PRELIMINARY STORMWATER MANAGEMENT REPORT

Flatt's Point Subdivision

Prince Edward County

December 4, 2025

Prepared by

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Revision Summary

December 4, 2025

Preliminary SWM Report was updated to account for a new private road access through the adjacent winery lands.

September 23, 2022

SWM Design Brief prepared by Groundwork Engineering. This report was based on an internal road.

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1 Introduction and Background

The owner of Part Lot A Concession South of Prince Edward Bay is seeking municipal approval for a plan of subdivision to create 17 rural residential lots. A private road and a wetland parcel will also be created. The lot sizes will be an average of 1ha and all lots will be larger than 0.8ha. The total land holding is approximately 20.6ha and has varied topography with mixed woodland and scrubland. The EIS report indicates the subject lands include a 2.7ha wetland that is adjacent to the Bay but separated by a stone beach and berm.

The property is situated beside Half Moon Bay along the east side of Prince Edward County (see Figure 1-1). Currently, access is gained from County Road 13 at the south end of the site, but a wetland traversing a portion of the site restricts access to the primary development area. A new access road from Country Road 13 is to be provided over an adjoining property, which will serve 16 of the proposed lots. The 17th lot will continue to use the existing access at the south end. In this configuration, the road will remain private and will not be the responsibility of PEC.

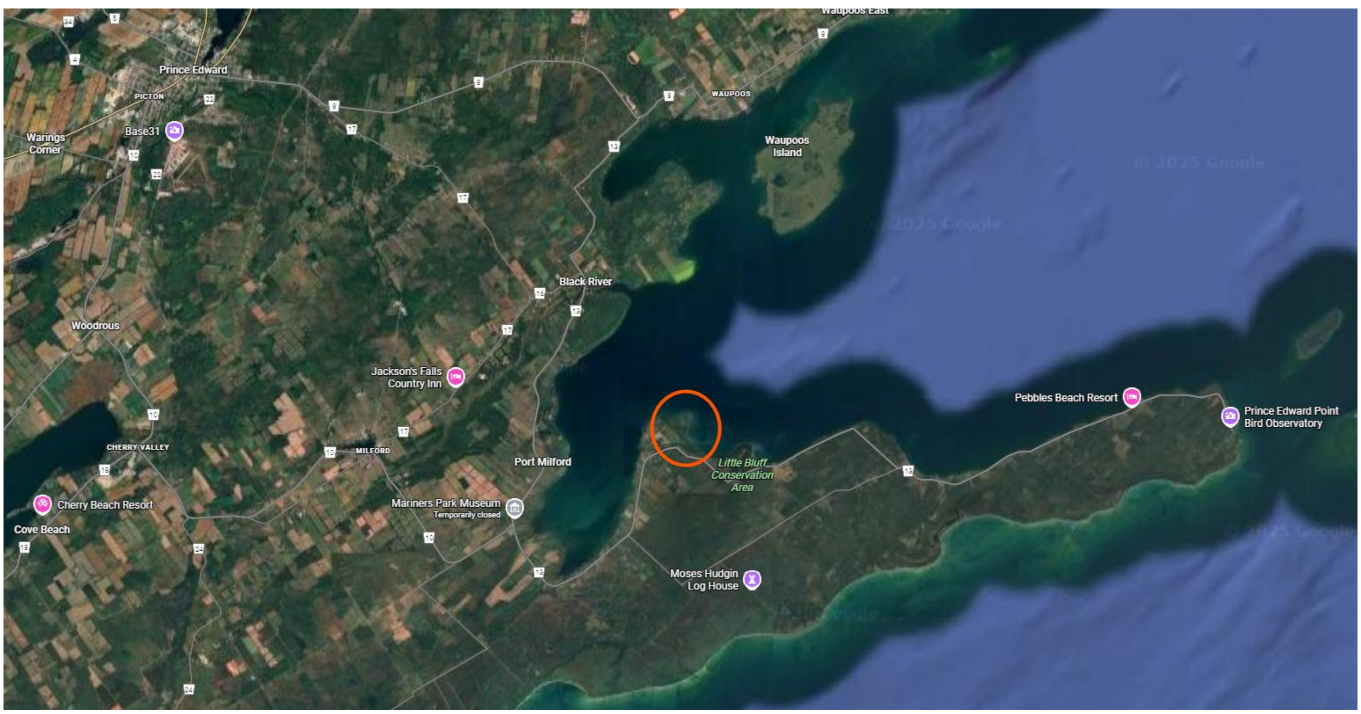

Figure 1-1: Development Site Location (Google, 2025)

The stormwater management report previously prepared to support the application for draft approval was prepared by Groundwork Engineering and last revised in 2022. Their plan included:

1. No quantity controls
2. Quality controls via best management practices (lot level controls and grassed swales)

3. Conveyance controls (sized to convey 100-yr flows)

1.1 Guiding Documents

The following guidance documents were referenced in the development of this plan.

- MTO Drainage Management Manual, 1997
- MOE Stormwater Management Planning and Design Manual, 2003
- MOE Design guidelines for Sewage Works, 2008
- PEC Official Plan, 2021
- Bay of Quinte Remedial Action Plan, SWM Design Guidelines, 2006
- Quinte Conservation Stormwater Management Submission Guidelines, 2012

1.2 Purpose

The purpose of the preliminary SWM report is to confirm that the storm water management strategy is appropriate and that the draft plan layout would accommodate the stormwater design with low risk of necessitating changes to the draft plan. Once approved, the preliminary plan will guide detailed design development stages and will be eventually republished as a Final SWM Report.

1.2.1 Official Plan

The official plan lists three objectives for stormwater management services. These include:

Objective 9

Ensure that the impacts on streams and the shore land systems from urban development are appropriately managed in order protect water quality, fish and wildlife habitat and to prevent erosion.

Objective 10

Minimize the number of County-owned stormwater management facilities through coordinating stormwater management needs of multiple developments.

Objective 11

Where appropriate, plan stormwater management facilities and features to co-locate with parklands and infrastructure.

The proposed stormwater management plan for Flatt's Point Subdivision will achieve all three objectives.

1.2.2 The Provincial Planning Statement, 2024

In 2024, the province updated the provincial policy statement, renaming it to the Provincial Planning Statement.

> Planning for stormwater management shall:
>
> a) be integrated with planning for sewage and water services and ensure that systems are optimized, retrofitted as appropriate, feasible and financially viable over their full life cycle;
> b) minimize, or, where possible, prevent or reduce increases in stormwater volumes and contaminant loads;
> c) minimize erosion and changes in water balance including through the use of green infrastructure;
> d) mitigate risks to human health, safety, property and the environment;
> e) maximize the extent and function of vegetative and pervious surfaces;
> f) promote best practices, including stormwater attenuation and re-use, water conservation and efficiency, and low impact development; and
> g) align with any comprehensive municipal plans for stormwater management that consider cumulative impacts of stormwater from development on a watershed scale.

1.2.3 BQRAP SWM Guidelines

The guidelines stated objective is to guide stormwater management in urban areas. While the current application is not within a traditional urban area, there are principles that can be applied to the current development proposal. This would include the protection of water resources along the Bay of Quinte through stormwater management.

The development site is within South Marysburgh that does not contribute directly into the Bay of Quinte, but instead drains to Lake Ontario (Prince Edward Bay and Half Moon Bay). The water quality target for Lake Ontario is *Normal*. The lands are not within an intake protection zone (IPZ 1 or 2) or a wellhead protection area and therefore there is no drinking water threat that would indicate a higher level of protection should be applied.

2 Existing Conditions

The lands are gently sloped and drain to Lake Ontario. Vegetation is well established and includes regions that are densely treed as well as some old field and wetland. There are several well travelled trails traversing the property and indications of former fence lines suggesting earlier agricultural use of the property.

Figure 2-1: Site Overview (PEC, GIS Mapping)

2.1 Soils

Soils were reviewed from the Agricultural Information Atlas which shows three soil types present (see Figure 2-2). These include Ameiliasburgh Clay Loam, Elmbrook Clay and Marsh.

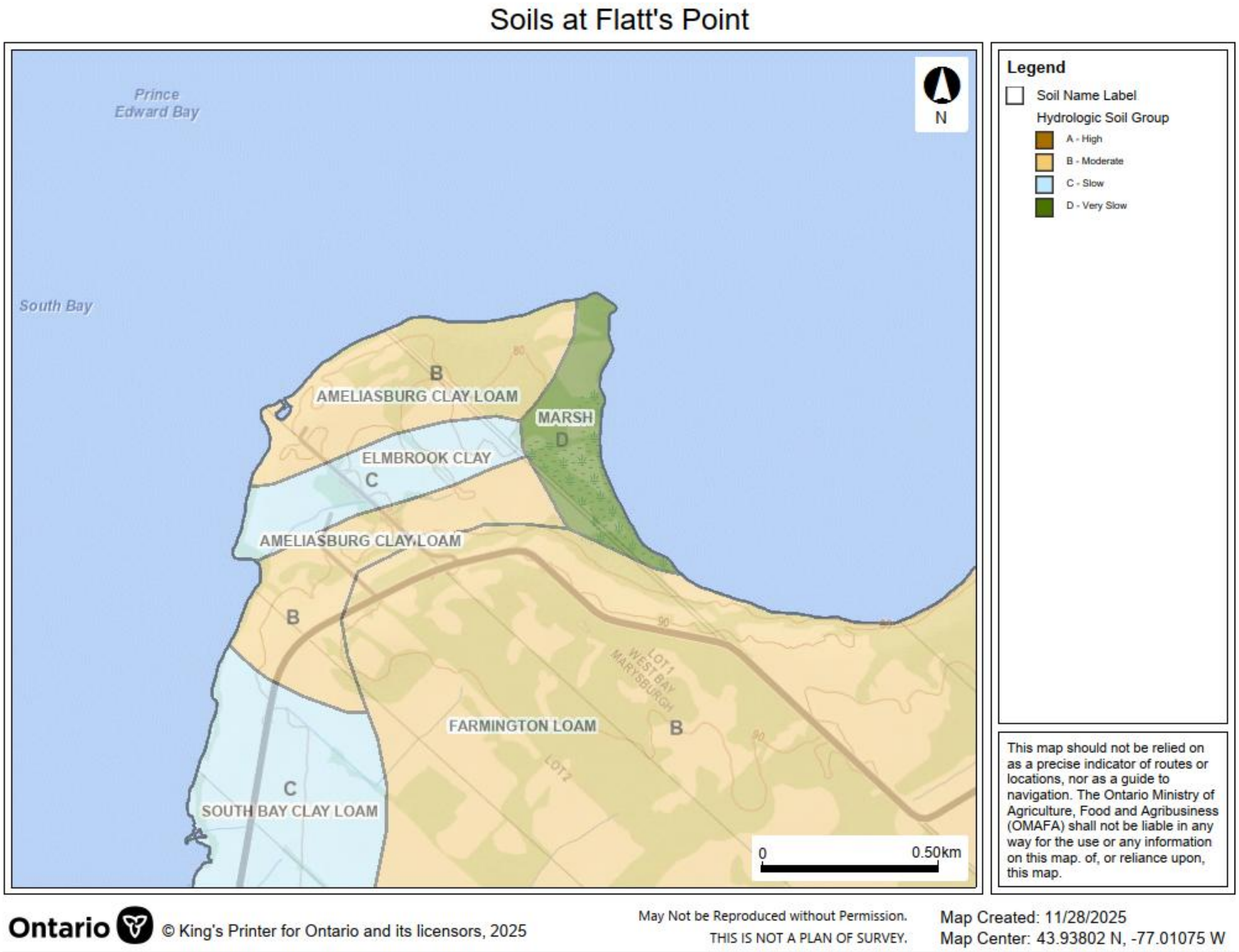

Figure 2-2: Soils Map from Agricultural Information Atlas

Soils are described in the Soils Report for Prince Edward County (Report #10)

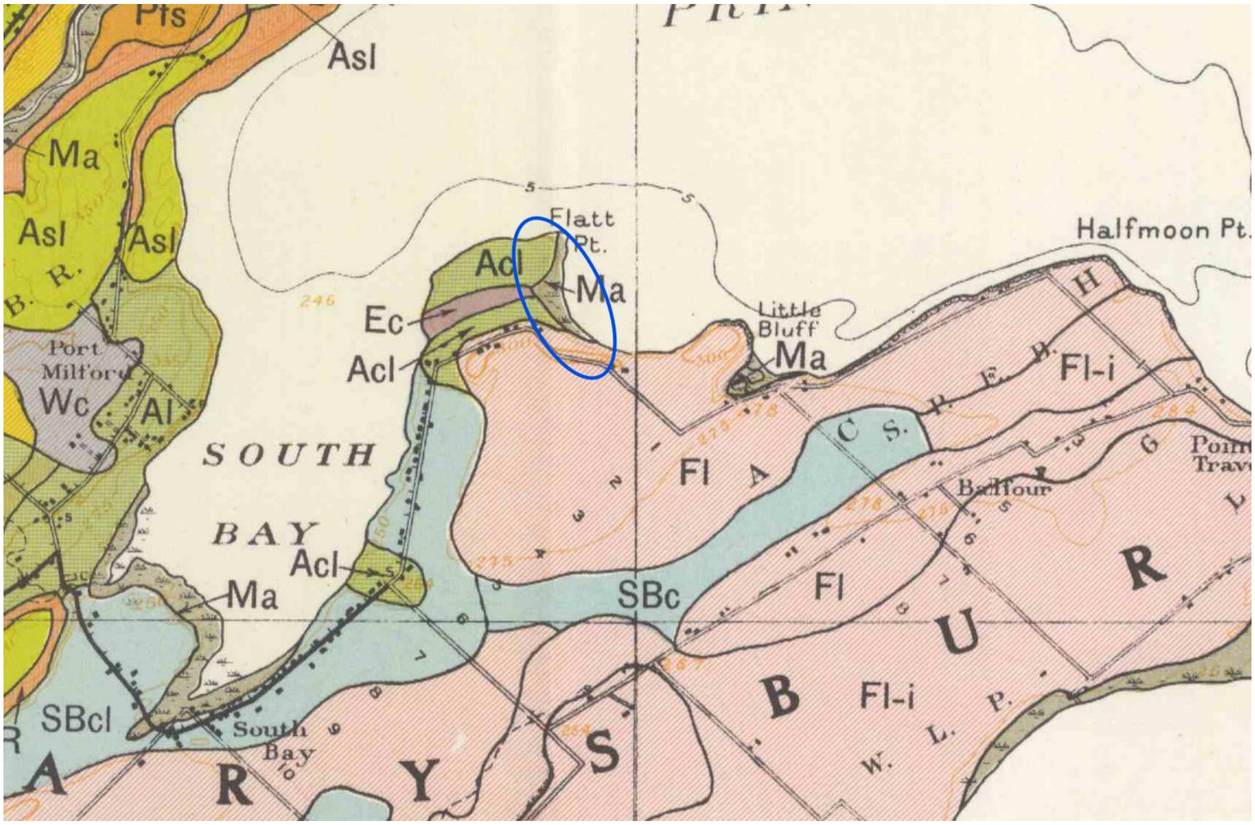

Figure 2-3: Soils from Soils Report of Prince Edward County

Ameliasburgh Clay Loam

These are mineral soils of glacial origin that include a mixture of boulders, sand, silt and clay. They are well-drained but not rapidly. The water storage capacity is moderate. Ameliasburgh clay loam is assigned a hydrologic soils group B classification.

Elmbrook Clay Loam

This soil type is formed of mineral soils of lacustrine origin. They are typically fine textured and imperfectly drained. Elmbrook Clay Loams are assigned a hydrologic soils group C classification.

Muck

Muck soils are predominantly organic in origin and are very poorly drained. They are often found within wetlands or associated with creek systems and characteristically have water table at or near the surface. These are hydrologic soils group D.

Figure 2-3 (MTO, 2008) outlines the classifications of Hydrologic Soils Groups.

Hydrologic Soil Group

The hydrologic soil group is used to classify soils into groups of various runoff potential.

The Soil Conservation Service (SCS) classifies bare thoroughly wet soils into four hydrologic soil groups (A, B, C and D). SCS descriptions of the four groups, modified slightly to suit Ontario conditions, are as follows: (Design Chart 1.09)

A: High infiltration and transmission rates when thoroughly wet, eg. deep, well drained to excessively-drained sands and gravels. These soils have a low runoff potential.

B: Moderate infiltration and transmission rates when thoroughly wet, such as moderately deep to deep open textured loam.

C: Slow infiltration and transmission rates when thoroughly wet, eg. fine to moderately fine-textured soils such as silty clay loam.

D: Very slow infiltration and transmission rates when thoroughly wet, eg. clay loams with a high swelling potential. These soils have the highest runoff potential.

In Ontario, soils have been found to lie between the main groups given above, and have therefore been interpolated as AB, BC, CD as appropriate, such as Guelph loam, which is classified as BC.

Figure 2-4: Soils MTO Drainage Management Manual – Description of Hydrologic Soils Groups

2.2 Bedrock

Malroz reported that bedrock can be found generally 0.3m to 1.7m below ground surface. Groundwork Engineering advanced five test pits and generally reported bedrock encountered within 0.5m from ground surface.

2.3 Groundwater Table

The water table was not clearly characterized by investigators. It is believed that the water table will be within the bedrock layer. Some holes were dry. Others were assigned a water table elevation that is below the level of Lake Ontario. That cannot be the case. Jewell will assume the water table is coincident with the top of the bedrock layer.

2.4 Targets

The stormwater management plan focuses on three environmental objectives when considering the treatment and conveyance of stormwater runoff. The objectives are to mitigate flooding, quality, and erosion impacts to the receiving system. These objectives, such as preventing increase in flood risk and protecting water quality, comply with the environmental guidelines set out by Lower Trent Conservation (2020) and the Ministry of Environment Stormwater Planning and Design Manual (2003).

The MTO Drainage Manual (1997) outlines potential negative impacts as a result of development, including increase in surface runoff, soil erosion, and higher downstream flow velocities.

Based on the guidance above, Jewell proposed a SWM methodology to achieve the following targets:

Quality Control

- Follow the Ministry of Environment guidelines to provide adequate quality treatment to runoff to ensure effluent meets **Enhanced** quality control objectives.

Erosion and Sediment Control

- Minimize the potential for erosion of soils,
- Mitigate the release of sediment offsite.

No quantity controls are required for the development as it is located immediately on Lake Ontario, and there is no downstream receiver of stormwater runoff from the site between the development and the lake.

Quality controls will be provided using a treatment train approach and a combination of Low Impact Development measures, discussed further in Sections 4.4 and 6.

3 Proposed Conditions

3.1 Drainage Scheme

The development site drains naturally towards Lake Ontario. Urban developments with storm sewer systems are encouraged to follow the major / minor strategy as outlined in the MECP 2003 manual and the 2008 Guidelines. Since this is a rural development, all drainage will be managed above ground using roadside ditches, grassed swales and diffuse overland flow patterns. Road gradients will be planned to direct surface runoff toward the east where it will be safely conveyed to Lake Ontario.

The portion of the access road through the private easement will drain to the private lands through an easement agreement with the owner who agrees to accept the minor drainage increase.

Water quality treatment will be performed with a combination of lot level controls, buffers, and grassed swales and ditches. In addition, impervious areas will be disconnected to encourage removal of TSS and infiltration of runoff.

Although the bedrock is known to be high and water table is suspected to also be high, the stormwater will be in contact with significant grassy contact areas. The principles of treatment would include filtration, settling and infiltration. Here, the infiltration component will be less than ideal due to the shallow soils. Nevertheless, infiltration will still occur over the shallow soils. Since the majority of the site has a type B soils cover that has good infiltration capability, grassed features will perform well for stormwater management purposes.

3.2 Determination of Peak Flows

Hydrologic modeling was not completed for this site since quantity controls are not required. Instead, Jewell used the Rational Method to estimate peak flows and size conveyance features as required. The Rational Method is suitable for areas less than 100ha.

The Rational Method equation is shown below. It relies on an estimation of runoff coefficient, rainfall intensity, and drainage area.

Equation 1: Rational Method

$$Q = \frac{1}{360} CiA$$

Where:

Q = Peak Flow in m^3/s

C = Runoff Coefficient
i = Rainfall Intensity in mm/hr
A = Area in hectares

4 Stormwater Management Controls

Rational Method calculations were used for sizing of the stormwater management controls as discussed below.

4.1 Precipitation

The local precipitation statistics for Prince Edward County are no longer current since Environment Canada has not maintained the Picton station. Instead, designer use Belleville or Trenton stations or apply the MTO IDF lookup tables. Jewell has applied the Trenton IDF station 6158875 for the current study.

4.2 Runoff Coefficient

The Rational Method calculations rely upon a runoff coefficient to determine the proportion of precipitation that will contribute to peak flows.

Since the site includes estate residential lots with an average lot area of 1.0ha, a low imperviousness of 7.4% is expected. Jewell has assumed the following in the calculation:

Access Road at 7m X 850m long	0.62ha
16 Dwellings at 250m^2 each	0.42ha
16 Driveways at 6m X 50m each	0.48ha
Total	**1.52ha**

Total imperviousness = 1.52ha / 20.6ha = 7.4%

Peak flow and quality flow calculations are derived using runoff coefficients. Published runoff coefficients contain values intended for peak return period flows (typically 5-yr and 100-yr). Quality flows are assumed to be generated from events lasting about 4 hours and with a frequency of several events per year. Runoff coefficients for quality flows are lower than those for peak flows.

A 100-yr post-development runoff coefficient of 0.4 was selected for estate residential. This was best suited to the Clay Loam soils low impervious cover, open landscaping and relatively flat grades of under 5% (Design Chart 1.07). It is expected that the treed cover will be maintained as much as possible which will tend to reduce the actual runoff coefficient slightly (but no lower than 0.35). Shallow soils will tend to cause the runoff coefficient to be slightly higher.

The selection of 0.4 for runoff coefficient represents a good balance of the expected land use, geological conditions and land cover.

Quality treatment runoff coefficients are not typically published. Jewell has assigned a runoff coefficient of 0.3 for the quality event. This follows the principle applied by MTO Design Chart 1.07 where the 2-yr to 10-yr would be 25% lower than the 100-yr.

4.3 Stormwater Conveyance

Runoff will be generally collected and conveyed along the road system contributing to the roadside ditches. The exception is rear yard drainage that will be collected and conveyed using grassed swales or permitted to drain diffusely toward Lake Ontario.

Roadside ditches will be enhanced with flat bottoms and check dams to increase the grassy contact, reduce velocity and improve sediment removal potential. Ditches will be sized using Rational Method and Manning's Open Channel Flow calculations.

A typical ditch with 0.75m flat bottom and longitudinal slope at 1% can convey 1.4m^3/s at 0.5m depth. The same ditch at 0.5% slope can convey 0.99m^3/s. There is a high point of land at Lot 4. The ditch east of this will flow easterly to the cul-de-sac and then through an easement to Lake Ontario.

Roadside Ditches

Catchments 203 and 204 will drain to the east ditch.

Catchments 202 will contribute to the south roadside ditch that drains westerly to the cross-culvert on the unopened road allowance.

Catchment 205 will also drain westerly, but along the north ditch and discharge on the downstream side of the cross-culvert.

Catchment 201 will drain to the cross-culvert.

The contributing area to the roadside ditches will not exceed 1.1ha in any ditch (Catchment 202). The peak discharge from 1.1ha is 0.11m^3/s, which is well below the ditch capacity.

The remaining lands will discharge as diffuse overland flow to Lake Ontario.

Easement

The offtake ditch from the road to the Lake would receive drainage from Catchments 203 and 204. Peak flow is 0.09m^3/s. A 1.5m flat bottom will be proposed for this ditch. It will have a capacity of 1.4m^3/s at 0.5%. This is more than adequate to convey the expected peak flow from the 100-yr event.

The roadside ditches and the offtake ditch will easily handle the expected peak flows in the 100-yr event.

4.4 Quality Treatment

Stormwater is understood to be degraded by development largely by washing contaminants off impervious surfaces. Stormwater quality treatment mitigates the impacts but does not fully erase the impacts. The provincial standard for mitigation on Lake Ontario is 70% removal of TSS (also known as *Normal*).

The treatment train approach will be employed, but calculations for quality treatment focus on the performance of the ditch to demonstrate *Normal* (70%) TSS removal.

Additional measures that are used but not included in the treatment calculations provide increased removal potential and assurance to the design. The measures include:

- Lot level controls,
- Grassed swales,
- Buffers and
- Diffuse overland flows.

Water quality flows are estimated following MOE 2003 guidelines (their equation 4.9).

Equation 2: Water Quality Event - Peak Intensity of 25mm Storm

$$i = 43C + 5.9$$

Where i is the peak rainfall intensity, and C is the runoff coefficient for the development. Water quality flow intensity is 18.8mm/hr and flow rate is $0.017m^3/s$ (Rational Method).

The roadside ditch, having the geometry described in Section 4.3, will have a flow depth of 0.055m and a velocity of 0.366m/s. This is within the recommended velocity target of 0.5m/s and is expected to achieve the quality mitigation per the design manual (p4-32).

Table 4-1: Quality Control – Roadside Ditches Only

Design Consideration	Ditch Configuration	
	Required	Provide
Velocity	0.5m/s	0.37m/s
Flow	$< 0.15m^3/s$	$0.017m^3/s$
Depth	<0.5m	0.055m

** Ditch Enhancement Required – Rock Check Dams*

The grassed ditches will provide opportunity for filtration of runoff and will slow the velocity to less than 0.5m/s. In a study performed by Terry Lucke et al, researchers studied the effectiveness of TSS removal in grassed swales and concluded **grass swales were very effective in a treatment train approach at providing pretreatment to prevent clogging of downstream treatment systems**. Swales investigated were triangular in shape and had slopes of 1% or less. They found:

> *Results showed that between 50% and 80% of the TSS was generally removed within the first 10 m of the swales. A further 10% to 20% reduction in TSS concentrations can be expected in swales up to 30 m long.*

The same removal rate can be expected in the roadside ditches with treatment length of approximately 300m in each ditch.

The Low Impact Development Guidelines (Toronto and Region Conservation Authority, 2010, pp. 4-141) states the dry pond bottom can be expected to achieve the following removal rates during small runoff events similar to the quality event:

TSS	76%
Total Phosphorus	55%
Total Nitrogen	50%

Factors that improve the removal rates include a reduced longitudinal slope and reduced velocity. The widened flat bottom will help to reduce the velocity and improve the performance of the roadside ditches.

The proposed technologies will provide TSS removal in excess of 80%, therefore the quality target of *Normal* TSS removal will be achieved.

5 Climate Change

Provincial direction in the PPS 2024 requires that all stormwater management design be resilient to the impacts of climate change. Impacts can include surcharging of storm sewers and stormwater management facilities as well as potential flooding.

Predictions on climate change impacts are varied. Recently published work indicates that there is no detectable trend in the short duration extreme precipitation across Canada (https://changingclimate.ca/CCCR2019/chapter/4-0/ accessed January 14, 2025). But annual precipitation depth may be increasing.

However, it is also known that precipitation statistics include a range of values and since the ditch sizing calculations rely on the statically derived intensities, it is prudent to have some flexibility in design calculations. Jewell recommends provision of at least 10% capacity in the conveyance features to account for statistical and climate uncertainties.

The stormwater management design includes roadside ditches that are sized based on short duration events (times of concentration less than one hour). Given the lack of observable trend in the short-duration events, there appears to be no risk of climate change impacts. Nevertheless, the roadside ditches and offtake ditch have unused capacity and can easily sustain additional flows.

The ditch configuration provides greater than 10% additional capacity and the development has demonstrated climate resiliency.

6 LID

Low Impact Development is a requirement of the 2024 Provincial Planning Statement. This requires that all developments consider LID strategies to reduce the impact of development on the hydrologic regime.

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 proposed drainage scheme will make use of surficial drainage (vegetated contact and enhanced swales), resulting in a significantly lower environmental impact compared to storm sewer conveyance.

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 4 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 applied with greater care 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.

6.1 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
- Tree clusters

The important hydrologic feature is the Lake Ontario shoreline and wetland. The proposed concept plan focuses development away from the shoreline and outside of the regulatory floodplain and wetland. The exception is the ditch outlet that naturally must discharge to the lake. Important hydrologic features are preserved.

6.2 Theme 2 – Application of Siting and Layout Techniques

Siting and layout techniques aim 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

Municipal standards limit the flexibility in the use of some siting and layout techniques such as reduced setbacks. However, given that the lot areas are larger and all back onto Lake Ontario, there is opportunity to eliminate sideyard swales and allow lots to drain diffusely to the lake. This also affords the opportunity to retain much of the natural vegetated cover that further reduces the environmental footprint.

6.3 Theme 3 – Reducing the Impervious Area

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

- Reducing street width
- Reducing building footprints
- Reducing parking footprints

- Considering alternatives to cul-de-sacs
- Eliminating unnecessary sidewalks and driveways

The very rural nature of the development provides opportunity to eliminate a sidewalk. Also, since the street will remain a private road in a rural setting, the asphalt surface width will be reduced.

6.4 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 lands drain radially to Lake Ontario and the wetland. The proposed drainage design will retain this drainage pattern. The impervious roads will be 'disconnected' by draining the roadside ditches through an offtake ditch. Roof downspouts from the dwellings will drain to the surrounding lawns to increase the grassy contact and improve water quality treatment.

Extensive vegetated contact is used in stormwater conveyance where possible and the proposed SWM solution works to mitigate the environmental impact of the proposed development.

6.5 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 stormwater management solution is consistent with provincial guidance for Low Impact Development.

7 Conclusions

The owner of the Flatt's Point Subdivision is proposing to develop a residential development that comprises approximately 20.6 hectares of land in Prince Edward County along County Road 13. The development will include 17 new estate residential lots, a private road and a wetland block.

The lands are situated along a point of land fronting onto Lake Ontario, therefore no quantity controls are required for the development.

Best management practices are proposed for water quality treatment, including enhancements to the roadside ditch as well as encouraging copious grassy contact through large rear yard setbacks.

A water quality treatment objective of *Normal* is required, but the design is expected to achieve TSS removal rates typical of *Enhanced* objectives. Treatment calculations were completed conservatively considering only the roadside ditches. Other best management practices are recommended including directing roof drainage to grassy areas, retention of the existing vegetation as much as possible and maintenance of a large setback from the wetland and Lake Ontario.

Water quantity controls are not required due to the proximity of Lake Ontario. Conveyance features (roadside ditches and offtake ditch) are sized for safe conveyance of peak flows up to 100-yr with residual capacity in excess of 10%.

Low impact development guidance (including disconnecting impervious areas, extending drainage distances, and reducing road widths) will be followed to ensure environmental impact of the development is successfully mitigated. Recommended techniques will be sized to provide adequate climate change resiliency.

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8 References

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APPENDIX A

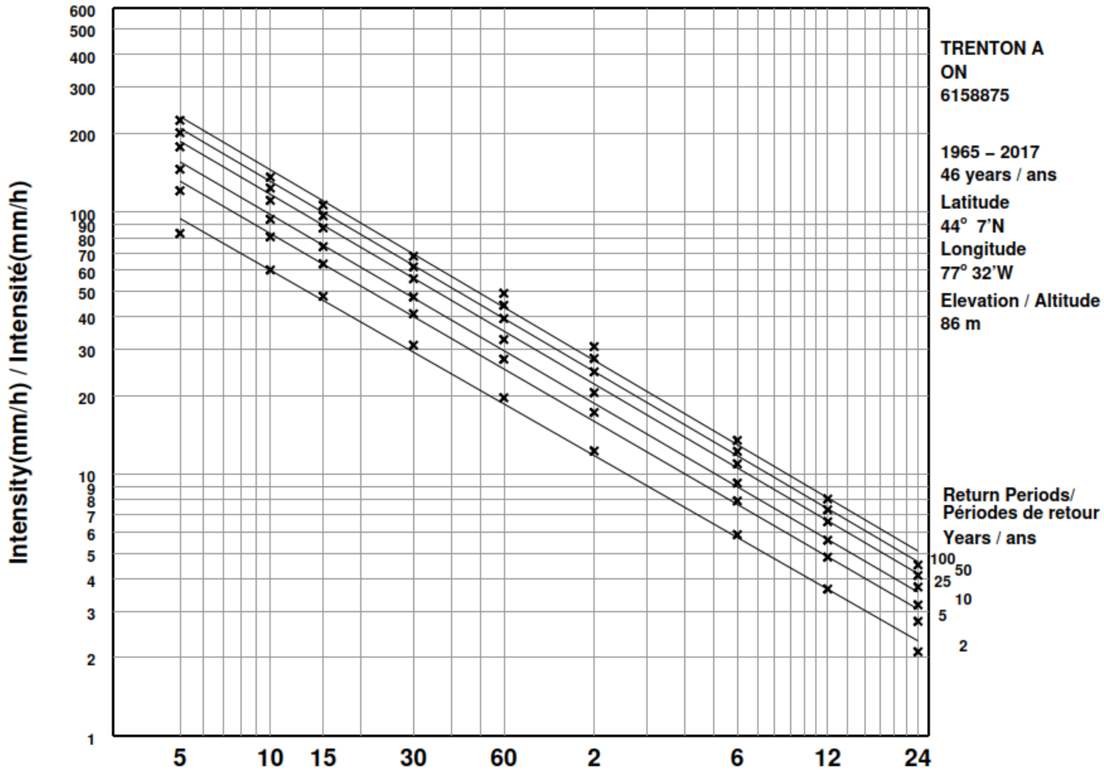
EC IDF Curve

Trenton

Short Duration Rainfall Intensity–Duration–Frequency Data

2022/10/31

Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée



Environment Canada Environnement Canada

Canada

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2022/10/31

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TRENTON A ON 6158875

Latitude: 44 7'N Longitude: 77 32'W Elevation/Altitude: 86 m

Years/Années : 1965 - 2017 # Years/Années : 46

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

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Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1965	7.4	10.9	14.7	17.3	18.3	19.0	26.9	29.5	43.9
1966	8.1	10.9	11.7	16.5	20.1	22.4	35.8	44.7	45.7
1967	9.1	10.9	11.7	14.2	15.5	16.3	29.7	47.2	69.6
1968	4.1	6.1	7.4	9.7	13.5	16.5	33.0	40.1	40.9
1969	5.8	9.7	13.5	18.8	21.6	24.6	34.0	39.1	54.9
1970	6.1	7.9	10.2	13.7	15.0	20.6	28.2	40.4	48.0
1971	7.1	10.9	11.2	12.2	12.7	17.5	22.1	29.0	35.1
1972	11.2	13.2	13.7	15.5	16.0	20.8	27.7	31.5	47.2
1973	6.6	10.4	10.4	15.0	15.5	22.4	43.2	52.1	53.6
1975	6.9	7.6	10.7	13.7	15.5	25.4	32.3	33.5	34.3
1976	6.9	11.2	11.7	12.7	14.0	14.5	27.9	29.2	30.2
1977	6.9	11.2	11.7	21.8	37.1	45.5	67.3	72.1	72.1
1978	7.1	9.9	11.2	15.0	15.9	19.9	31.7	34.1	36.6
1979	6.5	9.3	11.5	11.5	11.5	17.0	37.7	54.8	55.8
1980	9.3	14.0	16.3	22.9	31.1	37.6	46.6	46.6	60.0
1981	11.4	20.2	25.0	25.0	25.0	25.0	32.9	46.8	48.2
1982	14.2	18.4	22.2	22.4	23.2	30.7	39.0	39.0	39.0
1983	5.9	10.3	14.0	15.0	21.8	34.0	36.4	42.0	63.3
1984	4.4	7.2	7.8	10.1	11.8	13.0	27.7	41.7	42.2
1985	12.2	15.2	18.3	24.3	24.4	37.1	37.1	39.3	39.7
1986	24.3	24.8	26.0	27.1	27.1	32.8	63.2	65.0	65.6
1987	12.2	13.6	14.7	17.3	18.3	20.3	30.4	39.1	42.4
1988	4.7	8.1	8.8	9.9	15.1	15.2	20.2	28.0	28.0

1989	7.3	10.5	10.5	16.8	25.3	25.3	29.8	29.8	34.7
1990	6.6	7.5	9.0	11.0	12.7	16.7	32.9	46.1	50.0
1991	10.6	11.6	12.6	12.8	14.0	15.8	25.7	26.2	32.8
1992	4.7	8.1	9.6	12.1	14.9	20.2	30.1	38.0	42.8
1993	4.2	6.8	9.3	11.7	21.1	23.6	25.5	41.7	56.0
1994	5.6	8.8	10.5	14.6	17.8	19.6	31.3	32.5	34.8
1995	10.6	14.6	18.0	22.2	28.3	41.4	50.4	56.8	64.9
1996	3.4	6.2	7.3	9.5	14.2	19.8	30.0	33.8	42.8
1997	5.0	9.1	11.7	19.8	34.8	43.1	48.7	48.7	53.9
2000	11.4	17.6	22.3	33.5	59.6	68.2	69.8	69.8	71.6
2001	4.7	5.2	7.0	9.2	17.4	19.5	22.3	32.9	40.4
2002	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	78.8	78.8
2003	6.1	11.8	14.0	21.3	26.8	34.0	42.1	45.1	50.2
2004	7.1	10.0	14.9	18.9	31.7	48.9	88.9	109.6	123.7
2005	5.0	7.0	7.2	7.9	13.6	19.1	40.8	50.3	54.1
2006	5.0	8.1	9.6	15.6	20.4	25.0	42.9	55.1	69.9
2007	10.3	11.4	14.2	21.2	26.3	30.5	44.3	60.9	62.1
2008	6.1	12.1	14.0	21.2	23.1	32.5	32.7	40.4	47.6
2009	4.6	8.6	9.0	11.8	12.6	18.7	-99.9	58.0	75.8
2010	5.0	5.3	6.9	8.4	9.6	11.8	24.7	48.3	59.1
2012	5.5	8.0	10.5	21.1	35.7	44.5	60.5	79.9	80.6
2013	5.4	9.5	13.8	20.5	20.8	25.0	30.7	33.5	42.8
2014	7.8	10.7	11.3	13.7	23.9	33.6	43.3	47.1	79.4
2016	7.1	10.9	16.1	23.7	24.8	27.2	34.9	46.2	46.2
2017	5.5	10.3	12.6	13.8	20.3	27.8	33.8	52.0	66.3
# Yrs. Années	47	47	47	47	47	47	46	48	48
Mean Moyenne	7.5	10.7	12.7	16.5	21.1	26.4	37.5	46.4	53.3
Std. Dev. Écart-type	3.6	3.8	4.5	5.6	8.9	11.2	13.8	16.0	17.5
Skew. Dissymétrie	2.55	1.57	1.32	0.70	1.99	1.50	1.80	1.71	1.49
Kurtosis	12.61	6.57	4.92	3.48	9.40	6.09	6.82	7.30	7.19

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1986	5 min	24.3	18.7
1986	10 min	24.8	22.7
2000	1 h	59.6	49.0
2000	2 h	68.2	61.4
2004	6 h	88.9	80.8
2004	12 h	109.6	96.5
2004	24 h	123.7	108.1

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	6.9	10.1	12.2	14.8	16.8	18.7	47
10 min	10.0	13.4	15.7	18.5	20.6	22.7	47
15 min	12.0	15.9	18.5	21.8	24.2	26.7	47
30 min	15.5	20.5	23.8	27.9	31.0	34.0	47
1 h	19.6	27.5	32.7	39.3	44.2	49.0	47
2 h	24.5	34.4	41.0	49.2	55.4	61.4	47
6 h	35.3	47.5	55.5	65.7	73.3	80.8	46
12 h	43.8	57.9	67.2	79.1	87.8	96.5	48
24 h	50.4	65.9	76.1	89.0	98.6	108.1	48

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	83.1	120.9	146.0	177.7	201.2	224.5	47
	+/- 11.2	+/- 18.9	+/- 25.6	+/- 34.5	+/- 41.3	+/- 48.1	47
10 min	60.3	80.6	94.0	111.0	123.7	136.2	47
	+/- 6.0	+/- 10.2	+/- 13.7	+/- 18.5	+/- 22.1	+/- 25.8	47
15 min	47.8	63.6	74.0	87.1	96.9	106.6	47
	+/- 4.7	+/- 7.9	+/- 10.6	+/- 14.3	+/- 17.1	+/- 20.0	47
30 min	31.1	41.0	47.5	55.8	61.9	68.0	47
	+/- 2.9	+/- 4.9	+/- 6.7	+/- 9.0	+/- 10.8	+/- 12.5	47
1 h	19.6	27.5	32.7	39.3	44.2	49.0	47
	+/- 2.3	+/- 3.9	+/- 5.3	+/- 7.2	+/- 8.6	+/- 10.0	47
2 h	12.3	17.2	20.5	24.6	27.7	30.7	47
	+/- 1.5	+/- 2.5	+/- 3.3	+/- 4.5	+/- 5.4	+/- 6.3	47
6 h	5.9	7.9	9.3	11.0	12.2	13.5	46
	+/- 0.6	+/- 1.0	+/- 1.4	+/- 1.9	+/- 2.2	+/- 2.6	46
12 h	3.6	4.8	5.6	6.6	7.3	8.0	48
	+/- 0.3	+/- 0.6	+/- 0.8	+/- 1.1	+/- 1.3	+/- 1.5	48
24 h	2.1	2.7	3.2	3.7	4.1	4.5	48
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.6	+/- 0.7	+/- 0.8	48

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

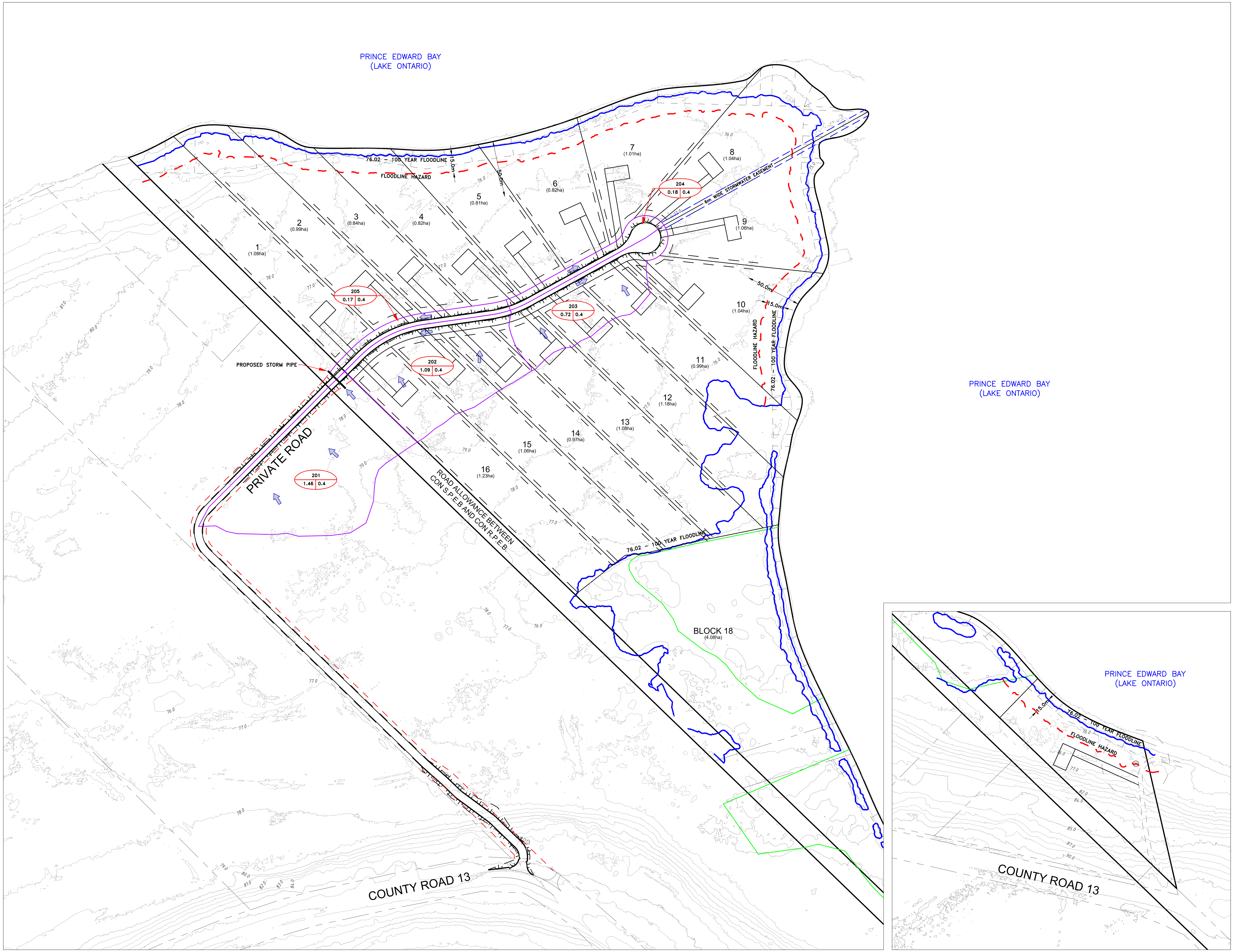
****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	29.5	40.7	48.1	57.4	64.4	71.2
Std. Dev. /Écart-type (RR)	28.6	40.4	48.3	58.4	65.8	73.2
Std. Error/Erreur-type	4.5	4.2	4.2	4.5	4.9	5.3
Coefficient (A)	18.6	25.2	29.6	35.2	39.3	43.4
Exponent/Exposant (B)	-0.656	-0.664	-0.668	-0.671	-0.673	-0.674
Mean % Error/% erreur moyenne	5.1	5.0	5.2	5.6	6.0	6.2

APPENDIX B

Catchment Area Drawings

12/02/2025



GENERAL NOTES:

- ALL INFORMATION TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK. ANY DISCREPANCIES ARE TO BE REPORTED TO THE CONSULTANT IMMEDIATELY.
- ALL UTILITY LOCATIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL CONFIRM THE LOCATION ON SITE AND ASSUME ALL LIABILITY FOR DAMAGE TO ALL UTILITIES.
- EXCLUDING THE BENCHMARK AND DESCRIPTION PROVIDED FOR THIS PROJECT, NO OTHER ELEVATIONS ARE TO BE USED AS A REFERENCE ELEVATION FOR ANY PURPOSE.

METRIC NOTE:

- ALL DIMENSIONS SHOWN ARE IN METRES OR MILLIMETRES, UNLESS OTHERWISE NOTED.

GEOMETRIC NOTE:

- ALL SURVEY DATA SHOWN ON THIS DRAWING WAS RECORDED USING REAL-TIME KINETIC (RTK) GPS OBSERVATIONS IN REFERENCE TO UTM 18 NORTH COORDINATE SYSTEM.
- ALL ELEVATIONS ARE IN REFERENCE TO LOCAL DATUM NAD83 - GEODETIC MODEL HT2_0, UNLESS DESCRIBED OTHERWISE.

* * DRAWINGS ARE NOT TO BE SCALED * *

REVISIONS

NO.	DATE	DESCRIPTION	BY

LEGEND

- FLOODLINE HAZARD
- 100-YR FLOODLINE - 76.02m
- WETLAND BOUNDARY
- STORMWATER CATCHMENTS
- 100 / 46.6 / 0.6 — CATCHMENTS AREA ID; DRAINAGE AREA (ha) & RUNOFF COEFFICIENT
- PROPOSED OVERLAND FLOW

N E S W

JEWELL ENGINEERING

FLATT'S POINT SUBDIVISION

COUNTY OF PRINCE EDWARD

STORMWATER CATCHMENTS

DRAWN BY: JH	PROJECT NO: 210-5054	
DESIGNED BY:	DATE: December 2025	
CHECKED BY: BK	SCALE: HORIZONTAL - 1:1,500 VERTICAL - N/A	
APPROVED BY:	CONTRACT NO:	DRAWING NO: SWM-1

F:\FTP\PROJECT FILES\1 CIVIL 3D PROJECT FILES\2105054 - KERFORD - FLAT POINT SUBDIVISION\3 SHEETS\2105054 - SWM

APPENDIX C

Rational Method Ditch Sizing

100-Yr Flow Check - Easement Ditch

Project:	Flatt Point Subd
Design:	B. Keene, P.Eng.
Date:	1-Dec-25

100-Yr Flow Estimate

Equations:

Rational Method

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

Where:

Q = Design Flow (cms)		
i = intensity (mm/hr)	91	mm/hr
A= Area (ha)	0.9	ha
C= Runoff Coefficient	0.4	

Intensity

$$i = A(T_C)^B$$

Where:

A =	43.4	
B =	-0.674	
T_c =	20	min

Contributing Area

203	0.72	
204	0.18	ha
Total =	**0.9**	

100-Yr Flow = **0.091** **cms**

Swale / Ditch Design

Equations:

Continuity

$$Q = VA$$

Manning's

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

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

Assumtions:

Well Maintained Ditch, n = 0.035
Poorly Maintained Ditch, n = 0.05

Ditch Configuration *Does not include Freeboard*

Given:

Bottom Width	**1.5**	m
Side Slopes	**3**	:1
Slope	**0.005**	m/m
Roughness	**0.035**	
Ditch Depth	**0.5**	m

(V-shaped if Bottom Width is set to 0)

Find:

V =	**0.949**	
Q =	**1.423**	**cms**
R =	1.500	
P =	4.662	
A =	0.322	

Capacity of the Ditch is 1.42 cms, which is adequate to convey desired flow of 0.09 cms.

100-Yr Flow Check - Grassed Ditches - East

Project:	Flatt Point Subd
Design:	B. Keene, P.Eng.
Date:	1-Dec-25

100-Yr Flow Estimate

Equations:

Rational Method

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

Where:

Q = Design Flow (cms)		
i = intensity (mm/hr)	91	mm/hr
A= Area (ha)	0.9	ha
C= Runoff Coefficient	0.4	

Intensity

$$i = A(T_C)^B$$

Where:

A =	43.4	
B =	-0.674	
T_c =	20	min

Contributing Area

203	0.72	ha
204	0.18	
Total =	**0.9**	

100-Yr Flow = **0.091** **cms**

Swale / Ditch Design

Equations:

Continuity

$$Q = VA$$

Manning's

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

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

Assumtions:

Well Maintained Ditch, n = 0.035
Poorly Maintained Ditch, n = 0.05

Ditch Configuration *Does not include Freeboard*

Given:

Bottom Width	**0.75**	m
Side Slopes	**3**	:1
Slope	**0.005**	m/m
Roughness	**0.035**	
Ditch Depth	**0.5**	m

(V-shaped if Bottom Width is set to 0)

Find:

V =	**0.880**	
Q =	**0.990**	**cms**
R =	1.125	
P =	3.912	
A =	0.288	

Capacity of the Ditch is 0.99 cms, which is adequate to convey desired flow of 0.09 cms.

100-Yr Flow Check - Grassed Ditches - West

Project:	Flatt Point Subd
Design:	B. Keene, P.Eng.
Date:	1-Dec-25

100-Yr Flow Estimate

Equations:

Rational Method

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

Where:

Q = Design Flow (cms)		
i = intensity (mm/hr)	91	mm/hr
A= Area (ha)	1.09	ha
C= Runoff Coefficient	0.4	

Intensity

$$i = A(T_C)^B$$

Where:

A =	43.4	
B =	-0.674	
T_c =	20	min

100-Yr Flow = **0.11** **cms**

Contributing Area

202	1.09	ha
Total =	**1.09**	

Swale / Ditch Design

Equations:

Continuity

$$Q = VA$$

Manning's

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

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

Assumtions:

Well Maintained Ditch, n = 0.035
Poorly Maintained Ditch, n = 0.05

Ditch Configuration *Does not include Freeboard*

Given:

Bottom Width	**0.75**	m
Side Slopes	**3**	:1
Slope	**0.005**	m/m
Roughness	**0.035**	
Ditch Depth	**0.5**	m

(V-shaped if Bottom Width is set to 0)

Find:

V =	**0.880**	
Q =	**0.990**	**cms**
R =	1.125	
P =	3.912	
A =	0.288	

Capacity of the Ditch is 0.99 cms, which is adequate to convey desired flow of 0.11 cms.

APPENDIX D

Water Quality Calculations

Quality Flow Check - Grassed Ditches

Project:	Flatt Point Subd
Design:	B. Keene, P.Eng.
Date:	1-Dec-25

Quality Flow Estimate

Equations:

Rational Method

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

Intensity

$$i = 43C + 5.9$$

Where:

Q = Quality Flow (cms)
i = intensity (mm/hr) 18.8 mm/hr
A= Area (ha) 1.09 ha
C= Runoff Coefficient 0.3

Contributing Area

202	1.09	ha
Total =	**1.09**	

Quality Flow = **0.017** **cms**

Swale / Ditch Design

Equations:

Continuity

$$Q = VA$$

Manning's

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

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

Assumtions:

Well Maintained Ditch, n = 0.035
Poorly Maintained Ditch, n = 0.05

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**0.75**	m	V =	**0.366**	
Side Slopes	**3**	:1	Q =	**0.018**	**cms**
Slope	**0.01**	m/m	R =	0.050	
Roughness	**0.035**		P =	1.098	
Flow Depth	**0.055**	m	A =	0.046	

(V-shaped if Bottom Width is set to 0)

Quality Flow Depth is 0.06 m and Velocity is acceptable for Quality Treatment 0.37 m/s.