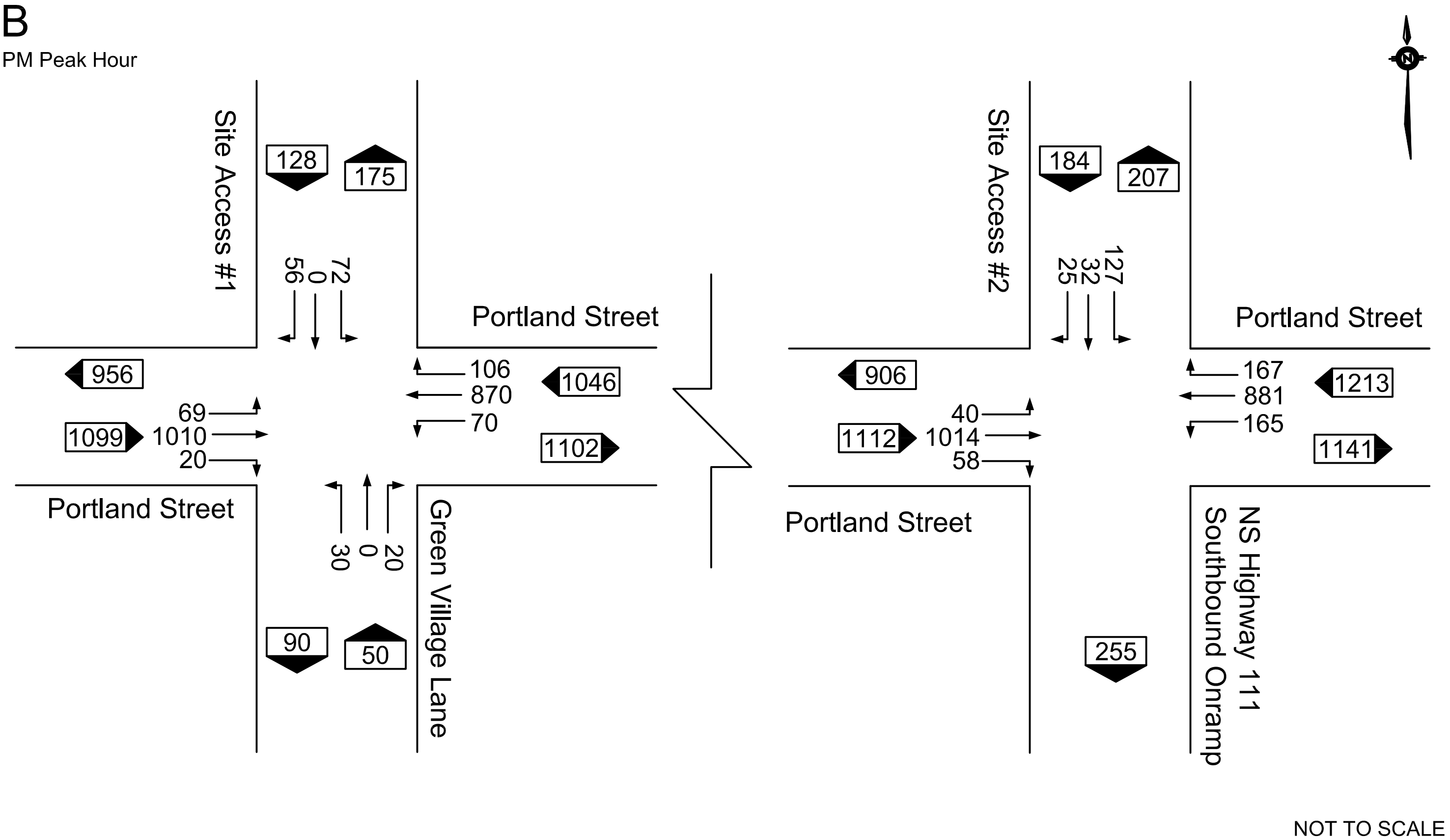


wsp	Traffic Impact Study - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-3
	Site Generated Trips Estimate	June 2020

A
AM Peak Hour



B
PM Peak Hour



wsp	Traffic Impact Study - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-4
	2030 Weekday AM and PM Peak Hour With Site Development	June 2020

APPENDIX

B

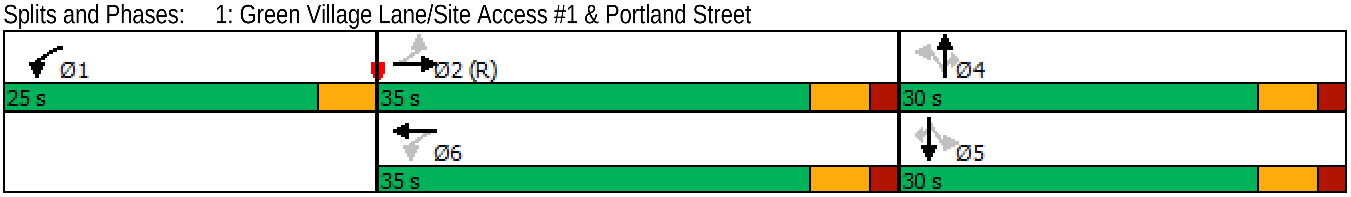
INTERSECTION PERFORMANCE ANALYSIS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	515	10	70	770	25	25	0	25	10	0	15
Future Volume (vph)	30	515	10	70	770	25	25	0	25	10	0	15
Satd. Flow (prot)	1770	3529	0	1770	3522	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.309			0.429				0.800		0.800		
Satd. Flow (perm)	576	3529	0	799	3522	0	0	1490	1583	1490	1863	1583
Satd. Flow (RTOR)		2			4				85			476
Lane Group Flow (vph)	33	590	0	76	873	0	0	27	27	11	0	16
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	67.8	67.8		74.2	67.8			7.8	7.8	7.8		7.8
Actuated g/C Ratio	0.75	0.75		0.82	0.75			0.09	0.09	0.09		0.09
v/c Ratio	0.08	0.22		0.10	0.33			0.21	0.13	0.09		0.03
Control Delay	6.3	5.3		2.2	5.9			41.8	1.2	38.6		0.1
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	6.3	5.3		2.2	5.9			41.8	1.2	38.6		0.1
LOS	A	A		A	A			D	A	D		A
Approach Delay		5.3			5.6			21.5			15.8	
Approach LOS		A			A			C			B	
Queue Length 50th (m)	1.9	19.8		2.0	32.5			4.7	0.0	1.9		0.0
Queue Length 95th (m)	5.9	29.8		5.0	47.7			12.7	0.0	7.0		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	433	2657		913	2652			397	484	397		771
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.08	0.22		0.08	0.33			0.07	0.06	0.03		0.02

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.33
Intersection Signal Delay: 6.2 Intersection LOS: A
Intersection Capacity Utilization 51.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

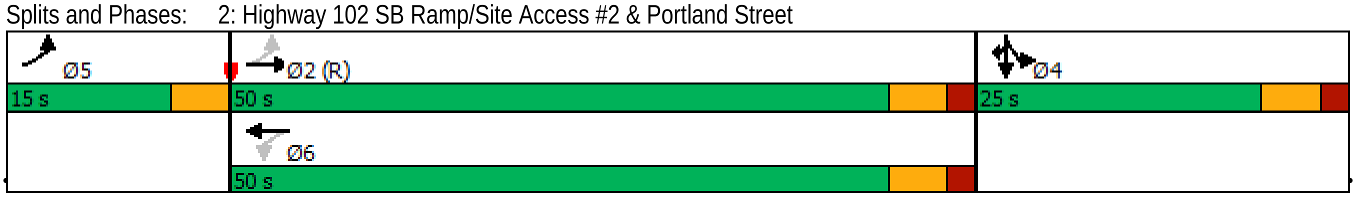


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	595	35	290	705	160	0	0	0	115	15	10
Future Volume (vph)	25	595	35	290	705	160	0	0	0	115	15	10
Satd. Flow (prot)	1770	3511	0	1770	4943	0	0	0	0	1681	1704	1583
Flt Permitted	0.293			0.393						0.950	0.963	
Satd. Flow (perm)	546	3511	0	732	4943	0	0	0	0	1681	1704	1583
Satd. Flow (RTOR)		9			82							85
Lane Group Flow (vph)	27	671	0	315	932	0	0	0	0	70	71	11
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	71.6	68.0		68.0	68.0					9.4	9.4	9.4
Actuated g/C Ratio	0.80	0.76		0.76	0.76					0.10	0.10	0.10
v/c Ratio	0.05	0.25		0.57	0.25					0.40	0.40	0.05
Control Delay	2.8	5.5		14.3	4.8					43.8	43.7	0.4
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	2.8	5.5		14.3	4.8					43.8	43.7	0.4
LOS	A	A		B	A					D	D	A
Approach Delay		5.4			7.2						40.6	
Approach LOS		A			A						D	
Queue Length 50th (m)	0.8	14.4		18.7	12.6					12.8	12.9	0.0
Queue Length 95th (m)	2.8	38.0		#80.4	32.0					25.6	26.1	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	593	2654		553	3754					354	359	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.05	0.25		0.57	0.25					0.20	0.20	0.03

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.57
Intersection Signal Delay: 9.0 Intersection LOS: A
Intersection Capacity Utilization 54.5% ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

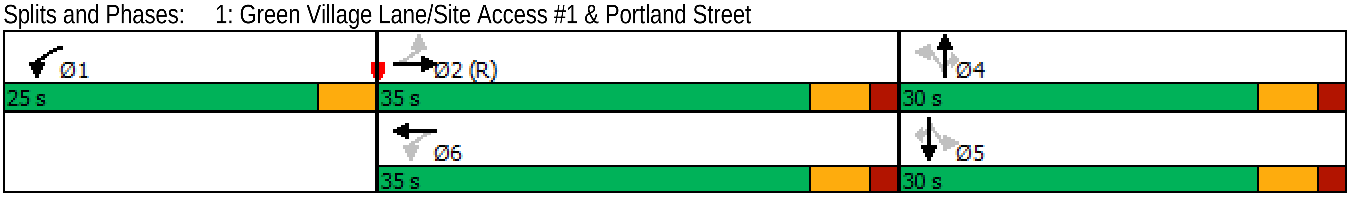


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	20	865	20	70	745	15	30	0	20	15	0	25
Future Volume (vph)	20	865	20	70	745	15	30	0	20	15	0	25
Satd. Flow (prot)	1770	3529	0	1770	3529	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.316			0.268				0.757		0.755		
Satd. Flow (perm)	589	3529	0	499	3529	0	0	1410	1583	1406	1863	1583
Satd. Flow (RTOR)		3			2				85			477
Lane Group Flow (vph)	22	983	0	76	853	0	0	33	22	16	0	27
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	67.2	67.2		73.9	67.2			8.1	8.1	8.1		8.1
Actuated g/C Ratio	0.75	0.75		0.82	0.75			0.09	0.09	0.09		0.09
v/c Ratio	0.05	0.37		0.15	0.32			0.26	0.10	0.13		0.05
Control Delay	6.6	6.6		2.6	6.2			42.8	0.9	39.2		0.2
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	6.6	6.6		2.6	6.2			42.8	0.9	39.2		0.2
LOS	A	A		A	A			D	A	D		A
Approach Delay		6.6			5.9			26.1			14.7	
Approach LOS		A			A			C			B	
Queue Length 50th (m)	1.3	38.9		2.1	32.1			5.8	0.0	2.8		0.0
Queue Length 95th (m)	4.6	59.6		5.3	49.1			14.6	0.0	8.9		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	439	2635		723	2634			376	484	374		771
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.05	0.37		0.11	0.32			0.09	0.05	0.04		0.04

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.37
Intersection Signal Delay: 7.0 Intersection LOS: A
Intersection Capacity Utilization 52.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

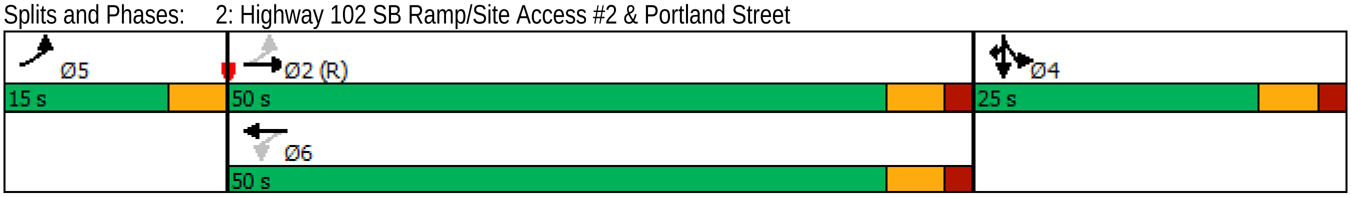


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	835	45	145	680	145	0	0	0	115	30	25
Future Volume (vph)	40	835	45	145	680	145	0	0	0	115	30	25
Satd. Flow (prot)	1770	3511	0	1770	4948	0	0	0	0	1681	1720	1583
Flt Permitted	0.312			0.291						0.950	0.972	
Satd. Flow (perm)	581	3511	0	542	4948	0	0	0	0	1681	1720	1583
Satd. Flow (RTOR)		9			76							85
Lane Group Flow (vph)	43	910	0	158	874	0	0	0	0	79	79	27
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	70.4	65.4		65.4	65.4					9.8	9.8	9.8
Actuated g/C Ratio	0.78	0.73		0.73	0.73					0.11	0.11	0.11
v/c Ratio	0.08	0.36		0.40	0.24					0.43	0.42	0.11
Control Delay	3.0	7.2		12.3	5.7					44.2	43.7	0.9
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	3.0	7.2		12.3	5.7					44.2	43.7	0.9
LOS	A	A		B	A					D	D	A
Approach Delay		7.0			6.7						37.7	
Approach LOS		A			A						D	
Queue Length 50th (m)	1.4	37.7		13.2	20.6					14.4	14.4	0.0
Queue Length 95th (m)	4.1	56.3		33.7	30.6					28.1	28.0	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	615	2553		393	3616					354	363	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.07	0.36		0.40	0.24					0.22	0.22	0.07

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.43
Intersection Signal Delay: 9.5 Intersection LOS: A
Intersection Capacity Utilization 53.4% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

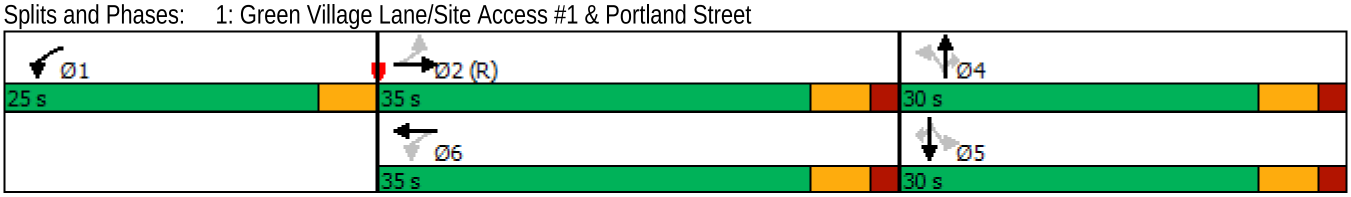


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	600	10	70	895	25	25	0	25	10	0	15
Future Volume (vph)	30	600	10	70	895	25	25	0	25	10	0	15
Satd. Flow (prot)	1770	3532	0	1770	3525	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.264			0.397				0.800		0.800		
Satd. Flow (perm)	492	3532	0	740	3525	0	0	1490	1583	1490	1863	1583
Satd. Flow (RTOR)		2			3				85			468
Lane Group Flow (vph)	33	663	0	76	1000	0	0	27	27	11	0	16
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	67.8	67.8		74.2	67.8			7.8	7.8	7.8		7.8
Actuated g/C Ratio	0.75	0.75		0.82	0.75			0.09	0.09	0.09		0.09
v/c Ratio	0.09	0.25		0.11	0.38			0.21	0.13	0.09		0.03
Control Delay	6.6	5.4		2.2	6.3			41.8	1.2	38.6		0.1
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	6.6	5.4		2.2	6.3			41.8	1.2	38.6		0.1
LOS	A	A		A	A			D	A	D		A
Approach Delay		5.5			6.0			21.5			15.8	
Approach LOS		A			A			C			B	
Queue Length 50th (m)	1.9	22.9		2.0	39.2			4.7	0.0	1.9		0.0
Queue Length 95th (m)	6.1	34.5		5.0	56.7			12.7	0.0	7.0		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	370	2659		876	2654			397	484	397		765
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.09	0.25		0.09	0.38			0.07	0.06	0.03		0.02

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.38
Intersection Signal Delay: 6.4 | Intersection LOS: A
Intersection Capacity Utilization 54.4% | ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

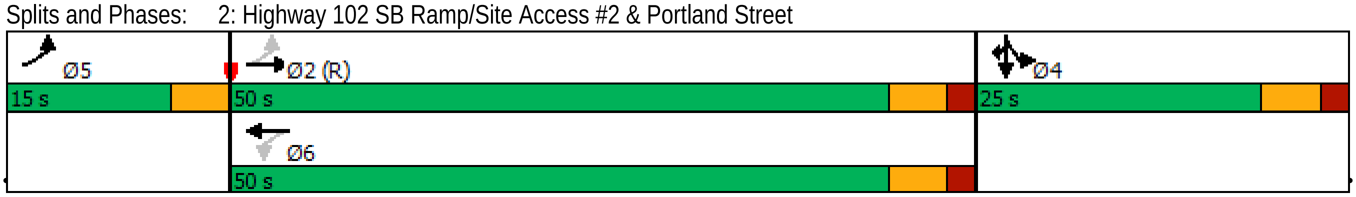


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	685	40	330	815	160	0	0	0	115	15	10
Future Volume (vph)	25	685	40	330	815	160	0	0	0	115	15	10
Satd. Flow (prot)	1770	3511	0	1770	4958	0	0	0	0	1681	1704	1583
Flt Permitted	0.252			0.342						0.950	0.963	
Satd. Flow (perm)	469	3511	0	637	4958	0	0	0	0	1681	1704	1583
Satd. Flow (RTOR)		9			64							85
Lane Group Flow (vph)	27	788	0	359	1060	0	0	0	0	70	71	11
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	71.6	68.0		68.0	68.0					9.4	9.4	9.4
Actuated g/C Ratio	0.80	0.76		0.76	0.76					0.10	0.10	0.10
v/c Ratio	0.06	0.30		0.75	0.28					0.40	0.40	0.05
Control Delay	2.9	5.7		24.5	5.1					43.8	43.7	0.4
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	2.9	5.7		24.5	5.1					43.8	43.7	0.4
LOS	A	A		C	A					D	D	A
Approach Delay		5.7			10.0						40.6	
Approach LOS		A			B						D	
Queue Length 50th (m)	0.8	17.7		27.7	15.2					12.8	12.9	0.0
Queue Length 95th (m)	2.8	46.0		#117.6	38.2					25.6	26.1	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	540	2654		481	3761					354	359	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.05	0.30		0.75	0.28					0.20	0.20	0.03

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.75
Intersection Signal Delay: 10.5 Intersection LOS: B
Intersection Capacity Utilization 59.3% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

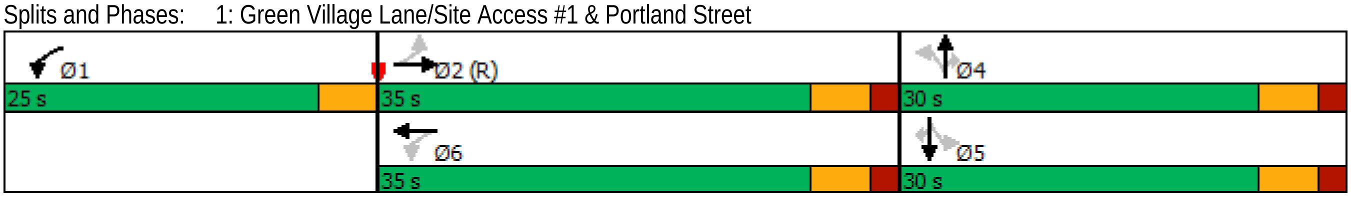


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	20	1010	20	70	870	15	30	0	20	15	0	25
Future Volume (vph)	20	1010	20	70	870	15	30	0	20	15	0	25
Satd. Flow (prot)	1770	3529	0	1770	3532	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.276			0.225				0.757		0.755		
Satd. Flow (perm)	514	3529	0	419	3532	0	0	1410	1583	1406	1863	1583
Satd. Flow (RTOR)		2			2				85			470
Lane Group Flow (vph)	22	1120	0	76	962	0	0	33	22	16	0	27
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	67.2	67.2		73.9	67.2			8.1	8.1	8.1		8.1
Actuated g/C Ratio	0.75	0.75		0.82	0.75			0.09	0.09	0.09		0.09
v/c Ratio	0.06	0.42		0.17	0.36			0.26	0.10	0.13		0.05
Control Delay	6.7	7.0		2.8	6.5			42.8	0.9	39.2		0.2
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	6.7	7.0		2.8	6.5			42.8	0.9	39.2		0.2
LOS	A	A		A	A			D	A	D		A
Approach Delay		7.0			6.2			26.1			14.7	
Approach LOS		A			A			C			B	
Queue Length 50th (m)	1.3	46.8		2.1	37.7			5.8	0.0	2.8		0.0
Queue Length 95th (m)	4.7	70.7		5.3	57.6			14.6	0.0	8.9		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	383	2636		674	2638			376	484	374		766
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.06	0.42		0.11	0.36			0.09	0.05	0.04		0.04

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.42
Intersection Signal Delay: 7.3 Intersection LOS: A
Intersection Capacity Utilization 56.1% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

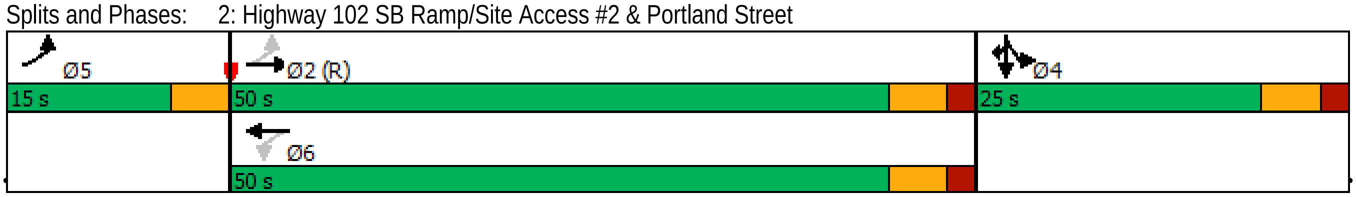


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	965	50	165	790	145	0	0	0	115	30	25
Future Volume (vph)	40	965	50	165	790	145	0	0	0	115	30	25
Satd. Flow (prot)	1770	3514	0	1770	4968	0	0	0	0	1681	1720	1583
Flt Permitted	0.263			0.227						0.950	0.972	
Satd. Flow (perm)	490	3514	0	423	4968	0	0	0	0	1681	1720	1583
Satd. Flow (RTOR)		8			58							85
Lane Group Flow (vph)	43	1103	0	179	1017	0	0	0	0	79	79	27
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	70.4	65.4		65.4	65.4					9.8	9.8	9.8
Actuated g/C Ratio	0.78	0.73		0.73	0.73					0.11	0.11	0.11
v/c Ratio	0.09	0.43		0.58	0.28					0.43	0.42	0.11
Control Delay	3.1	7.9		21.2	6.1					44.2	43.7	0.9
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	3.1	7.9		21.2	6.1					44.2	43.7	0.9
LOS	A	A		C	A					D	D	A
Approach Delay		7.7			8.4						37.7	
Approach LOS		A			A						D	
Queue Length 50th (m)	1.4	49.6		18.4	25.8					14.4	14.4	0.0
Queue Length 95th (m)	4.1	72.9		#61.1	37.3					28.1	28.0	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	552	2555		307	3625					354	363	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.08	0.43		0.58	0.28					0.22	0.22	0.07

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.58
Intersection Signal Delay: 10.2 Intersection LOS: B
Intersection Capacity Utilization 58.2% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

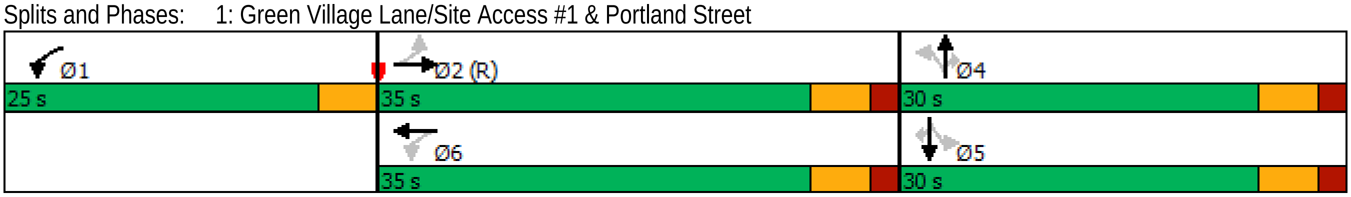


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	47	600	10	70	895	56	25	0	25	101	0	64
Future Volume (vph)	47	600	10	70	895	56	25	0	25	101	0	64
Satd. Flow (prot)	1770	3532	0	1770	3507	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.237			0.386				0.757		0.740		
Satd. Flow (perm)	441	3532	0	719	3507	0	0	1410	1583	1378	1863	1583
Satd. Flow (RTOR)		2			7				85			468
Lane Group Flow (vph)	51	663	0	76	1034	0	0	27	27	110	0	70
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	60.3	60.3		66.9	60.3			12.5	12.5	12.5		12.5
Actuated g/C Ratio	0.67	0.67		0.74	0.67			0.14	0.14	0.14		0.14
v/c Ratio	0.17	0.28		0.12	0.44			0.14	0.09	0.58		0.11
Control Delay	11.6	8.9		4.2	10.4			33.5	0.6	47.4		0.4
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	11.6	8.9		4.2	10.4			33.5	0.6	47.4		0.4
LOS	B	A		A	B			C	A	D		A
Approach Delay		9.1			10.0			17.1			29.1	
Approach LOS		A			B			B			C	
Queue Length 50th (m)	3.8	28.0		2.9	50.2			4.4	0.0	19.0		0.0
Queue Length 95th (m)	12.2	46.1		8.0	79.2			11.3	0.0	33.8		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	295	2368		805	2353			376	484	367		765
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.17	0.28		0.09	0.44			0.07	0.06	0.30		0.09

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.58
Intersection Signal Delay: 11.6
Intersection LOS: B
Intersection Capacity Utilization 59.6%
ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

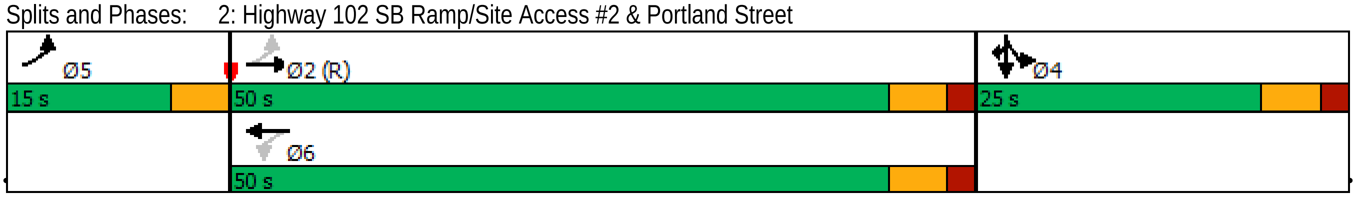


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	763	53	330	846	167	0	0	0	134	18	10
Future Volume (vph)	25	763	53	330	846	167	0	0	0	134	18	10
Satd. Flow (prot)	1770	3504	0	1770	4958	0	0	0	0	1681	1704	1583
Flt Permitted	0.239			0.302						0.950	0.963	
Satd. Flow (perm)	445	3504	0	563	4958	0	0	0	0	1681	1704	1583
Satd. Flow (RTOR)		11			64							85
Lane Group Flow (vph)	27	887	0	359	1102	0	0	0	0	83	83	11
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	71.0	67.4		67.4	67.4					10.0	10.0	10.0
Actuated g/C Ratio	0.79	0.75		0.75	0.75					0.11	0.11	0.11
v/c Ratio	0.06	0.34		0.85	0.30					0.45	0.44	0.04
Control Delay	3.1	6.3		36.5	5.5					44.4	44.1	0.3
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	3.1	6.3		36.5	5.5					44.4	44.1	0.3
LOS	A	A		D	A					D	D	A
Approach Delay		6.2			13.1						41.5	
Approach LOS		A			B						D	
Queue Length 50th (m)	0.8	21.5		34.8	16.9					15.1	15.1	0.0
Queue Length 95th (m)	3.0	55.0		#127.3	41.3					29.1	29.1	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	521	2627		421	3730					354	359	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.05	0.34		0.85	0.30					0.23	0.23	0.03

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.85
Intersection Signal Delay: 12.6 Intersection LOS: B
Intersection Capacity Utilization 61.9% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

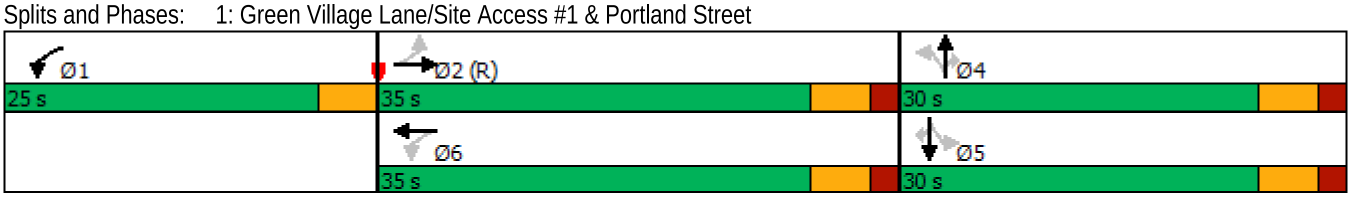


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	1010	20	70	870	106	30	0	20	72	0	56
Future Volume (vph)	69	1010	20	70	870	106	30	0	20	72	0	56
Satd. Flow (prot)	1770	3529	0	1770	3483	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.233			0.215				0.757		0.736		
Satd. Flow (perm)	434	3529	0	400	3483	0	0	1410	1583	1371	1863	1583
Satd. Flow (RTOR)		2			15				85			470
Lane Group Flow (vph)	75	1120	0	76	1061	0	0	33	22	78	0	61
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases		2		1	6			4			5	
Permitted Phases	2			6			4		4	5		5
Total Split (s)	35.0	35.0		25.0	35.0		30.0	30.0	30.0	30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	62.1	62.1		68.7	62.1			10.7	10.7	10.7		10.7
Actuated g/C Ratio	0.69	0.69		0.76	0.69			0.12	0.12	0.12		0.12
v/c Ratio	0.25	0.46		0.18	0.44			0.20	0.08	0.48		0.10
Control Delay	11.8	9.7		4.1	9.3			37.0	0.7	46.1		0.3
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	11.8	9.7		4.1	9.3			37.0	0.7	46.1		0.3
LOS	B	A		A	A			D	A	D		A
Approach Delay		9.8			9.0			22.5			26.0	
Approach LOS		A			A			C			C	
Queue Length 50th (m)	5.6	52.6		2.6	48.2			5.5	0.0	13.5		0.0
Queue Length 95th (m)	16.8	82.0		7.0	75.8			13.7	0.0	26.4		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	299	2434		639	2406			376	484	365		766
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.25	0.46		0.12	0.44			0.09	0.05	0.21		0.08

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.48
Intersection Signal Delay: 10.6 Intersection LOS: B
Intersection Capacity Utilization 58.9% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

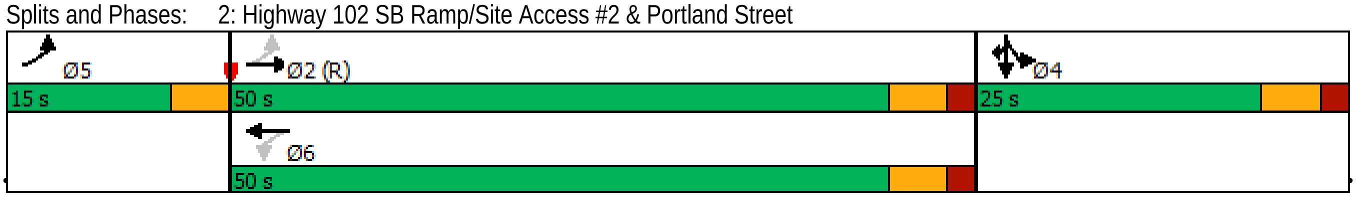


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1014	58	165	881	167	0	0	0	127	32	25
Future Volume (vph)	40	1014	58	165	881	167	0	0	0	127	32	25
Satd. Flow (prot)	1770	3511	0	1770	4963	0	0	0	0	1681	1718	1583
Flt Permitted	0.226			0.208						0.950	0.971	
Satd. Flow (perm)	421	3511	0	387	4963	0	0	0	0	1681	1718	1583
Satd. Flow (RTOR)		9			60							85
Lane Group Flow (vph)	43	1165	0	179	1140	0	0	0	0	86	87	27
Turn Type	pm+pt	NA		Perm	NA					Split	NA	Prot
Protected Phases	5	2			6					4	4	4
Permitted Phases	2			6								
Total Split (s)	15.0	50.0		50.0	50.0					25.0	25.0	25.0
Total Lost Time (s)	4.0	6.0		6.0	6.0					6.0	6.0	6.0
Act Effct Green (s)	70.1	65.1		65.1	65.1					10.1	10.1	10.1
Actuated g/C Ratio	0.78	0.72		0.72	0.72					0.11	0.11	0.11
v/c Ratio	0.10	0.46		0.64	0.32					0.46	0.45	0.11
Control Delay	3.4	8.4		26.1	6.5					44.5	44.2	0.8
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	3.4	8.4		26.1	6.5					44.5	44.2	0.8
LOS	A	A		C	A					D	D	A
Approach Delay		8.2			9.1						38.5	
Approach LOS		A			A						D	
Queue Length 50th (m)	1.4	54.3		20.0	30.2					15.6	15.8	0.0
Queue Length 95th (m)	4.2	80.1		#65.6	43.6					29.8	30.2	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	503	2541		279	3605					354	362	401
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.09	0.46		0.64	0.32					0.24	0.24	0.07

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.64
Intersection Signal Delay: 10.9 Intersection LOS: B
Intersection Capacity Utilization 59.8% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street



201-04486

MEMO

TO: Stephanie Mah, MES Planning, MCIP, LPP – Clayton Developments Limited

FROM: Greg O'Brien, P.Eng. – WSP Canada Inc.

SUBJECT: **Addendum to Penhorn Traffic Impact Study (June 2020)**

DATE: **December 4, 2020**

WSP has completed an addendum to the *Penhorn Traffic Impact Study (WSP, June 2020)* (June 2020 TIS) to consider impact to study intersections that would result from redevelopment of the existing commercial portion of the site. Figure 1 shows the two areas of the Penhorn site including the existing developed commercial portion in the southeast near Portland Street, and the added development in the north and west of the site that was considered in the Traffic Impact Study.

In the Traffic Impact Study the existing development on the commercial portion of the site was considered in the background traffic already using the street network. This Addendum reviews the traffic impact on study intersections that would result from increased density on this portion of the site. The increased density is expected to include a mix of more commercial development and added residential units.

Figure 1 – Study Area

TRAFFIC VOLUME DATA

All traffic volume data used in this Addendum has been extracted from the June 2020 TIS, Appendix A. The base volumes for this Addendum are the 2030 traffic volumes with the background developments from the TIS (*June 2020 TIS, Figure A-4, Appendix A)*.

TRIP GENERATION, DISTRIBUTION & ASSIGNMENT

When using the published rates in *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, Washington, 2017), the transportation engineer's objective should be to provide a realistic estimate of the number of trips that will be generated.

A concept for the redevelopment of the commercial portion of the site is shown in Figure 2. It is expected that if the existing Penhorn Plaza Site is redeveloped in the future, it could include an increase of 20% to the current commercial area and an additional 511 Multi-Family Apartment units. For the purposes of this Addendum, a combination of Mid-Rise and High-Rise Apartments were considered. Generated trips for Mid-Rise Apartments (Land Use 221) and High-Rise Apartments (Land Use 222) are estimated for the AM and PM peak hours of traffic by the number of units. The potential redevelopment is estimated to include approximately 435 Mid-Rise and 76 High-Rise Apartment units.

- The existing Penhorn Plaza Site generates 20% more vehicle trips than originally considered in the June 2020 TIS; and,
- Potential future redevelopment of the existing Penhorn Plaza Site is expected to result in an additional 511 multi-family apartment units.

1 Spectacle Lake Drive
Dartmouth, NS, Canada B3B 1X7
Tel.: +1 902-835-9955
Fax: +1 902-835-1645
www.wsp.com

Figure 2 - Concept Plan

Trip generation estimates for addition of residential units to the existing Penhorn Plaza Site are summarized in Table 1. It was estimated that the redevelopment will generate an additional:

- 125 two-way trips (32 entering and 93 exiting) during the AM peak hour; and,
- 150 two-way trips (92 entering and 58 exiting) during the PM peak hour.

Table 1 –Trip Generation Estimate for Potential Future Redevelopment of Penhorn Plaza

Land Use[1]	Units[2]	Trip Generation Rates[3]				Trip Generation Estimates[4]			
		AM Peak		PM Peak		AM Peak		PM Peak	
		In	Out	In	Out	In	Out	In	Out
Potential Future Penhorn Plaza Redevelopment									
Mid-Rise Apartments (Land Use 221)	435 Units	Equations from Pages 74 and 75 (Residential - Land Uses 200 - 299)				38	107	111	70
High-Rise Apartments (Land Use 222)	76 Units	Equations from Pages 153 and 154 (Residential - Land Uses 200 - 299)				8	26	21	13
Trip Generation Estimate for Proposed Site						46	133	132	83
30% Reduction for Non-Auto Trips[5]						14	40	40	25
Total Primary Trip Estimate for Proposed Site						**32**	**93**	**92**	**58**

NOTES:
1. Trip generation rates and equations are from Trip Generation, 10th Edition, (Institute of Transportation Engineers, Washington, 2017).
2. 'Number of Residential Units' for Mid-Rise and High-Rise Apartment Buildings.
3. Trip generation rates are 'vehicles per hour per unit'.
4. Trips generated are 'vehicles per hour' for AM and PM peak hours.
5. A 30% reduction for non-auto trips has been used to account for transit, cycling and walking trips as well as on-site synergies.

Trip generation for the expanded commercial activity on the site has been estimated by increasing the background volumes currently turning into and out of the site *(June 2020 TIS Figure A-1, Appendix A,)* by 20%.

The Addendum trip generation estimates were assigned to the roadway network based on the trip distribution in the June 2020 TIS, however, the trip assignment was modified slightly. Since this portion of the development is closer to Access #2, it is estimated that 70% of the traffic generated to/from the north, east and south will use Site Access #2. The AM and PM peak hour Addendum trip generation estimates are shown diagrammatically in Figure A-1, Appendix A.

The Addendum trip generation estimates (Figure A-1, Appendix A) have been added to the 2030 traffic volumes with the background developments from the June 2020 TIS *(June 2020 TIS, Figure A-4, Appendix A)* to provide projected 2030 AM and PM peak hourly volumes that include the Addendum generated trips. The 2030 traffic volumes with the Addendum generated trips are illustrated diagrammatically in Figure A-2, Appendix A.

OPERATIONAL ANALYSIS

Intersection capacity analysis was completed to estimate how the Study Intersections are expected to operate in the future with the additional Addendum trip generation estimates.

Synchro 10.0 software was used to evaluate the performance of the Study Intersections for the following scenarios:

A. Projected 2030 AM and PM peak hour volumes with proposed Penhorn Site Development *(June 2020 TIS, Figure A-4, Appendix A)*; and,
B. Projected 2030 AM and PM peak hour volumes with increased density on the existing commercial portion of the site (Figure A-2, Appendix A).

Detailed results of the analyses are included in Appendix B.

Intersection 1 – Portland Street and Site Access #1/Green Village Lane (Table 2) – With Addendum trips expected to be generated, analysis indicates minimal changes to delay residual capacity remains. This intersection is expected to operate within HRM guidelines with development of the proposed site.

Intersection 2 – Portland Street and Site Access #2/NS Highway 111 Southbound Onramp (Table 3) – With Addendum trips expected to be generated, analysis indicates minimal changes to delay residual capacity remains. This intersection is expected to operate within HRM guidelines with development of the proposed site.

Table 2 – Intersection Capacity Analysis for Portland Street and Site Access #1/Green Village Lane

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement									Overall Intersection
	Portland Street				Green Village Lane		Site Access #1			
	EB-L	EB-TR	WB-L	WB-TR	NB-LT	NB-R	SB-L	SB-T	SB-R	Delay
2030 AM Peak Hour with **Site Development** - Figure A-4, Appendix A, June 2020 TIS (Page B-1)										
Delay	4.5	8.9	4.2	10.1	37.3	0.7	53.6	0.0	0.6	11.7
v/c	0.13	0.29	0.13	0.45	0.14	0.10	0.61	0.00	0.14	
Queue	6.1	47.3	8.4	79.8	12.2	0.0	38.5	0.0	0.0	
2030 PM Peak Hour with **Site Development** - Figure A-4, Appendix A, June 2020 TIS (Page B-3)										
Delay	3.9	9.2	3.9	8.4	41.8	0.8	52.5	0.0	0.6	10.0
v/c	0.17	0.45	0.18	0.42	0.21	0.09	0.51	0.00	0.13	
Queue	7.0	84.6	7.1	75.1	14.9	1.0	29.0	0.0	0.0	
2030 AM Peak Hour with **Addendum Trips** (Page B-5)										
Delay	6.5	11.5	5.9	13.4	32.2	0.4	53.3	0.0	0.8	15.1
v/c	0.18	0.31	0.14	0.50	0.11	0.08	0.71	0.00	0.19	
Queue	9.5	55.4	10.4	97.9	11.2	0.0	53.3	0.0	0.0	
2030 PM Peak Hour with **Addendum Trips** (Page B-7)										
Delay	5.9	11.2	5.0	11.8	37.7	0.6	53.6	0.0	0.8	12.8
v/c	0.29	0.49	0.20	0.51	0.17	0.08	0.62	0.00	0.17	
Queue	11.5	92.6	8.5	93.4	14.1	0.0	39.0	0.0	0.0	

Table 3 – Intersection Capacity Analysis for Portland Street and Site Access #2/Highway 111 SB Ramps

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement							Overall Intersection
	Portland Street				Site Access #2			
	EB-L	EB-TR	WB-L	WB-TR	SB-L	SB-T	SB-R	Delay
2030 AM Peak Hour with **Site Development** - Figure A-4, Appendix A, June 2020 TIS (Page B-2)								
Delay	14.6	14.3	7.6	3.0	50.3	50.2	0.4	10.7
v/c	0.10	0.43	0.59	0.27	0.46	0.46	0.05	
Queue	8.7	84.2	31.6	25.9	30.8	31.0	0.0	
2030 PM Peak Hour with **Site Development** - Figure A-4, Appendix A, June 2020 TIS (Page B-4)								
Delay	11.7	12.5	6.2	3.5	50.5	50.1	0.9	10.6
v/c	0.16	0.53	0.44	0.30	0.48	0.48	0.11	
Queue	11.1	102.3	14.2	28.0	32.8	33.0	0.0	
2030 AM Peak Hour with **Addendum Trips** (Page B-6)								
Delay	17.6	17.3	10.4	3.9	51.1	51.3	9.1	13.5
v/c	0.14	0.49	0.63	0.31	0.56	0.57	0.26	
Queue	11.6	96.3	42.4	31.3	41.2	41.8	9.9	
2030 PM Peak Hour with **Addendum Trips** (Page B-8)								
Delay	13.8	13.5	7.0	3.9	51.4	50.8	9.5	11.7
v/c	0.21	0.55	0.46	0.33	0.54	0.54	0.27	
Queue	14.3	111.7	15.3	33.1	38.3	38.4	10.1	

SUMMARY

1. An addendum to the *June 2020 TIS* was completed in order to consider potential redevelopment of the existing Penhorn Plaza Commercial Site.

2. For the residential portion of the site, trip generation estimates were prepared using rates published in *Trip Generation, 10th Edition* (Institute of Transportation Engineers, Washington 2017). The commercial portion of the redevelopment is expected to increase current volume entering and exiting the site by 20%.

   It is estimated that redevelopment of the existing Penhorn Plaza Commercial Portion of the site will generate an additional:
   - 206 two-way trips (80 entering and 126 exiting) during the AM peak hour; and,
   - 236 two-way trips (136 entering and 100 exiting) during the PM peak hour.

3. The Study Intersections are expected to operate within HRM acceptable limits in 2030 with overall site buildout and redevelopment of the existing Penhorn Plaza Commercial portion of the site.

CONCLUSION

4. Since the access intersections for this redevelopment site have been constructed to accommodate traffic volumes for a large regional shopping center, there remains residual capacity on the driveway approaches. With added trips generated by the proposed development, the access intersections are projected to operate within HRM guidelines at full build-out of the site and redevelopment of the commercial portion of the site.

If you have any questions or comments, please contact me by email at greg.obrien@wsp.com or by telephone at 902-444-8347.

Sincerely,

Original Signed

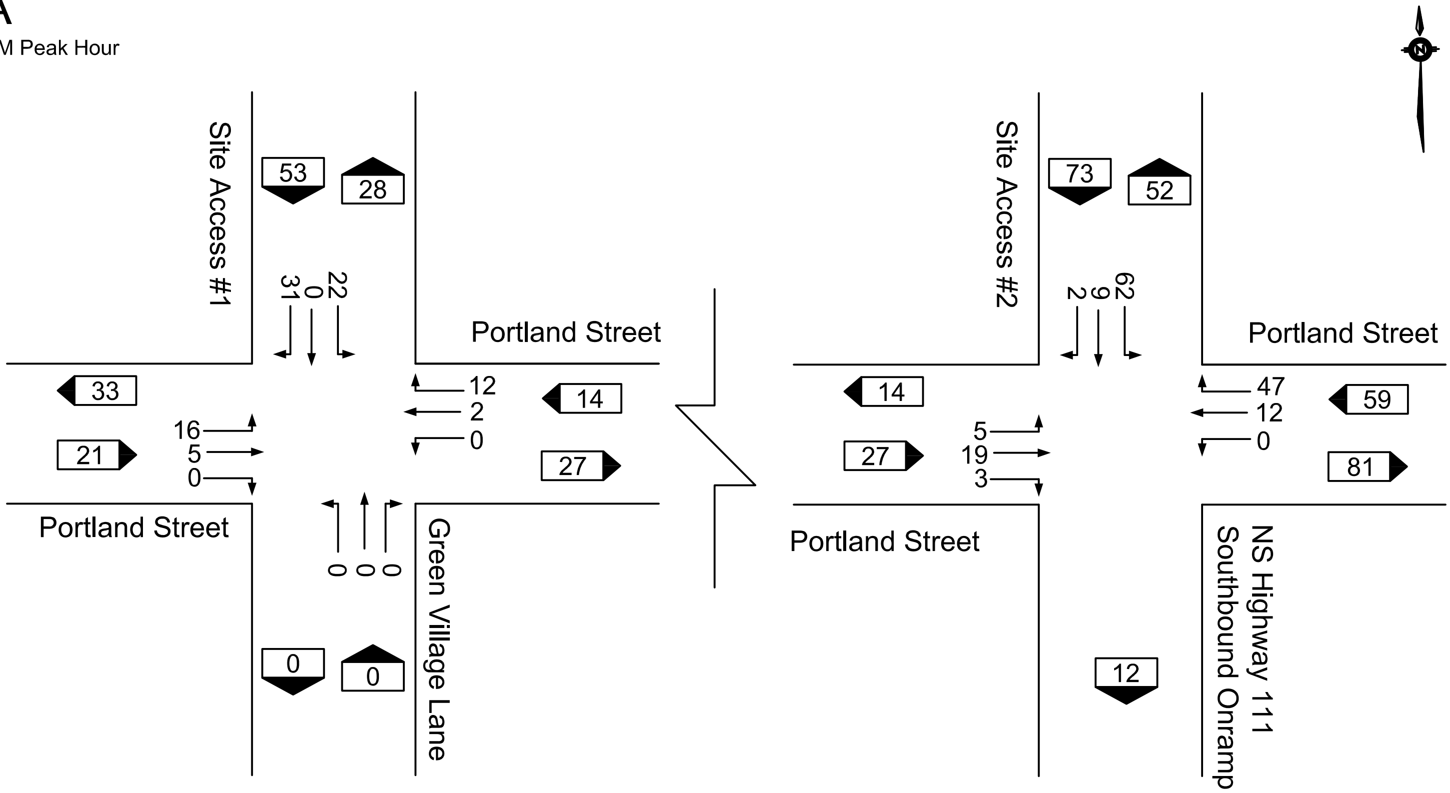
PROFESSIONAL
DATE
Original Signed
7508
PROVINCE OF NOVA SCOTIA

Atlantic Practice Manager
Traffic Engineering and Transportation Planning
WSP Canada Inc.

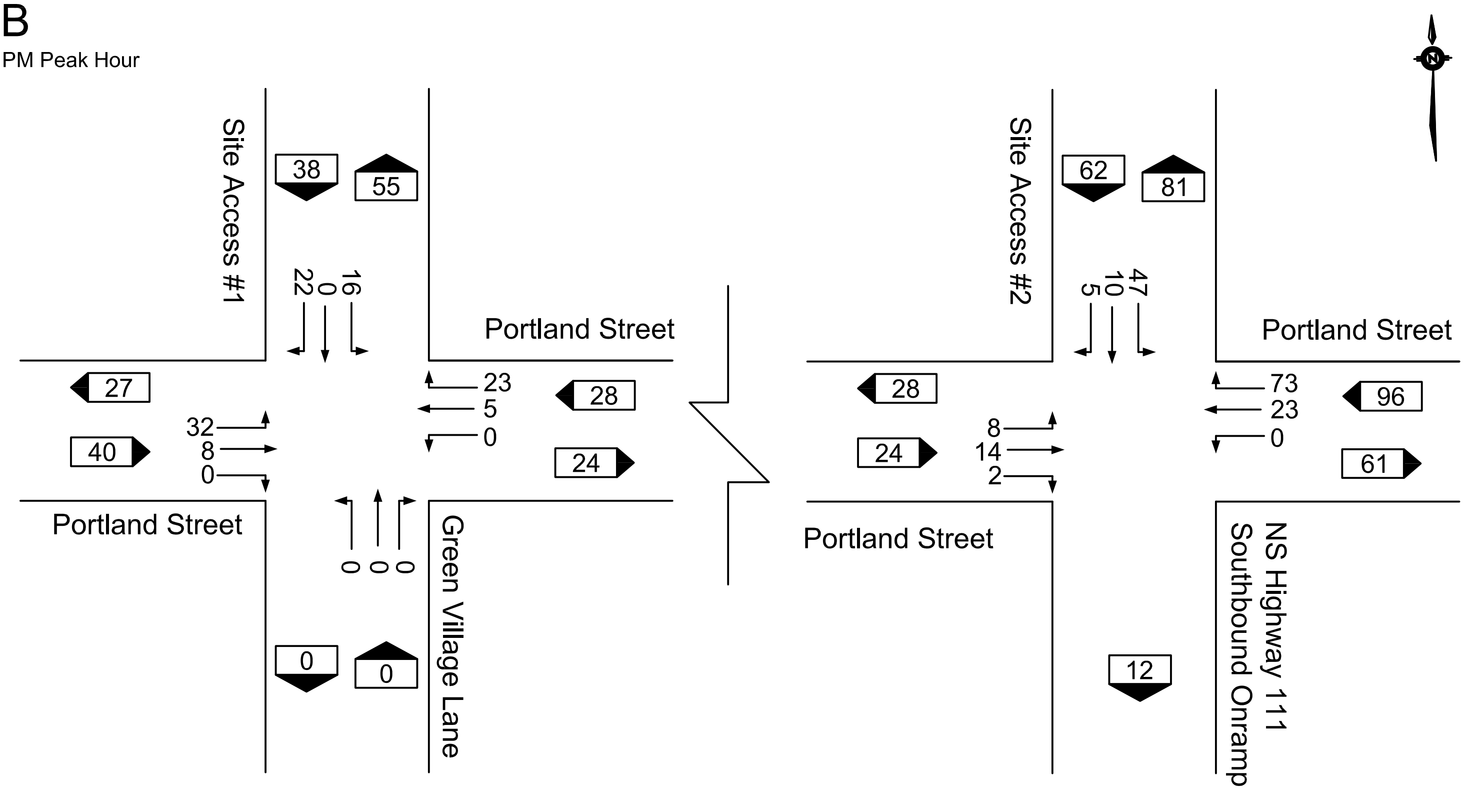
APPENDIX A

TRAFFIC VOLUME DATA

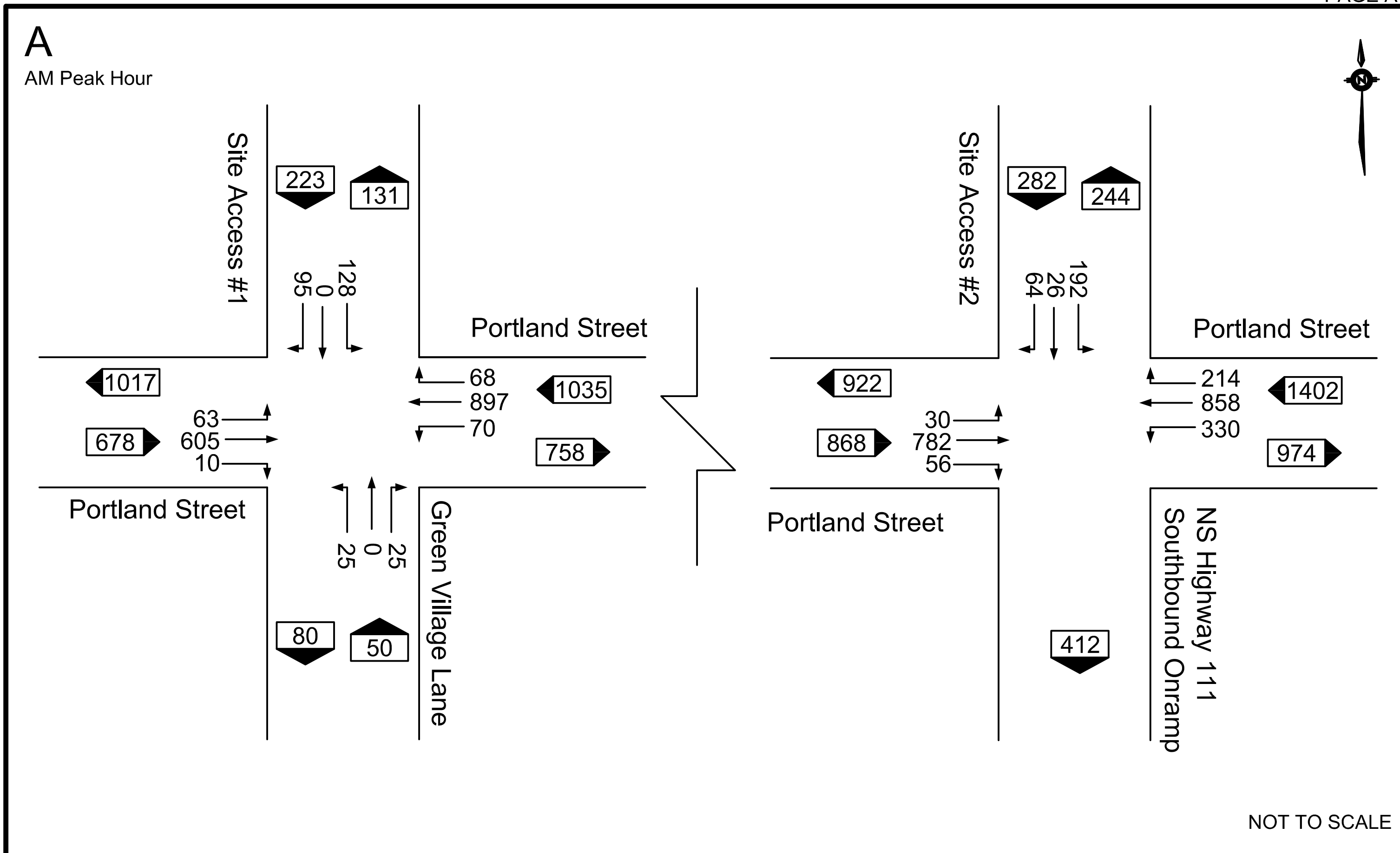
A
AM Peak Hour

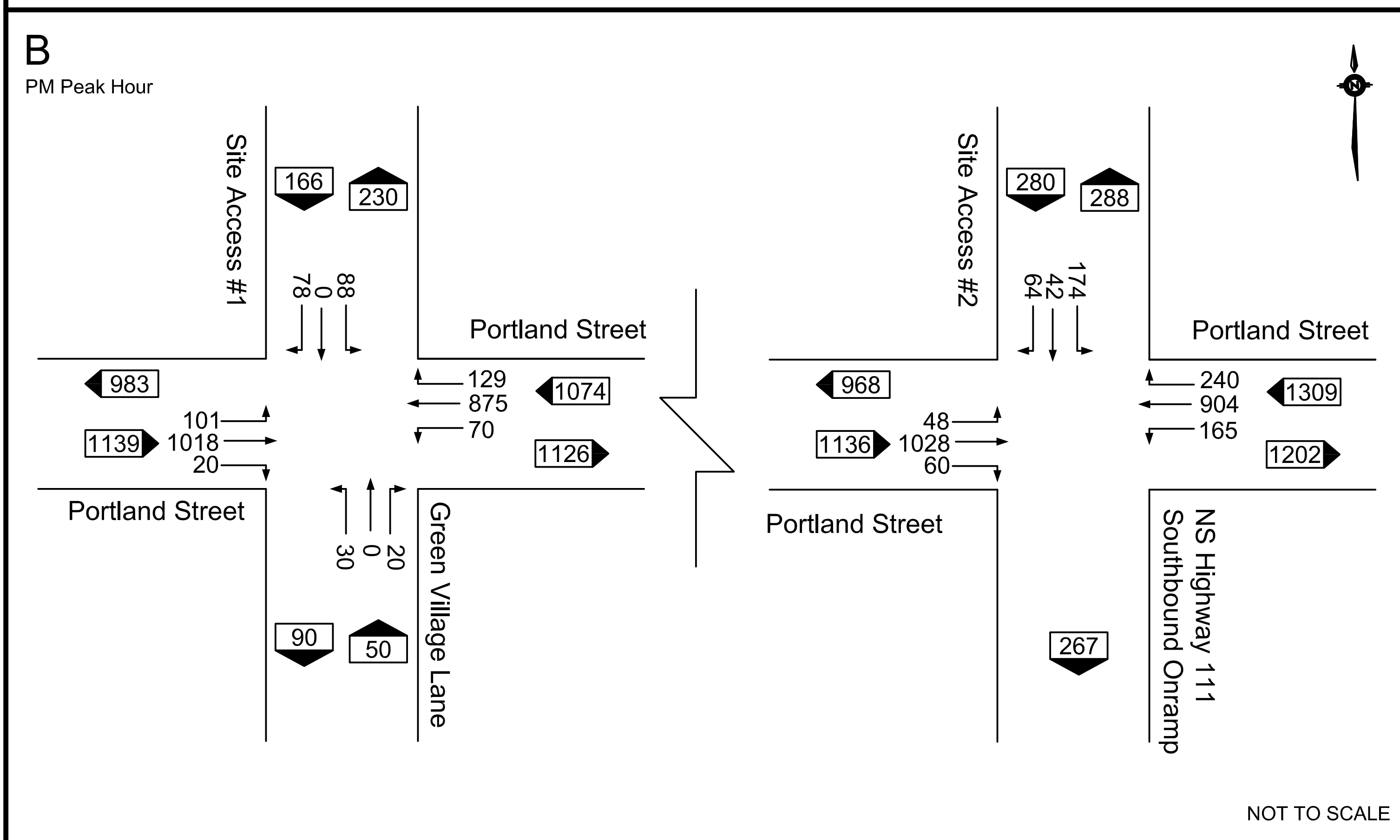


B
PM Peak Hour



wsp	Traffic Impact Study Addendum - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-1
	Addendum Generated Trip Estimate	December 2020





wsp	Traffic Impact Study Addendum - Proposed Penhorn Development Dartmouth, Nova Scotia	Figure A-2
	2030 Weekday AM and PM Peak Hour With Addendum Generated Trips	December 2020

APPENDIX B

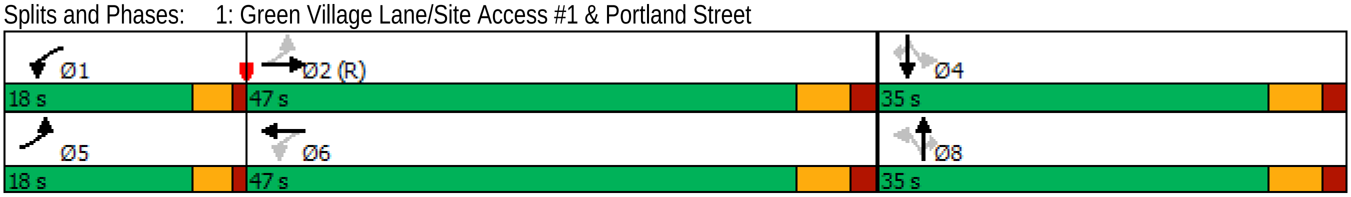
INTERSECTION PERFORMANCE ANALYSIS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	47	600	10	70	895	56	25	0	25	106	0	64
Future Volume (vph)	47	600	10	70	895	56	25	0	25	106	0	64
Satd. Flow (prot)	1770	3532	0	1770	3507	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.240			0.380				0.757		0.740		
Satd. Flow (perm)	447	3532	0	708	3507	0	0	1410	1583	1378	1863	1583
Satd. Flow (RTOR)		2			8				76			311
Lane Group Flow (vph)	51	663	0	76	1034	0	0	27	27	115	0	70
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8		8	4		4
Total Split (s)	18.0	47.0		18.0	47.0		35.0	35.0	35.0	35.0	35.0	35.0
Total Lost Time (s)	4.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	72.5	65.3		73.8	65.9			13.7	13.7	13.7		13.7
Actuated g/C Ratio	0.72	0.65		0.74	0.66			0.14	0.14	0.14		0.14
v/c Ratio	0.13	0.29		0.13	0.45			0.14	0.10	0.61		0.14
Control Delay	4.5	8.9		4.2	10.1			37.3	0.7	53.6		0.6
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	4.5	8.9		4.2	10.1			37.3	0.7	53.6		0.6
LOS	A	A		A	B			D	A	D		A
Approach Delay		8.6			9.7			19.0			33.6	
Approach LOS		A			A			B			C	
Queue Length 50th (m)	2.1	29.2		3.1	50.7			4.9	0.0	22.4		0.0
Queue Length 95th (m)	6.1	47.3		8.4	79.8			12.2	0.0	38.5		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	526	2306		688	2315			408	513	399		679
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.10	0.29		0.11	0.45			0.07	0.05	0.29		0.10

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.61
Intersection Signal Delay: 11.7 — Intersection LOS: B
Intersection Capacity Utilization 56.6% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

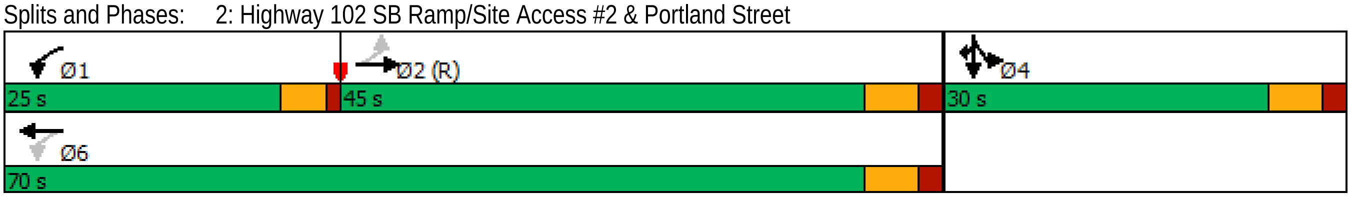


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	763	53	330	846	167	0	0	0	130	17	10
Future Volume (vph)	25	763	53	330	846	167	0	0	0	130	17	10
Satd. Flow (prot)	1770	3504	0	1770	4958	0	0	0	0	1681	1704	1583
Flt Permitted	0.247			0.251						0.950	0.963	
Satd. Flow (perm)	460	3504	0	468	4958	0	0	0	0	1681	1704	1583
Satd. Flow (RTOR)		8			82							82
Lane Group Flow (vph)	27	887	0	359	1102	0	0	0	0	79	80	11
Turn Type	Perm	NA		pm+pt	NA					Split	NA	Prot
Protected Phases		2		1	6					4	4	4
Permitted Phases	2			6								
Total Split (s)	45.0	45.0		25.0	70.0					30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.5	6.0					6.0	6.0	6.0
Act Effct Green (s)	58.4	58.4		81.9	81.6					10.2	10.2	10.2
Actuated g/C Ratio	0.58	0.58		0.82	0.82					0.10	0.10	0.10
v/c Ratio	0.10	0.43		0.59	0.27					0.46	0.46	0.05
Control Delay	14.6	14.3		7.6	3.0					50.3	50.2	0.4
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	14.6	14.3		7.6	3.0					50.3	50.2	0.4
LOS	B	B		A	A					D	D	A
Approach Delay		14.4			4.1						47.0	
Approach LOS		B			A						D	
Queue Length 50th (m)	2.5	52.9		14.6	16.8					16.3	16.5	0.0
Queue Length 95th (m)	8.7	84.2		31.6	25.9					30.8	31.0	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	268	2048		656	4060					403	408	442
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.10	0.43		0.55	0.27					0.20	0.20	0.02

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 10.7 Intersection LOS: B
Intersection Capacity Utilization 60.6% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

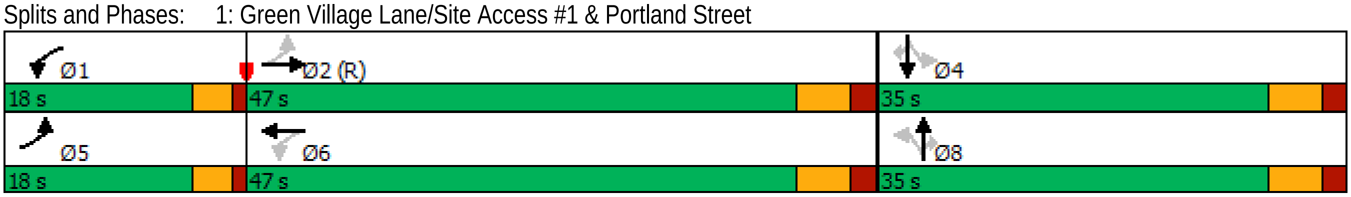


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	1010	20	70	870	106	30	0	20	72	0	56
Future Volume (vph)	69	1010	20	70	870	106	30	0	20	72	0	56
Satd. Flow (prot)	1770	3529	0	1770	3483	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.241			0.216				0.757		0.736		
Satd. Flow (perm)	449	3529	0	402	3483	0	0	1410	1583	1371	1863	1583
Satd. Flow (RTOR)		2			16				76			314
Lane Group Flow (vph)	75	1120	0	76	1061	0	0	33	22	78	0	61
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8		8	4		4
Total Split (s)	18.0	47.0		18.0	47.0		35.0	35.0	35.0	35.0	35.0	35.0
Total Lost Time (s)	4.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	77.5	71.3		78.9	72.0			11.2	11.2	11.2		11.2
Actuated g/C Ratio	0.78	0.71		0.79	0.72			0.11	0.11	0.11		0.11
v/c Ratio	0.17	0.45		0.18	0.42			0.21	0.09	0.51		0.13
Control Delay	3.9	9.2		3.9	8.4			41.8	0.8	52.5		0.6
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	3.9	9.2		3.9	8.4			41.8	0.8	52.5		0.6
LOS	A	A		A	A			D	A	D		A
Approach Delay		8.8			8.1			25.4			29.7	
Approach LOS		A			A			C			C	
Queue Length 50th (m)	2.6	53.5		2.7	48.1			6.3	0.0	15.3		0.0
Queue Length 95th (m)	7.0	84.6		7.1	75.1			14.9	0.0	29.0		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	550	2515		518	2511			408	513	397		682
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.14	0.45		0.15	0.42			0.08	0.04	0.20		0.09

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 10.0 Intersection LOS: B
Intersection Capacity Utilization 58.4% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

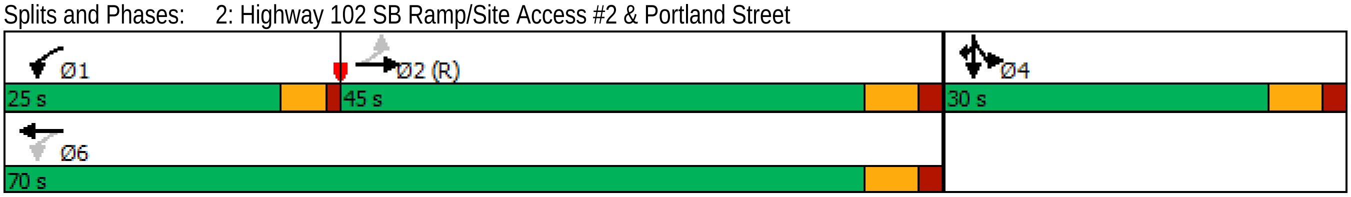


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1014	58	165	881	167	0	0	0	127	32	25
Future Volume (vph)	40	1014	58	165	881	167	0	0	0	127	32	25
Satd. Flow (prot)	1770	3511	0	1770	4963	0	0	0	0	1681	1718	1583
Flt Permitted	0.237			0.178						0.950	0.971	
Satd. Flow (perm)	441	3511	0	332	4963	0	0	0	0	1681	1718	1583
Satd. Flow (RTOR)		7			77							82
Lane Group Flow (vph)	43	1165	0	179	1140	0	0	0	0	86	87	27
Turn Type	Perm	NA		pm+pt	NA					Split	NA	Prot
Protected Phases		2		1	6					4	4	4
Permitted Phases	2			6								
Total Split (s)	45.0	45.0		25.0	70.0					30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.5	6.0					6.0	6.0	6.0
Act Effct Green (s)	62.5	62.5		78.9	77.4					10.6	10.6	10.6
Actuated g/C Ratio	0.62	0.62		0.79	0.77					0.11	0.11	0.11
v/c Ratio	0.16	0.53		0.44	0.30					0.48	0.48	0.11
Control Delay	11.7	12.5		6.2	3.5					50.5	50.1	0.9
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	11.7	12.5		6.2	3.5					50.5	50.1	0.9
LOS	B	B		A	A					D	D	A
Approach Delay		12.5			3.8						43.6	
Approach LOS		B			A						D	
Queue Length 50th (m)	3.3	63.4		6.6	18.2					17.6	17.8	0.0
Queue Length 95th (m)	11.1	102.3		14.2	28.0					32.8	33.0	0.0
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	275	2197		556	3857					403	412	442
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.16	0.53		0.32	0.30					0.21	0.21	0.06

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.53
Intersection Signal Delay: 10.6 Intersection LOS: B
Intersection Capacity Utilization 58.6% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

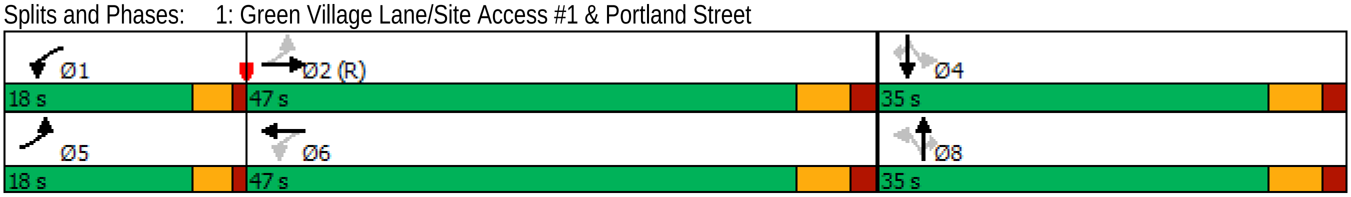


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	63	600	10	70	895	81	25	0	25	164	0	95
Future Volume (vph)	63	600	10	70	895	81	25	0	25	164	0	95
Satd. Flow (prot)	1770	3532	0	1770	3497	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.218			0.373				0.757		0.740		
Satd. Flow (perm)	406	3532	0	695	3497	0	0	1410	1583	1378	1863	1583
Satd. Flow (RTOR)		2			11				76			311
Lane Group Flow (vph)	68	663	0	76	1061	0	0	27	27	178	0	103
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8		8	4		4
Total Split (s)	18.0	47.0		18.0	47.0		35.0	35.0	35.0	35.0	35.0	35.0
Total Lost Time (s)	4.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	68.3	60.6		69.0	61.0			18.2	18.2	18.2		18.2
Actuated g/C Ratio	0.68	0.61		0.69	0.61			0.18	0.18	0.18		0.18
v/c Ratio	0.18	0.31		0.14	0.50			0.11	0.08	0.71		0.19
Control Delay	6.5	11.5		5.9	13.4			32.2	0.4	53.3		0.8
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	6.5	11.5		5.9	13.4			32.2	0.4	53.3		0.8
LOS	A	B		A	B			C	A	D		A
Approach Delay		11.0			12.9			16.3			34.0	
Approach LOS		B			B			B			C	
Queue Length 50th (m)	3.5	33.4		3.9	61.2			4.6	0.0	34.5		0.0
Queue Length 95th (m)	9.5	55.4		10.4	97.9			11.2	0.0	53.3		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	482	2141		649	2136			408	513	399		679
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.14	0.31		0.12	0.50			0.07	0.05	0.45		0.15

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 15.1 Intersection LOS: B
Intersection Capacity Utilization 60.6% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street

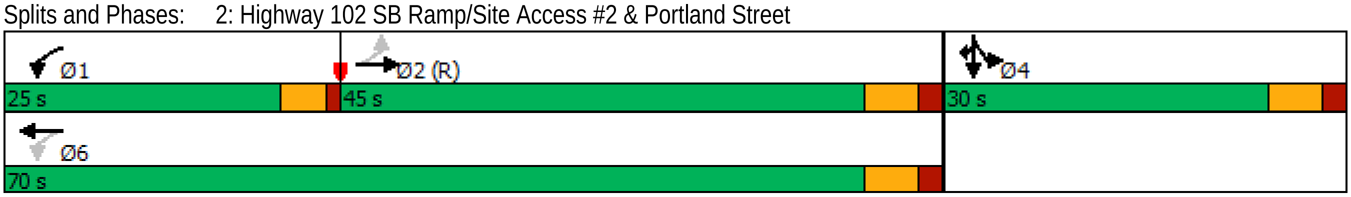


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	786	57	330	859	213	0	0	0	192	26	64
Future Volume (vph)	30	786	57	330	859	213	0	0	0	192	26	64
Satd. Flow (prot)	1770	3504	0	1770	4933	0	0	0	0	1681	1704	1583
Flt Permitted	0.231			0.228						0.950	0.963	
Satd. Flow (perm)	430	3504	0	425	4933	0	0	0	0	1681	1704	1583
Satd. Flow (RTOR)		9			119							82
Lane Group Flow (vph)	33	916	0	359	1166	0	0	0	0	117	120	70
Turn Type	Perm	NA		pm+pt	NA					Split	NA	Prot
Protected Phases		2		1	6					4	4	4
Permitted Phases	2			6								
Total Split (s)	45.0	45.0		25.0	70.0					30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.5	6.0					6.0	6.0	6.0
Act Effct Green (s)	53.3	53.3		77.1	75.6					12.4	12.4	12.4
Actuated g/C Ratio	0.53	0.53		0.77	0.76					0.12	0.12	0.12
v/c Ratio	0.14	0.49		0.63	0.31					0.56	0.57	0.26
Control Delay	17.6	17.3		10.4	3.9					51.1	51.3	9.1
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	17.6	17.3		10.4	3.9					51.1	51.3	9.1
LOS	B	B		B	A					D	D	A
Approach Delay		17.3			5.5						41.6	
Approach LOS		B			A						D	
Queue Length 50th (m)	3.2	58.6		17.0	19.8					24.0	24.6	0.0
Queue Length 95th (m)	11.6	96.3		42.4	31.3					41.2	41.8	9.9
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	229	1871		614	3760					403	408	442
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.14	0.49		0.58	0.31					0.29	0.29	0.16

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.63
Intersection Signal Delay: 13.5 | Intersection LOS: B
Intersection Capacity Utilization 61.6% | ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street

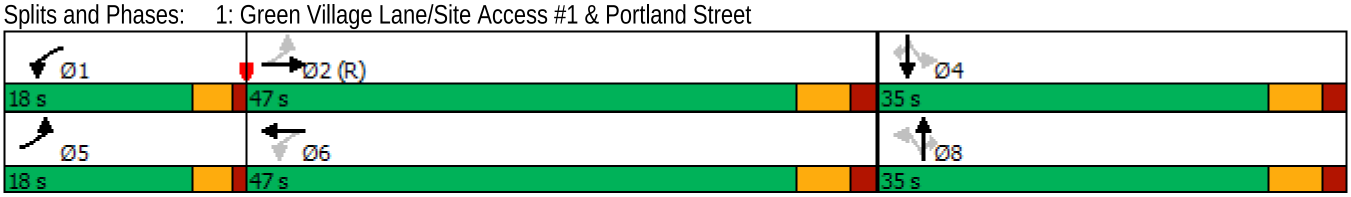


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	101	1010	20	70	870	160	30	0	20	108	0	78
Future Volume (vph)	101	1010	20	70	870	160	30	0	20	108	0	78
Satd. Flow (prot)	1770	3529	0	1770	3458	0	0	1770	1583	1770	1863	1583
Flt Permitted	0.201			0.213				0.757		0.736		
Satd. Flow (perm)	374	3529	0	397	3458	0	0	1410	1583	1371	1863	1583
Satd. Flow (RTOR)		2			26				76			314
Lane Group Flow (vph)	110	1120	0	76	1120	0	0	33	22	117	0	85
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm		Perm
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8		8	4		4
Total Split (s)	18.0	47.0		18.0	47.0		35.0	35.0	35.0	35.0	35.0	35.0
Total Lost Time (s)	4.0	6.0		4.0	6.0			6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	73.0	65.0		72.3	62.9			13.9	13.9	13.9		13.9
Actuated g/C Ratio	0.73	0.65		0.72	0.63			0.14	0.14	0.14		0.14
v/c Ratio	0.29	0.49		0.20	0.51			0.17	0.08	0.62		0.17
Control Delay	5.9	11.2		5.0	11.8			37.7	0.6	53.6		0.8
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0		0.0
Total Delay	5.9	11.2		5.0	11.8			37.7	0.6	53.6		0.8
LOS	A	B		A	B			D	A	D		A
Approach Delay		10.7			11.3			22.9			31.4	
Approach LOS		B			B			C			C	
Queue Length 50th (m)	4.7	59.2		3.2	58.2			6.0	0.0	22.8		0.0
Queue Length 95th (m)	11.5	92.6		8.5	93.4			14.1	0.0	39.0		0.0
Internal Link Dist (m)		186.0			98.3			168.8			141.4	
Turn Bay Length (m)	35.0			50.0					35.0	20.0		
Base Capacity (vph)	480	2293		494	2185			408	513	397		682
Starvation Cap Reductn	0	0		0	0			0	0	0		0
Spillback Cap Reductn	0	0		0	0			0	0	0		0
Storage Cap Reductn	0	0		0	0			0	0	0		0
Reduced v/c Ratio	0.23	0.49		0.15	0.51			0.08	0.04	0.29		0.12

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.62
Intersection Signal Delay: 12.8 Intersection LOS: B
Intersection Capacity Utilization 60.7% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 1: Green Village Lane/Site Access #1 & Portland Street



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	48	1042	63	165	932	209	0	0	0	157	39	64
Future Volume (vph)	48	1042	63	165	932	209	0	0	0	157	39	64
Satd. Flow (prot)	1770	3511	0	1770	4948	0	0	0	0	1681	1718	1583
Flt Permitted	0.213			0.166						0.950	0.971	
Satd. Flow (perm)	397	3511	0	309	4948	0	0	0	0	1681	1718	1583
Satd. Flow (RTOR)		7			100							82
Lane Group Flow (vph)	52	1201	0	179	1240	0	0	0	0	106	107	70
Turn Type	Perm	NA		pm+pt	NA					Split	NA	Prot
Protected Phases		2		1	6					4	4	4
Permitted Phases	2			6								
Total Split (s)	45.0	45.0		25.0	70.0					30.0	30.0	30.0
Total Lost Time (s)	6.0	6.0		4.5	6.0					6.0	6.0	6.0
Act Effct Green (s)	61.6	61.6		77.9	76.4					11.6	11.6	11.6
Actuated g/C Ratio	0.62	0.62		0.78	0.76					0.12	0.12	0.12
v/c Ratio	0.21	0.55		0.46	0.33					0.54	0.54	0.27
Control Delay	13.8	13.5		7.0	3.9					51.4	50.8	9.5
Queue Delay	0.0	0.0		0.0	0.0					0.0	0.0	0.0
Total Delay	13.8	13.5		7.0	3.9					51.4	50.8	9.5
LOS	B	B		A	A					D	D	A
Approach Delay		13.5			4.3						40.8	
Approach LOS		B			A						D	
Queue Length 50th (m)	4.3	68.3		7.1	21.3					21.7	22.0	0.0
Queue Length 95th (m)	14.3	111.7		15.3	33.1					38.3	38.4	10.1
Internal Link Dist (m)		93.0			221.7			87.6			105.5	
Turn Bay Length (m)	75.0			30.0						70.0		70.0
Base Capacity (vph)	244	2166		540	3802					403	412	442
Starvation Cap Reductn	0	0		0	0					0	0	0
Spillback Cap Reductn	0	0		0	0					0	0	0
Storage Cap Reductn	0	0		0	0					0	0	0
Reduced v/c Ratio	0.21	0.55		0.33	0.33					0.26	0.26	0.16

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.55
Intersection Signal Delay: 11.7 Intersection LOS: B
Intersection Capacity Utilization 59.5% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 2: Highway 102 SB Ramp/Site Access #2 & Portland Street