Innovation Hub & Mixed-Use Development
121 Hume Street

Functional Servicing &
Stormwater Management Report

Town of Collingwood, ON

December 17, 2020

Project: 16006

Town File No. D11420

Civil Consultant:

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Innovation Hub & Mixed-Use Development

121 Hume Street

Functional Servicing & Stormwater Management Report

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1.0 INTRODUCTION

The following Functional Servicing and Stormwater Management Report has been prepared by Urban Watershed Group Ltd. (UWGL), in support of the Site Plan Approval (SPA) application for a proposed mixed-use building at 121 Hume Street in the Town of Collingwood. The 0.246-hectare property is legally described as Lots 13 and 14 West of Market street and Part of Lot 14 East of St. Marie Street, Registered Plan 144. The site location is more generally identified in **Figure No. 1**.

The site is located at the northwest corner of the intersection of Hume Street and Market Street and is bound to the north and west by residential properties, Market Street to the East and Hume Street to the South. The existing lot has no structures, and largely consists of a gravel surface with a few trees along the perimeter. There are no known easements, natural heritage or drainage features or other encumbrances on the property. It is proposed to construct a 997.5 sq.m four (4) storey mixed-use building consisting of commercial, and office spaces. The building will have one (1) storey of underground parking.

Municipal water, storm, and sanitary services are available on Hume street. Municipal water and sanitary services are also available on Market Street. A proposed storm service is to be installed to the Hume Street municipal storm sewer.

This report aims to demonstrate the sanitary flows and water requirements for the proposed development. As well, this report identifies a stormwater management plan for the property to satisfy the criteria set out for the Town of Collingwood Development Standards (2007). In order to satisfy these criteria, an analysis of the runoff conditions on site during storm events up to a 100-year return period has been completed, and controls for stormwater quantity and quality control are proposed.

Drawing Title

SITE LOCATION PLAN

COMMERCIAL PROPERTY
COLLINGWOOD, ONTARIO

15955 AIRPORT ROAD, SUITE 304
CALEDON EAST, ONTARIO, L7C 1H9
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Client

PROPOSED MIXED USE DEVELOPMENT

Drawn By	Checked By	Drawing No.
B. KLESS	P. ELLIS	FIG1
Scale: N.T.S.	Project No.: 16006	

2.0 SITE STATISTICS

The existing condition of the property consists of a 2.465.5 sq.m lot on which there is an existing gravel surface, as shown in **Figure No. 2**. The site generally slopes from a central high point towards the property limits in all directions, and across an average change in grade of 0.65 meters at an average slope of approximately 2.5%. The site has been considered as two sub-catchments in the existing conditions to represent the drainage divide of flows to the northern neighbouring residential lots, and to the Hume Street ROW to the south. As the proposed development consists of a major infill type development, the rational method shall be used to determine the allowable release rate for storm drainage. The peak rate of runoff which is received by the Hume street storm sewer for a 5-year storm event under existing conditions shall be considered, and is calculated based on the site statistics and composite runoff coefficient provided below:

Existing Drainage Areas (Figure No. 2)

Land Use	Area (sq.m)	C	Ac
Semi-Pervious (Gravel)	878.0	0.50	439.0
Pervious (Grass)	152.0	0.25	38.0
Drainage Area to Hume Street	**1,030.0**	**0.46**	**477.0**
Semi-Pervious (Gravel)	1,126.6	0.50	563.3
Pervious (Grass)	308.9	0.25	77.2
Drainage Area to North	**1,435.5**	**0.45**	**640.5**
Total Site Area	**2,465.5**	**0.45**	**1,117.5**

The property in its post-development condition will capture and control runoff for discharge to the Hume Street storm sewer at the allowable release rate. For 100-year storm events runoff coefficients have been adjusted by a factor of 1.25 to a maximum value of 1.00, to account for soil saturation. The post-development site statistics are as follows:

Post-Development Drainage Areas (Figure No. 3)

Land Use	Area (sq.m)	C	Ac
Building Roof	997.5	0.90	897.8
Impervious (Asphalt and Concrete)	1,030.2	0.95	978.7
Pervious (Grass)	305.0	0.25	76.3
Streetscape	132.8	0.90	119.5
Total Site Area (to Hume Street)	**2,465.5**	**0.79**	**2,072.2**

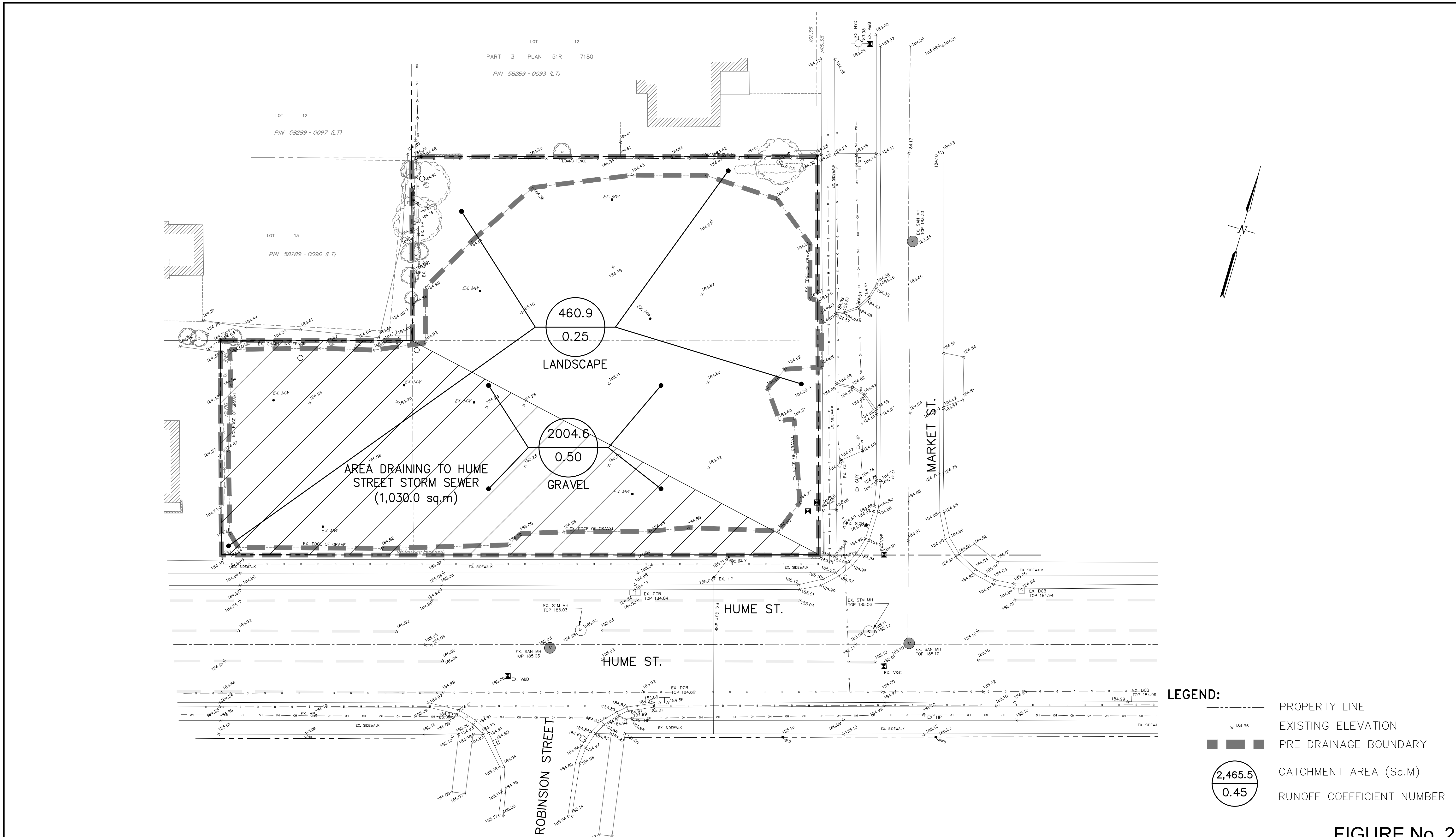

FIGURE No. 2

PROPOSED MIXED USE DEVELOPMENT

121 HUME STREET
COLLINGWOOD, ONTARIO

15955 AIRPORT ROAD, SUITE 304
CALEDON EAST, ONTARIO, L7C 1H9
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PRE DEVELOPMENT
DRAINAGE AREA PLAN

SCALE 1:400

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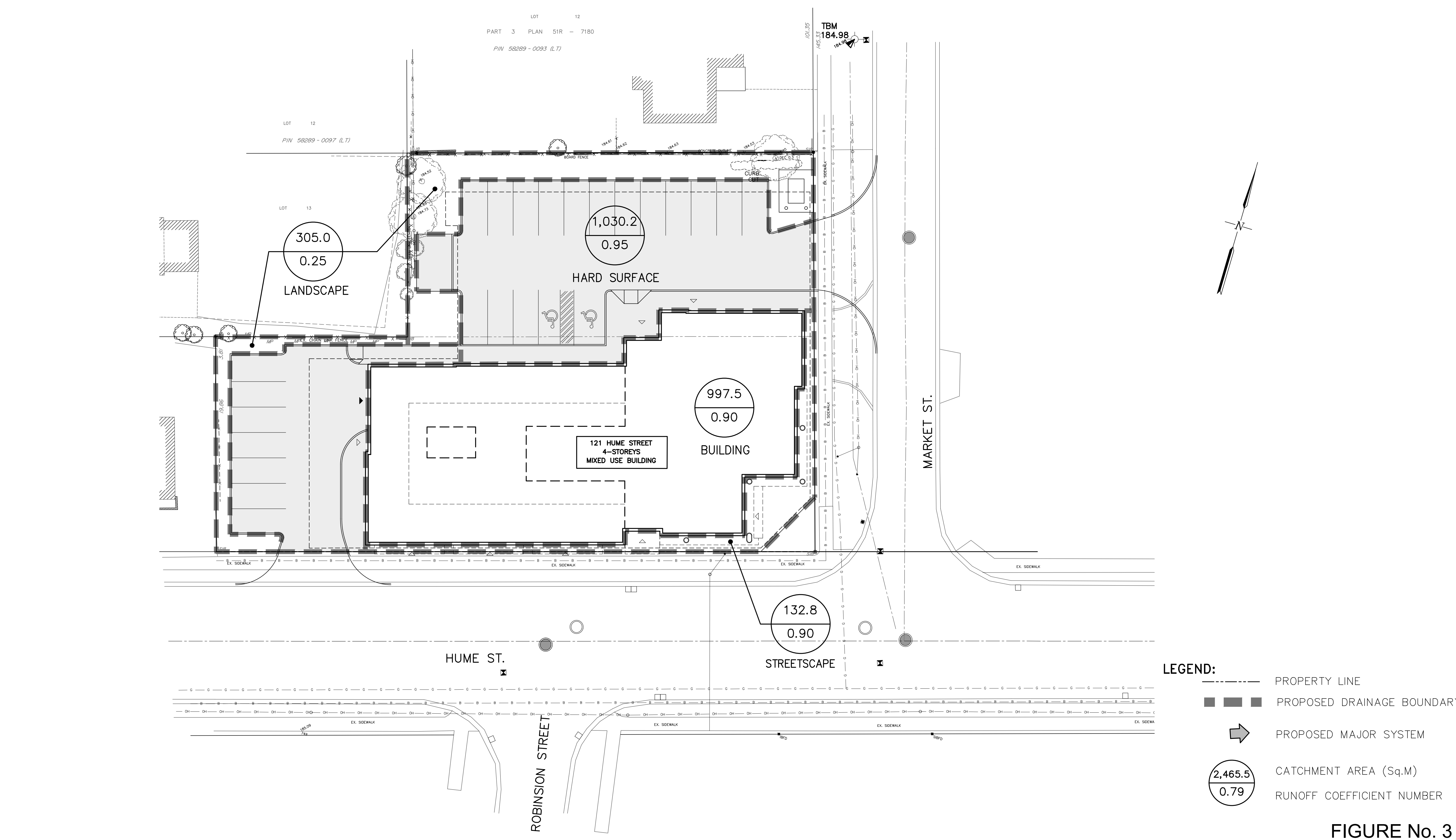

FIGURE No. 3

PROPOSED MIXED USE DEVELOPMENT

121 HUME STREET
COLLINGWOOD, ONTARIO

15955 AIRPORT ROAD, SUITE 304
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POST DEVELOPMENT DRAINAGE AREA PLAN

SCALE 1:400

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Dec 15, 2020 - 1:00pm

3.0 STORMWATER MANAGEMENT CRITERIA

The property is located within and unregulated area of the Nottawasaga Valley Conservation Authority (NVCA) Watershed. Runoff from the property is conveyed by sheet flow onto adjacent properties to the north and west and the municipal Right-of-Way (ROW) for Hume Street and Market Street to the south and east. Catchbasins at the intersection of Hume Street and Market Street collect storm runoff into an existing 500mm diameter westward draining storm sewer on Hume Street.

A plan and profile drawing, stormwater catchment area plan and storm sewer design sheet (5-year storm) for Hume Street have been prepared by R.J. Burnside & Associates Ltd., in June of 2017 (included in **Appendix A**), and detail the available capacities within the municipal storm sewer allotted for storm runoff from the subject property. Additional SWM criteria are outlined in a July 4th, 2017 pre-consultation memorandum from Herb Lemon of the Town of Collingwood Engineering Services Department. The proposed development will therefore be subject to the following SWM criteria:

- Control runoff to the existing 2-year storm event release rate from the property as a whole for all storms up to and including the 100-year event (Town of Collingwood);
- Maintain existing 5-year storm event release rate from the property to Hume Street storm sewers for all storms up to and including the 100-year event (Town of Collingwood);
- Provide an “Enhanced” level (80%) of water quality treatment for runoff (Town of Collingwood); and,
- Capture and infiltrate a volume of stormwater equivalent to a 5mm rainfall on the site (NVCA).

4.0 WATER QUANTITY CONTROL

4.1 Allowable Release Rate

The 2-year existing rate of runoff from the property as a whole has been calculated below to determine the peak allowable flow rate from the property.

2-Year Allowable Release Rate

$I_{2\,YR}$ $= A / (T_c + C)^B$
$= 807.44 / (10 + 6.75)^{0.828}$
$= 78.28$ mm/hr

$Q_{EXISTING}$ $= CIA / 3600$
$= 0.45 \times 78.28$ mm/hr $\times$ 2,465.5 m^2 / 3600
$= 24.12$ L/s

The 5-year existing rate of runoff to the Hume Street storm sewer has been calculated below for comparison to the allowable 2-year release rate from the property.

5-Year Allowable Release Rate

$I_{5\ YR}$ $= A / (T_c + C)^B$
$= 1135.4 / (10 + 7.5)^{0.841}$
$= 102.27$ mm/hr

$Q_{EXISTING}$ $= CIA / 3600$
$= 0.46 \times 102.27$ mm/hr $\times$ 1,030 m^2 / 3600
$= 13.46$ L/s

Therefore, the release of stormwater runoff from the site in the post-development condition shall be controlled to a rate of 13.46 L/s for all storms (up to and including the 100-year event), based on the existing rate of runoff to the Hume Street storm sewer during a 5-year storm event.

4.2 Stormwater Detention Storage

The proposed design will provide SWM storage on the building roof, and the driveway surface. The total stormwater detention volume required was calculated using the modified rational method detailed in **Figures 4 & 5** in **Appendix A**. The necessary volumes to detain the runoff rates for the 100-year post-development scenario to the 5-year pre-development level is 74.6 cu.m. This storage volume required comprises the following:

Upper Level Roof Top Storage	19.2 m^3
Lower Level Roof Top Storage	22.1 m^3
Surface Ponding Storage	33.3 m^3
Total Required and Provided Storage	**74.6 m^3**

4.3 Roof Drainage

The design of the proposed buildings incorporates a total roof area of 997.5 sq.m. Rooftop storage will be provided on the 490.5 sq.m fourth floor (upper level) roof area for stormwater detention storage. A green roof will be implemented on the 507 sq.m third floor (lower level) roof area for stormwater detention and retention storage. Based on a maximum release rate of 42 L/s/ha of roof area, the proposed release rate from the roof shall be no greater than 4.19 L/s. The roof designs will incorporate overflow scuppers in accordance with the Ontario Building Code (OBC).

4.3.1 Control Flo- Roof Drains

Conventional control-flo roof drains shall be implemented on the proposed upper level roof. The proposed release rate from the upper level roof shall be no greater than 2.18 L/s. Two (2) drains are proposed to control the roof drainage with one (1) weir provided for each drain. Each weir notch is expected to release approximately 0.383 L/s per inch of ponding, and at an 72mm (2.84") depth will produce a release rate of 1.09 L/s per notch (total release rate of 2.18 L/s). To produce the required 19.2 cu.m of rooftop storage a roof slope with a 51mm (2") rise is required. The drain down time will be approximately 17.5 hours.

4.3.2 StormCap + Detention Green Roof

A green roof garden will be implemented on approximately 50% of the lower level roof (with the remainder occupied by walkways and patios draining onto the green roof surfaces). The proposed green roof system is divided into two (2) assemblies to maximize the provided retention and detention storage volumes. The green roof garden will be comprised of a 267 sq.m vegetated assembly (for combined retention and detention). The remaining 240 sq.m of walkways and hard surfaces will be underlain with a non-vegetated assembly for additional detention storage. The total provided retention and detention storage volumes for the proposed StormCap system will be 11.17 cu.m and 33.91 cu.m, respectively (which is greater than the required 22.1 cu.m). Up to a 22mm (11.17 cu.m / 507 sq.m) rainfall event will be retained within the green roof system. The proposed green roof garden will have four (4) roof drains controlled to a combined peak release rate of 1.6 L/s by the proposed StormCap system. Product specifications and design calculations for the proposed StormCap + Detention green roof system can be found in **Appendix B**.

4.4 Surface Storage Volumes

Additional water quantity storage is to be provided on the surface of the parking lot and vegetative swale, above the area drain tops. There will be two surface storage areas (above AD1, AD2 and above CB2), at a ponding elevation of 184.92 m during a 100-year storm. A total storage volume of 33.3 cu.m at a maximum depth of 0.27 m will be provided.

4.5 Orifice Sizing

An orifice plate, shall be installed on the downstream side of Control Manhole 3 (CMH3) to control the release of runoff from the stormwater detention volumes. The required orifice size based on the release rate and head necessary to achieve the proposed ponding elevation and surface storage volumes has been calculated as 69.2mm. However, due to maintenance concerns related to clogging of the orifice, MOE guidelines recommend orifice sizes below 75mm not be used. A minimum sized 75mm diameter orifice will provide a controlled release rate as calculated below:

100-year Ponding Elevation (m)	=	184.92
Orifice Spring line (m)	=	183.32
H (head)	=	1.60 m

Orifice Area = $\pi/4 \times (0.075m)^2$

= $0.00442\ m^2$

Orifice Flow = $cA\sqrt{2g(\Delta h)}$

= $0.64 \times 0.00442 \times \sqrt{(2 \times 9.81 \times 1.60)}$

= 15.80 L/s

The minimum plausible release rate from the property during a 100-year storm event is 15.8 L/s. While this rate exceeds the allowable controlled flowrates calculated using the Town's Criteria (13.46 L/s), based on the small catchment area the site's SWM design is constrained by the minimum recommended orifice size.

5.0 WATER QUALITY CONTROL

To provide an 'Enhanced' level of water quality protection (corresponding to an 80% TSS removal rate), as set by MECP criteria, a multi-component approach will be utilized. The total impervious surface area (which will be exposed to sediment loading) for the site will be treated by a combination of pervious pavers and CB Shields or the perforated pipe system.

An analysis of TSS export from the site during a 40mm rainfall event (equivalent to 99% of average annual rainfall) has been completed for the proposed conditions, with and without implementation of LIDs for water quality treatment to demonstrate how the water quality objectives will be achieved. The site shall incorporate different LID features to meet the TSS removal criteria.

Retention features such as the Green Roof, Permeable Pavers and Perforated Pipe System will achieve TSS reduction by decreasing the average annual volume of runoff, thereby preventing sediment export from occurring. Additional filtration will also occur from these features during larger storm events.

Pervious pavers will be installed in the proposed parking areas, and will promote infiltration of runoff prior to being collected by the proposed catchbasins. In accordance with the Low Impact Development Stormwater Management Planning and Design Guide (2010), pervious pavers with

an underdrain system can be considered to reduce the average annual volume of runoff for a catchment by 45%. Furthermore, considering the additional filtration provided by the sand filter layer of the pervious pavers, a sediment removal efficiency of 50% is common for these features.

The proposed catchbasin (CB2) on-site will be equipped with a CB Shield to provide an initial average annual sediment removal rate of 53%. Product specifications and design charts for the CB Shield are provided in **Appendix C**.

Area drains installed along the north perimeter of the development will be connected to a perforated pipe system to promote infiltration and filter sediment from runoff. Planted swales between the asphalt surface and area drain inlets will further enhance TSS removal. Studies of the TSS removal efficiency for various grass sales and perforated pipe systems have demonstrated a removal efficiency between 81 – 96%.

The combined TSS removal rate for two features which operate in series (R = A + B – (A x B)), has been utilized in calculations to determine the post-development loading with mitigation. The TSS removal efficiency of each feature is summarized below:

LID Feature	TSS Removal Efficiency	Sub-Catchment	Notes
Green Roof	55%	Lower Roof	Runoff Reduction based (22mm)
Perforated Pipe	88%	North (AD1 & 2)	per TRCA guidelines
Permeable Pavers	50%	South (CB2)	per TRCA guidelines
CB Shield	53%	South (CB2)	CTV Certification

The proposed treatment train for the site will provide an 80.5% reduction is the annual post-development sediment loading. The results of the TSS analysis are included in **Appendix D**. A greater TSS removal efficiency can be expected during rainfall events less the 40mm, as treatment efficiencies will increase based on lower volumes of runoff to the proposed LID features.

Goss traps are to be installed in each catchbasin to capture floatables and oils which may be present within surface runoff.

6.0 WATER BALANCE

NVCA criteria require a stormwater runoff volume from a 5mm rainfall event across the total site area be captured and infiltrated on site. The require rainfall retention volume required is calculated as follows:

Rainfall to be Captured for Retention = 2,465.5 sq.m x 5 mm = 12.3 cu.m

The proposed 305 sq.m landscape surfaces have been considered to provide a 5mm initial abstraction of rainfall runoff. This will result in a 1.5 cu.m (305 sq.m x 0.005m), contribution to the required water balance capture volume.

The proposed 349 sq.m impervious areas will drain onto a permeable pavement surface to promote infiltration. A 25mm runoff abstraction from the permeable pavers has been considered for water balance calculations. This will result in 8.7 cu.m (349 sq.m x 0.025 m) of runoff retention for infiltration during frequent rainfall events.

An additional 2.4 cu.m will be captured within the perforated pipe system. A 681 sq.m area from the northern parking lot will drain into the perforated pipe system and provide a 3.5 mm abstraction for infiltration retention storage.

Therefore, a total retention volume of 12.6 cu.m (1.5 cu.m + 8.7 cu.m + 2.4 cu.m) is provided, equivalent to a 5.1mm volume of rainfall retention. Additional 11.2 cu.m retention storage provided on the lower level green roof garden will further reduce the sites contribution of stormwater runoff to the municipal storm sewer.

The existing site soils were observed to be predominately a granular fill. Based on literature an estimated coefficient of permeability of 1.0×10^{-5} m/sec has been made for these soils based on a clayey gravel mixture classification. Using the correlation of hydraulic conductivity to percolation time presented in Appendix C of the CVC Low Impact Development Stormwater Management Planning and Design Guide, an infiltration rate for the existing soils can be calculated as follows:

Hydraulic Conductivity	= 6e-11 x (Infiltration Rate)$^{3.7363}$
Infiltration Rate	= (HC / 6e-11)$^{1/3.7363}$
	= (10e-5 / 6e-11)$^{1/3.7363}$
	= 46 mm/hr
Design Infiltration Rate	= Measured Infiltration Rate / Safety Factor
	= 46 mm/hr / 2.5
	= 18.4 mm/hr

6.1 Permeable Pavement Design

A portion of the proposed parking lot shall consist of a surface of permeable paving stones. A storage bed is to be provided beneath the permeable pavers to provide the necessary stormwater retention volumes. The storage bed is to be constructed of a 19mm diameter clear stone with an average porosity of 40%. The proposed pervious pavement structure will be constructed as Eco-Priora pavers (or approved equivalent), placed on 50mm of open graded granular material meeting ASTM No. 8 specifications and underlain by 470 mm of 19mm diameter clear stone. Based on the 116 sq.m parking surface to be provided, a minimum retention volume of 21.8 cu.m will be provided. An under-drain system is to be installed within the storage bed and is to be connected to the storm manholes.

The capacity of the permeable pavement has been verified by calculating the maximum rainfall depth which can be infiltrated within a 2-hour period for the 220mm depth of clear stone bedding installed beneath the subdrain (assuming a 50% clogging factor). Design calculations have been completed using the formula given in the LID Design Guide:

d = [Qr(R) + P – I(T)] /Vr For Qr = 0 and rearranging for P (rainfall depth)

P = dVr – iT

= 0.22m x 0.40 – 0.441 m/day x 0.0833 days x 50% clogging factor

= 0.0256 m (25.6mm)

Therefore, it is expected that the 220mm depth of clear stone bedding will draw down a 25 mm rainfall depth within 2 hours following a rainfall event.

6.2 Perforated Pipe System Design

Area drains will be used to direct clean runoff from the proposed impervious areas into the perforated pipe system. The perforated pipe system is to be constructed with 50mm diameter clear stone with a perforated 200mm diameter PVC sub-drain system and wrapped in filter cloth. 100mm high baffles will be provided at each area drain to promote runoff retention. A 210mm depth of clear stone will be provided beneath the subdrain. Detailed infiltration bed design calculations, following Section 4.5.8 of the MOECC Stormwater Planning and Design Manual (2003), have been completed below:

Equation 4.2

depth = Pt

t = depth / P

= 0.31 / 18.4 x 1000

= 16.8 hr

Equation 4.3 Area = 1000V / (Pnt),

V = Area x Pnt / 1000

= 19.5 x (18.4 x 0.40 x 16.8) / 1000

= 2.4 cu.m

Therefore, for the perforated pipe system with and area of 19.5 sq.m (39.0 m long x 0.5 m wide) and 0.31 m depth (below the baffles within the subdrain) will allow a 2.4 cu.m volume of rainwater to infiltrate within 16.8 hours.

7.0 EROSION AND SEDIMENT CONTROL

A temporary silt fence (as per OPSD 219.130) is to be installed along all property lines where there is a risk of sediment runoff onto the adjacent property during construction. This fencing shall be installed prior to site grading and shall be maintained throughout the construction period. Once the storm sewer is installed the catchbasins and area drains shall be protected from sediment. The erosion and sediment controls described above shall be maintained until all exposed soil is stabilized on the site. The Erosion and Sediment Control Plan provides complete details of the above.

8.0 WATER DISTRIBUTION SERVICING

8.1 Domestic Water & Fire Flow Demand Assessment

Domestic water demands have been estimated using the Town of Collingwood Development Standards (2007). For the 2,217.6 sq.m gross floor area, the domestic water demands have been estimated for a water usage of 3,750 L/day/1,000 sq.m GFA (as suggested by the MOE Guidelines for the Design of Water Distribution Systems), a maximum daily demand factor of 2 and a peak hourly demand factor of 4.5 (based on Town of Collingwood Development Standards).

Daily Water Consumption = Gross Floor Area x Water Usage
= 2,217.6 sq.m x 3,750 L/day/1,000 sq.m GFA
= 8,316 L/day

Maximum Daily Demand = Daily Water Consumption x Maximum Day Factor
= 8,316 L/day x 2
= 16,632 L/day
= 0.1925 L/s

Peak Hourly Demand = Daily Water Consumption x Peak Hour Factor
= 8,316 L/day x 4.5 / 24 hours/day
= 1,559 L/hour
= 0.433 L/s

The fire flow requirements for the building have been estimated using the NFPA Fire Underwriters Survey's Water Supply for Public Fire Protection (1999). The proposed 2,217.6 sq.m gross floor area above grade, has been used to calculate the fire flow requirements. Detailed calculations of the fire flow demand are included in **Appendix E** and summarized in the table below:

Water Demand	Mixed-Use	Units
Daily Water Consumption	8,316	L/day
Max Day Demand	0.1925	L/s
Fire Flow Demand	169.00	L/s
Total Water Demand (Fire Flow + Max Day)	169.193	L/s

The maximum anticipated water demand from the development will be 169.193 L/s, or 2,682 GPM. The proposed water system has been added to the Town water model to ensure adequate water flow and pressure for all demands including fire. The Watermain Hydraulic Assessment prepared by C3 Water Inc. (December 15, 2020) indicates an available fire flow of 232 L/s at the minimum operating pressure of 20 PSI within the 150mm diameter watermain on Market Street, which is in excess of the anticipated Total Water Demand for the development.

9.0 SANITARY SERVICING

9.1 Proposed Sanitary Flow Rates

The peak sanitary flow rate from the proposed mixed-use building has been considered the same as the peak hourly water demand calculated in **Section 8.1**. An infiltration allowance of 0.23 L/s/ha has been considered as per Town Standards. The expected sanitary flows from the property are calculated as follows:

Peak Hourly Sanitary Flow Rate	= 0.843 L/s
Peak Sanitary Flow Rate	= Peak Hourly Flow Rate + Infiltration Allowance = 0.433 L/s + (0.25 ha x 0.23 L/s/ha) = 0.433 L/s + 0.058 L/s = 0.491 L/s

Therefore, the peak sanitary flow rate expected from the property is 0.491 L/s.

10.0 CLOSURE

The proposed Stormwater Management Plan demonstrates that the development will meet the established criteria with respect to stormwater management set forth in governing documents. The internal storm sewer systems will control the release rate to the existing levels based on the observed site conditions. On-site stormwater detention storage has been provided up to a quantity of 74.6 cu.m in order to facilitate the proposed SWM controls. A StormCap green roof system will provide on site stormwater runoff retention to reduce the total volume of runoff received by the municipal storm sewer. Water quality control is to be provided by the proposed pervious pavers, CB Shields, perforated pipe system and goss traps. A rainfall depth equivalent to a 5.1 mm event from the property will be capture by the proposed permeable pavers and perforated pipe system to meet the water balance criteria.

Proposed maximum anticipated water demand and peak sanitary demand have been calculated as 2,682 GPM and 0.491 L/s, respectively. These values will be used in the Town's water supply model to determine whether adequate service capacity exists within the municipal infrastructure.

In conclusion, the proposed stormwater management and servicing plan supports the concept of an environmentally sustainable development. The proposed plan will mitigate anticipated stormwater impacts associated with the construction of the proposed development and aims to mimic the pre-development hydrological characteristics of the site. Additionally, the proposed water and sanitary demand requirements for the development have been calculated in conformance with Town standards to asses the plausibility of providing new service connections to the property.

Appendix A

Figures No. 4 & 5 - Modified Rational Method Calculations

STORMWATER MANAGEMENT ANALYSIS - FIGURE No. 4

PROJECT NUMBER:	16006
CLIENT:	GREENLAND CONSULTING
LOCATION:	121 HUME ST
IDF STATION:	OWEN SOUND

SITE INFORMATION

Number of Catchment Areas: 1

This Analysis is for Subcatchment Area No's. **1**

	AREA (m2)	RUNOFF COEFFICIENT*
Upper Level Roof	490.5	1.00
Lower Level Roof	507.0	1.00
Hard Surfaces	1,030.2	1.00
Landscape	305.0	0.31
Streetscape (Uncontrolled)	132.8	1.00
Overall Area	2,465.5	0.91
Controlled Area**	1,335.2	0.84

*runoff coefficients have been adjusted by a factor of 1.25 to a maximum value of 1.00

** Controlled Area includes Hard Surfaces and Landscape draining to CMH3

Allowable Release Rate from Site (L/s):

Total Allowable Release Rate=	13.46
Release Rate from Upper Roof=	2.18
Release Rate from Lower Roof=	1.60
Allowable Release from Controlled Area=	9.68

DETERMINATION OF NECESSARY STORAGE VOLUME - FIGURE No. 5

This Analysis is for Catchment Area No. 1

Modified Rational Method used to determine storage volume:

Q=CiA/360, i= A / (tc + C)^B for: A = 2193.1, B = 0.871, C = 9.04

TIME	i	INFLOW (m3/sec) (Q=CiA/360)			ACCUMULATED RUNOFF VOLUME (m3) (Vacc = Q x tc)			ALLOWABLE RELEASE VOL. (m3) (Vrel = Q100yr x tc)			REQ'D STORAGE (m3) (Vreq'd = Vacc - Vrel)			
(MIN.)	(mm/hr)	UPPER ROOF	LOWER ROOF	SURFACE	UPPER ROOF	LOWER ROOF	SURFACE	UPPER ROOF	LOWER ROOF	SURFACE	UPPER ROOF	LOWER ROOF	SURFACE	TOTAL
1	294.1	0.040	0.041	0.092	2.4	2.5	5.5	0.1	0.1	0.6	2.3	2.4	4.9	9.6
2	270.8	0.037	0.038	0.085	4.4	4.6	10.2	0.3	0.2	1.2	4.2	4.4	9.0	17.5
3	251.1	0.034	0.035	0.079	6.2	6.4	14.1	0.4	0.3	1.7	5.8	6.1	12.4	24.2
4	234.2	0.032	0.033	0.073	7.7	7.9	17.6	0.5	0.4	2.3	7.1	7.5	15.3	29.9
5	219.6	0.030	0.031	0.069	9.0	9.3	20.6	0.7	0.5	2.9	8.3	8.8	17.7	34.8
6	206.9	0.028	0.029	0.065	10.1	10.5	23.3	0.8	0.6	3.5	9.4	9.9	19.8	39.1
7	195.6	0.027	0.028	0.061	11.2	11.6	25.7	0.9	0.7	4.1	10.3	10.9	21.6	42.8
8	185.5	0.025	0.026	0.058	12.1	12.5	27.8	1.0	0.8	4.6	11.1	11.8	23.2	46.1
9	176.6	0.024	0.025	0.055	13.0	13.4	29.8	1.2	0.9	5.2	11.8	12.6	24.6	49.0
10	168.4	0.023	0.024	0.053	13.8	14.2	31.6	1.3	1.0	5.8	12.5	13.3	25.8	51.5
15	137.5	0.019	0.019	0.043	16.9	17.4	38.7	2.0	1.4	8.7	14.9	16.0	30.0	60.9
20	116.6	0.016	0.016	0.036	19.1	19.7	43.8	2.6	1.9	11.6	16.5	17.8	32.1	66.4
25	101.6	0.014	0.014	0.032	20.8	21.5	47.6	3.3	2.4	14.5	17.5	19.1	33.1	69.6
30	90.1	0.012	0.013	0.028	22.1	22.8	50.7	3.9	2.9	17.4	18.2	20.0	33.3	71.4
35	81.1	0.011	0.011	0.025	23.2	24.0	53.3	4.6	3.4	20.3	18.6	20.6	32.9	72.2
40	73.9	0.010	0.010	0.023	24.2	25.0	55.4	5.2	3.8	23.2	18.9	21.1	32.2	72.3
50	62.9	0.009	0.009	0.020	25.7	26.6	59.0	6.5	4.8	29.0	19.2	21.8	29.9	70.8
60	54.9	0.007	0.008	0.017	26.9	27.8	61.7	7.8	5.8	34.9	19.1	22.1	26.9	68.0
70	48.8	0.007	0.007	0.015	27.9	28.8	64.0	9.1	6.7	40.7	18.8	22.1	23.4	64.2
80	44.0	0.006	0.006	0.014	28.7	29.7	66.0	10.5	7.7	46.5	18.3	22.0	19.5	59.8
90	40.1	0.005	0.006	0.013	29.5	30.5	67.6	11.8	8.6	52.3	17.7	21.8	15.3	54.9
100	36.8	0.005	0.005	0.012	30.1	31.1	69.1	13.1	9.6	58.1	17.1	21.5	11.0	49.6

Appendix B

StormCap + Detention Product Specifications

MEMORANDUM

Date: 12 December 2019

Subject: 121 Hume Street – StormCap™+Detention results

To: Sasha Aguilera, Next Level Stormwater Management

From: Brad Garner, Researcher/Software Engineer

Green Roof Diagnostics has reviewed the proposed StormCap™+Detention green roof assembly for stormwater performance at the aforementioned project. Areas are as follows:

Area (m^2)	Profile	Retention Storage (m^3)	Detention Storage (m^3)
267 vegetated assembly	50mm GM, 50mm MW, 50mm RC	11.17	33.91
240 non-vegetated assembly	Hard surfaces, 50 mm RC		

**The outflow from the downspout of a 15 m^2 stairwell roof into the 4th floor green roof has been incorporated in the calculations. It is critical to ensure the downspout is not located very close to any 4th floor drain and that it's outflow is well distributed upon entering the green roof.*

StormCap™+Detention with Reservoir Cell (2 different assemblies on certain areas of the roof):

Complete vegetated assembly:

- 25 mm Pre-grown Sedum Blanket
- 50 mm Growing Media
- 50 mm Needled Mineral Hydro Blanket
- 50 mm Reservoir Cell
- 5 mm Detention Mat
- 0.5 mm Root Barrier

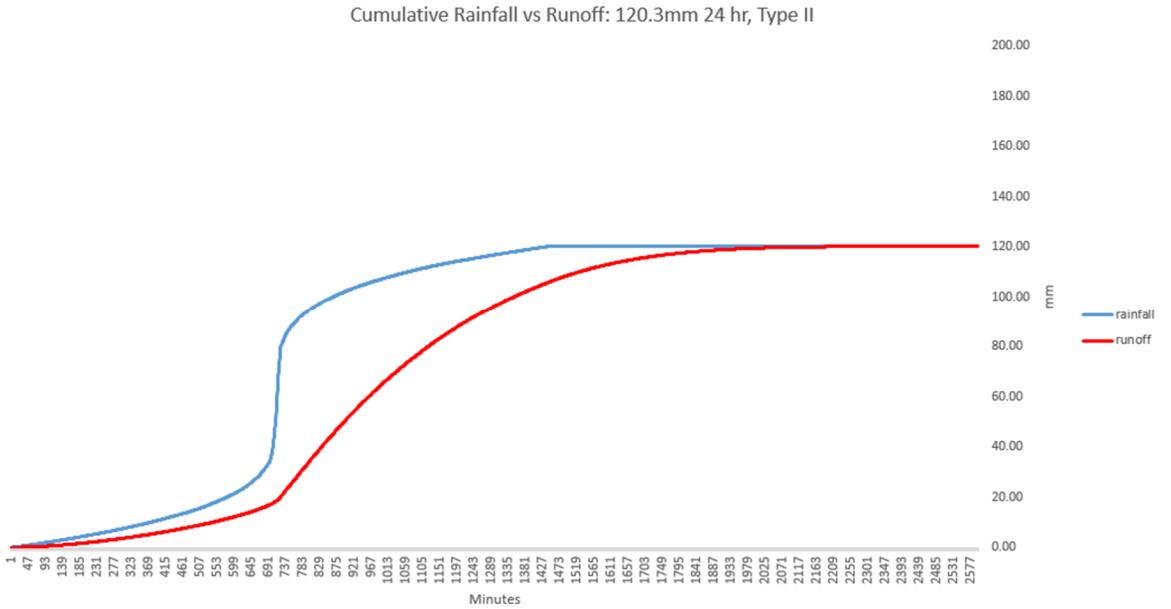
Full non-vegetated assembly:

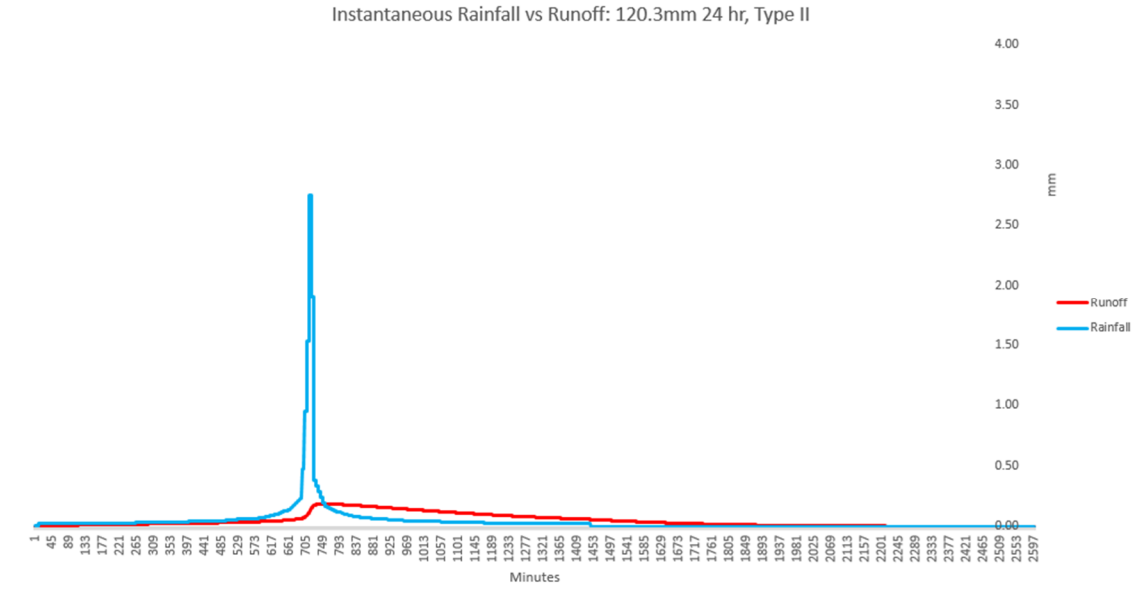
- Walkway/deck/planter/seating area
- 50 mm Reservoir Cell
- 5 mm Detention Mat
- 0.5 mm Root Barrier
-

Green Roof Diagnostics, 17416 Germanna Highway, Culpeper, VA 22701

More Information:

- Maximum modeled outflow rate of the 501 m² roof = 30.72 L/s/ha
- Dead load (dry): 54 kg/m²
- Dead load (at maximum retention value): 125 kg/m²
- Detention live load (only) at maximum capacity: 59 kg/m²
- Total weight at maximum capacity (live load + dead load): 184 kg/m²
- Peak Flow Delay time (centroid delay): 4.1 hours
- Peak Flow Reduction: 93%
- Recharge timeframe: 19.7 hours





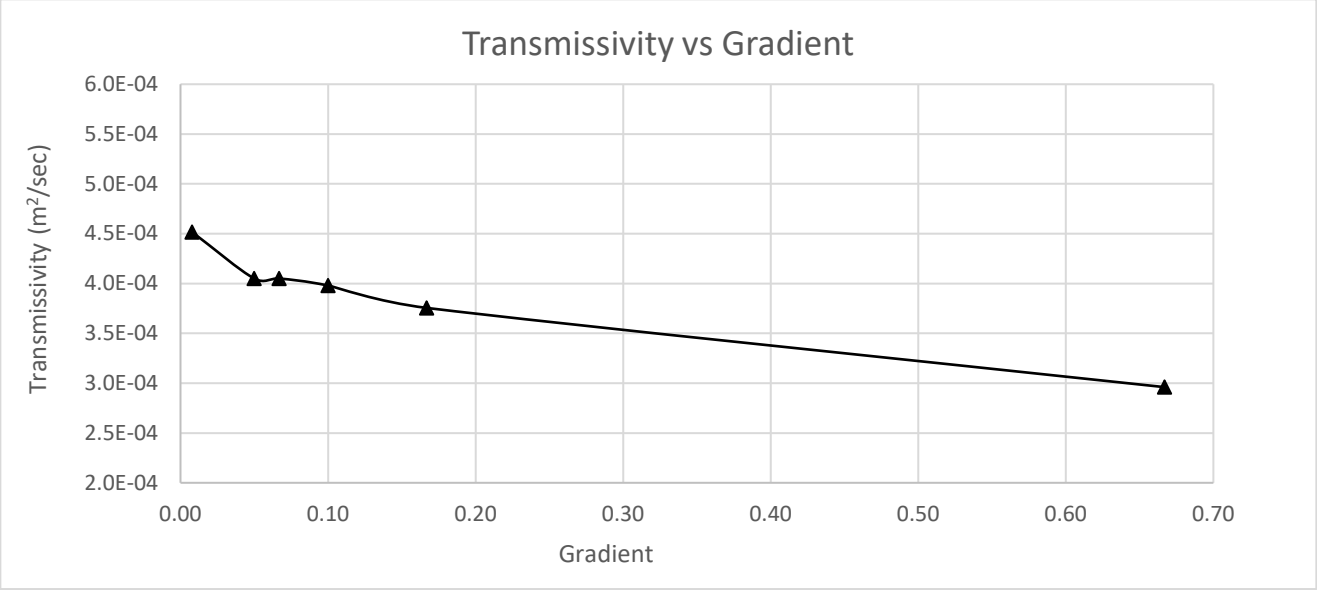
DECEMBER 2019 19128215

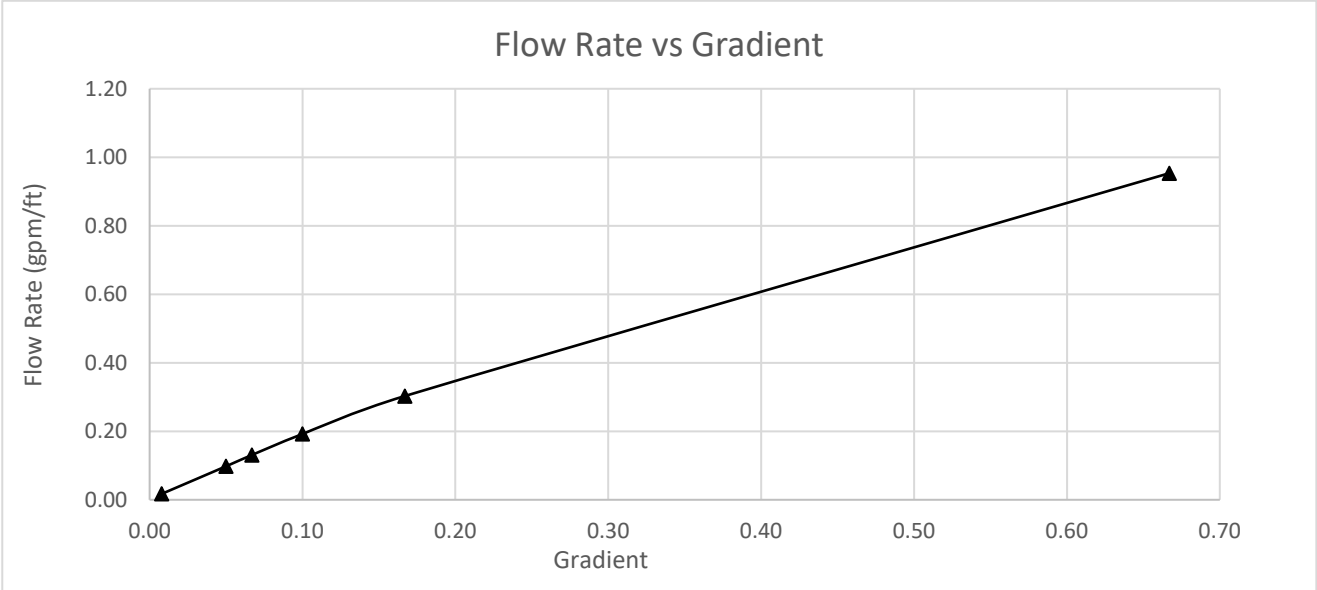
TRANSMISSIVITY TEST RESULTS
ASTM D4716

PROJECT NAME: GREEN ROOF/2019 LAB TESTING/VA
SAMPLE NUMBER: 5mmc HC50 MW

Configuration: Plate / 5mmc (perpendicular to stripes) / 50 mm Honeycomb / Mineral Wool / Plate
Seating Time: 15 minutes
Pressure: 50 psf

	Transmissivity (m^2/sec)			Flow Rate (gpm/ft)		
Gradient	Specimen 1	Specimen 2	Average	Specimen 1	Specimen 2	Average
0.008	4.58E-04	4.45E-04	4.52E-04	0.018	0.017	0.017
0.050	4.39E-04	3.71E-04	4.05E-04	0.106	0.090	0.098
0.067	4.37E-04	3.73E-04	4.05E-04	0.141	0.121	0.131
0.100	4.23E-04	3.73E-04	3.98E-04	0.204	0.180	0.192
0.167	4.01E-04	3.50E-04	3.76E-04	0.323	0.283	0.303
0.667	3.15E-04	2.77E-04	2.96E-04	1.015	0.892	0.954





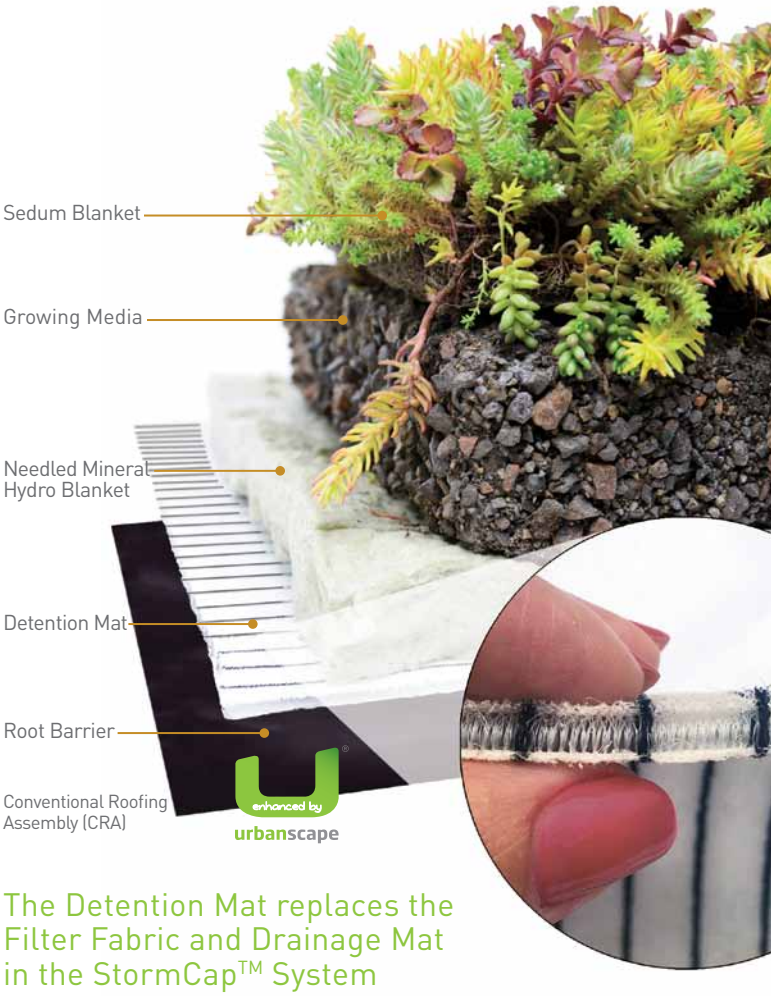
Next Level™
STORMWATER MANAGEMENT

StormCap™+Detention

Maximum Water-Retaining and Water-Detaining Pre-Vegetated System

Best ROI
All your stormwater managed on the roof!

No more buried cost
Reduce or eliminate the cistern



The Detention Mat replaces the Filter Fabric and Drainage Mat in the StormCap™ System

StormCap™+Detention manages stormwater on the roof by providing *retention* and *detention*, making it a full-fledged stormwater tool ready to face second day and extra-large storms. Detention provides a clear return on investment. StormCap™+Detention reduces or eliminates cisterns and bioretention facilities and frees up valuable space for income-generating development. It even works on a low-sloped roof!

What to do with all that space?

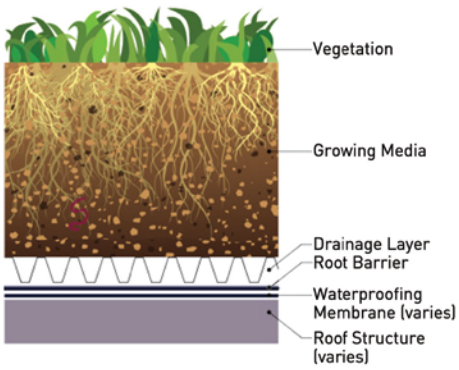
- Park cars
- Bicycle storage
- Build a fitness centre
- Open a coffee shop
- Childcare space
- More!

091019

Next Level Stormwater Management™
416 637 5772 | info@nlsm.ca | nlsm.ca

Putting storms in their place.

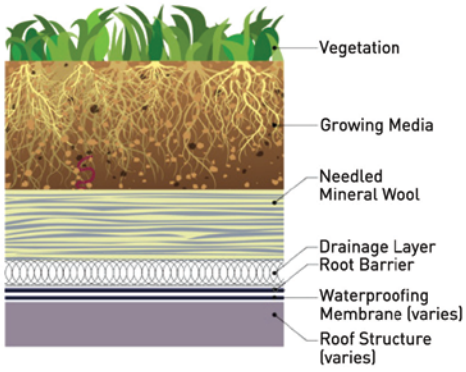
How does StormCap™+Detention work?



Traditional

- [x] Retention
- [ ] Enhanced Retention
- [ ] Detention

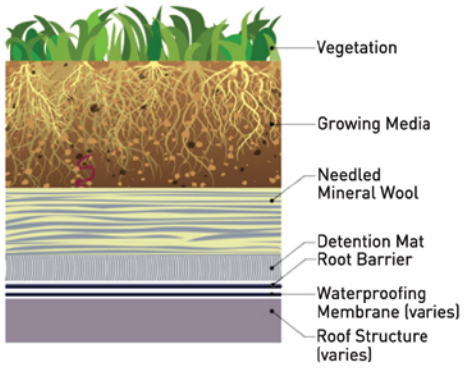
All green roofs provide retention. Retention can be achieved and replicated only when the system dries to a certain level. To become dry, water must leave as vapour through the slow process of evapotranspiration.



StormCap™

- [x] Retention
- [x] Enhanced Retention
- [ ] Detention

Incorporates needled mineral wool for enhanced retention. The rest of the water runs off, particularly in large storms and second-day storms.



StormCap™+Detention

- [x] Retention
- [x] Enhanced Retention
- [x] Detention

Manages heavy rain events typically controlled by tanks or ponds. Incorporates a surface roughness layer - detention - that helps fill and submerge the system in rainwater, and then slowly empties afterwards.

SAMPLE PROJECT using a custom assembly of StormCap™+Detention

1696 m^2	Size	6.5 hours	Runoff delay (centroid)
2%	Slope	7.6 hours	Recharge timeframe
Type II 24-hr 157mm	Design Storm	97%	Peak flow reduction
16.8 L/s/ha	Max Outflow Rate	104 m^3	Detention storage
6	Roof drains	46 m^3	Retention storage

Project-specific ROI:

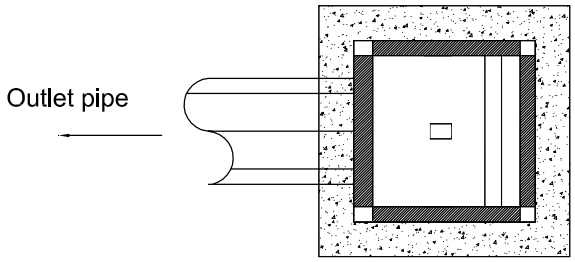
- **Eliminated stormwater tank**
- **Dramatically reduced excavation and foundation costs**

Contact Sasha Aguilera, Design Ambassador, who will help run calculations specific for your project.
Sasha@nlsm.ca or 416 637 5772 ext 2.

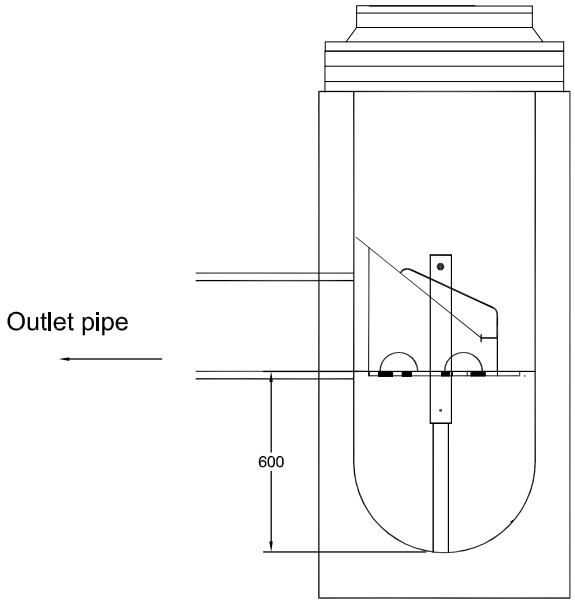
Appendix C

CB Shield Product Specifications

Notes
1. CB Shield can be installed at any time. In a non frozen condition.
2. The frame and cover should be well aligned with the catchbasin for proper installation
3. The catchbasin sump must be clean before installation
4. The grate should be at the same level as the standing water in the sump.



Top view



Profile view

CB Shield (600mm Sump)

Average Annual Sediment Removal Rates (%) using a CB Shield (based on ETV Sediment - 1 to 1000 micron Particle Size Distribution)

Area to CB (ha)	Imperviousness[1] (%)					
	20%	35%	50%	65%	80%	100%
0.02	57%	57%	57%	57%	56%	56%
0.05	56%	56%	56%	55%	55%	54%
0.10	56%	55%	54%	53%	52%	51%
0.20	54%	53%	51%	49%	48%	46%
0.30	53%	50%	48%	46%	45%	43%
0.40	51%	48%	46%	44%	42%	40%
0.50	50%	47%	44%	42%	40%	38%
0.60	49%	45%	43%	40%	39%	36%

Notes:

1. Runoff Coefficient 'C' is approximately equal to 0.05 + 0.9*Impervious Fraction.
2. Above chart is based on long term continuous hydrologic analysis of Toronto, Ontario (Bloor St) rainfall data.
3. Assumes 0.6 m sump in CB and that maintenance is performed (i.e. CB cleaning) when required by sediment/pollutant build-up or otherwise.
4. See accompanying chart for suggested maintenance scheduling - AND - get CB Shield Inc. to monitor it for you in field.
5. Sediment/Pollutant removal rates based on third party certified laboratory testing using ETV sediment (PSD analysis available on request).
6. See additional discussion regarding scour protection from CB Shield during more infrequent runoff events.

CB SHIELD

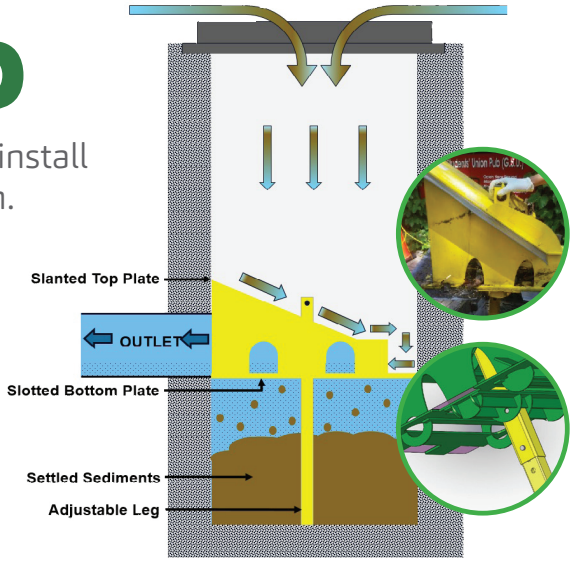
info@cbshield.com | 519-212-9161 | www.cbshield.com

NOW ETV VERIFIED

CB Shield is the most cost-effective device to install and maintain in a stormwater treatment train.

50% OR GREATER TSS CAPTURE

REDUCE SCOURING BY AS MUCH AS 92%



Appendix D

TSS Mitigation Calculations

Mitigated TSS Loading

Rainfall Event 40 mm

Surface	Area (sq.m)	Runoff Coefficient	Peak Runoff Volume (m3)	Initial Concentration (Mg/L)	Initial TSS Loading (g)	Treatment Type	TSS Removal Efficiency	TSS Removed (g)
Building Areas								
Upper	490.5	0.90	17.7	7.0	124	N/A	0%	0
Lower	507.0	0.90	18.3	7.0	128	Green Roof	55%	70
Impermeable Areas								
North	681.0	0.95	25.9	90.0	2,329	Perforated Pipe	88%	2,050
South	349.2	0.95	13.3	90.0	1,194	Pavers + CB Shield	77%	914
Landscaped Areas								
North	234.2	0.25	2.3	24.0	56	Perforated Pipe	88%	49
South	70.8	0.25	0.7	24.0	17	Pavers + CB Shield	77%	13
Boulevard Areas								
Uncontrolled	132.8	0.00	0.0	90.0	0	N/A	0%	0
Total Site Area	**2,465.5**		**78.1**	**49.3**	**3,848**		**80.5%**	**3,096**
							TSS Remaining:	**752**

Appendix E

Fire Flow Demand Calculations

WATER SUPPLY FOR PUBLIC FIRE PROTECTION - 1999
FIRE UNDERWRITERS SURVEY

Job No.: 16006
Date: 17/12/2020

121 Hume Street - Innovation Hub & Mixed Use Development

1. Required Fire Flow Calculation

F=220C(A)^0.5

F= 10360 l/min

F= the required fire flow in litres per minute
C= coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible)
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire resistive construction (fully protected frame, floors, roof)
A= the total floor area in square metres in the buidling being considered

Type of Construction = Non- Combustible
C= 1.0

Total GFA = 2,218 m²

2. Determine if occupancy type has a low contents fire hazard or high contents fire hazard.

F= 7800 l/min

Contents Classification	
1) Non-Combustible	-25%
2) Limited Combustible	-15%
3) Combustible	0%
4) Free Burning	15%
5) Rapid Burning	25%

Per Appendix A - Occupancy is Considered Low Fire Hazard

1	-25%
0	0%
0	0%
0	0%
0	0%
Total	-25%

3. Automatic Sprinkler Protection Reduction

F= -3510 l/min

Sprinkler Reduction Ratings	
1) Sprinkler System Conforms to NFPA 13 and other NFPA Sprinkler Standards	-30%
2) Water supply standard for both the sprinkler system and fire department hose lines	-10%
3) Fully supervised sprinkler system	-5%

Sprinkler Reduction Ratings - Building is Sprinklered

1	-30%
1	-10%
1	-5%
Total	-45%

4. Exposure to adjacent buildings

F= 5850 l/min

Separation	Charge
1) 0 to 3.0m	25%
2) 3.1 to 10.0m	20%
3) 10.1 to 20.0m	15%
4) 20.1 to 30.0m	10%
5) 30.1 to 45.0m	5%

The total % shall be the sum of the % of all sides but shall not exceed 75%.

Number of Walls within Exposure Limits

0	0%
0	0%
1	15%
8	80%
	0%
Total	75%

THEREFORE TOTAL FIRE FLOW REQUIRED = 10140 l/min
or 169.00 l/s