STORMWATER MANAGEMENT DESIGN BRIEF

Drake Hotel Properties

Drake Devonshire and Motor Inn Site Plan

November 11, 2024

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Revision History

November 11, 2024

Revision initiated by the client to respond to updated site plan. Filter strips adjusted to provide trench drain treatment to each of three filter strips. Filter strip sizes and locations adjusted slightly for landscape features.

April 24, 2024

Revision for updated site layout. The current revision was expanded to include quality treatment since the revised site plan layout will result in a small increase in imperviousness. The report is issued to support Site Plan Approval.

July 16, 2021

Original Submission for Zoning By-Law Amendment

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1 Background Information

Jewell Engineering Inc. (Jewell) was retained by Drake Hotel Properties (Drake) to assist with the planning applications for the Drake Devonshire at 20 and 24 Wharf Street in Wellington, Ontario (Figure 1). Zoning approval was received April 2022 to change the permitted use of the 20 Wharf St. parcel to Core Commercial (CC-6) zone, which would allow the proposed hotel use.

Since the granting of the re-zoning request in 2022, the Drake is preparing a site plan application for the hotel improvements. The current study is issued in support of a site plan approval application.

The property comprises 0.59ha of land with waterfront onto Lake Ontario on the south side and also includes the main branch of Lane Creek. The area around the Drake is mostly commercial along the north and northeast, with residential abutting along the west. To the east of Wharf Street there is some commercial use and a residential property along the waterfront.

Figure 1-1: Project Location (Google, 2018).

The house at 20 Wharf Street will be demolished and the Hotel will be expanded onto that property. Additional site improvements will include a reconfiguration of the access for fire protection purposes, adjustment of the parking areas and some landscaping. In addition, a shed will be replaced by a new mechanical building.

The proposed improvements in the current site plan concept will result in small increase in the overall property imperviousness from the existing 30.8% to 37.4%. Development impacts are inferred by impervious cover and since this is expected to increase, some stormwater impacts are also anticipated.

The expected stormwater impacts and any stormwater management measures that would be required to mitigate negative impacts are discussed in the following sections.

2 Stormwater Quality and Quantity Targets

Site imperviousness is defined as the percentage of hard surfacing that would impede or prevent precipitation from infiltrating into the ground. An increase in imperviousness is an indicator that water quality and quantity impacts may result. Since the proposed site improvements will result in an increase in imperviousness, one would infer both quality and quantity impacts are to be expected.

However, the site drains directly to the mouth of Lane Creek and therefore, no quantity impacts will result. Therefore, the stormwater management for the Drake Devonshire in Wellington is focused on quality control.

2.1 Quality Target

In the existing conditions, the site is relatively well developed with an impervious cover measuring 30.8%. This value includes the entire land holdings on both sides of Lane Creek. All changes will be on the east side of Lane Creek and no development is proposed on the west side. The proposed imperviousness will be 41.8%.

The proposed changes will include an increase in the coverage of buildings, pavers, and concrete as well as a corresponding decrease in the gravel and landscaped surfaces. See Table 2-1 for the land cover changes and a calculation of the weighted imperviousness.

Table 2-1: Landcover and Weighted Imperviousness

Cover Type	Existing		Proposed	
	Area (m^2)	% Imp	Area (m^2)	% Imp
Gravel	1,165.3	60%	150.1	60%
Buildings	947.7	100%	1341.7	100%
Asphalt/Concrete	15.2	100%	562.7	100%
Pavers	150.1	100%	467	100%
Landscaped	3,614.8	0%	3371.6	0%
Total	**5,893.1**	**30.8%**	**5,893.1**	**41.8%**

The target for quality treatment at the outlet on Lake Ontario in a non-sensitive environment is *Normal* objective (70% TSS removal). Remedial treatment should meet or exceed this removal rate.

3 Low Impact Development

The SWM solution for this development applies Low Impact Development (LID) methodologies to reduce the impact of development on the hydrologic regime. LID is a requirement of the 2014 Provincial Policy Statement and requires that all developments consider these types of strategies. After consideration of the site-specific information presented in Section 2, LID strategies are applicable for this development and are discussed further below.

The Low Impact Development Guidelines (Toronto and Region Conservation Authority, 2010) states that "increases in the quantity, rate, and frequency of runoff can be linked to two root causes:

- the conversion of undeveloped or agricultural land cover to urban uses, and
- the application of storm sewer systems."

The goal of LID site design strategies is to minimize these two sources of hydrologic impacts (Toronto and Region Conservation Authority, 2010, p. 3.3). Large urban areas are negatively impacted by flash flooding associated with extensive hardening. The LID design techniques seek to mitigate flooding and erosion associated with urbanization. While water quality improvements are associated with the recommended techniques, quantity control remains the focus of LID.

The guidelines provide some site design strategies for reducing the hydrologic impact postulating four major groupings or "themes":

1) Preserving important hydrologic features and functions;
2) siting and layout of development;
3) reducing impervious area; and
4) using natural drainage systems.

The site design incorporates all four of the themes. Some strategies are carefully applied since municipal requirements limit such techniques as setbacks, road design, parking, and drainage design. The LID guidelines provide a hierarchy of applying the LID techniques by first invoking the use of natural hydrologic areas and then development of green infrastructure. As such, the site design makes extensive use of the natural features and adds limited green technologies that will encourage infiltration.

Discussion of the LID design used in the stormwater management design is provided below.

Theme 1 – Preserving Important Hydrologic Features

This theme focuses on preservation. Site design is adjusted to preserve natural features that benefit hydrology.

- Preserve stream buffers, including along intermittent and ephemeral channels
- Preserve areas of undisturbed soil and vegetation cover
- Avoid development on permeable soils
- Preserve existing trees and, where possible, tree clusters.

Important hydrologic features include:

- highly permeable soils
- pocket wetlands
- significant small (headwater) drainage features
- riparian buffers
- floodplains
- undisturbed natural vegetation
- and tree clusters.

The Drake Devonshire development is established along Lane Creek and Lake Ontario. There will be no intrusion by the development into the creek and Lake Ontario as these natural features are to be maintained. The development pressure is focused toward Wharf Street.

Theme 2 – Application of Siting and Layout Techniques

Siting and layout techniques have the objective to reduce the environmental impacts of the development by fitting the development within the framework of the natural heritage features.

- Fit the design to the terrain
- Use open space or clustered development
- Use innovative street network designs
- Reduce roadway setbacks and lot frontages

Only minor grading changes are proposed.

Theme 3 – Reducing the Impervious Area

Imperviousness can be reduced by minimizing unnecessary surface hardening. Some strategies include:

- Reduce street width
- Reduce building footprints
- Reduce parking footprints
- Consider alternatives cul-de-sacs
- Eliminate unnecessary sidewalks and driveways

Significant design effort has been extended by the design team to minimize the impervious cover. The existing gravel is maintained where possible and where it is to be replaced, the replacement surface will be constructed with pervious pavers. The benefit of infiltration at this site must be understood in the context of the shallow soils over bedrock that minimize the effectiveness of infiltration in both the existing conditions and the proposed conditions.

Theme 4 – Using Natural Drainage Systems

These strategies focus on the use of existing natural drainage systems where available "to take advantage of undisturbed vegetated areas and natural drainage patterns".

- "Disconnect" impervious areas
- Preserve or create micro-topography
- Extend drainage flow paths

The roof areas will discharge to surface where there will be some limited opportunity for infiltration. It is noted that the site is immediately adjacent to Lake Ontario and the hydrologic benefit of infiltration is nil from a quantity control perspective. Improvements can be expected for quality treatment. The quality treatment plan will be to provide some landscaping enhancements in the form of rain gardens along side Lane Creek to intercept drainage from the parking areas.

LID Summary

The development site design follows the LID strategies provided in the Low Impact Development guide and makes extensive use of techniques to preserve natural drainage features, adjust the layout to the site, reduce impervious areas and take advantage of natural drainage features.

The LID approach to the design of the subdivision satisfies the requirements of the Provincial Policy Statement.

4 Stormwater Quality Treatment

Stormwater quality treatment is required for the difference in impervious areas. The roof areas are generally less impacted and may be treated with just grassy contact. The downspouts from the roof will drain to the rear and be directed across the grass toward Lake Ontario.

4.1 Required Treatment

The parking areas are generally considered more impacted and would be in need of treatment. The increase in surface hardening is 693.5m^2. This includes roof and driveway (pavers).

The area required to be treated for quality mitigation is 649.3m^2 (at 100% imperviousness)

Since it is not feasible to separate out and treat only the newly developed areas, Jewell recommends treating the parking areas, which represent a larger area than the increased total imperviousness. The area that will be treated is:

Hard Surface = 961.6m^2 (100% imperviousness)

Landscaped = 127.1m^2 (0% imperviousness)

Total = 1,088.7m^2 (961.6m^2 at 100% imperviousness)

Figure 4-1 identifies the lands that will be treated in the SWMF. The weighted imperviousness of the area being directed to the SWMF is 88.3% (see Appendix B).

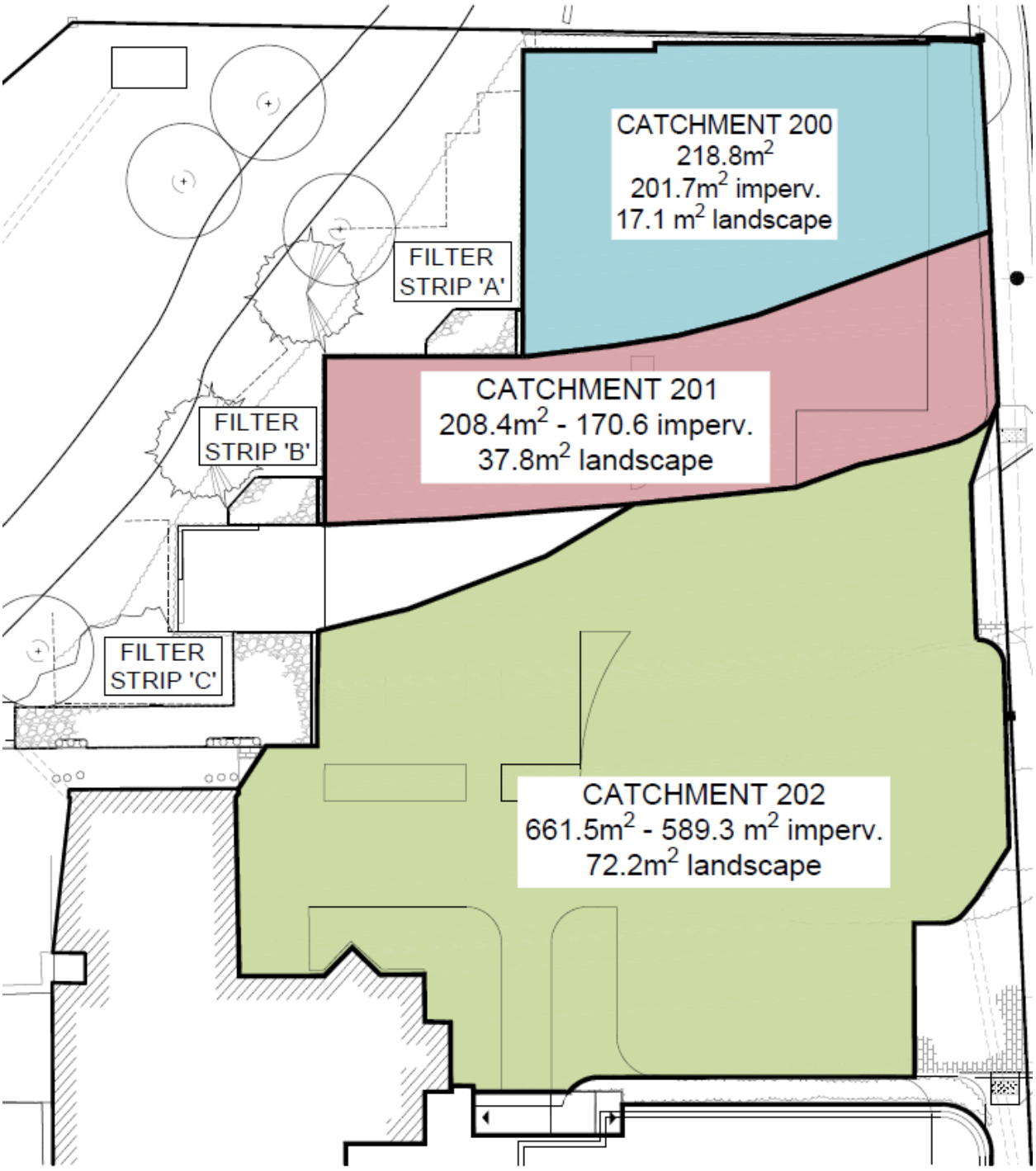

Figure 4-1: Area to be Directed to SWMF

4.2 Proposed Treatment Technology

The treatment options for small sites include mechanical treatment devices and measures that are mostly reliant upon infiltration.

4.2.1 Oil/Grit separators

Underground treatment devices such as Oil/Grit Separators are intended to be paired with storm sewer. At the Drake site all drainage will remain above ground using overland flow pathways. Therefore, underground treatment devices are not suitable for use at the Drake.

4.2.2 Infiltration basins / Trenches

Infiltration technologies will be limited in their application since the bedrock elevations are quite shallow.

4.2.3 Ponds / Wetlands

The minimum land area required to support a pond or wetland is 5ha. The site east of the creek is much too small to use these technologies.

4.2.4 Enhanced Swales

Enhanced swales are listed among infiltration technologies, but also provide filtration benefits. The application at the Drake site appears to be limited since referenced studies indicate a minimum of 20m of swale length is required to achieve the targeted TSS reduction. There is no area where a 20m long swale can be situated.

4.2.5 Vegetated Filter Strips

There is opportunity to use filter strips. This type of technology employs infiltration, natural filtration and nutrient uptake in plants that can help to provide water quality improvement. They are suitable for areas less than 2ha and flat topography (<10% slope) and in areas of shallow groundwater (see Table 4-1 from MOE, 2003).

Additionally, vegetated filter strips should have some form of pretreatment device. Since the contributing area is quite small a trench drain may be placed at the outlet of the parking area to capture the major grit fraction. The trench drain will help to provide some pre-treatment.

This technology has been selected for use at the Drake. The stormwater management treatment will contain storage within stone media that is sized according to the Table 3-2 from MOE 2003.

4.3 Proposed Quality Treatment

A Vegetated Filter Strip is proposed along the southwest limit of the parking area. Two smaller filter strips are also proposed at the south limit of each of the two north retaining walls in the event that some drainage from the gravel parking areas bypasses the main filter strip in future

parking lot maintenance. The filter strip is a settlement-based technology that relies on a velocity limit of 0.5m/s. The flow velocity is tested in the following section.

Filter Strip A

Filter strip A is 2m wide by 3.65m long. It includes a trench drain for pretreatment with 100mm drain. Filter strip A treats Catchment 200.

Filter Strip B

Filter strip B is also 2m wide by 3.65m long and includes a trench drain for pretreatment with 100mm drain piping. It treats Catchment 201.

Filter Strip C

Filter strip C is 4.45m wide and 3.3m long with an extension that is 9.3m by 1.35m. Filter strip C will receive pretreatment with a trench drain. This filter strip treats Catchment 202.

4.3.1 Flow Depth and Velocity

The filter strips are generally comprised of 0.4m depth of 20mm clear stone media wrapped in non-woven filter fabric and topped with 0.15m depth of river stone. On either side of the filter strips will be high infiltration soils amended with 1/3 sand and 15% compost. This will encourage growth of grasses and perennial plants including shrubs. The clear stone media is intended to enhance the filter strips by spreading the flow and storing stormwater and encouraging subsurface flow-through.

A level spreader is intended to have a shallow depth of water across the surface (50mm – 100mm). Shallow flow depths are preferred since the technology works best as sheet flow (Ontario Ministry of the Environment, 2003, p. 4.44).

Flows will generally be spread using the level river stone. Jewell is proposing a variation of the spreader that would have a 1.35m wide surface with river stone over a stone media storage area wrapped in filter fabric. Flanking the stone on either side will be a 0.9m vegetation strip with amended soils to enhance the infiltration potential. The available lands limit the length of the largest filter strip to 12m.

The majority of the site will drain to Filter Strip C and the calculations below for depth and velocity assume all drainage will flow to Filter Strip C. This is a **conservative assumption**.

The water quality event is estimated using Equation 4.9 from the design manual that estimates the quality intensity and the Rational Method equation. Equation 4.9 estimates the rainfall intensity that is supplied to the Rational Method.

Equation 1: Quality Intensity Formula (MOE, 2003)

$$i = 43C + 5.9$$

Where:

i = rainfall intensity in mm/hr
C = runoff coefficient

The weighted runoff coefficient for the parking area is 0.9. The calculated intensity is **44.6mm/hr**.

Equation 2: Rational Method

$$Q = \frac{CiA}{360}$$

Where:

Q = peak flow in m^3/s
A = area in ha
i = rainfall intensity in mm/hr
C = runoff coefficient

The water quality treatment flow is 0.012cms.

The flow depth in the Vegetated Filter Strip is calculated using the Manning's Open Channel Flow equation. This is a combination of the Continuity equation and Manning's.

Equation 3: Manning's Open Channel Flow equation

$$V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:

V = Channel Velocity (m/s)
S = Channel Slope (m/m)
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Flow Area (m^2)
n = Manning's Roughness Coefficient

Equation 4: Continuity equation

$$Q = VA$$

Where:

Q = Channel Flow Capacity
V = Channel Velocity (m/s)
A= Flow Area (m^2)

From the equations above, one finds the flow depth in the channel is 35mm and the velocity is 0.11m/s (see Appendix B). This indicates that the proposed filter strip will have a shallow flow depth and will emulate sheet flow. The low velocity is well within the typical limits of 0.5m/s. The vegetated filter strip is expected to function well in this application.

4.3.2 Storage

Storage is not a requirement for this technology, but is added as an enhancement to improve the function of the filter strip. The desired storage volume is calculated to be 2.3m^3. A safety factor of 2.5 is commonly applied to infiltration technologies bringing the desired storage volume to 5.7m^3. A total storage volume of 6.4m^3 is provided collectively within the three stone reservoirs. Although the vegetated filter strip is not planned as an infiltration technology, there will be some infiltration benefit.

Storage is intended to capture the excess runoff from a 10mm, 4-hr Chicago distribution event. In a hydrologic model this can be emulated directly. For this small site a hydrologic model is not feasible and instead Jewell has referenced the storage requirement from Table 3-2 from MOE, 2003 for an infiltration technology. This is calculated in Appendix B.

The storage will be effectively provided within the three stone reservoirs under the filter strip (that is, storage within the river stone is ignored). Stormwater released from the stone reservoirs will discharge into the flanking high infiltration soils for filtration.

4.3.3 Quality Summary

The Vegetated Filter Strips will provide adequate quality treatment exceeding the Normal quality treatment objectives.

- The flow depth of 35mm is within the maximum allowable of 100mm.
- The velocity of 0.11m/s is also well within the maximum allowable velocity of 0.5m/s.
- The storage provided in the stone media alone (6.4m^3) exceeds the desired storage of 5.7m^3.

5 Erosion and Sediment Controls

There is a high risk of sediment release during construction activities. Typical sediment and erosion control measures include:

- Siltation fencing,
- Strawbale check dams,
- Rip-rap check dams,
- Filter sock inserts in catch basins, and
- Silt Socks in concentrated flow areas.

Controls are to be placed downstream of all active work areas and upstream of protected receivers. Controls should also be placed around stockpiles of topsoil and fill materials.

Typical OPSDs provide good instruction on the correct placement and construction of the controls. The controls provide some protection if they are properly maintained, but they should be considered last-resort measures. The most effective means of control are those which prevent or reduce erosion at the source. This would include diligent stabilization of exposed areas immediately after grading is completed. Stabilization measures include sod, erosion blankets, or rip-rap and filter cloth on steep slopes, as well as topsoil and hydroseed on gently sloped areas (with slope 10% or less).

Existing stormwater management facilities should not be used for control of sediment. The site developer and contractor should actively maintain the new drainage works to remove accumulations of sediment within sediment accumulation areas.

A silt fence should be located along the down gradient perimeter of all sensitive features during the construction process, which should be maintained until the lands have stabilized or as directed by the municipality. There would be benefit in maintaining this silt fence for up to 2 growing seasons.

6 Maintenance

Silts and sands applied mostly during winter maintenance on parking lot surfaces will wash off the parking lots and accumulate in the stormwater treatment areas. Generally, maintenance of the parking areas by mechanically sweeping will reduce the sediment that is washed into the stormwater treatment areas.

The filter strips include components that are intended to capture sediment. These are the trench drains and filter fabric.

Site operators should remove the sediment within the trench drains annually. This may be adjusted after several years of experience if sediment accumulation rates indicate more frequent or suggest frequent intervals.

The pores within the filter fabric may become clogged over time and will need to be replaced. Site operators should remove and wash the river stone. The exposed filter fabric should be cut out and replaced with new. The washed river stone can then be replaced.

7 Conclusions

As a result of the small change in impervious area and proximity to Lane Creek and Lake Ontario, only quality controls are required for the Drake development. Quality treatment is proposed in the form of Vegetated Filter Strips along the southwest perimeter of the parking area. Three filter strips are proposed. The largest (Filter Strip C) will receive most of the drainage while Filter Strips A and B will treat smaller catchments. Each will receive some pre-treatment in trench drains. The filter fabric surrounding the 20mm stone medium will also provide pretreatment.

Some LID based technologies are being proposed to reduce the area of imperviousness. Some of the driveway and loading area surfaces will be finished with paving stones. This will help to promote some infiltration.

Some conservatism has been imposed on the stormwater management plan since retrofit treatment is incorporated into the plan. The stormwater management plan will treat existing parking areas rather than roof areas. In this way, the more impacted portions of the site will be treated. This represents a larger area than the total area of surface hardening.

Jewell is proposing the implementation of sediment and erosion controls to limit any sediment deposition. Best management practices are to be used during construction to limit potential negative environmental impacts.

The stormwater management plan will achieve the required mitigation for the minor quality impacts expected from the expansion of the Drake Devonshire property.

Submitted by:

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APPENDIX A

DEVELOPMENT SITE PLAN

Submitted Separately

APPENDIX B

Hydrologic and Hydraulic Calculations

Calculation of Storage for Infiltration SWMF

per Table 3-2 (MOE, 2003)

Drake Devonshire
B. Keene, P.Eng.
11-Nov-24

Calculation of New Imperviousness

Cover Type	% Imp	Existing Area (m^2)	Proposed Area (m^2)	*Change Area (m^2)*	
Gravel	60%	1165.3	150.1	*-1015.2*	
Buildings	100%	947.7	1341.7	*394*	
Asphalt / Concrete	100%	15.2	562.7	*547.5*	
Pavers	100%	150.1	467	*316.9*	
Landscaped	0%	3614.8	3371.6	*-243.2*	
Total		**5893.1**	**5893.1**	***0***	m^2
Impervious Area		**1812.18**	**2461.46**	***649.3***	m^2
Percent Imperviousness		**30.8%**	**41.8%**	***11.0%***	

New Impervious Area =	**649.3**	m^2
Storage Required **=	**2.3**	m^3
Safety Factor =	**2.5**	
Factored Storage Required =	**5.7**	m^3

**** Storage Req'd from MOE Table 3-2 - *Normal***

% Imp	Storage (m^3/ha)	
70%	25	
85%	30	
100.0%	**35.0**	*Extrap*

Treatment Locations		***Facility A***	***Facility B***	***Facility C***	***Total***
Catchment		***200***	***201***	***202***	
Cover Type	**% Imp**	**(m^2)**	**(m^2)**	**(m^2)**	**(m^2)**
Hard	100%	201.7	170.6	589.3	961.6
Landscaped	0%	17.1	37.8	72.2	127.1
Total		**218.8**	**208.4**	**661.5**	1088.7
Imperviousness		**92.2%**	**81.9%**	**89.1%**	**88.3%**
		201.7	**170.6**	**589.3**	**961.6**

Imp Area Draining to Facilities =	**961.6**	m^2
Proration = 649.3 / 961.6 =	**68%**	

Facility	Total Area	Imp	Full Storage		Proration*	Storage	Storage	
	m^2	%	(m^3/ha)	m^3		Factor **	Required	Provided
A	218.8	92.2%	32.4	0.71	0.68	2.5	1.2	1.04
B	208.4	81.9%	29.0	0.60	0.68	2.5	1.0	1.04
C	661.5	88.3%	31.1	2.06	0.68	2.5	3.5	4.32
				3.37			**5.7**	**6.4**

** 68% required to be treated*

*** per LID Design Manual, 2010*

Facility Summary

Facility	Length	Width	Depth	Porosity	Storage
	m	m	m	%	m^3
A	3.25	2	0.4	0.4	1.04
B	3.25	2	0.4	0.4	1.04
C	12	2.25	0.4	0.4	4.32
					6.4

Quality Treatment Flows Using Rational Method

Drake Devonshire
B. Keene, P.Eng.
11-Nov-24

Eqn 1 **Rational Method**

$$Q = \frac{CiA}{360}$$

Q = Peak Flow (cms)
i = Intensity (mm/hr)
A = Area (ha)
C = Runoff Coefficient (dimensionless)

Eqn 2 **Intensity**

$$i = 43C + 5.9$$

i = Intensity (mm/hr)
C = Runoff Coefficient (dimensionless)

From Equation 2

C =	0.9	
i =	**44.6**	**mm/hr**

From Equation 1

i =	44.6	mm/hr
A =	1088.7	m^2
C =	0.9	
Q =	**0.012**	**cms**

Manning's - Open Channel Flow

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Drake
Design: B. Keene, P.Eng.
Date: 11-Nov-24

Equations: **Continuity** **Manning's**

Q = VA

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

Where:
V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.012** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**	
Bottom Width	**1.35**	m	V =	**0.112**
Side Slopes	**50**	:1	Q =	**0.012** **cms**
Slope	**0.005**	m/m	R =	0.109
Roughness	**0.05**		P =	4.851
Channel Depth	**0.035**	m	A =	0.022

Capacity of the Proposed Channel is 0.012 cms, which is adequate to convey desired flow of 0.012 cms