
McCamus Ida Subdivision
Part of Lot 12, Concession XI (Cavan)
1910 County Road 10
Township of Cavan Monaghan

Hamlet of Ida
County of Peterborough
Project No. 23-D-6213

STORMWATER MANAGEMENT QUALITY AND QUANTITY CONTROL REPORT

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1.0 INTRODUCTION

The proposed McCamus Ida Subdivision is located on Part of Lot 12, Concession XI in the geographic Township of Cavan, now in the Township of Cavan Monaghan, in the County of Peterborough. The property is known municipally as 1910 County Road 10. Tamara and Barry McCamus, the owners of the property, are proposing to develop a 1.433 hectare portion of the property north of Sharpe Line and west of County Road 10, herein referred to as the subject site. M.J. Davenport & Associates Ltd. has been retained to complete a Stormwater Management Report in support of a 5-lot single family rural residential draft plan of subdivision.

The subject site is located in the hamlet of Ida, approximately ten kilometres southwest of the City of Peterborough, north of Highway No. 7A. The subject site is bordered by agricultural farmland to the north, hamlet residential lands and agricultural farmland to the east, hamlet residential lands across Sharpe Line to the south and hamlet residential lands and agricultural farmland to the west. The subject lands are designated hamlet settlement area in the Township of Cavan Monaghan Official Plan and zoned Agriculture in the Comprehensive Zoning Bylaw. The site is well vegetated and comprised of cultivated agricultural farmland. Property boundary fence rows exist along the south and west site borders. The land is mildly sloped to the east with approximately 5 metres of relief from the northwest corner of the site to the southeast corner.

A stormwater management plan must address the potential impact of increased surface water runoff from the project site taking into consideration the quantity and quality of that runoff plus implement erosion controls. The project site will have a relatively low imperviousness typical of a rural residential subdivision. Mild slopes on the site make utilizing source and conveyance controls a viable option. Therefore, each lot will utilize source and conveyance control techniques and contain one lot level LID control practice to provide quantity and quality control for the development.

The location plan on Figure 1 on page 2 provides an overview of the location of the proposed McCamus Ida Subdivision. The layout of the proposed 5 lots within the 1.433 hectare parcel of land that is the subject of this report is identified on the Lot Grading Plan, Drawing No. 6213-03 prepared by M.J. Davenport & Associates and is included in Appendix I.

Figure 1: Location Plan

2.0 PRE-DEVELOPMENT CONDITIONS

The pre-development site has variable topography with good vegetation cover over the majority of the site. The site topography varies from moderately sloping (2.0%) to steep (8.0%), with much of the site being in the range of 2.0% - 3.0%.

The Ontario Ministry of Agriculture and Food soil mapping for Peterborough County shows Otonabee Loam as the sole surficial soil present within the subject site and on the adjacent land directing runoff through the site. Otonabee Loam is considered a well drained loam soil. The Soil Conservation Service (SCS) hydrologic soil grouping classifies Otonabee Loam as a Type ‘B’ soil.

The subject site is considered two subwatershed areas under pre-development conditions based on the natural topography of the land determined from contour data taken from Ontario base maps, a topographical survey and a visual field inspection completed by M.J. Davenport & Associates Ltd.

Published County of Peterborough base mapping of the area shows a watercourse crossing the northern extent of the subject site. However, during multiple field visits, an active watercourse was not observed. The watercourse shown on the base mapping likely represents a low area in the active farm field that directs runoff easterly toward County Road 10. An area of agricultural farmland to the north of the subject site directs stormwater runoff into the low area and through the site. In the post development condition this depression will be redirected into the rear yard swales of the lots and continue to drain to County Road 10.

Base mapping contour information suggests that the agricultural land west of the site directs runoff easterly through the subject site. However, our field visit revealed an earth and stone fence along the westerly property line of the site. The fence re-directs stormwater runoff southerly into the Sharpe Line roadside ditch. The pre-development subwatershed areas are illustrated on Pre-Development Subwatershed Areas Drawing No. 6213-SW1.

The pre-development subwatershed areas include:

Subwatershed Area PRE. 1

Subwatershed Area PRE. 1 (0.911 hectares) represents the area of the subject site that directs stormwater runoff into the Sharpe Line roadside ditch. Under pre-development conditions, this subwatershed area directs runoff as sheet flow south-easterly into the Sharpe Line roadside ditch, ultimately outletting into a watercourse located east of the subject site. This subwatershed area is comprised entirely of cultivated row crop area and does not contain any area external to the development. The calculated percentage of total impervious area of this subwatershed is 0.0%.

Subwatershed Area PRE. 2

Subwatershed Area PRE. 2 (0.522 hectares) consists of the remaining area of the subject site and directs stormwater runoff easterly to the County Road 10 roadside ditch. Under pre-development conditions, this subwatershed area directs runoff as sheet flow easterly into an existing swale within the drainage easement across 914 and 916 Sharpe Line that exists to the benefit of the proposed subdivision. The swale within the drainage easement outlets directly into the County Road 10 roadside ditch, with runoff eventually entering the watercourse that is located east of the subject site in the Hamlet area.

This subwatershed area is comprised entirely of cultivated row crop area. In the pre-development condition, external drainage area to the north of the subject site drains into a low area and through subwatershed PRE.2 to the drainage easement. However, in the post development condition, the external drainage area will be redirected into the swale along the rear of the proposed lots. Runoff generated by the external drainage area will bypass the subdivision lands and enter the drainage easement as it does in the pre-development scenario. Therefore, the flows from the external drainage area are not accounted for subwatershed area PRE.2. The calculated percentage of total impervious area of this subwatershed is 0.0%.

The parameters used in the pre-development Rational Method peak flow calculations are presented below in **Error! Reference source not found.**.

Table 1: Pre-Development Subwatershed Area Parameters

Sub-watershed Area	Area (ha)	Landuse	Slope (%)	Length (m)	Weighted Runoff 'C'	Time of Concentration (min.)
PRE.1	0.911	Agricultural/Row Crop	2.6	200	0.35	22.4
PRE.2	0.522	Agricultural/Row Crop	2.5	205	0.35	22.9

The weighted runoff coefficient, 'C' is based upon "Design Chart 1.07: Runoff Coefficients" of the MTO Drainage Management Manual (MTO, 1997). The 'C' value considers the land use and topography plus the hydrologic soil classification or soil texture then is used to calculate "Time of Concentration." In accordance with the MTO Drainage Management Manual, we have increased the 25-year, 50-year, and 100-year runoff coefficient (C) by 10%, 20% and 25%, respectively.

The pre-development time of concentration T_c was calculated using the Airport Method. If the time of concentration was calculated to be less than 15 minutes, a T_c value of 15 minutes was used in accordance with normal municipal stormwater management design criteria as the minimum inlet time when using IDF curve data with the rational method. Figure 1 in Appendix I "Supporting Information" includes the calculation of the weighted runoff coefficient, 'C' and the "time of concentration" for each subwatershed area.

The rational method has been used to calculate the selected return period peak discharges for the pre-development condition. Intensity-Duration-Frequency (IDF) curves developed from the 1971 to 2006 Peterborough Airport data were used in the stormwater calculations. Peak flows for varying return periods were computed for the entirety of the subject site (Subwatershed Areas PRE.1 and PRE.2 combined). The results are shown below in Table 3. The detailed rational method calculations are provided in Figure 2 in Appendix I.

3.0 POST DEVELOPMENT CONDITIONS

The development will create 5 rural estate residential lots each fronting onto Sharpe Line. No new streets will be constructed to provide access to this subdivision.

The proposed rural subdivision configuration and lot grading will have a minor impact on the existing division of post development subwatershed areas compared to the pre-development condition. Lot grading and swale construction will be required to prevent stormwater runoff from entering adjacent properties and to divert external subwatershed area runoff from entering the subdivision lands.

Each proposed rural estate residential lot is assumed to contain the same amount of impervious area for stormwater management design purposes. The estimated total impervious area per lot is 492 square metres. This total impervious area consists of an estimated 250.0 square metre single detached family house and a 242.0 square metre (6.10 metre wide by 39.67 metre long) paved driveway. Based on the proposed grading plan, the entirety of the proposed driveway area and front yard area will drain toward the Sharpe Line roadside ditch. The majority of the rooftop area will also be directed to the roadside ditch. A portion of rooftop runoff and the rear yards of the lots will generally drain to the north, into the rear yard swale and through the existing drainage easement to the County Road 10 roadside ditch.

A lot-level Low Impact Development rain garden feature is proposed on the southeast corner of each of the five lots. Each rain garden infiltration feature is sized to fully capture the 25mm quality storm event generated by the area of the proposed driveway that can be feasibly directed to the feature. In addition, the combined storage capacity provided in the five rain gardens is sized to provide quantity control for the development.

The proposed development consists of two (2) subwatershed areas based on the proposed subdivision grading plan and natural topography of the land. The subwatershed areas are divided according to the area directing stormwater runoff into the Sharpe Line roadside ditch (Subwatershed Area PR. 1) and the remaining site area directing runoff easterly through the drainage easement across the two adjacent properties and into the County Road No. 10 roadside ditch (Subwatershed Area PR. 2). The proposed catchment areas are illustrated on Post Development Subwatershed Areas Drawing No. 6213-SW2.

The post-development subwatershed areas include:

Subwatershed Area PR. 1

Subwatershed Area PR. 1 (0.966 hectares) represents the area of the developed site that directs stormwater runoff into the Sharpe Line roadside ditch. This subwatershed area is comprised of building area, asphalt driveway and maintained grass yard area. In the post development condition, the majority of stormwater runoff from this subwatershed area is directed into a series of swales and outlets into the roadside ditch. Quality treatment and quantity control for the stormwater runoff from most of the asphalt driveway, grass front yard area and a portion of the rooftop area will be provided by the proposed LID rain gardens located on each lot adjacent to the roadside ditch. Flows greater than the capacity of the rain gardens will overflow directly into the Sharpe Line roadside ditch. The calculated percentage of total impervious area of this subwatershed is 23.5%.

Subwatershed Area PR. 2

Subwatershed Area PR. 2 (0.467 hectares) consists of the remaining area of the subject site and directs stormwater runoff easterly to the County Road 10 roadside ditch. This subwatershed area is comprised primarily of maintained grass yard area with a small portion of rooftop area. All surface water runoff from this subwatershed area is considered clean and does not require quality treatment. Therefore, in the post development scenario, this subwatershed area has no proposed stormwater controls and directs runoff easterly into an existing swale within the drainage easement across 914 and 916 Sharpe Line and into the County Road No. 10 roadside ditch.

The grading design presented in the Lot Grading Plan Drawing No. 6213-03 specifies that the runoff directed toward the site from the external drainage area to the north be redirected into the rear yard swale of the proposed lots. The runoff from the external drainage area will then bypass the subdivision lands and enter the drainage easement as it does in the pre-development scenario. The calculated percentage of total impervious area of this subwatershed is 4.1%.

All parameters used to model the post-development subwatershed areas in the Visual Otthymo computer simulation are shown in Table 2 below.

Table 2: Post Development Subwatershed Area Parameters

Sub-watershed Area	Area (ha)	Landuse	Slope (%)	Length (m)	Weighted Runoff 'C'	Time of Concentration (min.)
PR.1	0.966	Estate Residential	1.8	82	0.36	15.8
PR.2	0.467	Estate Residential	2.8	180	0.23	22.9*

*Time of concentration for Subwatershed Area PR.2 was calculated as 25.5 minutes, however, as per typical municipal standards, the time of concentration was reduced to 22.9 minutes to not exceed the pre-development subwatershed area PRE.2 time of concentration.

4.0 PEAK RUNOFF CALCULATIONS

The development of the site into a rural residential subdivision will result in an overall increase in total impervious area over the pre-development site. The increase in impervious area is anticipated to result in an increase in post development peak flows leaving the subject site if left uncontrolled.

Peak flows listed in this report were calculated using the Rational Method applying the subwatershed area parameters provided in Table 1 and Table 2. Peak flows were calculated for each of the 2, 5, 10, 25, 50 and 100-year return periods. The pre-development and post-development uncontrolled peak flows generated for the entire subject site using the Rational Method calculation is provided in Table 3. The spreadsheets detailing the Rational Method calculations are included in Appendix I. Rainfall data for the site was taken from the Peterborough Airport gauging station and is included in Appendix I.

Table 3: Pre-Development and Post Development Uncontrolled Peak Flow Rates Discharging Offsite

Design Storm (yr)	Peak Flows (m^3/s)					
	PRE.1	PRE.2	Total Pre-Dev.	PR.1	PR.2	Total Post Dev.
2	0.041	0.023	**0.064**	0.054	0.014	**0.068**
5	0.054	0.031	**0.085**	0.071	0.018	**0.089**
10	0.063	0.035	**0.098**	0.082	0.021	**0.103**
25	0.081	0.046	**0.127**	0.105	0.027	**0.132**
50	0.098	0.055	**0.153**	0.127	0.032	**0.160**
100	0.112	0.063	**0.175**	0.145	0.037	**0.182**

Table 3 indicates that off site peak flows will increase under post development conditions. Stormwater management controls are required to reduce peak flows to be equal to or less than the calculated pre-development peak flow rates for all storm events listed.

5.0 STORMWATER MANAGEMENT CONTROLS

5.1 Low Impact Development (LID) Controls

Several different low impact development techniques were considered for the site to promote infiltration and achieve a pre/post development water balance. It is important to note that the low impact development stormwater management planning and design guide accepts the fact that low impact development techniques can work in any soil type, despite low measured groundwater infiltration rates.

Oakridge Environmental Ltd. determined the hydraulic conductivity (K) of the native soils on site is on the order of 9.0 x 10^{-5} cm/sec. Using Appendix C of the LIDSWMPPD to convert the measured hydraulic conductivity (K) to an infiltration rate yields a rate range of approximately 12 mm/hr and 30 mm/hr. The design of low impact development practices for the project site considers the measured infiltration rate of the soils on the site.

It was determined that a lot-level rain garden constructed on each proposed lot in the development was the best solution to meet quality and quantity control objectives for the subdivision without requiring a dedicated stormwater management block. Due to grading constraints, the proposed LID rain gardens will capture and infiltrate runoff from Subwatershed Area PR. 1 only.

Each of the proposed LID rain gardens are sized to capture at a minimum the volume of runoff generated by the 25mm quality storm event from the 230 square metres of asphalt driveway area directed to each individual facility. Typical stormwater management guidelines specify that for of estate residential lots, rooftop and grass yard runoff is considered clean and does not require treatment. In this case, the runoff from the asphalt driveway is the only area that requires on-site quality control.

The combined stormwater storage capacity provided in the surface ponding area above the rain garden and the amended soil storage layer within the rain garden is sized to provide the required quantity control volume to reduce peak flows to be equal to or less than pre-development conditions. Runoff generated by storm events larger that the capacity of the rain gardens will overflow the rain garden berm and enter the Sharpe Line roadside ditch.

The proposed LID rain gardens have dimensions of 4.27 metres by 4.27 metres with a surface ponding depth of 0.25 metres and an amended soil storage layer depth of 0.60 metres. The storage layer is composed of native soils amended with a high sand content (60%) and low volume of organic materials such as compost (3-5%). A 50-75mm thick layer of hardwood mulch shall be placed on the top of the rain garden for weed suppression and to provide pre-treatment of the stormwater entering the facility. Each rain garden as designed provides a total volume of 8.92 cubic metres of storage, after adjusting for void ratio of 0.40 in the amended soil storage layer. A proposed 0.20m high berm constructed across the front of the lots will direct surface runoff into the rain gardens. The detailed calculation of the storage volume provided in each LID rain garden is included in Appendix I.

For infiltration practices, a minimum separation of 1.0 m is recommended from the bottom of practice to the seasonally high groundwater level. The Oakridge Environmental report measured the average groundwater depth on site to be approximately 1.1 metres below existing ground.

As the groundwater level across the site is generally shallow, best practices have been used to provide maximum separation from the bottom of the rain garden storage layer to the level of the groundwater. A minimum 0.50 metre vertical separation from the measured groundwater level to the rain garden storage layer has been provided.

Several factors after development of the subdivision will affect the groundwater level in the proximity of the subdivision. The finished grade across the entire site will be raised compared to existing to provide adequate drainage for the proposed lots. The swale proposed across the rear of the lots will direct external surface water away from the subject site, removing a potential surficial source affecting the groundwater level.

Furthermore, the installation of subdrains around the houses will also work to lower the groundwater level in the immediate area of the development. As a result, the 0.50 metres of separation provided from the base of the rain gardens to the measured groundwater level provided in the Oakridge Report is a conservative assumption.

In addition to the LID rain garden facilities proposed, driveway areas and downspouts will be directed to pervious surfaces where possible to passively treat runoff during conveyance and increase infiltration. The lot grading has been reduced to a minimum of target of 2.0% to promote filtration and infiltration of runoff during conveyance.

5.2 Quality Control

Developing the subject site with the proposed asphalt driveways and houses will increase the impervious area on site compared with the pre-development condition and can cause additional pollutants to be conveyed offsite if left uncontrolled. The proposed asphalt driveways on the site require "Enhanced" level protection (80% T.S.S. removal) as described in the Ontario Ministry of the Environment's "Stormwater Management Practices Planning and Design Manual, 2003". The remainder of the areas on site are not subject to stormwater controls as runoff from rooftop and landscaped areas is considered clean.

Primary stormwater quality control for the proposed impervious areas will be achieved for this site using infiltration within the proposed LID rain gardens. Quality control for the majority of the proposed asphalt driveways will be accomplished by directing driveway runoff first across the grass landscaped front lawn and into the proposed lot level rain garden for primary treatment and minimum 80% T.S.S. removal.

The combined storage volume provided in the surface ponding area (4.55 m^3) and soil storage layer (4.37 m^3) for each rain garden meets or exceeds the MOE quality storage guidelines for an enhanced level of protection (80% T.S.S. removal) prescribed in Table 3.2 of the Ontario Ministry of the Environment's "Stormwater Management Practices Planning and Design Manual, 2003." Extrapolating from Table 3.2 for Enhanced, 80% long-term T.S.S. removal at 100% impervious level, the required storage volume is 45 m^3/ha. The driveway area directed to each rain garden is 0.023 ha, which results in a total required infiltration storage volume of 1.04 m^3. The provided combined rain garden storage volume of 8.92 m^3 greatly exceeds the required storage volume to provide an Enhanced level of treatment for each driveway area.

Another criteria typically used the Peterborough region to evaluate if adequate quality control is provided is to ensure that the proposed stormwater management facility can completely capture the 25mm quality storm event volume. The total stormwater runoff volume generated by the 25mm storm event from the asphalt driveway area on each lot directed to the proposed rain garden is approximately 5.18 cubic metres. The provided rain garden volume of 8.92 cubic metres exceeds the required 25mm storm volume. The detailed calculation of the 25mm storm event volume is included in Appendix I.

Therefore, a minimum of 80% T.S.S. removal will be accomplished for the impervious areas requiring treatment in the development.

5.3 Quantity Control

The proposed post development condition of the site results in an overall increase in total impervious area over the pre-development site. The increase in impervious area would result in an increase in post development peak flows offsite if left uncontrolled. Stormwater management facilities must maintain post development at pre-development levels to ensure the proposed development does not increase downstream flooding potential.

The modified Rational Method has been used to calculate the required on-site storage volumes to reduce post development peak flows to be equal or less than pre-development peak flows.

Table 4 summarizes the cumulative required stormwater quantity storage volume for the 2, 5, 10, 25, 50 and 100-year return periods.

Table 4: Modified Rational Method Storage Volume Requirement

Design Storm (yr)	Modified Rational Method Storage Volume Requirement		
	Allowable Peak Flow (m^3/s)	Required Peak Flow Storage (m^3/s)	Required Storage Volume (m^3)
2	0.0644	0.0538	**16.14**
5	0.0847	0.0707	**21.22**
10	0.0982	0.0820	**24.59**
25	0.1266	0.1057	**31.71**
50	0.1533	0.1278	**38.33**
100	0.1753	0.1461	**43.84**

From the modified Rational Method, the total required on-site storage volume is 43.84 cubic metres for the 100-year storm event. The detailed calculations of the modified Rational Method for all storm events are included on Figure 5 in Appendix I.

The proposed storage volume in each LID rain garden is 8.92 m^3. An equally sized rain garden is proposed on each of the five lots. The five rain gardens provide a total combined storage volume of 44.60 cubic metres, which exceeds the required storage volume to reduce post development peak flows to be equal or below pre-development peak flow rates.

6.0 EROSION AND SEDIMENTATION CONTROL

Erosion and sedimentation control measures will be installed prior to the commencement of any on-site construction activity. These measures will be maintained throughout the construction period until the site has been stabilized with vegetation to prevent construction sediment from affecting lands external to the development.

During all phases of construction, vehicle refueling and maintenance operations shall occur a minimum distance of 15 metres away from any natural water feature, storm drain or temporary sediment control pond.

Prior to commencement of any on-site construction activity, clearing and grubbing operations shall take place along the south property boundary adjacent to Sharpe Line to provide access to the site.

Once clearing and grubbing is complete, light duty silt fence will be installed according to OPSD 219.110 in locations as specified on Drawing No. 6213-EC1 prepared by M.J. Davenport & Associates Ltd. Silt fence will be installed completely along the South boundary of the development as shown on the drawing. Since the site will be developed on a lot-by-lot basis, opportunities for erosion control practices are limited. Sediment control practices are the primary method of downstream protection for this development.

The front, side and rear lot grades of the development are designed to generally match the existing ground contours. Therefore, rough grading of the building lots will not be necessary until such time as a home builder begins home construction. With no significant earth moving operations proposed, a mud mat construction entrance is not warranted for this development. Once constructed, the gravel driveway entrances will provide access to the site. The contractor/home builders shall be responsible for cleaning Sharpe Line as required until construction is complete.

The re-grading of the north roadside ditch of Sharpe Line and construction of the five entrance driveways for each building lot shall now commence. Prior to commencement, two strawbale flow checks shall be installed according to OPSD 219.180 within the existing roadside ditch downstream (east) of the proposed works. The ditch area disturbed during construction shall be seeded immediately upon completion of grading operations. Once vegetation is established and the area is stabilized, the temporary strawbale flow check dams can be removed.

During construction of new homes, the home builder shall erect, on a lot-by-lot basis, light duty silt fence on the down gradient side of all disturbed areas on their construction site sufficient to contain silt prior to that surface water runoff entering watercourses and ditches. Staked straw bales shall be installed in the swales at the front of the lots, if front draining, and both the front and rear of the lots if split drainage is proposed. A typical individual lot erosion control detail is provided on Drawing No. 6213-EC1. Lot level LID rain gardens shall be constructed on a lot-by-lot basis after home construction is completed and the lot area draining to the rain garden is stabilized with vegetation.

All areas disturbed that are to remain exposed for more than 30 days and are not subject to active construction will be seeded or otherwise stabilized to protect against erosion during the remaining phases of construction. Any dewatering operations required during the construction process shall follow the dewatering detail shown on Drawing No. 6213-EC1.

All erosion and sediment control practices including perimeter silt fence shall be inspected weekly and after every significant storm event (defined as greater than 15mm of rain over a 24-hour period or an event with rainfall intensity greater than or equal to 5mm/hr with a total rainfall amount of 10mm or greater). For the facilities to continue to function as intended, maintenance of all temporary sediment control measures will be the responsibility of the on-site contractor and developer. Sediment deposits shall be removed when the deposit reaches one-third the height of the fence. The accumulated construction sediment must be removed carefully so as not to damage the silt fence fabric or undermine the structural base support. Maintenance shall be carried out within 24 hours on any part of the facilities requiring repair.

Once home building is complete, final site stabilization and decommissioning of erosion and sediment control features can commence. During this phase, the staged removal of the erosion and sediment control features will begin once the remaining disturbed soil areas are stabilized. All accumulated construction sediment shall be removed from the ESC features. Finally, all remaining erosion and sediment controls such as silt fence, flow check dams etc. shall be removed and disposed of offsite.

7.0 CONCLUSIONS

The development of a five-lot rural residential subdivision on vacant land on Part of Lot 12, Concession XI in the Township of Cavan Monaghan has the potential to increase pollutants in the stormwater runoff and increase the peak runoff rates when compared to the pre-development condition. The stormwater management design presented in this report addresses the potential to affect downstream receivers.

In our professional opinion, stormwater quality control for the subdivision will be provided by the lot level Low Impact Development rain gardens that provide a stormwater storage volume that exceeds the required volume prescribed in Table 3.2 of the Ontario Ministry of the Environment Stormwater Management Practices Planning & Design Manual, 2003 to provide an enhanced level of protection. In addition, the rain gardens are sized to fully capture the 25mm quality storm event from the impervious drainage area directed to each practice. These features combined will provide a minimum of "Enhanced" level of treatment (80% T.S.S. removal) for the impervious areas on site requiring treatment.

In our professional opinion, the increase in post development surface water runoff created by the increased impervious areas proposed on the subject site will be adequately controlled at equal to or below pre-development peak flow runoff rates by the lot level Low Impact Development rain gardens all storm events up to and including the 100-year storm event.

Erosion and sediment control measures have been designed to limit the potential for construction sediment from affecting surrounding lands during the construction period. If the proposed erosion and sediment control measures are placed in accordance with the design, installed correctly and maintained during construction, the risk of transport of construction sediment to downstream lands is minimal.

If the stormwater management design is implemented as designed, the rural residential subdivision can be constructed without negative impacts to adjacent or downstream landowners.

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APPENDIX I

STORMWATER MANAGEMENT SUPPORTING CALCULATIONS

FIGURE 1 - PRE-DEVELOPMENT SUBWATERSHED AREA HYDROLOGIC PARAMETERS (UNCALIBRATED)

Project Name: McCamus Ida Subdivision, Part of Lot 12, Concession IX, Township of Cavan Monaghan
Project No. : 23-D-6213
Rain Gauge: Peterborough Airport

Subwatershed Area No. And Description		Catchment Area (ha), Land Use, Hydrologic Soil Group, CN Value and Runoff Coefficient														
		Hydrologic Soil Group 'B'							Hydrologic Soil Group 'C'							
		Impervious	Gravel	Grass Yard	Woodlots and Forest	Pasture and Unimproved Land	Crop and Other Improved Land	Lakes and Wetland	Impervious	Gravel	Grass Yard	Woodlots and Forest	Pasture and Unimproved Land	Crop and Other Improved Land	Lakes and Wetland	
		'C' = 0.90	'C' = 0.60	'C' = 0.20	'C' = 0.25	'C' = 0.28	'C' = 0.35	'C' = 0.05	'C' = 0.90	'C' = 0.80	'C' = 0.30	'C' = 0.35	'C' = 0.40	'C' = 0.60	'C' = 0.05	
Name	Description	CN = 98	CN = 80	CN = 61	CN = 58	CN = 65	CN = 74	CN = 50	CN = 98	CN = 80	CN = 73	CN = 71	CN = 76	CN = 82	CN = 50	**Total**
PRE.1	Area to Sharpe Line Ditch						0.911									**0.911**
PRE.2	Area to Drainage Path						0.522									**0.522**

Subwatershed Area No. And Description		Catchment Parameters														
Name	Description	Total Impervious Percent (%)	Directly Connected Impervious Percent (%)	Visual Otthymo Command (NasHyd or StandHyd)	Weighted 'CN'	Composite Runoff Coefficient	Length of Catchment (m)	High Elevation (m)	Low Elevation (m)	Average Catchment Slope (%)	Slope Class (0-2% Flat, 2-6% Rolling, >6% Hilly)	Time of Concentration using Airport Method (min)	Time of Concentration using Bransby-Williams Method (min)	Minimum Time of Concentration (min)	Time to Peak (min)	Time to Peak (hr)
PRE.1	Area to Sharpe Line Ditch	0.0%	0.0%	NasHyd	74.0	0.35	200	285	279.85	2.6	Rolling	22.4	9.5	10.0	15.0	0.250
PRE.2	Area to Drainage Path	0.0%	0.0%	NasHyd	74.0	0.35	205	285	279.9	2.5	Rolling	22.9	10.4	10.0	15.3	0.256

Notes:
1. Curve Number (CN) is based upon Design Chart 1.09: Soil/Land Use Curve Numbers of the M.T.O. Drainage Management Manual, 1997.
2. Runoff coefficients taken from M.T.O. Design Chart 1.07, M.T.O. Drainage Management Manual, 1997.
3. The CN values used for each subcatchment are the weighted values calculated based upon the different soils and land use.
4. Time to Peak Calculated as 0.67 x Time of Concentration
5. Time of Concentration calculated using the Airport Formula where C< 0.40, where C > 0.40, the Bransby Williams Formula was used.
6. Calculated composite runoff coefficients (C) have been adjusted for storm events exceeding the 10-year return period by multiplying by: 1.10 for 25 year, 1.20 for 50 year and 1.25 for 100 year
7. Minimum Time to Concentration used in the Hydrologic Model is 10 minutes (0.167 hr)

FIGURE 2 - PRE-DEVELOPMENT RATIONAL METHOD PEAK FLOW CALCULATIONS

Project Name: McCamus Ida Subdivision, Part of Lot 12, Concession IX, Township of Cavan Monaghan
Project No. : 23-D-6213
Rain Gauge: Peterborough Airport

Subwatershed Area No. And Description		Runoff Coefficient ('C') For Varying Storm Return Periods						Return Rainfall Rates ('i') based on Tc (mm/hr)					
Name	Description	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
PRE.1	Area to Sharpe Line Ditch	0.35	0.35	0.35	0.39	0.42	0.44	46.1	60.6	70.2	82.4	91.4	100.4
PRE.2	Area to Drainage Path	0.35	0.35	0.35	0.39	0.42	0.44	45.4	59.8	69.3	81.3	90.2	99.0

Subwatershed Area No. And Description		Rational Method Peak Flows (m^3/s)					
Name	Description	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
PRE.1	Area to Sharpe Line Ditch	0.041	0.054	0.063	0.081	0.098	0.112
PRE.2	Area to Drainage Path	0.023	0.031	0.035	0.046	0.055	0.063
PRE.1 + PRE.2	Total Site Peak Flows	**0.064**	**0.085**	**0.098**	**0.127**	**0.153**	**0.175**

Notes:
1. Runoff coefficients taken from M.T.O. Design Chart 1.07, M.T.O. Drainage Management Manual, 1997.
2. Calculated composite runoff coefficients (C) have been adjusted for storm events exceeding
the 10-year return period by multiplying by: 1.10 for 25 year, 1.20 for 50 year and 1.25 for 100 year

FIGURE 3 - POST-DEVELOPMENT SUBWATERSHED AREA HYDROLOGIC PARAMETERS (UNCALIBRATED)

Project Name: McCamus Ida Subdivision, Part of Lot 12, Concession IX, Township of Cavan Monaghan
Project No. : 23-D-6213
Rain Gauge: Peterborough Airport

Subwatershed Area No. And Description		Catchment Area (ha), Land Use, Hydrologic Soil Group, CN Value and Runoff Coefficient														
		Hydrologic Soil Group 'B'							Hydrologic Soil Group 'C'							
		Impervious	Gravel	Grass Yard	Woodlots and Forest	Pasture and Unimproved Land	Crop and Other Improved Land	Lakes and Wetland	Impervious	Gravel	Grass Yard	Woodlots and Forest	Pasture and Unimproved Land	Crop and Other Improved Land	Lakes and Wetland	
		'C' = 0.90	'C' = 0.60	'C' = 0.20	'C' = 0.25	'C' = 0.28	'C' = 0.35	'C' = 0.05	'C' = 0.90	'C' = 0.80	'C' = 0.30	'C' = 0.35	'C' = 0.40	'C' = 0.60	'C' = 0.05	
Name	Description	CN = 98	CN = 80	CN = 61	CN = 58	CN = 65	CN = 74	CN = 50	CN = 98	CN = 80	CN = 73	CN = 71	CN = 76	CN = 82	CN = 50	**Total**
PR.1	Area to Sharpe Line Ditch	0.227		0.739												**0.966**
PR.2	Area to Drainage Path	0.019		0.448												**0.467**

Subwatershed Area No. And Description		Catchment Parameters														
Name	Description	Total Impervious Percent (%)	Directly Connected Impervious Percent (%)	Visual Otthymo Command (NasHyd or StandHyd)	Weighted 'CN'	Composite Runoff Coefficient	Length of Catchment (m)	High Elevation (m)	Low Elevation (m)	Average Catchment Slope (%)	Slope Class (0-2% Flat, 2-6% Rolling, >6% Hilly)	Time of Concentration using Airport Method (min)	Time of Concentration using Bransby-Williams Method (min)	Minimum Time of Concentration (min)	Time to Peak (min)	Time to Peak (hr)
PR.1	Area to Sharpe Line Ditch	23.5%	23.5%	StandHyd	69.7	0.36	82	284.85	283.4	1.8	Flat	15.8	4.2	10.0	10.6	0.176
PR.2	Area to Drainage Path	4.1%	4.1%	NasHyd	62.5	0.23	180	284.73	279.76	2.8	Rolling	25.5	9.0	10.0	17.1	0.284
												22.9				

*Time to Concentration for PR.2 in Rational Method Calculations reduced to 22.9 minutes to match pre-development Tc

Notes:
1. Curve Number (CN) is based upon Design Chart 1.09: Soil/Land Use Curve Numbers of the M.T.O. Drainage Management Manual, 1997.
2. Runoff coefficients taken from M.T.O. Design Chart 1.07, M.T.O. Drainage Management Manual, 1997.
3. The CN values used for each subcatchment are the weighted values calculated based upon the different soils and land use.
4. Time to Peak Calculated as 0.67 x Time of Concentration
5. Time of Concentration calculated using the Airport Formula where C< 0.40, where C > 0.40, the Bransby Williams Formula was used.
6. Calculated composite runoff coefficients (C) have been adjusted for storm events exceeding the 10-year return period by multiplying by: 1.10 for 25 year, 1.20 for 50 year and 1.25 for 100 year
7. Minimum Time to Concentration used in the Hydrologic Model is 10 minutes (0.167 hr)

FIGURE 4 - POST DEVELOPMENT RATIONAL METHOD PEAK FLOW CALCULATIONS

Project Name: McCamus Ida Subdivision, Part of Lot 12, Concession IX, Township of Cavan Monaghan
Project No. : 23-D-6213
Rain Gauge: Peterborough Airport

Subwatershed Area No. And Description		Runoff Coefficient ('C') For Varying Storm Return Periods						Return Rainfall Rates ('i') based on Tc (mm/hr)					
Name	Description	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
PR.1	Area to Sharpe Line Ditch	0.36	0.36	0.36	0.40	0.44	0.46	54.9	71.8	83.0	97.0	107.5	117.9
PR.2	Area to Drainage Path	0.23	0.23	0.23	0.25	0.27	0.29	45.4	59.8	69.3	81.3	90.2	99.0

Subwatershed Area No. And Description		Rational Method Peak Flows (m^3/s)					
Name	Description	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
PR.1	Area to Sharpe Line Ditch	0.054	0.071	0.082	0.105	0.127	0.145
PR.2	Area to Drainage Path	0.014	0.018	0.021	0.027	0.032	0.037
PR.1 + PR.2	Total Site Peak Flows	**0.068**	**0.089**	**0.103**	**0.132**	**0.160**	**0.182**

Notes:
1. Runoff coefficients taken from M.T.O. Design Chart 1.07, M.T.O. Drainage Management Manual, 1997.
2. Calculated composite runoff coefficients (C) have been adjusted for storm events exceeding the 10-year return period by multiplying by: 1.10 for 25 year, 1.20 for 50 year and 1.25 for 100 year

FIGURE 5 - POST DEVELOPMENT RATIONAL METHOD STORAGE CALCULATIONS

Project Name: McCamus Ida Subdivision, Part of Lot 12, Concession IX, Township of Cavan Monaghan
Project No. : 23-D-6213
Rain Gauge: Peterborough Airport

2 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	92.0	0.1182	0.0644	0.0538	**16.14**
10	68.2	0.0876	0.0644	0.0232	13.94
15	56.0	0.0719	0.0644	0.0076	6.81
20	49.3	0.0633	0.0644	-0.0010	0.00
25	42.6	0.0547	0.0644	-0.0096	0.00
30	35.9	0.0461	0.0644	-0.0183	0.00

5 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	121.0	0.1554	0.0847	0.0707	**21.22**
10	87.7	0.1127	0.0847	0.0280	16.78
15	73.1	0.0939	0.0847	0.0092	8.29
20	64.7	0.0831	0.0847	-0.0016	0.00
25	56.2	0.0722	0.0847	-0.0125	0.00
30	47.8	0.0614	0.0847	-0.0233	0.00

10 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	140.2	0.1801	0.0982	0.0820	**24.59**
10	100.7	0.1294	0.0982	0.0312	18.73
15	84.5	0.1086	0.0982	0.0104	9.36
20	74.9	0.0962	0.0982	-0.0019	0.00
25	65.2	0.0838	0.0982	-0.0144	0.00
30	55.6	0.0714	0.0982	-0.0267	0.00

25 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	164.4	0.2323	0.1266	0.1057	**31.71**
10	117.0	0.1653	0.1266	0.0387	23.23
15	98.8	0.1396	0.1266	0.0130	11.69
20	87.7	0.1239	0.1266	-0.0027	0.00
25	76.6	0.1082	0.1266	-0.0184	0.00
30	65.5	0.0926	0.1266	-0.0341	0.00

50 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	182.3	0.2810	0.1533	0.1278	**38.33**
10	129.1	0.1990	0.1533	0.0457	27.45
15	109.4	0.1686	0.1533	0.0154	13.84
20	97.2	0.1498	0.1533	-0.0034	0.00
25	85.1	0.1312	0.1533	-0.0221	0.00
30	72.9	0.1124	0.1533	-0.0409	0.00

100 Year Required Storage Volume					
Tc (min)	**I (mm/hr)**	**Q (cms)**	**Qallow (cms)**	**Qstored (cms)**	**Qstorage (cu.m)**
5	200.2	0.3215	0.1753	0.1461	**43.84**
10	141.1	0.2266	0.1753	0.0512	30.75
15	120.0	0.1927	0.1753	0.0174	15.62
20	106.7	0.1713	0.1753	-0.0040	0.00
25	93.5	0.1501	0.1753	-0.0252	0.00
30	80.2	0.1288	0.1753	-0.0466	0.00

McCAMUS IDA SUBDIVISION – PART OF LOT 12, CONCESSION IX
TOWNSHIP OF CAVAN MONAGHAN, COUNTY OF PETERBOROUGH

RAIN GARDEN INFILTRATION PRACTICE DESIGN

Maximum Depth of Infiltration Layer of Rain Garden

The maximum depth of the proposed infiltration practice on site is dependent on the native soil infiltration rate, an infiltration rate factor of safety, porosity of the chosen storage media and the desired drawdown time of the practice in-between storm events. The safety correction factor is based on ratio of mean measured infiltration rate at the bottom elevation of the BMP divided by the measured infiltration rate of the least permeable soil horizon within 1.5m taken from Table C2, Appendix C of the LIDSWMPPD.

Oakridge Environmental Ltd. determined the hydraulic conductivity (K) of the native soils on site is on the order of 9.0×10^{-5} cm/sec. Using Appendix C of the LIDSWMPPD to convert the measured hydraulic conductivity (K) to an infiltration rate yields a range of approximately 12 mm/hr and 30 mm/hr. The design of low impact development practices for the project site utilizes an unadjusted infiltration rate of 15 mm/hr, a typical infiltration rate found in the native soils in the Peterborough area.

From the Oakridge report, the soils encountered in the test pits at the approximate depth of the bottom of the proposed rain garden storage layers was homogeneous. From the borehole logs, the soil horizon in the post-development conditions was found to be homogeneous for at least 1.5m below the proposed LID controls. From this, the derived ratio of mean measured infiltration rates is 1.0. Therefore, a safety correction factor of 2.5 is applied to the infiltration rate in accordance with the LID Design Manual, Appendix C, Table C2.

From the LIDSWMPPD guide 2010, page 4-57, the maximum depth of the storage layer of the rain gardens can be calculated using:

$$d_{r\,max} = i/f \times t_s/V_r$$

Where:

$d_{r\,max}$	= Maximum infiltration layer depth (mm)
i	= Infiltration rate for native soils (mm/hr)
	= 15 mm/hr (Within range for native soils provided by Oakridge)
f	= Safety correction factor
	= 2.5
V_r	= Void space ratio for amended soils
	= 0.40
t_s	= Maximum time to drain
	= 48 hours (recommended by guide)

$d_{r\ max} = (15/2.5) \times (48/0.40)$
$d_{r\ max} = 720mm$

From the calculations outlined above, the maximum permissible depth of infiltration practices on this site is 720mm.

25mm Storm Depth:

To capture the 25mm quality storm event, the combined storage volume provided in both the surface ponding area and in the infiltration storage layer of the proposed rain garden must meet or exceed the volume expected to accumulate during this storm event. The area requiring treatment for each lot is the asphalt driveway area.

A proposed 0.20m high berm constructed across the front of each lot will direct driveway runoff across the grass landscaped front lawn and into the rain garden. Approximately 230 square metres of driveway area can be feasibly directed into each rain garden. A runoff coefficient of 0.90 will be used for the impervious asphalt driveway area.

To determine the capture volume necessary, the equation below was used.

$$V = A \times D \times C$$

Where:

V = Volume required to contain the 15mm storm (m^3)
A = Area (m^2)
= 230 m^2 impervious, 0 m^2 pervious
D = Depth of rainfall event (m)
= 0.025 m
C = Runoff coefficient (unitless)
= 0.90 for impervious areas, 0.20 for pervious areas

$V = 230 \times 0.025 \times 0.90$
$V = 5.15\ m^3$ required to contain the 25mm storm event

Rain Garden Storage Volume:

Each proposed LID rain garden has design dimensions of 4.27 metres by 4.27 metres with a surface ponding depth of 0.25 metres and an amended soil storage layer depth of 0.60 metres. The storage layer is composed of native soils amended with a high sand content (60%) and low volume of organic materials such as compost (3-5%).

The total combined stormwater storage available in each rain garden is calculated below.

Rain Garden Infiltration Layer

$$Volume = L \times W \times D \times V_r$$

Where:

V	= Total storage volume available in layer
L	= Length of Practice
	= 4.27 metres
W	= Width of Practice
	= 4.27 metres
D	= Depth of Practice
	= 0.60 metres
V_r	= Void space ratio for media used
	= 0.40

$$Volume = 4.27m \times 4.27m \times 0.60m \times 0.40$$
$$Volume = 4.37\ m^3$$

Rain Garden Surface Ponding Area

$$Volume = L \times W \times D$$

Where:

V	= Total storage volume available on surface
L	= Length of Practice
	= 4.27 metres
W	= Width of Practice
	= 4.27 metres
D	= Depth of Ponding Area
	= 0.25 metres

$$Volume = 4.27m \times 4.27m \times 0.25m$$
$$Volume = 4.55\ m^3$$

Therefore, by adding the storage volume of the infiltration layer and the surface ponding volume, the total storage volume available in each rain garden is 8.92 cubic metres.

3.3.2 Water Quality Sizing Criteria

The volumetric water quality criteria are presented in Table 3.2. The values are based on a 24 hour drawdown time and a design which conforms to the guidance provided in this manual. Requirements differ with SWMP type to reflect differences in removal efficiencies. Of the specified storage volume for wet facilities, 40 m^3/ha is extended detention, while the remainder represents the permanent pool.

Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level 35%	55%	70%	85%
Enhanced 80% long-term S.S. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. removal	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. removal	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

[1]*Table 3.2 does not include every available SWMP type. Any SWMP type that can be demonstrated to the approval agencies to meet the required long-term suspended solids removal for the selected protection levels under the conditions of the site is acceptable for water quality objectives. The sizing for these SWMP types is to be determined based on performance results that have been peer-reviewed. The designer and those who review the design should be fully aware of the assumptions and sampling methodologies used in formulating performance predictions and their implications for the design.*

[2]*Hybrid Wet Pond/Wetland systems have 50-60% of their permanent pool volume in deeper portions of the facility (e.g., forebay, wet pond).*

Design Chart 1.07: Runoff Coefficients

- Urban for 5 to 10-Year Storms

Land Use	Runoff Coefficient	
	Min.	Max.
Pavement - asphalt or concrete	0.80	0.95
- brick	0.70	0.85
Gravel roads and shoulders	0.40	0.60
Roofs	0.70	0.95
Business - downtown	0.70	0.95
- neighbourhood	0.50	0.70
- light	0.50	0.80
- heavy	0.60	0.90
Residential - single family urban	0.30	0.50
- multiple, detached	0.40	0.60
- multiple, attached	0.60	0.75
- suburban	0.25	0.40
Industrial - light	0.50	0.80
- heavy	0.60	0.90
Apartments	0.50	0.70
Parks, cemeteries	0.10	0.25
Playgrounds (unpaved)	0.20	0.35
Railroad yards	0.20	0.35
Unimproved areas	0.10	0.30
Lawns - Sandy soil		
- flat, to 2%	0.05	0.10
- average, 2 to 7%	0.10	0.15
- steep, over 7%	0.15	0.20
- Clayey soil		
- flat, to 2%	0.13	0.17
- average, 2 to 7%	0.18	0.22
- steep, over 7%	0.25	0.35

For flat or permeable surfaces, use the lower values. For steeper or more impervious surfaces, use the higher values. For return period of more than 10 years, increase above values as 25-year - add 10%, 50-year - add 20%, 100-year - add 25%.

The coefficients listed above are for unfrozen ground.

Design Chart 1.07: Runoff Coefficients (Continued)

- Rural

Land Use & Topography[3]	Soil Texture		
	Open Sand Loam	Loam or Silt Loam	Clay Loam or Clay
CULTIVATED			
Flat 0 - 5% Slopes	0.22	0.35	0.55
Rolling 5 - 10% Slopes	0.30	0.45	0.60
Hilly 10- 30% Slopes	0.40	0.65	0.70
PASTURE			
Flat 0 - 5% Slopes	0.10	0.28	0.40
Rolling 5 - 10% Slopes	0.15	0.35	0.45
Hilly 10- 30% Slopes	0.22	0.40	0.55
WOODLAND OR CUTOVER			
Flat 0 - 5% Slopes	0.08	0.25	0.35
Rolling 5 - 10% Slopes	0.12	0.30	0.42
Hilly 10- 30% Slopes	0.18	0.35	0.52
BARE ROCK	COVERAGE[3]		
	30%	50%	70%
Flat 0 - 5% Slopes	0.40	0.55	0.75
Rolling 5 - 10% Slopes	0.50	0.65	0.80
Hilly 10- 30% Slopes	0.55	0.70	0.85
LAKES AND WETLANDS	0.05		

2 Terrain Slopes

3 Interpolate for other values of % imperviousness

Sources: American Society of Civil Engineers - ASCE (1960)
U.S. Department of Agriculture (1972)

Design Chart 1.08: Hydrologic Soil Groups

- Based on Surficial Geology Maps

Map Ref.No.	Soil Type or Texture	Hydrologic Soil Group (Tentative)
	Ground Moraine	
1a	Usually sandy till, stony, varying depth. (Most widespread type in Shield).	Usually B (shallow); may be A or AB
1b	Clayey till, varying depth.	BC-C
	End or Interlobate Moraine	
2a	Sand & stones, deep. (May be rough topography).	A
2b	Sand & stones capped by till, deep.	A-C depending on type of till.
2c	Sand & stones, deep. (Smoother topography).	A
	Kames & Eskers	
3a	Sand & stones, deep. (May be rough topography).	A
3b	Sand & stones capped by till, deep.	A-C depending on type of till.
3c	Sand & stones, deep. (Smoother topography).	A
	Lacustrine	
4a	Clay & silt, in lowlands.	BC-C
4b	Fine sand, in lowlands.	AB-B
4c	Sand, in lowlands.	AB
4d	Sand (deltas & valley trains).	A-AB
	Outwash	
5	Sand, some gravel, deep.	A
	Aeolian	
6	Very fine sand & silt, shallow. (Loess)	B
	Bedrock	
7	Bare bedrock (normally negligible areas).	Varies according to rock type.

Source: Ministry of Natural Resources - MNR

Design Chart 1.08: Hydrologic Soil Groups (Continued)

- Based on Soil Texture

Sands, Sandy Loams and Gravels		
-	overlying sand, gravel or limestone bedrock, very well drained	A
-	ditto, imperfectly drained	AB
-	shallow, overlying Precambrian bedrock or clay subsoil	B
Medium to Coarse Loams		
-	overlying sand, gravel or limestone, well drained	AB
-	shallow, overlying Precambrian bedrock or clay subsoil	B
Medium Textured Loams		
-	shallow, overlying limestone bedrock	B
-	overlying medium textured subsoil	BC
Silt Loams, Some Loams		
-	with good internal drainage	BC
-	with slow internal drainage and good external drainage	C
Clays, Clay Loams, Silty Clay Loams		
-	with good internal drainage	C
-	with imperfect or poor external drainage	C
-	with slow internal drainage and good external drainage	D

Source: U.S. Department of Agriculture (1972)

Design Chart 1.09: Soil/Land Use Curve Numbers

Land Use	Treatment or Practice	Hydrologic Condition[4]	Hydrologic Soil Group			
			A	B	C	D
Fallow	Straight row	---	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	" and terraced	Poor	66	74	8	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	" and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded	Straight row	Poor	66	77	85	89
legumes[2]	" "	Good	58	72	81	85
or	Contoured	Poor	64	75	83	85
rotation	"	Good	55	69	78	83
meadow	" and terraced	Poor	63	73	80	83
	" and terraced	Good	51	67	76	80
Pasture		Poor	68	79	86	89
or range		Fair	49	69	79	84
	Contoured	Good	39	61	74	80
	"	Poor	47	67	81	88
	"	Fair	25	59	75	83
		Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		---	59	74	82	86
		---	72	82	87	89
		---	74	84	90	92

For average anticedent soil moisture condition (AMC II)
[2] Close-drilled or broadcast.

[4] The hydrologic condition of cropland is good if a good crop rotation practice is used; it is poor if one crop is grown continuously.

Source: U.S. Department of Agriculture (1972)

Design Chart 1.09: Soil Conservation Service Curve Numbers (Continued)

Land Use or Surface	Hydrologic Soil Group						
	A	AB	B	BC	C	CD	D
Fallow (special cases only)	77	82	86	89	91	93	94
Crop and other improved land	66** (62)	70** (68)	74	78	82	84	86 AMC I
Pasture & other unimproved land	58* (38)	62* (51)	65	71	76	79	81
Woodlots and forest	50* (30)	54* (44)	58	65	71	74	77
Impervious areas (paved)							98
Bare bedrock draining directly to stream by surface flow							98
Bare bedrock draining indirectly to stream as groundwater (usual case)							70
Lakes and wetlands							50

Notes

(i) All values are based on AMC II except those marked by * (AMC III) or ** (mean of AMC II and AMC III).

(ii) Values in brackets are AMC II and are to be used only for special cases.

(iii) Table is not applicable to frozen soils or to periods in which snowmelt contributes to runoff.

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Environment Canada/Environnement 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

2014/12/21

==

PETERBOROUGH A ON 6166418

Latitude: 44 14'N Longitude: 78 22'W Elevation/Altitude: 191 m

Years/Années : 1971 - 2006 # Years/Années : 33

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

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1971	4.3	5.8	7.4	11.7	17.5	24.6	30.7	34.8	34.8
1972	5.8	6.1	8.1	10.2	13.2	16.5	22.9	41.4	44.2
1973	6.9	13.2	18.0	19.3	20.8	26.7	48.0	48.3	58.2
1974	7.6	13.5	14.0	16.0	20.1	25.7	43.9	49.8	49.8
1975	6.3	9.9	13.7	21.8	39.6	55.1	55.1	67.8	67.8
1976	5.3	8.4	11.9	15.0	16.3	16.5	22.6	24.6	37.6
1977	8.4	12.7	13.7	19.6	24.9	24.9	52.3	62.2	62.5
1978	7.2	12.4	17.3	19.2	21.7	27.7	43.9	45.6	45.8
1979	10.1	13.8	15.3	17.5	26.2	31.6	33.3	33.7	33.7
1980	8.8	16.0	21.6	29.0	32.0	48.3	61.8	62.2	83.2
1981	9.7	18.6	27.9	42.3	52.2	53.2	53.4	53.4	54.1
1982	5.3	7.6	7.8	9.9	11.7	15.4	30.3	34.1	34.1
1983	11.3	18.3	23.3	25.1	26.1	36.3	56.8	57.1	77.5
1984	8.9	14.2	17.3	18.9	25.3	29.4	35.5	37.8	39.2
1985	7.6	10.4	12.0	19.7	22.7	26.8	36.4	53.6	53.6
1986	12.5	15.8	19.3	19.7	19.7	23.2	35.8	42.0	44.8
1987	17.9	21.3	22.7	23.2	23.2	23.2	23.2	26.0	29.0
1988	7.8	11.5	14.5	20.7	23.2	24.4	27.0	28.8	30.4
1989	9.9	14.2	15.7	18.7	20.2	26.3	46.1	47.8	52.8
1990	8.9	13.4	17.8	23.2	23.7	23.7	42.2	43.4	44.8
1991	4.1	6.8	7.6	8.8	9.2	12.2	17.1	21.2	29.6
1992	8.6	9.3	12.8	20.4	25.8	31.7	38.9	45.0	51.2
1993	9.1	10.9	14.1	20.4	21.9	23.3	29.9	34.2	42.0
1994	8.8	14.4	17.4	19.8	22.2	24.1	24.1	33.6	41.5
1995	9.3	12.1	18.1	32.2	49.0	82.5	89.8	90.1	90.1
1996	6.8	8.6	10.5	13.9	16.5	22.0	38.3	40.8	41.0
1997	3.6	7.2	7.6	9.2	17.8	30.6	35.0	35.2	35.2
1998	11.4	15.7	16.5	18.7	28.1	32.4	60.0	65.1	76.2
1999	8.4	11.4	13.5	18.6	23.2	32.5	39.9	46.8	55.6
2000	6.4	10.0	12.7	16.6	18.8	23.5	47.8	61.2	61.2
2002	7.3	9.6	10.4	13.8	23.4	35.1	50.9	73.6	73.6
2004	6.2	10.9	15.2	22.0	26.5	41.6	65.9	80.1	97.8
2006	7.4	11.1	12.5	14.2	15.0	17.8	22.0	34.0	42.5
# Yrs.	33	33	33	33	33	33	33	33	33

Années									
Mean Moyenne	8.1	12.0	14.8	19.1	23.6	30.0	41.2	47.1	52.0
Std. Dev. Écart-type	2.7	3.7	4.8	6.7	9.1	13.7	15.5	16.4	18.1
Skew. Dissymétrie	1.33	0.45	0.55	1.30	1.66	2.13	0.92	0.75	0.92
Kurtosis	7.16	3.29	3.67	6.74	6.80	9.09	4.68	3.45	3.35

*-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
1981	30 min	42.3	40.1
1981	1 h	52.2	52.0
1987	5 min	17.9	16.7
1995	2 h	82.5	72.9

****

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	7.7	10.1	11.7	13.7	15.2	16.7	33
10 min	11.4	14.6	16.8	19.5	21.5	23.5	33
15 min	14.0	18.3	21.1	24.7	27.4	30.0	33
30 min	18.0	23.9	27.8	32.8	36.4	40.1	33
1 h	22.1	30.1	35.4	42.1	47.1	52.0	33
2 h	27.7	39.8	47.8	57.9	65.4	72.9	33
6 h	38.7	52.4	61.5	72.9	81.4	89.9	33
12 h	44.4	58.9	68.5	80.6	89.5	98.4	33
24 h	49.0	65.0	75.6	88.9	98.9	108.7	33

****

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	92.0	121.0	140.2	164.4	182.3	200.2	33
	+/- 10.3	+/- 17.3	+/- 23.3	+/- 31.5	+/- 37.7	+/- 43.9	33
10 min	68.2	87.7	100.7	117.0	129.1	141.1	33
	+/- 6.9	+/- 11.7	+/- 15.7	+/- 21.2	+/- 25.4	+/- 29.6	33
15 min	56.0	73.1	84.5	98.8	109.4	120.0	33
	+/- 6.1	+/- 10.2	+/- 13.8	+/- 18.6	+/- 22.3	+/- 26.0	33
30 min	35.9	47.8	55.6	65.5	72.9	80.2	33
	+/- 4.2	+/- 7.1	+/- 9.6	+/- 12.9	+/- 15.4	+/- 18.0	33
1 h	22.1	30.1	35.4	42.1	47.1	52.0	33
	+/- 2.8	+/- 4.8	+/- 6.5	+/- 8.7	+/- 10.4	+/- 12.1	33
2 h	13.9	19.9	23.9	29.0	32.7	36.4	33
	+/- 2.1	+/- 3.6	+/- 4.9	+/- 6.6	+/- 7.9	+/- 9.2	33
6 h	6.4	8.7	10.2	12.2	13.6	15.0	33

	+/- 0.8	+/- 1.4	+/- 1.8	+/- 2.5	+/- 3.0	+/- 3.5	33
12 h	3.7	4.9	5.7	6.7	7.5	8.2	33
	+/- 0.4	+/- 0.7	+/- 1.0	+/- 1.3	+/- 1.6	+/- 1.8	33
24 h	2.0	2.7	3.1	3.7	4.1	4.5	33
	+/- 0.2	+/- 0.4	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.0	33

****

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	33.4	44.0	51.0	59.9	66.5	73.1
Std. Dev. /Écart-type (RR)	32.1	41.8	48.1	56.2	62.2	68.1
Std. Error/Erreur-type	7.4	10.0	11.7	14.0	15.6	17.2
Coefficient (A)	20.5	27.4	31.9	37.7	41.9	46.1
Exponent/Exposant (B)	-0.680	-0.675	-0.672	-0.670	-0.669	-0.668
Mean % Error/% erreur moyenne	8.4	10.1	10.8	11.4	11.7	12.0

6 Hour SCS Type II Intensity Hyetographs 2006 Peterborough Airport Weather Station (mm/hr)						
Time (min.)	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.6	2.1	2.5	2.9	3.3	3.6
30	1.6	2.1	2.5	2.9	3.3	3.6
45	2.3	3.2	3.7	4.4	4.9	5.4
60	2.3	3.2	3.7	4.4	4.9	5.4
75	2.3	3.2	3.7	4.4	4.9	5.4
90	2.3	3.2	3.7	4.4	4.9	5.4
105	3.9	5.2	6.2	7.3	8.1	9.0
120	3.9	5.2	6.2	7.3	8.1	9.0
135	4.6	6.3	7.4	8.8	9.8	10.8
150	4.6	6.3	7.4	8.8	9.8	10.8
165	23.2	31.4	36.9	43.7	48.9	53.9
180	60.4	81.8	95.9	113.7	127.0	140.2
195	8.5	11.5	13.5	16.0	17.9	19.8
210	8.5	11.5	13.5	16.0	17.9	19.8
225	3.9	5.2	6.2	7.3	8.1	9.0
240	3.9	5.2	6.2	7.3	8.1	9.0
255	3.1	4.2	4.9	5.8	6.5	7.2
270	3.1	4.2	4.9	5.8	6.5	7.2
285	2.3	3.2	3.7	4.4	4.9	5.4
300	2.3	3.2	3.7	4.4	4.9	5.4
315	1.6	2.1	2.5	2.9	3.3	3.6
330	1.6	2.1	2.5	2.9	3.3	3.6
345	1.6	2.1	2.5	2.9	3.3	3.6
360	1.6	2.1	2.5	2.9	3.3	3.6
P_{tot} (mm)	38.750	52.445	61.600	72.900	81.475	89.925

6 Hour SCS Type II Intensity Hyetographs
2006 Peterborough Airport Weather Station
(mm/hr)

Time (min.)	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
0	0	0	0	0	0	0
15	1.6	2.1	2.5	2.9	3.3	3.6
30	1.6	2.1	2.5	2.9	3.3	3.6
45	2.3	3.2	3.7	4.4	4.9	5.4
60	2.3	3.2	3.7	4.4	4.9	5.4
75	2.3	3.2	3.7	4.4	4.9	5.4
90	2.3	3.2	3.7	4.4	4.9	5.4
105	3.9	5.2	6.2	7.3	8.1	9.0
120	3.9	5.2	6.2	7.3	8.1	9.0
135	4.6	6.3	7.4	8.8	9.8	10.8
150	4.6	6.3	7.4	8.8	9.8	10.8
165	23.2	31.4	36.9	43.7	48.9	53.9
180	60.4	81.78	95.9	113.7	127.0	140.2
195	8.5	11.5	13.5	16.0	17.9	19.8
210	8.5	11.5	13.5	16.0	17.9	19.8
225	3.9	5.2	6.2	7.3	8.1	9.0
240	3.9	5.2	6.2	7.3	8.1	9.0
255	3.1	4.2	4.9	5.8	6.5	7.2
270	3.1	4.2	4.9	5.8	6.5	7.2
285	2.3	3.2	3.7	4.4	4.9	5.4
300	2.3	3.2	3.7	4.4	4.9	5.4
315	1.6	2.1	2.5	2.9	3.3	3.6
330	1.6	2.1	2.5	2.9	3.3	3.6
345	1.6	2.1	2.5	2.9	3.3	3.6
360	1.6	2.1	2.5	2.9	3.3	3.6

12 and 24 Hour – 100 Year SCS Type II Hyetographs
2006 Peterborough Airport Weather Station
(mm/hr)

12 Hour - (98.4mm)		24 Hour - (108.7mm)	
Time Ending (hours)	Intensity	Time Ending (hours)	Intensity
0	0	0	0
2	2.5	2	1.2
3	3.0	4	1.4
3.5	3.9	6	1.7
4	3.9	7	0
4.5	5.9	8	4.4
5	7.9	8.5	0
5.5	11.8	9	5.9
5.75	47.2	9.5	3.5
6	129.9	9.75	0
6.5	17.7	10	7.8
7	7.9	10.5	5.0
7.5	5.9	11	6.7
8	5.9	11.5	10.4
10	3.4	11.75	45.2
12	2.0	12	120.0
		12.5	15.7
		13	8.0
		13.5	1.5
		14	8.9
		16	3.3
		20	2.0
		24	1.3

The above noted values should be reduced to smaller time steps in the hydrograph computations.

<u>IDF Curve Parameters:</u> Parameters for design storm of less than 3 hour durations shall use curve fitting valuations outlined in Table B.1.7.1. For design storm hyetographs requiring IDF curve equations for the 100 year frequency - 12 and 24 hour durations, the following parameters may be used.

A = 1697.0

B = 10.51

C = 0.808

APPENDIX II

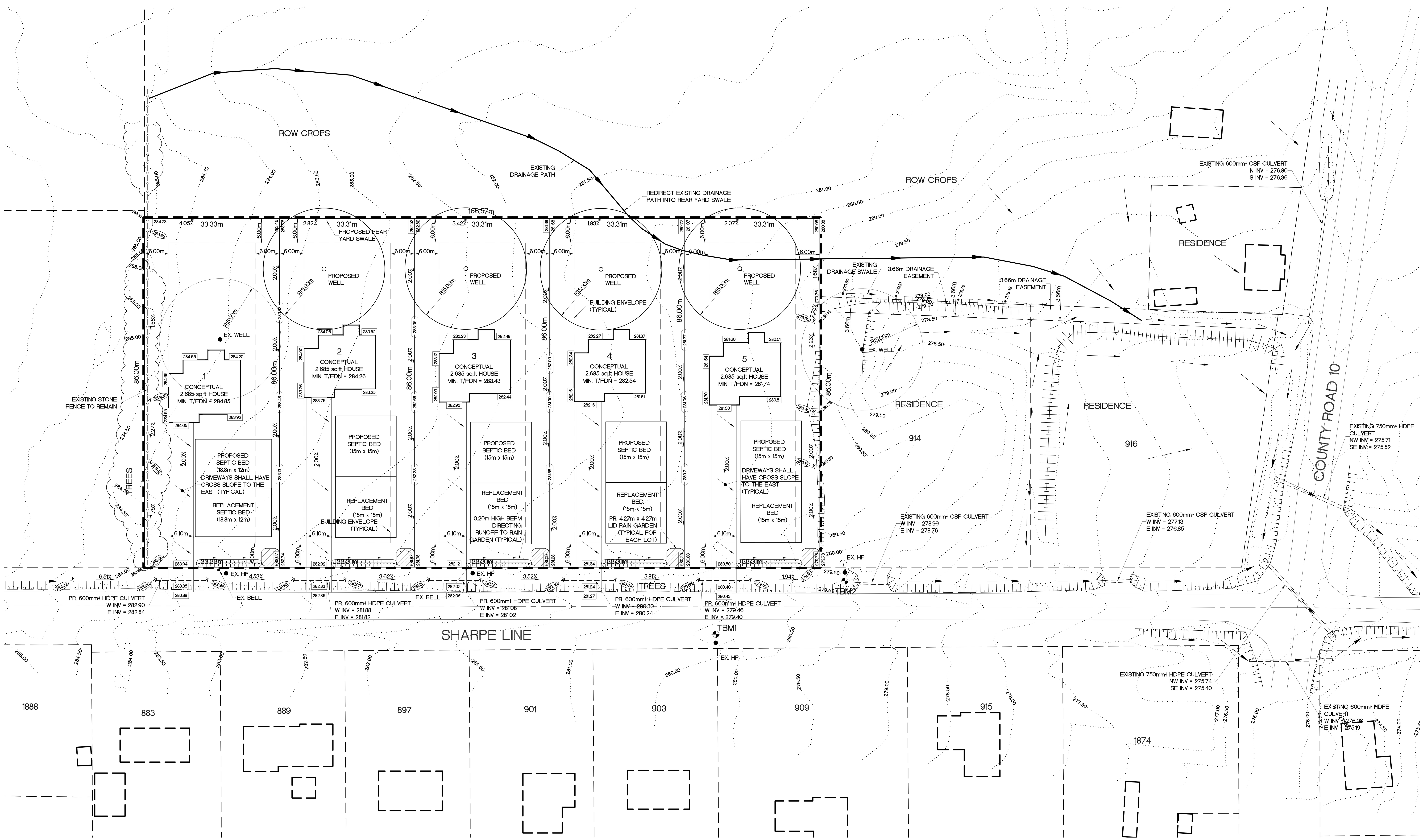
ENGINEERING DESIGN DRAWINGS

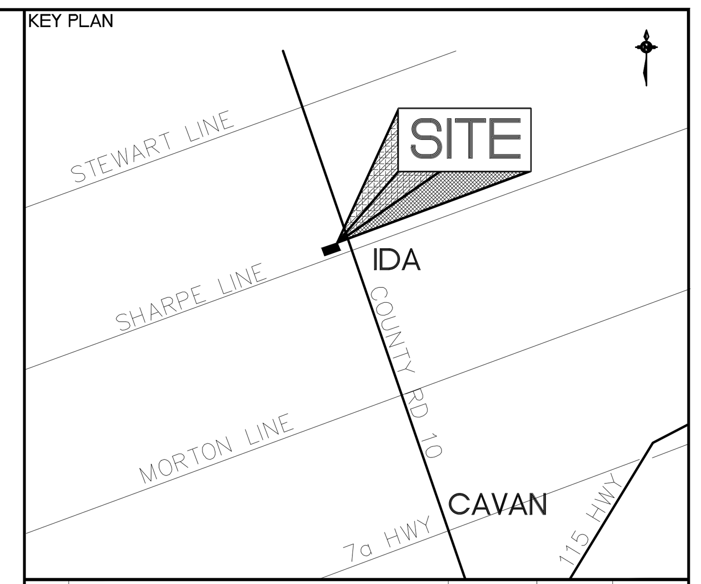
GENERAL NOTES

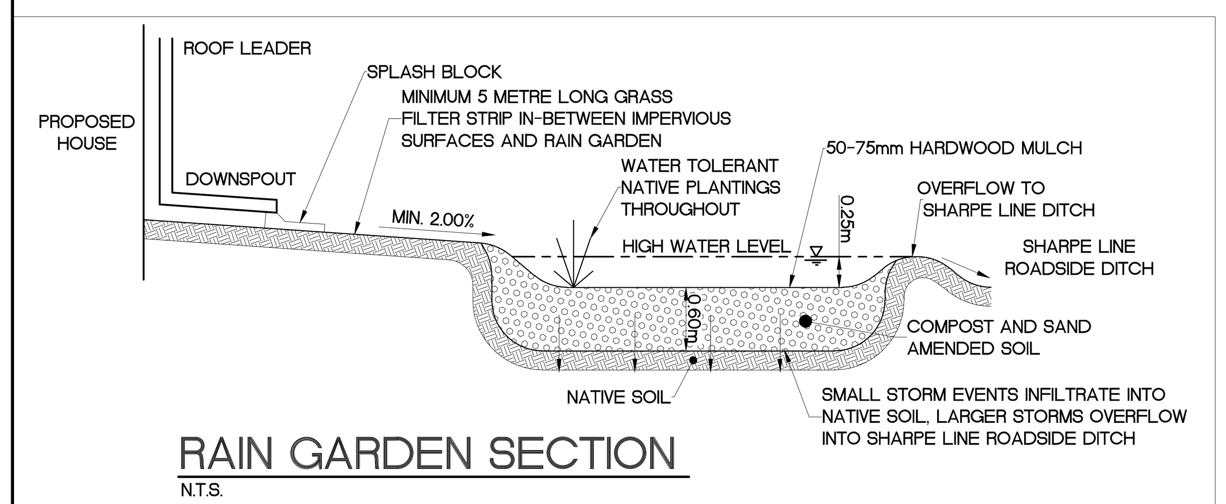
1. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES TO M.J. DAVENPORT + ASSOCIATES LTD. PRIOR TO CONSTRUCTION.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL FIELD LOCATES OF EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. THE LOCATION OF EXISTING UTILITIES IS TO BE CHECKED BY THE CONTRACTOR AND ANY DISCREPANCIES REPORTED TO M.J. DAVENPORT + ASSOCIATES LTD.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING A COPY OF ALL STANDARDS ASSOCIATED WITH THE PROJECT INCLUDING THE ONTARIO PROVINCIAL STANDARDS, LOCAL UTILITY SPECIFICATIONS AND LOCAL MUNICIPAL SPECIFICATIONS.
4. THE WORK IS TO BE COMPLETED IN ACCORDANCE WITH OPSS MUNI GENERAL CONDITIONS OF CONTRACT (OPSS.MUNI 100).
5. ALL PERMITS RELATING TO CONSTRUCTION WORKS SHALL BE OBTAINED AND PAID FOR BY THE CONTRACTOR. THIS INCLUDES, BUT IS NOT LIMITED TO THE FOLLOWING: SERVICE CONNECTIONS, RELOCATION OF SERVICES, AND ROAD CUT PERMITS, ETC.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL LAYOUT FOR CONSTRUCTION PURPOSES.
7. DRAWING ELEVATIONS ARE GEODETIC MEASURED USING COSINE, ONTARIO'S GEODETIC CONTROL DATABASE.
8. THE CONTRACTOR SHALL PROVIDE SAFETY AND TRAFFIC CONTROL MEASURES REQUIRED DURING CONSTRUCTION.
9. ALL SLOPES SHALL BE A MAXIMUM OF ONE VERTICAL TO THREE HORIZONTAL UNLESS OTHERWISE SPECIFIED.
10. ALL COSTS IN RELATION TO THE RESTORATION OF THE RIGHT OF WAY SHALL BE THAT OF THE APPLICANT.
11. RESPECTING ALL WORK IN THE MUNICIPAL RIGHT OF WAY, THE CONTRACTOR IS TO PROVIDE AT LEAST 48 HOURS PRIOR NOTICE TO THE PUBLIC WORKS DEPARTMENT.
12. A ROAD OCCUPANCY AND/OR CUT PERMIT WILL BE REQUIRED FOR ANY WORK BEING UNDERTAKEN IN THE MUNICIPAL ROAD ALLOWANCE.
13. ALL WORK COMPLETED IN THE ROAD ALLOWANCE, INCLUDING RESTORATION, MUST BE PERFORMED AS PER MUNICIPAL FIELD STAFF DIRECTION

SERVICING NOTES

1. ENGINEERED FILL FOR HOUSES SHALL BE COMPACTED TO MINIMUM OF 97% STANDARD PROCTOR.
2. ALL CULVERTS TO BE BOSS 2000 HDPE PIPE WITH A SPECIFIED STIFFNESS OF 320kPa AND CONFORMING TO CSA GROUP STANDARD B182.8, UNLESS SPECIFIED OTHERWISE.
3. ALL SINGLE FAMILY DETACHED HOUSES TO HAVE A MAXIMUM DRIVEWAY WIDTH OF 9.0m UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS..
4. ALL ROOFTOP RAINWATER LEADERS MUST BE DIRECTED TO OUTLET ONTO A LANDSCAPED OR GRASSED SURFACE. PROPOSED DRIVEWAYS SHOULD BE GRADED TOWARDS LANDSCAPED AREAS WHEREVER POSSIBLE. RAIN WATER LEADERS AT THE FRONT OF THE HOUSES MUST BE DIRECTED TOWARDS THE STREET R.O.W.
5. THE LOCATION AND SIZE OF THE PROPOSED PRIMARY AND RESERVE SEPTIC BEDS SHOWN ON THE DESIGN DRAWINGS ARE APPROXIMATE. THE DETAILED DESIGN AND FINAL SIZING OF THE SEPTIC BEDS SHALL BE THE RESPONSIBILITY OF THE HOUSE BUILDER. DURING THE BUILDING PERMIT PROCESS, ALL REQUIRED APPROVALS SHALL BE ACQUIRED AND A DETAILED LOT GRADING PLAN SHALL BE PROVIDED TO THE TOWNSHIP OF CAVAN MONAGHAN FOR REVIEW AND APPROVAL.







RAIN GARDEN SECTION
N.T.S.

LOW IMPACT DEVELOPMENT INFILTRATION SYSTEM NOTES

1. HEAVY EQUIPMENT AND TRAFFIC SHALL AVOID TRAVELING OVER THE FACILITIES TO PREVENT UNWANTED COMPACTION OF THE SOIL. IF HEAVY VEHICLE TRAFFIC ON THE LOT IS ANTICIPATED AFTER LID INSTALLATION, SIGNAGE INDICATING THE LOCATION OF THE PRACTICES AND STATING NO VEHICLE TRAFFIC IS TO BE ERECTED AFTER THE LID FEATURE IS INSTALLED.
2. THE LOT LEVEL LID RAIN GARDENS SHALL BE CONSTRUCTED ON A LOT BY LOT BASIS AND SHALL NOT BE CONSTRUCTED UNTIL THE AREA DRAINING TO THE PRACTICE IS STABILIZED AND VEGETATED. THIS IS TO PREVENT EXCESSIVE BUILD-UP OF CONSTRUCTION SEDIMENT WITHIN THE PRACTICE, WHICH WOULD LIMIT THE LONG TERM INFILTRATION POTENTIAL.
3. THE FACILITIES SHOULD BE EXCAVATED TO DESIGN DIMENSIONS USING AN EXCAVATOR AND THE BASE OF THE FACILITY SHOULD BE LEVEL OR NEARLY LEVEL.

NO.	REVISIONS	DATE	BY	APP'D
1.	REVISED GRADING AND SERVICING LAYOUT	16/08/24	JZ	JC

BENCHMARKS

BM 1 (U.T.M.) ELEV. 212.084 (CGVD2013)

Township: CAVAN - C.P.RY., BRIDGE OVER MILLBROOK-OMEMEE ROAD, 2.4 KM SOUTHWEST OF STATION AND 55.7 KM FROM HAVELOCK, BOLT IN SOUTHWEST CONCRETE ABUTMENT, SOUTHEAST END OF NORTHEAST FACE, 43 CM ABOVE BRIDGE SEAT.

STATION: 0011918U208G

TBM 1 ELEV. 280.26

NAIL ON NORTH FACE OF HYDRO POLE, 0.20m ABOVE GRADE, SOUTH OF SHARPE LINE, BETWEEN #903 AND 909.

TBM 2 ELEV. 279.53

NAIL ON SOUTH FACE OF HYDRO POLE, 0.20m ABOVE GRADE, AT SOUTHWEST CORNER OF #914 SHARPE LINE.

LEGEND

- PROPERTY LIMIT
- PHASE LIMIT
- NEW SANITARY SEWER
- NEW STORM SEWER
- NEW WATERMAIN
- PROPOSED DRAINAGE
- 100.00 PROPOSED LOT CORNER ELEVATION
- X 100.00 PROPOSED ELEVATION AT HOUSE
- 100.00 PROPOSED SWALE ELEVATION
- EXISTING DRAINAGE
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING WATERMAIN
- 100.00 EXISTING LOT CORNER ELEVATION
- *100.00 EXISTING ELEVATION TO REMAIN THE SAME

LICENSED PROFESSIONAL ENGINEER
J. D. CLARK
100226373
OCT. 15, 2024
PROVINCE OF ONTARIO

M.J. DAVENPORT
& ASSOCIATES LIMITED
P.O. BOX 2452 STN MAIN,
PETERBOROUGH, ONTARIO K9J 7Y8
TEL. : (705) 745-6676
FAX : (705) 745-7326

McCAMUS IDA SUBDIVISION

1910 COUNTY ROAD 19, HAMLET OF IDA
PART OF LOT 12, CONCESSION XI (CAVAN)
TOWNSHIP OF CAVAN MONAGHAN
COUNTY OF PETERBOROUGH

LOT GRADING PLAN

DESIGNED BY: J. CLARK	SCALE: 1 : 500
DRAWN BY: J. ZHOU	
DATE: AUGUST, 2023	DRWG. NO.: 6213-03
PROJECT NO.: 23-D-6213	

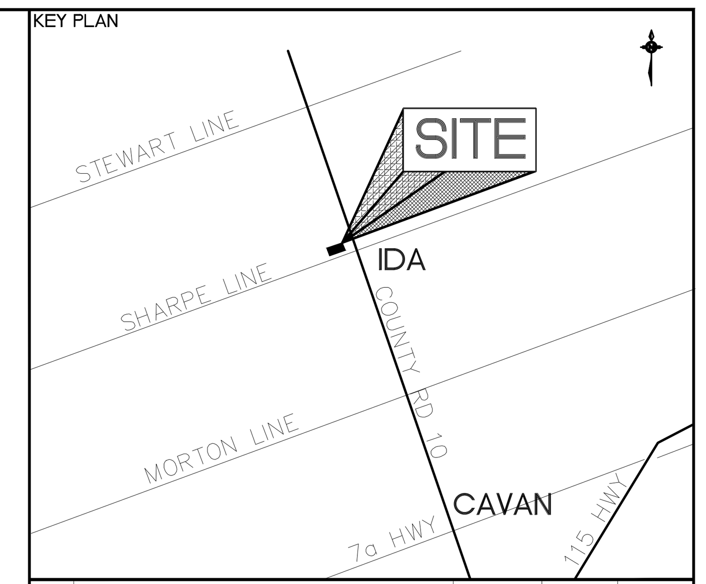
DUST CONTROL NOTES

1. UNPAVED ROADS AND TRAFFICKED ACCESS ROUTES SHALL HAVE WATER APPLIED AS NECESSARY AS A DUST SUPPRESSANT DURING NON-FREEZING CONDITIONS.
2. DURING MATERIAL HANDLING, MATERIAL SHALL BE DROPPED FROM THE SHORTEST POSSIBLE DISTANCE. IF MATERIAL IS ON THE GROUND, IT SHALL BE PUSHED UP WITH A LOADER WHEREVER POSSIBLE TO PREVENT MATERIAL FROM BEING DROPPED.
3. SHARPE LINE SHALL BE CLEANED AS REQUIRED UNTIL CONSTRUCTION IS COMPLETED.

NOTES:

1. PRIOR TO ANY EARTH MOVING, THE PROPOSED SILT FENCE SHALL BE ERECTED AS DETAILED ON THE EROSION AND SEDIMENT CONTROL DRAWING EC1.
2. ALL PROPOSED GRADING ON THE SITE SHALL BE MAXIMUM 3:1 SLOPE.
3. SILTFENCE SHALL BE ENVIROFENCE MANUFACTURED BY MIRAFI INC., AMOCO 13.80/2125 SILT STOP OR APPROVED EQUAL.
4. TEMPORARY EROSION CONTROL MEASURES SHALL BE MAINTAINED UNTIL CONSTRUCTION HAS BEEN COMPLETED AND BALANCE OF SITE VEGETATED AND STABILIZED.
5. TOPSOILING AND SEEDING OF ANY AREAS NOT SUBJECT TO ACTIVE CONSTRUCTION IS REQUIRED WITHIN 30 DAYS FOLLOWING SITE GRADING. ALL AREAS DISTURBED THAT ARE TO REMAIN TEMPORARILY EXPOSED (LESS THAN 30 DAYS) WITH NO ACTIVE CONSTRUCTION ARE TO BE SCARIFIED.
6. TOPSOIL PILES REMAINING IN PLACE LONGER THAN 30 DAYS SHALL BE SEEDED OR OTHERWISE STABILIZED TO PREVENT EROSION.
7. THE CONTRACTOR WILL ENSURE THAT EQUIPMENT ACTIVITIES SUCH AS STORAGE, MAINTENANCE, REFUELING AND SIMILAR ACTIVITIES OCCUR A MINIMUM OF 15 METRES AWAY FROM ANY WATER FEATURE.
8. ALL WATER DISCHARGED DURING DEWATERING OPERATIONS MUST BE PUMPED DIRECTLY INTO AN APPROPRIATELY SIZED SEDIMENT BAG. THIS SEDIMENT BAG MUST BE LOCATED IN A VEGETATED AREA. THE DEWATERING DETAIL ON THIS SHEET TO BE FOLLOWED.
9. THE ON-SITE CONTRACTOR SHALL INSPECT SEDIMENT CONTROLS ON A WEEKLY BASIS AND AFTER EVERY RAINFALL EVENT DURING CONSTRUCTION. ANY NECESSARY REPAIRS AND CLEANOUTS SHALL BE DONE WITHIN 24 HOURS.
10. THE LOT LEVEL LID RAIN GARDENS SHALL BE CONSTRUCTED ON A LOT BY LOT BASIS AND SHALL NOT BE CONSTRUCTED UNTIL THE AREA DRAINING TO THE PRACTICE IS STABILIZED AND VEGETATED. THIS IS TO PREVENT EXCESSIVE BUILD-UP OF CONSTRUCTION SEDIMENT WITHIN THE PRACTICE, WHICH WOULD LIMIT THE LONG TERM INFILTRATION POTENTIAL.

KEY PLAN



NO.	REVISIONS	DATE	BY	APP'D
1.	REVISED GRADING AND SERVICING LAYOUT	16/08/24	JZ	JC

BENCHMARKS

BM 1 (U.T.M.) ELEV. 212.084 (CGVD2013)

Township: CAVAN - C.P.RY., BRIDGE OVER MILLBROOK-OMEMEE ROAD, 2.4 KM SOUTHWEST OF STATION AND 55.7 KM FROM HAVELOCK, BOLT IN SOUTHWEST CONCRETE ABUTMENT, SOUTHEAST END OF NORTHEAST FACE, 43 CM ABOVE BRIDGE SEAT.

STATION: 0011918U208G

TBM 1 ELEV. 280.26

NAIL ON NORTH FACE OF HYDRO POLE, 0.20m ABOVE GRADE, SOUTH OF SHARPE LINE, BETWEEN #903 AND 909.

TBM 2 ELEV. 279.53

NAIL ON SOUTH FACE OF HYDRO POLE, 0.20m ABOVE GRADE, AT SOUTHWEST CORNER OF #914 SHARPE LINE.

LEGEND

- PROPERTY LIMIT
- PHASE LIMIT
- NEW SANITARY SEWER
- NEW STORM SEWER
- NEW WATERMAIN
- PROPOSED DRAINAGE
- 100.00 PROPOSED LOT CORNER ELEVATION
- X 100.00 PROPOSED ELEVATION AT HOUSE
- 100.00 PROPOSED SWALE ELEVATION
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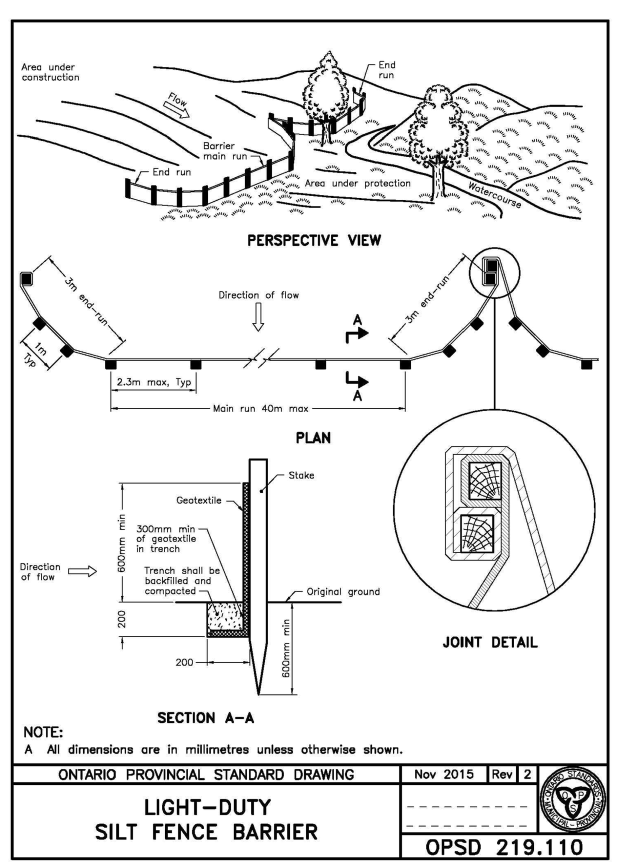
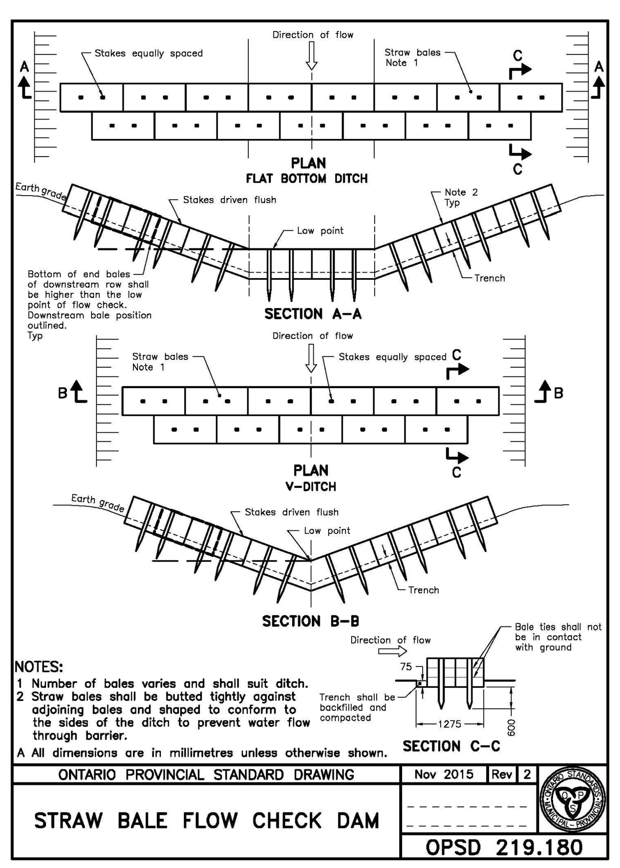
McCAMUS IDA SUBDIVISION

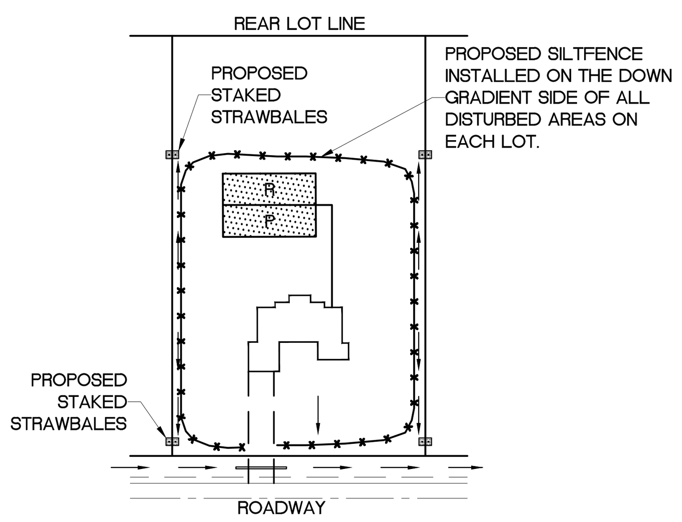
1910 COUNTY ROAD 19, HAMLET OF IDA
PART OF LOT 12, CONCESSION XI (CAVAN)
TOWNSHIP OF CAVAN MONAGHAN
COUNTY OF PETERBOROUGH

EROSION AND SEDIMENT CONTROL PLAN

DESIGNED BY: J. CLARK	SCALE: 1 : 500
DRAWN BY: J. ZHOU	
DATE: AUGUST, 2023	DRWG. NO.: 6213-EC1
PROJECT NO.: 23-D-6213	







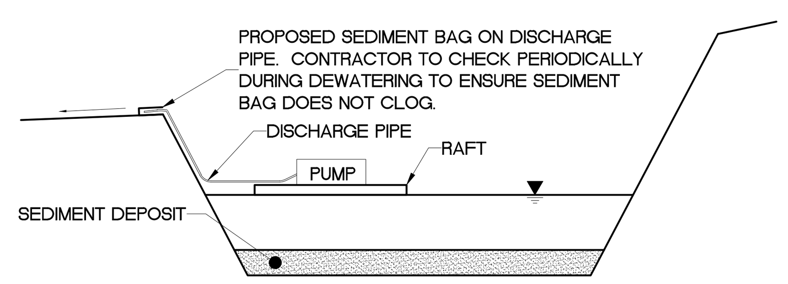
TYPICAL INDIVIDUAL LOT EROSION CONTROL

SCALE : NTS

NOTE:
EACH HOME BUILDER SHALL INSTALL SILTFENCE ON THE DOWN GRADIENT SIDE OF ALL DISTURBED AREAS ON THEIR CONSTRUCTION SITE SUFFICIENT TO CONTAIN SILT PRIOR TO THAT SURFACE WATER RUNOFF ENTERING WATERCOURSES AND DITCHES. STAKED STRAWBALES SHALL BE INSTALLED IN THE SWALES AT FRONT AND REAR OF LOTS.

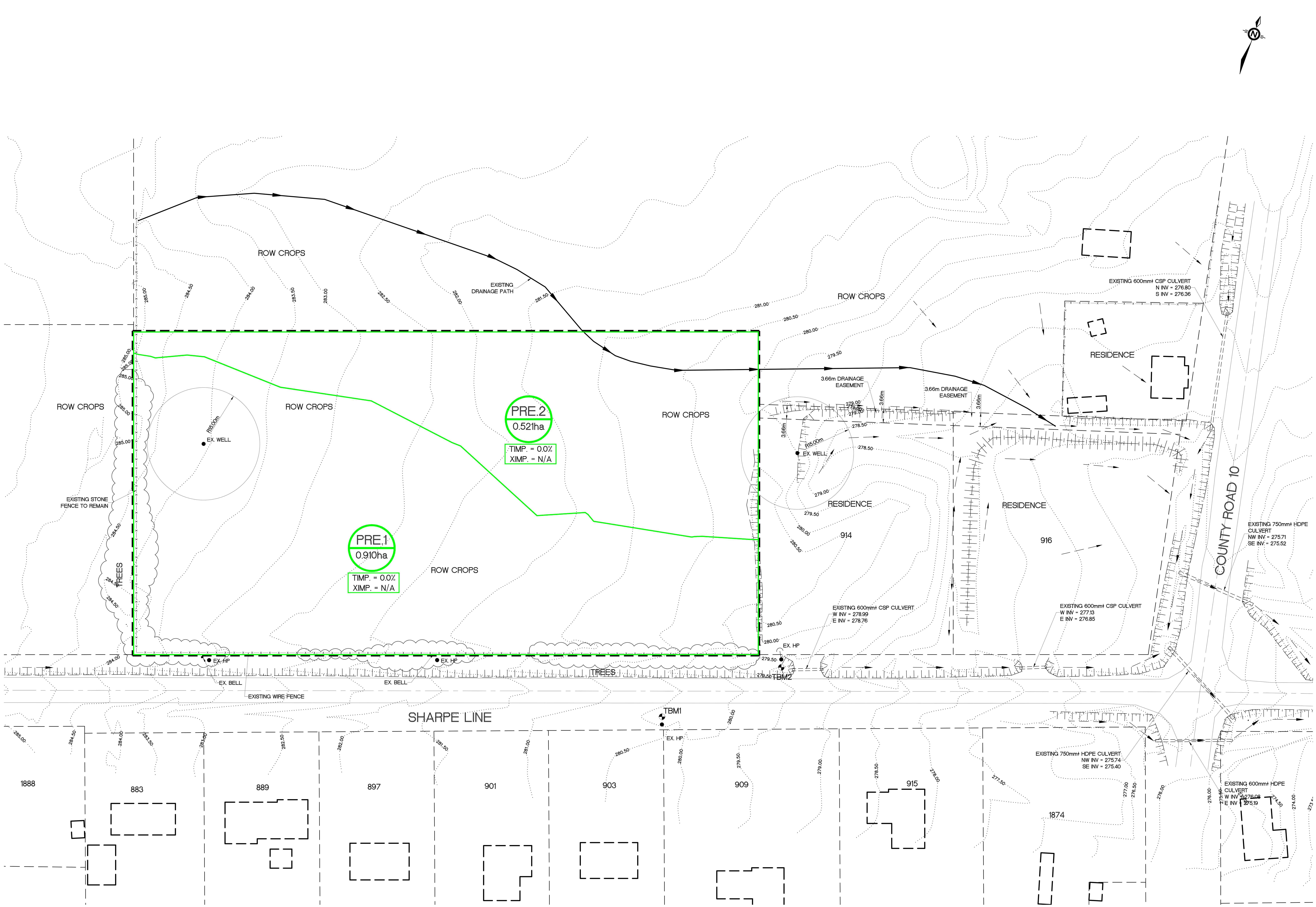
NOTE:

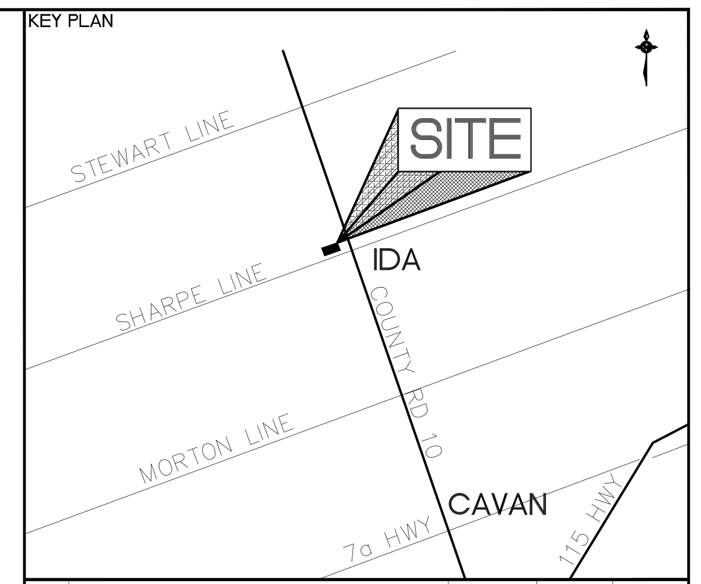
1. PROPOSED 2" PUMP SHALL BE PLACED ON A RAFT TO DRAW WATER FROM THE SURFACE. STANDARD 2" PUMP HAS A FLOW RATE OF 290 l/min.
2. US FABRICS 15'x15' FILTER BAG (OR APPROVED EQUIVALENT) MUST BE PLACED ON DISCHARGE PIPE OUTLET. CONTRACTOR TO ENSURE SEDIMENT BAG DOES NOT CLOG. SEDIMENT BAG HAS A MAXIMUM FLOW RATING OF 3,657 l/min/sm.



DEWATERING PLAN

SCALE: NTS





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LICENSED PROFESSIONAL ENGINEER
J. D. CLARK
100226373
OCT. 15, 2024
PROVINCE OF ONTARIO

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PRE-DEVELOPMENT WATERSHED AREAS

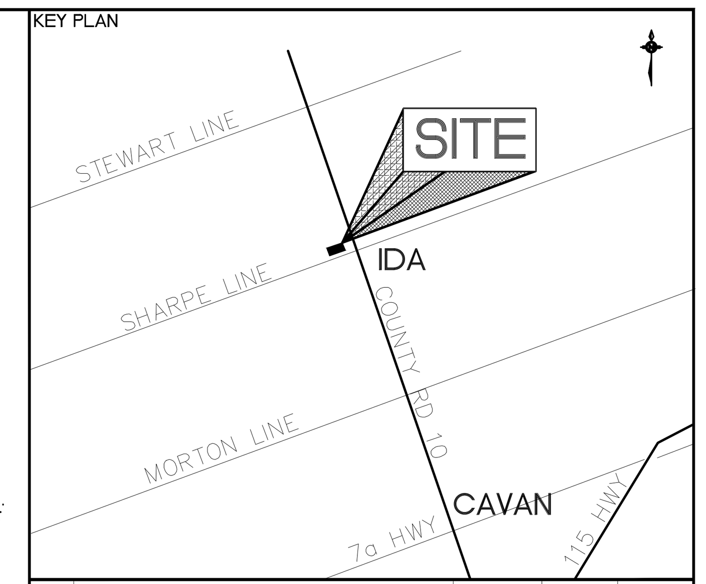
DESIGNED BY: J. CLARK	SCALE: 1 : 500
DRAWN BY: J. ZHOU	
DATE: AUGUST, 2023	DRWG. NO.: 6213-SW1
PROJECT NO.: 23-D-6213	

WATERSHED SOILS
1. OTONABEE LOAM (OI)
HYDROLOGIC SOIL GROUP B - WELL DRAINED

PRE-DEVELOPMENT SUBWATERSHED PRE.1 SUMMARY		
DESCRIPTION	AREA (m^2)	COVERAGE (%)
IMPERVIOUS AREA	0.00	0.00
GRASS LANDSCAPED AREA	0.00	0.00
ROW CROP AREA	5,215.42	100.00
WOODLOT/FOREST AREA	0.00	0.00
TOTAL	5,215.42	100.00

PRE-DEVELOPMENT SUBWATERSHED PRE.2 SUMMARY		
DESCRIPTION	AREA (m^2)	COVERAGE (%)
IMPERVIOUS AREA	0.00	0.00
GRASS LANDSCAPED AREA	0.00	0.00
ROW CROP AREA	9,109.61	100.00
WOODLOT/FOREST AREA	0.00	0.00
TOTAL	9,109.61	100.00

KEY PLAN



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POST-DEVELOPMENT WATERSHED AREAS

WATERSHED SOILS
1. OTONABEE LOAM (OI)
HYDROLOGIC SOIL GROUP B - WELL DRAINED

POST-DEVELOPMENT SUBWATERSHED AREA 1 SUMMARY		
DESCRIPTION	AREA (m^2)	COVERAGE (%)
IMPERVIOUS AREA	2,273.70	23.53
GRASS LANDSCAPED AREA	7,387.79	76.47
PASTURE/UNIMPROVED LAND	0.00	0.00
WOODLOT/FOREST AREA	0.00	0.00
TOTAL	9,661.49	100.00

POST-DEVELOPMENT SUBWATERSHED AREA 2 SUMMARY		
DESCRIPTION	AREA (m^2)	COVERAGE (%)
IMPERVIOUS AREA	188.00	4.03
GRASS LANDSCAPED AREA	4,475.53	95.97
PASTURE/UNIMPROVED LAND	0.00	0.00
WOODLOT/FOREST AREA	0.00	0.00
TOTAL	4,663.53	100.00

DESIGNED BY:	J. CLARK	SCALE:	1 : 500
DRAWN BY:	J. ZHOU		
DATE:	AUGUST, 2023	DRWG. NO.:	6213-SW2
PROJECT NO.:	23-D-6213		