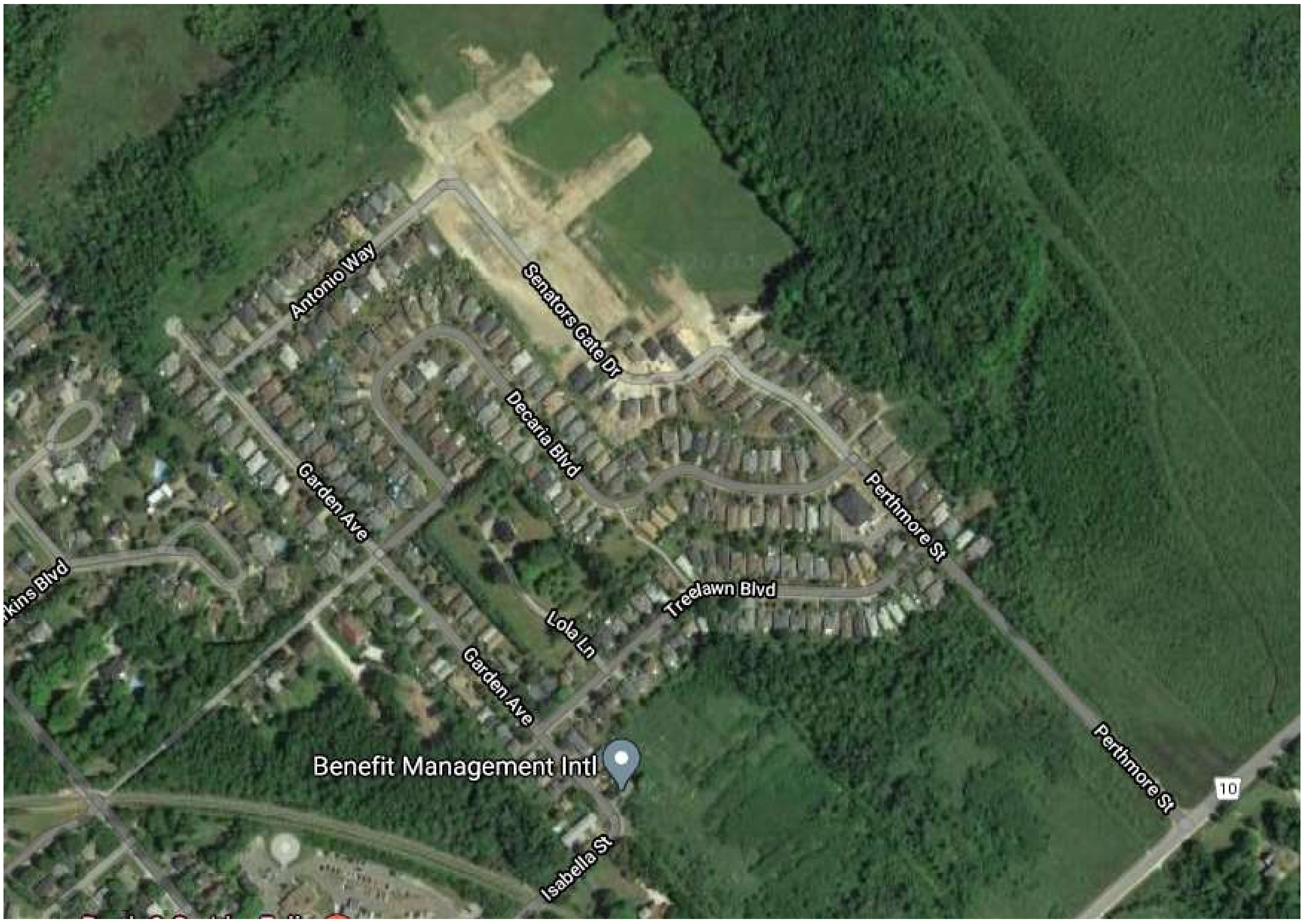
PRELIMINARY SERVICING AND STORMWATER MANAGEMENT REPORT
PERTHMORE SUBDIVISION - PHASE 6



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1.0 PROJECT DESCRIPTION

1.1 Purpose

McIntosh Perry (MP) has been retained by Perthmore Developments Co. to prepare this Preliminary Servicing and Stormwater Management Report in support of the Draft Plan of Subdivision Application for Phase 6 of the Perthmore Subdivision in Perth, Ontario.

The main purpose of this report is to present preliminary servicing options for the development in accordance with the recommendations and guidelines provided by the Ministry of the Environment, Conservation and Parks (MECP), Rideau Valley Conservation Authority (RVCA) and the Town of Perth (Town). This report will address the servicing for the entire development so that an overall servicing scheme can be presented, ensuring that existing and available services will adequately service the proposed development.

1.2 Site Description

The subject property is generally located within the northeastern quadrant of the Town of Perth and south of Provincial Highway 7. The property is legally described as Part of the northeast and southwest halves of Lot 3 and the southwest half of Lot 4, Concession 2, within the geographic Township of Drummond now in the Town of Perth and part of Block 15 registered plan 27M-21. This phase of development encompasses approximately 5.40 hectares and is bound by vacant land to the north and east, and by the existing phases of the subdivision immediately to the south and west. Refer to the Draft Plan of Subdivision in Appendix 'A' for more details.

The topography of the site varies with a ridge generally bisecting the property near the western limit and splitting the drainage in easterly and westerly directions. The elevation generally slopes off near the eastern limit at the proposed cul-de-sac of Street A. The land is generally overgrown with a variety of grass, shrubs and bush along with some trees located at the northeast portion of the site. At the time of writing of this report, portions of the property have been cleared or are in the process of being cleared.

Phase 6 is made up of 53 lots with 35 single family homes, 36 semi-detached units (18 lots) and 1 apartment block with 14 units. There is also approximately 725 meters of associated municipal roadway and municipal services. The Town and the RVCA will be reviewing and approving this report as part of the Draft Plan of Subdivision Application.

2.0 BACKGROUND INFORMATION

Background studies that have been completed for the site include review of as-built drawings, a topographical survey of the site, along with servicing and stormwater reports from previous phases of the development.

Various as-built drawings, design drawings and design calculations for the existing subdivision services were reviewed in order to determine proper servicing schemes for the site.

A topographic survey of the site was completed by MPSI dated August, 2020 and can be found under separate cover.

The following reports have previously been completed and are available under separate cover:

- Drainage Design Report – Perthmore Subdivision Phase 3 prepared by McIntosh Hill dated March 1998.
- Sanitary Sewer Report – Perthmore Subdivision Phase 3 prepared by McIntosh Hill dated February 1998.
- Stormwater Management Report – Perthmore Subdivision Phase 4 prepared by McIntosh Perry dated September 12, 2002
- Preliminary Stormwater Management Report – Perthmore Subdivision Phase 5 prepared by McIntosh Perry dated February 17, 2004

3.0 EXISTING SERVICES

Phase 6 of the Perthmore Subdivision will be serviced partially via existing services and infrastructure within the existing phases of the development. Newly proposed storm sewers and an associated stormwater management facility will provide storm service for the project.

Existing services within Senators Gate Drive include a 200mm sanitary sewer, a 200mm watermain and a 450mm storm sewer. Existing services within Perthmore Street include a 200mm sanitary sewer, a 300mm watermain and a 525mm storm sewer. Stubs have been left at the intersection of Senators Gate Drive and Perthmore Street. There are stubs extending in both the northeast and northwest directions. Stubs have also been left at the intersection of Senators Gate Drive and Street B. The storm sewer at this intersection is a 300mm and the sanitary and water are both 200mm in diameter.

A newly proposed stormwater management pond will be constructed to service Phase 6. Previous discussions of reconstructing the Phase 5 pond have been eliminated due to sizing constraints that push the pond too close to the existing wetland. The proposed facility is located well outside of the wetland setback.

Gas, hydro, cable and telephone utilities are available nearby and locations will be confirmed from respective utility companies during detailed design process.

4.0 SERVICING PLAN

4.1 Proposed Servicing Overview

The overall servicing of Phase 6 of the subdivision will be accomplished through multiple connections to the existing stubs as detailed below. See below for more details pertaining to each specific service.

4.2 Watermain Design

Water servicing for the proposed development will be accomplished through connections at three locations: to the existing 200mm stub at the intersection of Senators Gate Drive and Street A and to the existing 300mm and 200mm stubs at the intersection of Senators Gate Drive and Perthmore Street. The watermain will be 200mm in diameter throughout Phase 6. Flow control valves will be installed as required. See *Drawing 100 – General Plan of Services* for details pertaining to the layout of the watermain.

Fire hydrants will be located on-site as required. The fire hydrants will be spaced 90m to 180m apart in order to meet municipal firefighting requirements. The fire hydrants will be owned and operated by the Town. Individual water services will be installed and will be Pex conforming to AWWA C904. Curb stops will be installed on all water services on the property line, away from driveways and any aboveground utilities. All watermains and associated structures will be designed and constructed per the design criteria detailed in the Design Guidelines for Drinking-Water Systems 2008 by the MECP and constructed per the Ontario Provincial Standard Details (OPSD's).

The watermain is designed to have a minimum of 2.4m cover and when crossing over or under utilities the watermain will have a minimum 0.3m clearance. A minimum horizontal separation of 2.5m (from pipe wall to pipe wall) will be maintained between the proposed watermain and storm/sanitary mains.

Water demands have been calculated per MECP Design Guidelines for Drinking-Water Systems 2008. The population for Phase 6 is calculated as 241.4 people creating the following demands:

- Average Day Flow = 46.94 L/min
- Max. Day Flow = 129.08 L/min
- Peak Hourly Flow = 193.86 L/min

Water demands which account for the anticipated population from the future development areas have also been completed using a population of 554.6 people creating the following demands:

- Average Day Flow = 110.52 L/min
- Max. Day Flow = 303.94 L/min
- Peak Hourly Flow = 456.46 L/min

See *Water Demands Sheets 1 and 2* in Appendix 'B' of this report for more details.

Prior to connecting to the municipal water distribution system, it is essential to determine whether the system has adequate capacity and that the overall impact to the existing system is minimal. A WaterCAD model will be generated at the detailed design stage to confirm the capacity, pressure and size of pipes required to service the proposed site.

4.3 Sanitary Sewer Design

The sanitary sewers for the proposed development will flow by gravity to the existing sanitary sewers. Sanitary connections will be made to the stubs at the intersection of Senators Gate Drive and Perthmore Street. See *Drawing 100 – General Plan of Services* for details pertaining to the layout of the sanitary sewers.

The sanitary sewers within the new phase of development are 200mm diameter will be installed throughout with a minimum full flow target velocity (cleansing velocity) of 0.6 m/s and a full flow velocity of not more than 3.0 m/s. All sewers and associated structures will be designed and constructed per the design criteria detailed in the Design Guidelines for Sewage Works 2008 by the MECP and constructed per the Ontario Provincial Standard Details (OPSD's).

Design parameters for Phase 6 include an extraneous infiltration rate of 0.33 L/s/ha. Daily per capita flow rates of 280 L/p/d and residential densities of 3.4 persons per single unit, 2.7 persons per semi-detached units, 1.8 persons per apartment unit and 60 persons per net hectare of futured development blocks were used in the design of this development. The residential peaking factor used is based on the Harmon Equation, with a maximum of 4.0 and a minimum of 2.0.

Phase 6 of the subdivision has been accounted for in the design of sanitary sewers of previous phases. As noted above the new phase of the subdivision will have multiple sanitary outlets. Ultimately the flows will be directed towards the Treelawn Boulevard and to Garden Avenue sewer outlets. Within the *Perthmore Development Phase III – Sanitary Sewer Report*, dated February 1998 by McIntosh Hill, the Treelawn Boulevard and Garden Avenue Sewers have been sized to accommodate the full buildout of the Perthmore Subdivision.

It was assumed the total number of lots being serviced by the Treelawn Boulevard sewer would be 258 lots with a total flow of 17.6 L/s for the full build-out of the development. According to the previous report, the existing 200mm sanitary sewer within Treelawn Boulevard is sloped at 0.40%, therefore the total capacity of the pipe is approximately 21.6 L/s. Phase 6 of the development will generate a total flow of 5.8 L/s to be captured by the Treelawn Boulevard sanitary sewer. This also includes the future Blocks, which have been accounted for as high-density residential developments. Service easements will be implemented as required to adequately service the future Blocks.

See *Sanitary Sewer Design Sheet* and *PP-13-9668-01 – Sanitary Drainage Areas - SAN* in Appendix 'C' of this report for more details.

4.4 Storm Sewer Design

Stormwater runoff will be conveyed through curb and gutter and rear-yard swale networks towards catch basins, where it will be captured and conveyed into the new storm sewer network. The storm sewers are designed with a minimum of 1.5m cover. The storm sewer network within the subdivision is designed to accommodate a storm event with a 5-year return period. Storms in excess of this event will result in surcharging at catch basin and road sag locations. Stormwater runoff during these major events will be conveyed via overland flow routes within rear-yard swales and along the roadway, as is typical in subdivisions of this nature. A detailed lot grading and drainage plan will prepared during the detailed design stage outlining the proposed drainage pattern within the subdivision.

The storm sewers within Phase 6 will flow via gravity to a newly proposed stormwater management facility located to the south of the Street A cul-de-sac at the eastern boundary of the property. Storm sewers stubs will be provided in support of the future medium/high-density residential development areas which have been detailed in Section 5.5. Future development areas will require additional design to be carried out during their respective designs. See Drawing 100 – General Plan of Services for details pertaining to the layout of the storm sewers.

The storm sewers within this phase of development range in diameter from 250mm to 900mm and are designed with a minimum full flow target velocity (cleansing velocity) of 0.8 m/s (cleansing velocity) and a full flow velocity of not more than 3.0 m/s. No storm sewer will have a slope less than 0.1%. Appropriately sized maintenance holes will be installed at every change in pipe size or direction and will be spaced no more than 120m apart in order to facilitate cleaning and maintenance. All sewers and associated structures will be designed and constructed per the design criteria detailed in the Design Guidelines for Sewage Works 2008 by the MECP and constructed per the Ontario Provincial Standard Details (OPSD's).

A preliminary storm sewer design sheet was created using the rational method, which allows for the proper sizing of the storm pipes within the development. Drainage area information, along with respective pipe slopes and other necessary information was utilized to evaluate the performance of the storm sewer network. The time of concentration calculated for the storm sewer system is based on a 20-minute inlet time. Rainfall intensities were obtained from Intensity-Duration-Frequency (IDF) curves for the Town of Perth from the Ministry of Transportation (MTO).

The preliminary storm sewer design sheet identifies the 5-year flow that is conveyed through each pipe section of the storm sewer network. The peak flow and peak velocity are the maximum results based on gravity flow. Included in the sheet is the full flow capacity of the pipe and the associated full flow velocity when the pipe is under gravity flow condition. The peak flow was checked against the full flow capacity to ensure that each storm sewer pipe can convey the 5-year flow unrestricted.

The proposed storm sewer layout and approach is further detailed in Section 5.0 *Proposed Stormwater Management.*

See *Storm Sewer Design Sheet* and *PP-13-9668-01 - Storm Drainage Areas - STM* in Appendix 'D' of this report for more details regarding pipe sizing.

4.5 Site Utilities

All relevant utility companies will be contacted prior to construction in order to confirm adequate utility servicing for the site. Existing utilities are present in prior phases of the development and will be extended to provide service for this phase.

4.6 Service Locations/Cover

The minimum cover for the sanitary, storm and water mains will be as follows:

Service	Minimum Cover
Sanitary Sewer	1.8m
Storm Sewer	1.5m
Watermain	2.4m

All minimum cover requirements are as per municipal standards. Separation distances between the storm, water and sanitary will be maintained as per the MECP requirements.

5.0 PROPOSED STORMWATER MANAGEMENT

5.1 Design Criteria and Methodology

In the absence of a subwatershed plan for this area, the MECP *Stormwater Management Planning and Design Manual* (March 2003) is used to govern the management of stormwater. This methodology promotes stormwater management from an environmentally sustainable perspective. The intent of the stormwater management plan is to provide adequate stormwater treatment for both quantity and quality control.

Stormwater Best Management Practices (BMPs) will be implemented at the "lot level" and "conveyance" locations. These concepts are explained further in Section 5.7.1. To summarize, roof water will be directed to grass surfaces that in turn will be collected in grassed swales or in rear yard/roadway catchbasins prior to entering into the proposed storm sewer network.

An existing stormwater management (SWM) pond is located on the northeast side of Perthmore Street as shown on Figure 1, below. As part of development of this subsequent phase, this SWM facility will remain intact and a standalone SWM pond will be constructed to address the water quality and quantity control requirements for this tributary drainage area.

5.2 Runoff Calculations

As the existing stormwater pond will continue to serve Phase 5, this new phase will look to direct all runoff towards an end of pipe facility. The ultimate outlet for this site will remain consistent in being the Perth Long Swamp, however, as previous submissions included the reconstruction of the existing Phase 5 pond, the total surficial area required to facilitate a SWM facility to adequately handle that volume of runoff was so large, it was required to expand towards the wetland boundary, which was deemed unacceptable to the RVCA. The new strategy will see a pond located outside of the wetland boundary, with the capabilities of handling this Phase in isolation.

A Visual OTTHMO Version 5 (VO5) model was assembled for the analysis. The VO5 hydrologic model requires various measured and calculated input parameters. The calculations of these input parameters area detailed below.

5.3 Pre-Development Parameters

5.3.1 General

Since the pre-development land use was rural, the NASHYD command was employed in the VO5 model to calculate the runoff flows. NASHYD is used to simulate runoff flows with NASH instantaneous unit hydrograph. This hydrograph is made of a cascade of "n" linear reservoirs. The n (number of linear reservoirs) parameter was set at 3, in the model, and the rainfall losses were computed by the SCS CN procedure.

5.3.2 Time of Concentration/Time to Peak

The Time of Concentration (Tc), for the pre-development drainage basins, was calculated using the Airport Formula.

$$T_c = 3.26 * (1.1 - C) * L^{0.5} * S_w^{-0.33}$$

Where:

Tc = time of concentration in minutes
C = runoff coefficient
L = watershed length in metres
S_w = watershed slope in percentage

From the Tc value, the Time to Peak (Tp) value was calculated as 0.67 times Tc. The parameters employed in the calculation of Tc and Tp for the single drainage basins is shown in Table 1.

Table 1 – Time to Peak

Sub-Catchment	Area	Flow Length	Fall	Slope	Tc[1]	Tp[2]
	ha	m	m	%	min	hrs
Area 1	12.20	435	7	1.61	54.6	0.61

Notes: 1 – Airport Formula
2 – 0.67*Tc

5.3.3 SCS Curve Number

The Curve Number (CN) is the most important parameter in determining surface runoff when the SCS equation is used. Table 2 shows the parameters and the resulting CN value for Area 1.

Table 2 – Curve Number

Sub-Catchment	Land Use / Soil Type	Land Use / Soil Type	Land Use / Soil Type	Land Use / Soil Type	Runoff	CN^2	Ia
	Pasture B (ha)	Pasture C (ha)	Forest B (ha)	Forest C (ha)	$Coefficient^1$	(AMC II)	mm
Area 1	5.45	1.76	1.56	3.20	0.16	64.0	6.9

Notes: 1 – MTO Drainage Management Manual – Design Chart 1.07, 2 - MTO Drainage Management Manual – Design Chart 1.09

5.3.4 Rainfall

For the rainfall input to the VO5 model, the 12 hour SCS rainfall distribution, representing a high volume lower intensity storm, and a 4 hour Chicago rainfall distribution, representing a high intensity “thunder storm” type of rainfall event were used ion the analysis. The Intensity-Duration-Frequency (IDF) curve was obtained from the Ministry of Transportation (MTO) IDF Curve Lookup tool with the location centred over the property.

5.4 Pre-Development Results

Employing the above noted parameters and the VO5 hydrologic model, Table 3 shows the calculated pre-development flow values for the 12-hour SCS and 4-hour Chicago rainfall hyetographs. These flow values will be used for the water quantity control assessment of the proposed SWM facility.

Table 3 – Pre-Development Calculated Flows (Area 1)

Return Period (Yrs)	12 hour SCS (m^3/s)	4 hour Chicago (m^3/s)
2	0.11	0.05
5	0.21	0.11
10	0.28	0.15
25	0.38	0.21
50	0.46	0.26
100	0.56	0.32

5.5 Post-Development Drainage

When reviewing the now proposed stormwater management strategy, the end of pipe SWM facility will capture all runoff from this phase of the development and be independent of the previous SWM pond. The proposed drainage plan will see stormwater from future medium and high-density areas accounted for which will require their own site-specific stormwater management design, as the development of those blocks undergoes site plan control. Runoff from these controlled areas will still be directed to the ponds and therefore, undergo a further reduction of peak flow rates. These areas have been broken down into three distinct areas given the location of current proposed and future roadway connections.

They are labelled:

- **West Block,** located at the west portion of the site along the rear of Lots 49 to 53 (includes Block 54);
- **Central Block,** located at the north central portion of the site along the rear of Lots 38 to 48; and
- **East Block,** located at the northeastern portion of the site along the rear of Lots 34 to 37.

5.5.1 Post-Development Parameters

For the post-development hydrologic analysis, since the proposed development is fully urban with full municipal services, the STANHYD command was used in the VO5 model. Table 4 shows the post-development input parameters for the VO5 model. The three blocks (West, Central and East) are slated for high density residential development and therefore the total imperviousness and directly connected parameters were set accordingly. The previous phases and the remaining sub-catchments, in the proposed additional phase, are slated or have been constructed as single-family residential development. The total imperviousness and directly connected parameters were calculated based on a typical lot in the existing development area. The flow lengths for the pervious area were assumed to be 10 m and the flow lengths for the impervious area were calculated by the standard equation in the VO5 model as shown in the notes below the table. Lastly, the slopes used in the model for pervious and impervious areas were assumed to be 2.0% and 1.0% respectively.

Table 4 – Post-Development Hydrologic Model Parameters

					Pervious Area				Impervious Area			
Sub-Catchment	Area	Total Imp.	Directly Connected	CN	Slope	Flow Length	Manning n	Ia	Slope	Flow Length[1]	Manning n	Depression Storage
	ha	%	%		%	m		mm	%			mm
West Block [4]	3.43	70.0	60.0	59.0	2.0	10.0	0.25	5.0	1.0	150.0	151.2	0.013
Central Block[4]	1.56	70.0	60.0	59.0	2.0	10.0	0.25	5.0	1.0	150.0	102.0	0.013
East Block [4]	0.65	70.0	60.0	75.0	2.0	10.0	0.25	5.0	1.0	100.0	65.8	0.013
Block 70	0.83	0.0	0.0	75.0	2.0	10.0	0.25	10.0	1.0	75.0	74.4	0.013
SWM Block[2,4]	0.41	0.0	0.0	75.0	2.0	10.0	0.25	5.0	1.0	50.0	52.3	0.013
Developed Portions[3,4]	5.32	50.0	35.0	59.0	2.0	10.0	0.25	5.0	1.0	350.0	188.3	0.013

Notes: 1 - Flow Length = SquareRoot (Area/1.5) - (Area in square metres), 2 – Block 71, 3 - 604(1) - 0.56ha, 604(2) - 0.23ha, 606 - 1.07ha, 608 - 0.79ha, 609 - 0.16ha, 612 - 1.21ha, 614 - 0.25ha, 617 - 0.48ha, RY1 - 0.32ha and RY2 - 0.25ha, 4 – To Pond

5.6 Quantity Control

The quantity control for the site will mainly be provided by the reconstructed end of pipe facility. For the three future Blocks the hydrologic modelling assumes that the peak flows, up to and including the 100-year storm event, from the blocks are controlled through the use of on-site detention storage. The preliminary calculation of the required on-site detention storage is 1,100 m^3 for the West Block, 500 m^3 for the Central Block and 170 m^3 for the East Block. The imperviousness value for the SWM block was assumed to be high, since and rainfall on the block would be converted to direct runoff.

Tables 5 and 6 show the calculated post-development (uncontrolled) and controlled flow values outletting from the proposed SWM facility. As the 12hr SCS storm resulted in higher outflows and more storage requirements, the results are shown below, however, the 4-year Chicago storm data can be found in Appendix F. To provide the quantity control as shown in the tables would require a total of 2,733 m^3 of detention storage. Further details of the SWM facility are available within Appendix F, which were used to ensure the conceptual pond met all MECP design criteria. Further pond details will be developed and confirmed during detailed design.

Table 5 – Post-Development Calculated Flows – Uncontrolled

12 hour SCS Uncontrolled								
Return Period	West Block	Central Block	East Block	Block 70	Swm Block	Developed Portions	Total	Pre-dev
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.215	0.17	0.08	0.02	0.01	0.18	0.68	0.11
5	0.306	0.23	0.11	0.04	0.02	0.28	0.99	0.21
10	0.384	0.27	0.13	0.06	0.03	0.36	1.23	0.28
25	0.481	0.34	0.16	0.08	0.04	0.45	1.54	0.38
50	0.551	0.38	0.18	0.09	0.04	0.54	1.79	0.46
100	0.634	0.44	0.20	0.11	0.05	0.63	2.06	0.56

Table 6 – Post-Development Calculated Flows – Controlled

12 hour SCS Controlled									
Return Period	West Block [1]	Central Block [1]	East Block [1]	Block 70	Swm Block	Developed Portions	Outflow From Pond	Outflow From Site	Pre-dev
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.03	0.05	0.08	0.02	0.01	0.18	0.04	0.04	0.11
5	0.04	0.06	0.11	0.04	0.02	0.28	0.11	0.11	0.21
10	0.05	0.07	0.13	0.06	0.03	0.36	0.16	0.17	0.28
25	0.06	0.09	0.16	0.08	0.04	0.45	0.24	0.25	0.38
50	0.07	0.10	0.18	0.09	0.04	0.54	0.29	0.30	0.46
100	0.08	0.12	0.20	0.11	0.05	0.63	0.33	0.35	0.56

5.6.1 Major Drainage Route

The pipe network within the subdivision will be designed to accommodate the 5-year storm. Storm events greater that 5-year will make use the roadway as the major drainage route and this will be incorporated into the grading plan design. The roadway will direct these flows to the proposed SWM pond. Rear yard drainage swales and easements will be incorporated to provide additional overflow capacity.

5.7 Quality Control

Water quality control will be provided by the reconstructed SWM facility. The facility will be designed as a wet pond to provide an enhanced level of water quality control (80% T.S.S. removal). Table 3.2 in the *Stormwater Management Planning and Design Manual* was used to calculate the required storage volume. The weighted impervious level for the total tributary drainage area is 46%. Therefore, interpreting between the specific storage volumes shown in Table 3.2, a total 165 m^3/ha of storage volume is required to provide an enhanced level of treatment. Given the upstream individual storage requirements for West, Central and East Blocks, which make up almost half of the site's catchment, the MECP Manual notes (Section 3.3.2) that when upstream storage facilities exist, the extended detention can be increased from 40m^3/ha to 80m^3/ha to ensure that the flooding of downstream ponds does not occur. This increase to the extended detention reduces the permanent pool volume, as the majority of the runoff reaching the site has already achieved the 80% TSS removal from the upstream facilities. With that, the permanent pool for this site is required to be 966 m^3 with an extended detention volume (458 m^3) can be combined with the water quantity volume detailed.

Therefore, the total storage volume required for the proposed SWM facility would be approximately 3,700 m^3. As noted, conceptual pond details are included in Appendix F, which include forebay calculations, 25mm event and extended detention drawdown, pond cleanout, emergency spillway, outlet control device sizing and stage storage discharge tables that were used in modelling the site in VO5. All these features meet MECP requirements and will be further vetted and refined through the detailed design.

It should be noted, while not specifically included for quality control, through the need to meet the water balance criteria, the site will employ mitigation measures, mainly infiltration trenches to ensure that the site is able to meet its infiltration targets. While these features will not be designed for the 25mm storm (quality storm), their presence will further provide another step in the treatment train approach for achieving the quality control requirements for the site.

5.7.1 Best Management Practices

The entire subdivision will employ Best Management Practices (BMPs) wherever possible. The intent of implementing stormwater BMPs throughout the entire development is to ensure that water quality and quantity concerns are addressed at all stages of the development. Stormwater BMPs will be implemented at lot, conveyance and end of pipe levels.

Lot level BMPs include the directing of roof leaders onto grassed areas, minimizing ground slopes and maintaining as much of the lot as possible in a natural state. Roof leaders will flow to grass areas, which will provide an opportunity for initial filtration of any sediment and provide an opportunity for absorption and ground water recharge. Recent recommendations by a number of Conservation Authorities and the MECP suggest that yard grading as flat as 0.5% be implemented to promote infiltration. The target range for finished ground slopes will be 1% - 5% where possible. This range of slope will still provide an opportunity for the absorption and filtration process.

The conveyance system to be employed within the subdivision is a combination of side/rear swales and road catchbasins. All swales will be constructed at minimal gradient where possible, thus promoting absorption and infiltration, as well as providing some opportunity for particle filtration. The gradient of the system will be enough to ensure the continuous flow of stormwater, limiting any standing water. Rip-rap will be placed at erosion-prone areas and all disturbed areas shall be landscaped as soon as possible.

6.0 WATER BALANCE – FEATURES

6.1 Purpose

The RVCA through their review comments have requested that a water balance be reviewed for the site to ensure that the site did not reduce the overall infiltration volumes given that this area is a sensitive groundwater aquifer. As such, the following provides a review of the conceptual water balance, complete with mitigation measures for the site which were reviewed and broken into the requirements for the developed portion of the land as well as the individual blocks to provide guidance to the designers when they proceed through their site plan control process.

6.2 Land Use

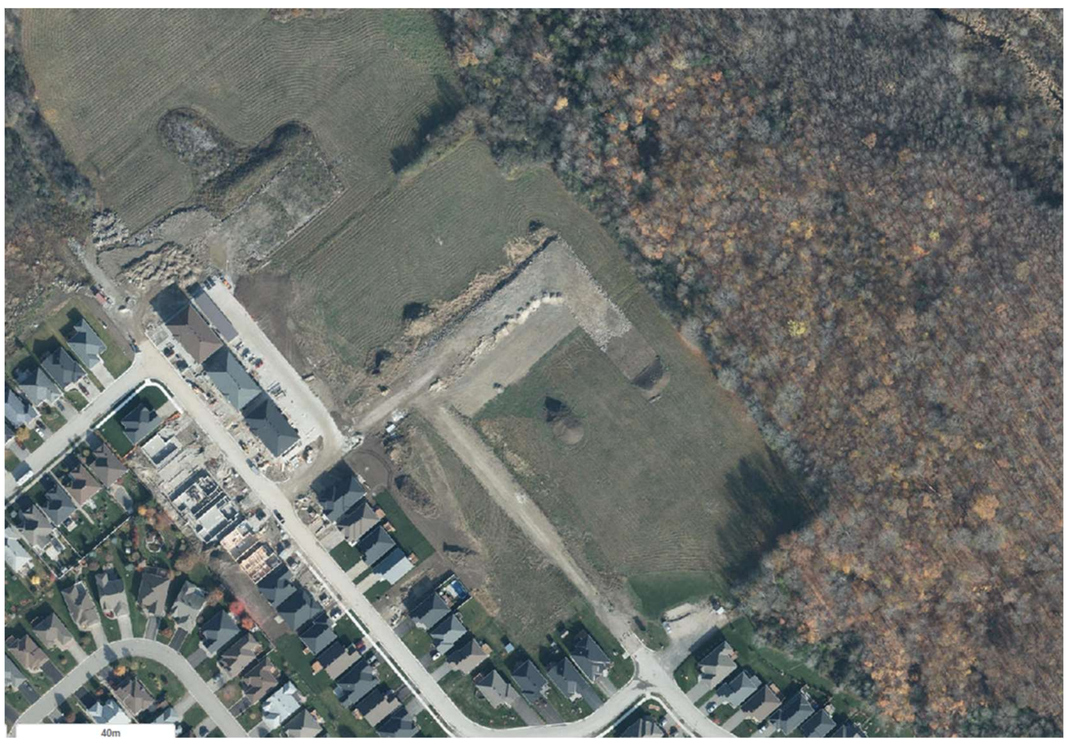

Figure 1 - Land Use

The current vacant land is predominantly a mixture of pasture sections (generally the western, southern and central portions of this phase) and treed areas (generally the northern and eastern extremities of this phase). Perthmore subdivision is directly adjacent to the Perth Long Swamp wetland which surrounds the site to the north, east and west. It is acknowledged that the Provincially Significant Wetlands are a significant natural heritage feature therefore, tree removal and other disturbances will be limited as much as possible. The entire undeveloped site is sloped toward the above-noted wetland. Elevations range from 134 m at the northeast corner of the site to 141 m at the highpoint of the property.

6.3 Soil Conditions

A detailed Geotechnical Report is not available at the conceptual design stage. Therefore, MP used the publicly available documents on AgMaps to review the soils for the site. The area is primarily comprised of Hydrological Soil Group B and C soils through the developed portion of land. The surrounding wetland is Hydrological Soils Group D. Based on the previous phase, McIntosh Perry has assumed that here is approximately 2’ or 0.6m of soil overlaying bedrock. This relatively thin soils has been accounted for within the calculations to determine the soil moisture retention capacities of the soils. It is anticipated that during the detailed design stage, a geotechnical report will be completed at which time, these values can be updated if required.

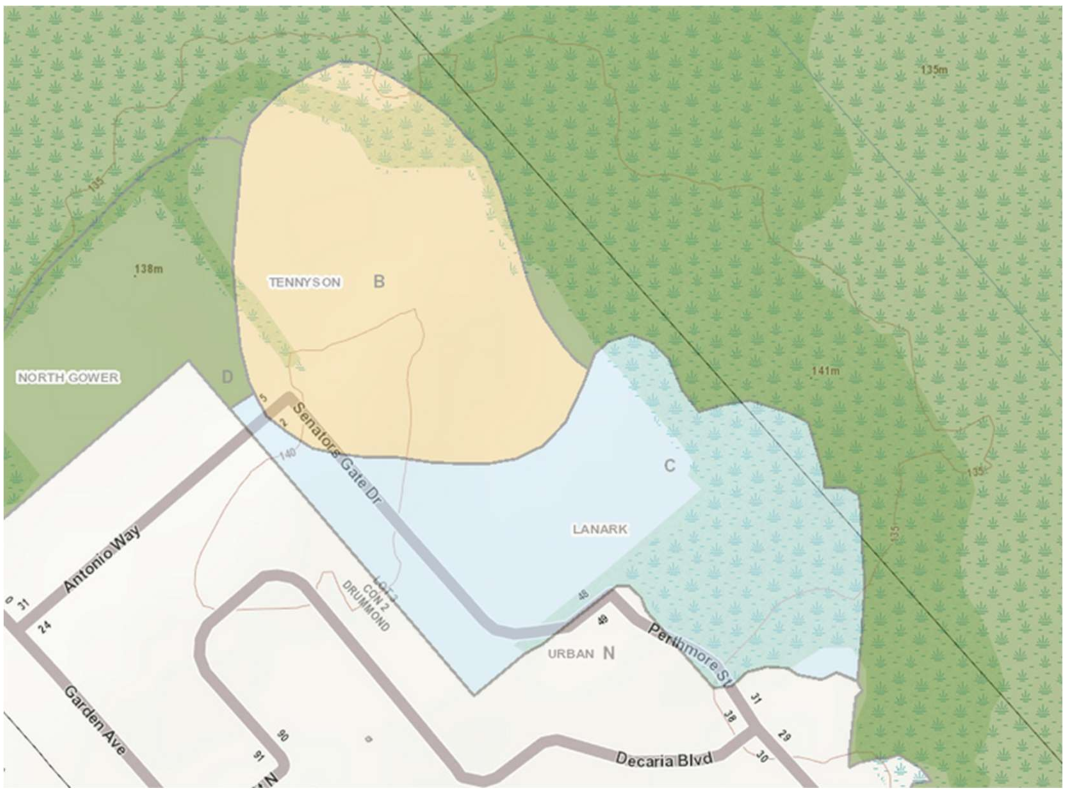

Figure 2 - AgMaps - Site Soils

6.4 Topographic Maps

Topographic maps (pre- and post-development drainage plan) have been included in Appendix F, which confirm and illustrate the existing drainage patterns on site as well as the existing soils including their classifications. As detailed grading has not been advanced, it is anticipated that slopes will remain relatedly low, consistent with the previous phases.

6.5 Grading Plan

The proposed Conceptual Grading Plan has been included in Appendix G, which illustrates the proposed lot fabric, and road network within the development. Based on the enclosed, several blocks remain which will require site plan control in order to develop. These specific blocks form approximately half of the site area and will require site specific stormwater management and water balance criteria in order to be in place prior to development.

The proposed residential development will be disconnected from the previous phases as it relates to the stormwater management, grading and drainage. No previous phased works are anticipated to flow into the pond or into this phase of the site. As such, the flow from the road network, dwellings and lots will flow to a stormwater management pond which will be controlled to pre-development peak flow rate levels in addition to the mitigation measures to meet the water balance controls described herein. Through a combination of infiltration trenches, rear yard grass swales and the end of pipe facility, the development is anticipated to exceed the quality control requirements prior to discharging runoff into the adjacent wetland.

6.6 Stormwater Management Design

As part of this assignment and to satisfy both RVCA and the Town, a servicing and stormwater management report has been prepared to ensure that the design criteria from both review agencies along with recommendations from the MNRF, MTO and MECP are adhered to. Site-specific stormwater management facilities will be located in the three future high-density Blocks, which will be required to meet site-specific stormwater management criteria in order to be developed. The combination of these facilities, the mitigation measures that will be discussed below and the ultimate end of pipe facility, will ensure that runoff reaching the wetland is controlled to pre-development rates and meets an **enhanced** level of quality control (80% Total Suspended Solids (TSS) removal).

6.7 Erosion And Sediment Control

The proposed development will implement on-site temporary and permanent means to manage erosion and sediment control. A detailed Sediment and Erosion Control Plan will be prepared by McIntosh Perry during the detailed design stage.

7.0 WATER BALANCE - CALCULATIONS

7.1 Data

Potential impacts to the existing wetland were reviewed through the use of standard water balance calculations. Data from Environment Canada for the Ottawa International Airport was used to calculate the runoff surplus and total precipitation for the site. Environment Canada data was limited to the precipitation and temperature data, while the remaining information was calculated using the Thornthwaite-Mather water balance methodology as described in the “Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance, C.W. Thornthwaite and J.R. Mather, 1957”. Please see sample typical calculations within Appendix D. The pre- and post-development conditions were subdivided for the water balance as follows:

Soils:

- Sandy loam, noted to be HSG B; and
- Silt / clay loam, noted to be HSG C.

Pervious Land uses:

- Pasture overtopping sandy loam;
- Pasture overtopping silt/clay loam;
- Forest overtopping sandy loam; and
- Forest overtopping silt/clay loam.

Impervious Land Uses:

- Dwellings and asphalt.

Each of these pervious categories was reviewed based on Table 10 of the Thornthwaite – Mather literature to obtain the applicable soil moisture retention of the underlying soils. The soil moisture retention used in our calculations is provided as “mm/m”, therefore once the average on-site soil depth above the groundwater (is estimated to be 0.6 m) was applied, a corresponding site-specific soil moisture retention value was obtained for each category above. These soil moisture retention values are used to determine the soil moisture storage, given the accumulated water losses which are calculated based on the climatic data (temperature and precipitation) for the site. These tables are only noted in specific depths (25 mm and 50 mm intervals), therefore in some instances, the closest possible table was used. Table 7 below illustrates an example at a soil moisture retention value of 75 mm. Located in Appendix D, calculations for 75 mm, 100 mm, 125 mm, 150 mm, 200 mm, 250 mm, 350 mm and 400 mm were completed as part of a bulk sensitivity analysis for the surplus data. Results of this analysis, as calculated for each soil moisture value noted above, indicate that changing moisture retention values by 25 mm to 50 mm yields approximately 1% change in water surplus. This would indicate that regardless of whether the soils had 150 mm or 200 mm of moisture retention, the difference in surplus will be minor.

Table 7 – Monthly Water Balance Example - 75mm - Climate Data per Environment Canada data for Ottawa International Airport (1981 - 2010)

Month	Temp	Heat Index	PET	P	ΔP = P - PET	WL	ST	ΔS	AET	D	S	RO	SMRO	TR	DT
January	-10.3	0	0	65	65		217	0	0	0	0	11	0	11	228
February	-8.1	0	0	54	54		271	0	0	0	0	5	0	5	276
March	-2.3	0	0	64	64		336	0	0	0	0	2	0	2	338
April	6.3	1.4	32	75	43		75	0	32	0	43	22	26	48	166
May	13.3	4.4	79	80	2		75	0	79	0	2	12	117	129	206
June	18.5	7.2	112	93	-19	-19	57	-18	111	1	0	6	59	65	122
July	21	8.8	133	92	-41	-60	33	-24	116	17	0	3	29	32	65
August	19.8	8.0	114	86	-29	-88	22	-11	97	18	0	2	15	17	39
September	15	5.3	73	90	17		39	17	73	0	0	1	7	8	47
October	8	2.0	34	86	52		75	36	34	0	17	9	4	13	105
November	1.5	0.2	5	82	77		75	0	5	0	77	43	2	45	197
December	-6.2	0	0	76	76		151	0	0	0	0	22	1	23	174
Total		37.4	580	944				0	545	35	138	138	260	398	

PET = Potential Evapotranspiration, P = Total Precipitation, ΔP = P-PET, WL = Accumulated Water Loss, ST= Storage, ΔS = Soil Moisture Storage, AET = Actual Evapotranspiration, D = Soil Moisture Deficit, S = Soil Moisture Surplus, RO = Water Runoff, SMRO = Snow Melt Runoff, TR = Total Runoff, DT = Total Moisture Detention

Note: Shaded cells taken from Thornwaite-Mather Tables. See sample calculation in Appendix D for cell by cell calculations. Total Surplus for example above is 398mm.

Monthly T from Environment Canada:

Heat Index (I) = 37.4, a: 1.06

Next, the infiltration factors were chosen based on the following data:

Table 8 - Infiltration Factors from the "Tier 1 Water Budget and Water Quantity Stress Assessment" prepared by the Mississippi-Rideau Source Protection Region, August 2009

Description of Area / Development Site	Value of Infiltration Factor
Topography	
Flat Land (<1.5 slope range)	0.172
Rolling land (1.5 – 3% slope range)	0.120
Hilly land (>3% slope range)	0.073
Soil	
Low (clay, silt)	0.10
Low-Medium (till, sand-silt)	0.15
Medium (till, silty sand)	0.20
Medium-High (sands)	0.30
High (gravel, sands, organic deposits)	0.40
Variable (till)	0.20
Variable (fill)	0.40
Variable (sand)	0.35
Variable (bedrock)	
Precambrian Bedrock	0.20
Paleozoic Bedrock	0.05
Land Cover	
Low Infiltration – urban, aggregate	0.05
Medium Infiltration – agriculture, pasture, abandoned fields, wetland	0.10
High Infiltration – forest and plantation	0.20

For pre-development, the site has slopes generally under 1.5%, and as such was assigned a topographic infiltration factor of 0.172.

The soil classification was predominately sandy loam (infiltration rate of 0.2) for the HSG B soils and 0.15 for the HSG C soils.

The site is comprised of open vegetated areas which will results in a value of 0.10 being used and in forested areas, a land cover infiltration factor of 0.20 was used.

The soil classification for each area will not be changed for the pervious surfaces. This will be confirmed when the detailed grading design is advanced.

7.2 Pre-Development, Post-Development and Post-Development with Mitigation

Under pre-development, post-development and post-development with mitigation, precipitation, drainage, and infiltration conditions were reviewed. In pre-development, one lone area was used, where as in post-development and post-development with mitigation, the site was broken into each block (west, central and east) as well as the remaining roadways, residential lots, SWM block and Block 70 (not developable). The purpose of this breakdown is to provide each of those blocks guidance when it comes to the site plan control to achieve approval in order to meet the site-specific stormwater management criteria. If they were not separated from the "main" area, it would be difficult to break out their individual contributions for the future. The summary, however, combines all together to ensure that the site as a whole meets the requirements of pre-development as desired by the RVCA. The results have been summarized below:

Table 9 - Summary Water Balance Table

Characteristic	Pre-Development	Post-Development	Change (Pre – to Post)	Post-Development with Mitigation	Change (Pre- to Post- with Mitigation
Developed Lands to Perth Long Swamp Pre = Post Areas					
Input (Volumes)					
Precipitation (m^3/year)	115168	115168	0%	115168	0%
Output (Volumes)					
Total Infiltration (m^3/year)	23051	12320	-47%	22811	-1%
Total Runoff (m^3/year)	23876	65413	174%	54922	130%

Table 3, above, illustrates that the pre-and post-development areas for the entire development remain relatively similar. The total infiltration is illustrated to indicate that in all instances, the development on-site (i.e.: when comparing post- to pre-development) results in a reduction in infiltration. To address the deficiency, infiltration-promoting measures will be required to ensure runoff is intercepted and permitted to recharge the groundwater aquifer.

Finally, the total runoff illustrated confirms that the wetland will see an increase in total volume as a result of the development. This will result in additional volume within the wetland temporarily until it is permitted to flow downstream. This information is critical for the natural sciences consultant to confirm that the vegetation communities are capable of withstanding the additional volume of runoff over the short term. Please see Appendix G for the water balance tables broken out for each catchment.

8.0 MITIGATION

As a result of the lack of recharge when comparing post- to pre-development, the project will require infiltration trenches to ensure that the volume of runoff required enters the ground, providing groundwater recharge and continuing to ensure that the aquifer is maintained.

In order to design the trenches, the 5 mm event was reviewed. Environment Canada data as shown in Table 4 below, indicates that there are 25.2 days with rain over 10 mm, 46.5 days with rain over 5 mm and 118.4 days of rain over 0.2 mm. Therefore, at a minimum there is:

- (46.5 – 25.2) days = 21.3 days x 5 mm = 107 mm; +
- (118.4 - 46.5) days = 71.9 days x 0.2 mm = 14 mm;
- Summing these volumes = 107 mm + 14 mm = 121 mm of minimum total volume that would be anticipated to be captured if the trenches are designed to accept the entire 5mm storm event.

Table 10 - Environment Canada - Days with Precipitation

1981 to 2010 Canadian Climate Normals station data

Days with Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
>= 0.2 mm	4.4	3.9	6.7	10.9	13.4	13.2	11.9	11	12.3	13.7	11	6	118.4	A
>= 5 mm	1.6	1.2	2.1	4	4.9	5.8	5.4	4.8	5.1	5	4.2	2.3	46.5	A
>= 10 mm	0.87	0.57	1	2	2.7	2.9	3.1	2.8	3.2	2.7	2.1	1.2	25.2	A
>= 25 mm	0.13	0.07	0.10	0.33	0.47	0.73	0.77	0.67	0.60	0.47	0.43	0.13	4.9	A

As described above, the mitigation measures were reviewed for each catchment. The exact geometry and location within the catchment have been completed by the civil engineering team during the detailed design of the development. Based on the volume to be infiltrated, mitigation measures meet or exceed the required infiltration volume required to balance the site.

Table 11 - Mitigation Measure Sizing - Development Lands to Perth Long Swamp

	(Bk 70, SWM Bk, Residential Lots and Roadway)	West Block	Central Block	East Block
Area of Asphalt (m^2)	26600	24010	10920	4550
Asphalt Runoff Coefficient	0.9	0.9	0.9	0.9
Volume of Runoff in 5 mm Event (m^3) to be infiltrated	120	108	49	20
Mitigation Required (m^3/yr)	2873	2593	1179	491
Annual Volume to be infiltrated by designing for 5 mm Event (m^3)	2897	2615	1189	495

The civil engineering team will be required to facilitate infiltration measures to provide within the proposed development with 120 m^3, with 108 m^3, 49m^3 and 20m^3 being required for the West, Central and East Blocks respectively.

8.1 Target Infiltration Volume - MECP Criteria

The MECP guidelines provide the criteria for water quality storage for infiltration features to meet basic, normal and enhanced criteria. The infiltration facilities on this site are not specifically designed to meet all MECP criteria as the OGS unit and dry pond / swale have been sized to meet all quality and quantity control requirements. However, by virtue of the volumes required to mitigate the additional impervious percentage on site, these features, in combination with the other features on site, will result in exceeding the minimum target quality control requirements for the site (80% TSS removal – enhanced quality control). Based on Table 3.2 in the MECP guidelines, the minimum infiltration volumes required to meet enhanced quality control are indicated below:

Table 12 - Quality Control Confirmation

	(Blk 70, SWM Blk, Residential Lots and Roadway)	West Block	Central Block	East Block
% Impervious	50%	70%	70%	70%
Table 3.2 (MECP Guidelines) m^3/ha	30	35	35	35
Total Upstream Area (ha)	**5.5**	**3.43**	**1.56**	**0.56**
Total Required Storage Volume to achieve Enhanced Quality Control (m^3)	165	120	55	20
Provided Infiltration Volume (m^3)	120	108	49	20
Meets MECP criteria for water quality (Table 3.2)	No	No	No	Yes

Based on the table above, the development and the West and Central Blocks will require additional features to achieve the MECP criteria for water quality. Please note that the purpose of these infiltration trenches is primarily from a water balance perspective, and they are not intended to replace the other facilities on site.

8.2 Drawdown Of Infiltration Trenches

As noted previously the infiltration trenches have not been sized to meet MECP quality control criteria, rather to address mitigation requirements for water balance. As detailed above, the trenches were sized for the 5 mm storm and not the quality event (25 mm storm). The design criteria typical for a site outletting to a wetland is that the trenches must be able to drawdown fully between 5 mm storm events. It is acknowledged that in larger events, the trenches will be overtopped and the grading on site will provide conveyance measures to direct the overtopped runoff towards the stormwater management facilities. With the assumed infiltration rates noted below, the drawdown values were reviewed to verify that the trenches were empty between 48-72 hrs as recommended by the TRCA.

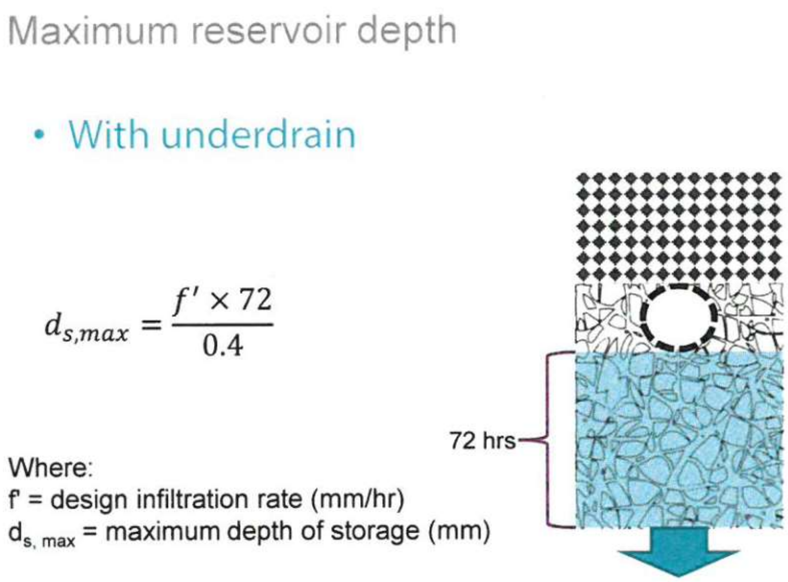

Figure 3 - Maximum Reservoir Depth (TRCA, 2018)

Table 13 - Drawdown Calculations

	(Blk 70, SWM Blk, Residential Lots and Roadway)	West Block	Central Block	East Block
Infiltration Rate (mm/hr)	25	25	25	25
Factor of Safety	4.5	4.5	4.5	4.5
Design Infiltration Rate (mm/hr) **assumed*	5.5	5.5	5.5	5.5
Maximum Depth of Storage – 72 hrs (mm)	990	990	990	990
Maximum Depth of Storage – 48 hrs (mm)	660	660	660	660
Depths of Trenches Provided On Site (mm)	750	750	750	750
Meets Infiltration Drawdown Criteria	Yes	Yes	Yes	Yes

As indicated above, the infiltration trench is anticipated to empty between 48 – 72 hrs and therefore, is assumed to meet the drawdown criteria and is anticipated to function as intended by being empty within 2 to 3 days of a 5 mm storm event.

9.0 ANALYSIS OF IMPACTS TO THE WETLAND

Drainage will be directed from the site to the underground storm sewer network prior to reaching the stormwater management pond and ultimately outlet towards the wetland. Riprap and other flow spreaders will be used at the pond outlet to disperse surface flows and dissipate the associated energy of the flows directed to the wetland. This will ensure that any concentrated flows are spread out to reduce the potential for downstream erosion. The discharge from this pond is expected to be reduced through infiltration and evaporation between the outlet of the stormwater management feature and the edge of the wetland.

This hydrologic impact assessment determined that there was a change in total infiltration when comparing post- to pre-development. This has resulted in the requirement of proposed mitigation measures for the proposed development and site-specific requirements for each of the future Blocks (West, Central and East). The change in total runoff entering the wetland will be mitigated by the stormwater management facilities which will reduce the peak flows to pre-development rates. The overall area of the Perth Long Swamp wetland is immense when compared to the size of this site. Any additional volume, in excess of pre-development volume, once the pond and mitigation measures are in place will not make a measurable difference to the quality, function and operation of the wetland.

10.0 SEDIMENT EROSION CONTROL

10.1 Temporary Measures

Before construction begins, temporary silt fence, straw bales or rock flow check dams will need to be installed at all-natural runoff outlets from the property. It is crucial that these controls be maintained throughout construction and inspection of sediment and erosion control will be facilitated by the Contractor or Contract Administration staff throughout the construction period.

The Contractor, at their discretion or at the instruction of the Town of Perth, RVCA or the Contract Administrator shall increase the quantity of sediment and erosion controls on-site to ensure that the site is operating as intended and no additional sediment finds its way into the storm sewer network on site. The straw bales and silt fences shall be inspected weekly and after rainfall events. Care shall be taken to properly remove sediment from the fences and check dams as required.

Work through winter months shall be closely monitored for erosion along sloped areas. Should erosion be noted, the Contractor shall be alerted and shall take all necessary steps to rectify the situation. Should the Contractor’s efforts fail at remediating the eroded areas, the Contractor shall contact the Conservation Authority to review the site conditions and determine the appropriate course of action.

As each lot is developed, proper sediment and erosion controls will need to be installed and maintained. Sediment controls shall consist of, at minimum, straw bales at the down gradient property line. Grass shall be established as soon as possible and excess fill shall be removed or leveled promptly. All manholes, catch basins and other drainage structures shall be covered in geosock when installed.

10.2 Permanent Measures

Rip-rap will be placed at all locations that have the potential for concentrated flow. It is crucial that the Contractor ensure that the geotextile is keyed in properly to ensure runoff does not undermine the rip-rapped area. Additional rip-rap is to be placed at erosion prone locations as identified by the Contractor / Contract Administrator / Town of Perth or RVCA.

It is expected that the Contractor will promptly ensure that all disturbed areas receive topsoil and seed/sod and that grass be established as soon as possible. Any areas of excess fill shall be removed or levelled as soon as possible and must be located a sufficient distance from any watercourse to ensure that no sediment is washed out into the watercourse. As the vegetation growth within the site provides a key component to the control of sediment for the site, it must be properly maintained once established. Once the construction is complete, it will be up to the landowner to maintain the vegetation and ensure that the vegetation is not overgrown or impeded by foreign objects.

11.0 SUMMARY

- A new subdivision with 35 single family homes, 36 semi-detached homes and 14 apartment units will be constructed in Phase 6 of the Perthmore Subdivision.

- Proposed watermains ranging in diameter from 200mm to 300mm will be installed throughout the subdivision and will have multiple connection points to existing infrastructure.

- The proposed sanitary sewer will be 200 mm in diameter, will be installed throughout the subdivision and will gravity drain through the existing subdivision infrastructure though multiple connections.

- The proposed storm sewer, ranging in diameter from 250 mm to 900 mm, will be installed throughout the subdivision and will drain to a newly proposed stormwater management facility.

- Stormwater quantity and quality control will be provided by the proposed SWM facility. The facility will be designed as a wet pond to provide an enhanced level of water quality control (80% T.S.S. removal). A treatment train approach has been enacted using infiltration trenches, conveyance measures in rear yard swales and the end of pipe facility.

- Water balance criteria was reviewed and mitigation measures will be required to meet the pre-development infiltration volumes. Infiltration trenches have been proposed, volume sizing has been completed with further design details such as placement to be confirmed with the detailed grading and drainage plan in detailed design.

- Through ensuring that the stormwater management and water balance criteria are not exceed in post-development from pre-development rates and volumes, and by locating the pond upstream of the wetland, no adverse impacts are anticipated to the Perth Long Swamp.

- Sediment and erosion protection measures will be installed as soon as ground conditions warrant and permit and shall remain in place until construction is complete and vegetation is re-established.

12.0 RECOMMENDATIONS

Based on the information presented in this report, we recommend that the Town approve this Preliminary Servicing and Stormwater Management Report in support of the Draft Plan of Subdivision Application for Phase 6 of the Perthmore Subdivision.

This report is respectfully being submitted for Draft Plan of Subdivision Application.

Regards,

McIntosh Perry Consulting Engineers Ltd.

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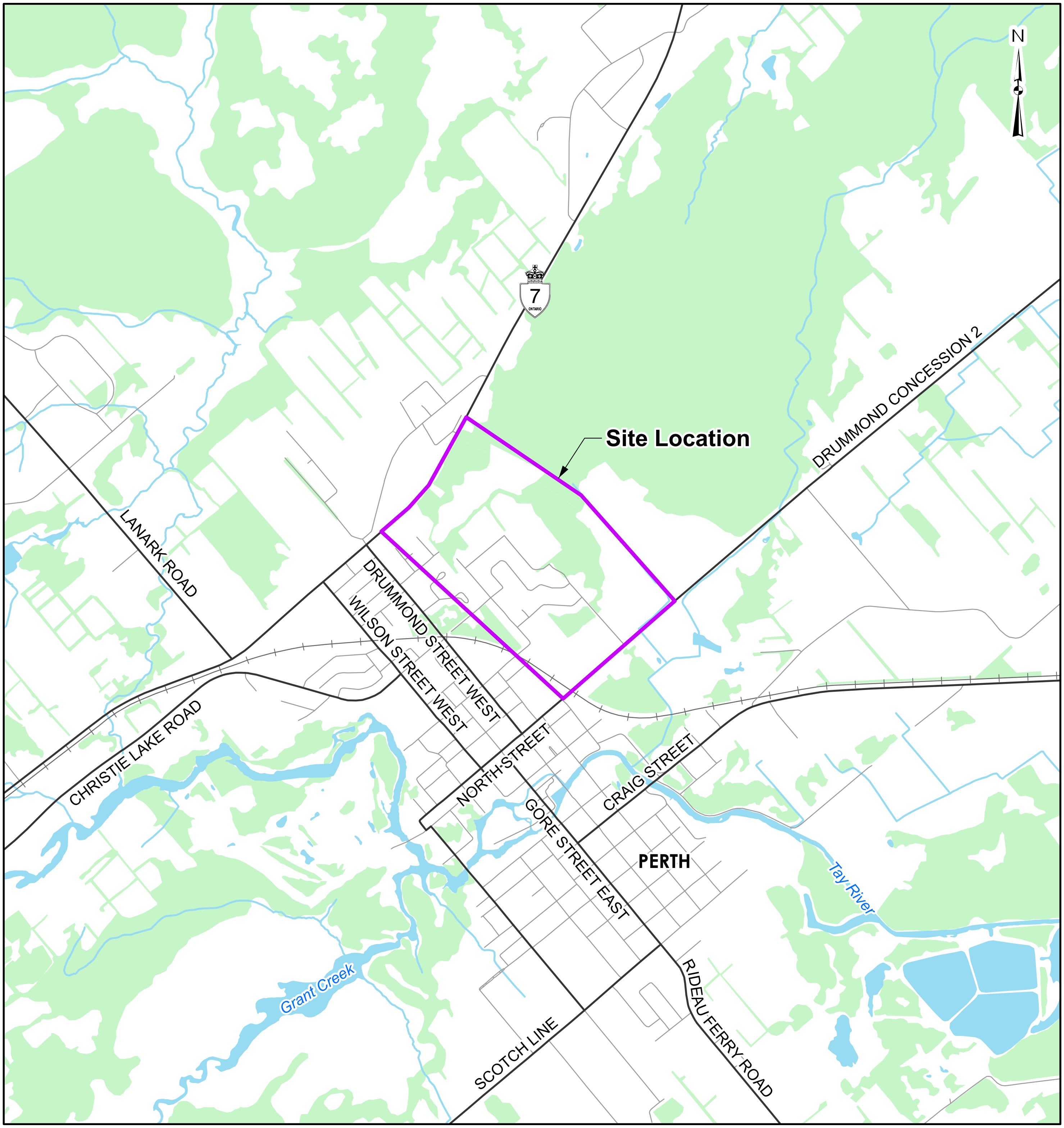
13.0 STATEMENT OF LIMITATIONS

This report was produced for the exclusive use of Perthmore Developments Co. The purpose of the report is to assess the existing servicing infrastructure and to provide recommendations and designs for the post-construction scenario that are in compliance with the guidelines and standards from the Ministry of the Environment, Conservation and Parks, Town of Perth and local approval agencies. McIntosh Perry reviewed the site information and background documents listed in Section 2.0 of this report. While the previous data was reviewed by McIntosh Perry and site visits were performed, no field verification/measures of any information were conducted.

Any use of this review by a third party, or any reliance on decisions made based on it, without a reliance report is the responsibility of such third parties. McIntosh Perry accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this review.

The findings, conclusions and/or recommendations of this report are only valid as of the date of this report. No assurance is made regarding any changes in conditions subsequent to this date. If additional information is discovered or becomes available at a future date, McIntosh Perry should be requested to re-evaluate the conclusions presented in this report, and provide amendments, if required.

APPENDIX A
LOCATION PLAN



1,000 500 0 1,000

Scale 1:30,000 Metres

LEGEND

- Approximate Site Boundary
- Local Road
- Major Road
- Railroad
- Watercourse
- Waterbody
- Wooded Area

CLIENT:
PERTHMORE DEVELOPMENT CO.

PROJECT:
PERTHMORE SUBDIVISION PHASE 6

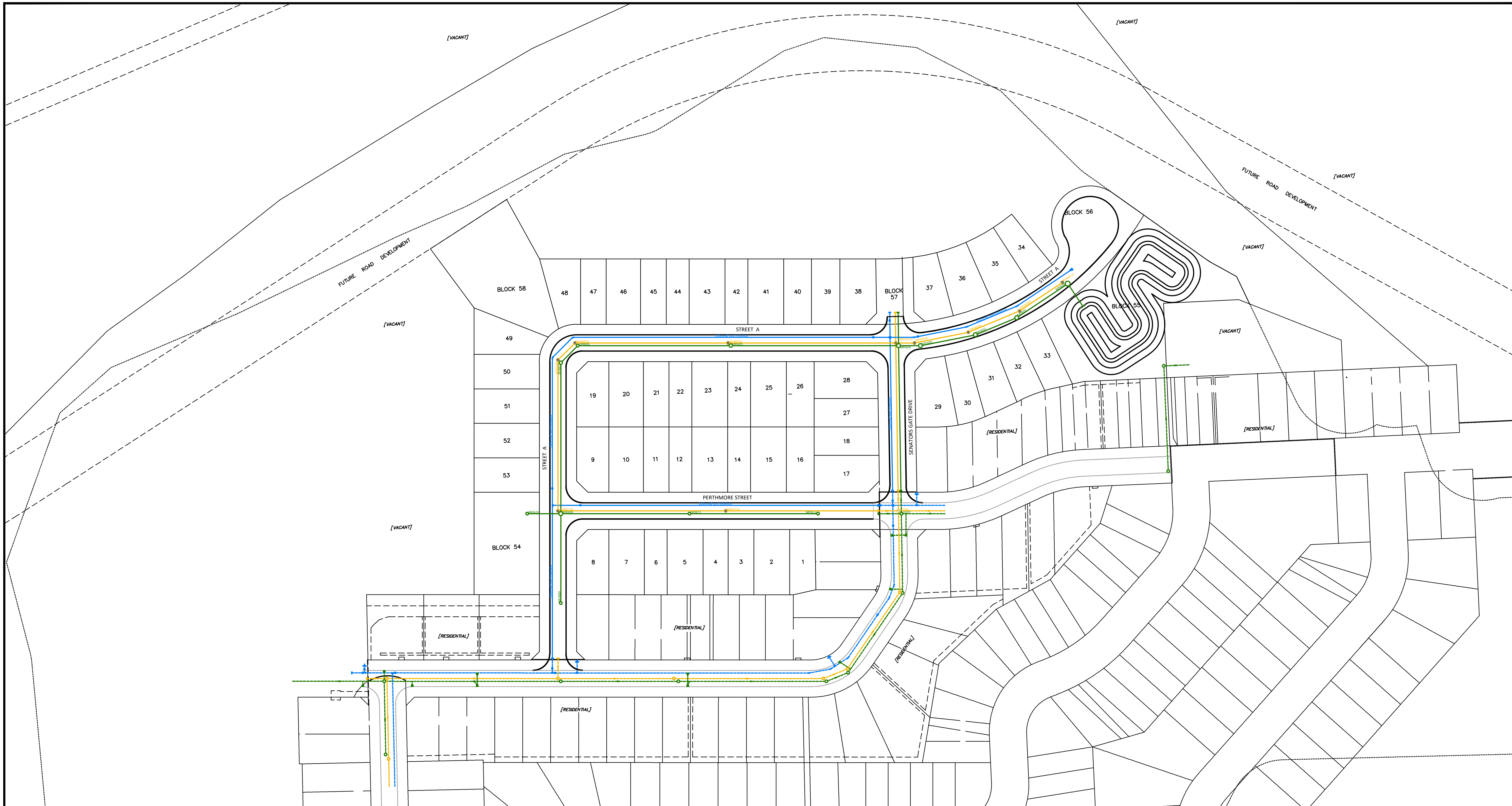
TITLE:
LOCATION PLAN

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:PP-13-9668-01		FIGURE:
Date	Dec., 21, 2020	1
GIS	EU	
Checked By	CH	

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2020.



LEGEND

- - - -	EXISTING WATERMAIN
——	PROPOSED WATERMAIN
- - - -	EXISTING SANITARY SEWER
——	PROPOSED SANITARY SEWER
- - - -	EXISTING STORM SEWER
——	PROPOSED STORM SEWER

SCALE 1 : 2000

0 50 100 150 200 Metres

McINTOSH PERRY

115 Walgreen Road, RR3, Carp, ON K0A 1L0
Tel: 613-836-2184 Fax: 613-836-3742
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Client: PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

Project: PERTHMORE SUBDIVISION PHASE 6

Drawing Title: GENERAL PLAN OF SERVICES

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale: 1:2000	Project Number: PP-13-9668-01

No.	Revisions	Date
2	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022
1	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020

Drawing Number: 100

FILENAME: U:\Ottawa\01 Project - Proposals\2013 Jobs\OPP-13-9668-01 Perthmore Development Co_Perthmore Subdivision\03-Drawings\Production\PP-13-9668-01_Drawings.dwg
LAST SAVED: Wednesday, August 03, 2022 LAST SAVED BY: c.hampel
LAST PLOTTED: Thursday, August 04, 2022 CTB FILE USED: ----

APPENDIX B
WATERMAIN DESIGN

McINTOSH PERRY

PP-13-9668-01 - Perthmore Subdivision Phase 6 - Water Demands 1

Peaking Factors:

Table 3-1: Peaking Factors

POPULATION	MINIMUM RATE FACTOR (MINIMUM HOUR)	MAXIMUM DAY FACTOR	PEAK RATE FACTOR (PEAK HOUR)
500 - 1,000	0.40	2.75	4.13
1,001 - 2,000	0.45	2.50	3.75
2,001 -3,000	0.45	2.25	3.38
3,001 - 10,000	0.50	2.00	3.00
10,001 - 25,000	0.60	1.90	2.85
25,001 - 50,000	0.65	1.80	2.70
50,001 - 75,000	0.65	1.75	2.62
75,001 - 150,000	0.70	1.65	2.48
greater than 150,000	0.80	1.50	2.25

Note: Domestic water demand peaking factors are per Section 3.4.2 of the Design Guidelines for Drinking-Water Systems 2008.

Population Density:

Unit Type	Persons Per Unit (ppu)
Single Family	3.4
Semi-detached	2.7
Townhouse	2.7
Apartment	1.8
Unknown	60/ha

Calculations:

Phase 6 - Consists of 35 single family, 36 Semi-detached units, 14 Apartment units

Population = 241.40 people

*Average Day Flow		Max. Day Flow		Peak Hourly Flow		
(L/s)	(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	
0.78	46.94	2.15	129.08	3.23	193.86	
0.78	**46.94**	**2.15**	**129.08**	**3.23**	**193.86**	**Total**

*Domestic flow was assumed to be 280L/(cap-day)

PP-13-9668-01 - Perthmore Subdivision Phase 6 - Water Demands 2

Peaking Factors:

Table 3-1: Peaking Factors

POPULATION	MINIMUM RATE FACTOR (MINIMUM HOUR)	MAXIMUM DAY FACTOR	PEAK RATE FACTOR (PEAK HOUR)
500 - 1,000	0.40	2.75	4.13
1,001 - 2,000	0.45	2.50	3.75
2,001 -3,000	0.45	2.25	3.38
3,001 - 10,000	0.50	2.00	3.00
10,001 - 25,000	0.60	1.90	2.85
25,001 - 50,000	0.65	1.80	2.70
50,001 - 75,000	0.65	1.75	2.62
75,001 - 150,000	0.70	1.65	2.48
greater than 150,000	0.80	1.50	2.25

Note: Domestic water demand peaking factors are per Section 3.4.2 of the Design Guidelines for Drinking-Water Systems 2008.

Population Density:

Unit Type	Persons Per Unit (ppu)
Single Family	3.4
Semi-detached	2.7
Townhouse	2.7
Apartment	1.8
Unknown	60/ha

Calculations:

Phase 6 - Consists of 35 single family, 36 Semi-detached units and 14 Apartment units

Future Development - Consists of 5.45 ha development area

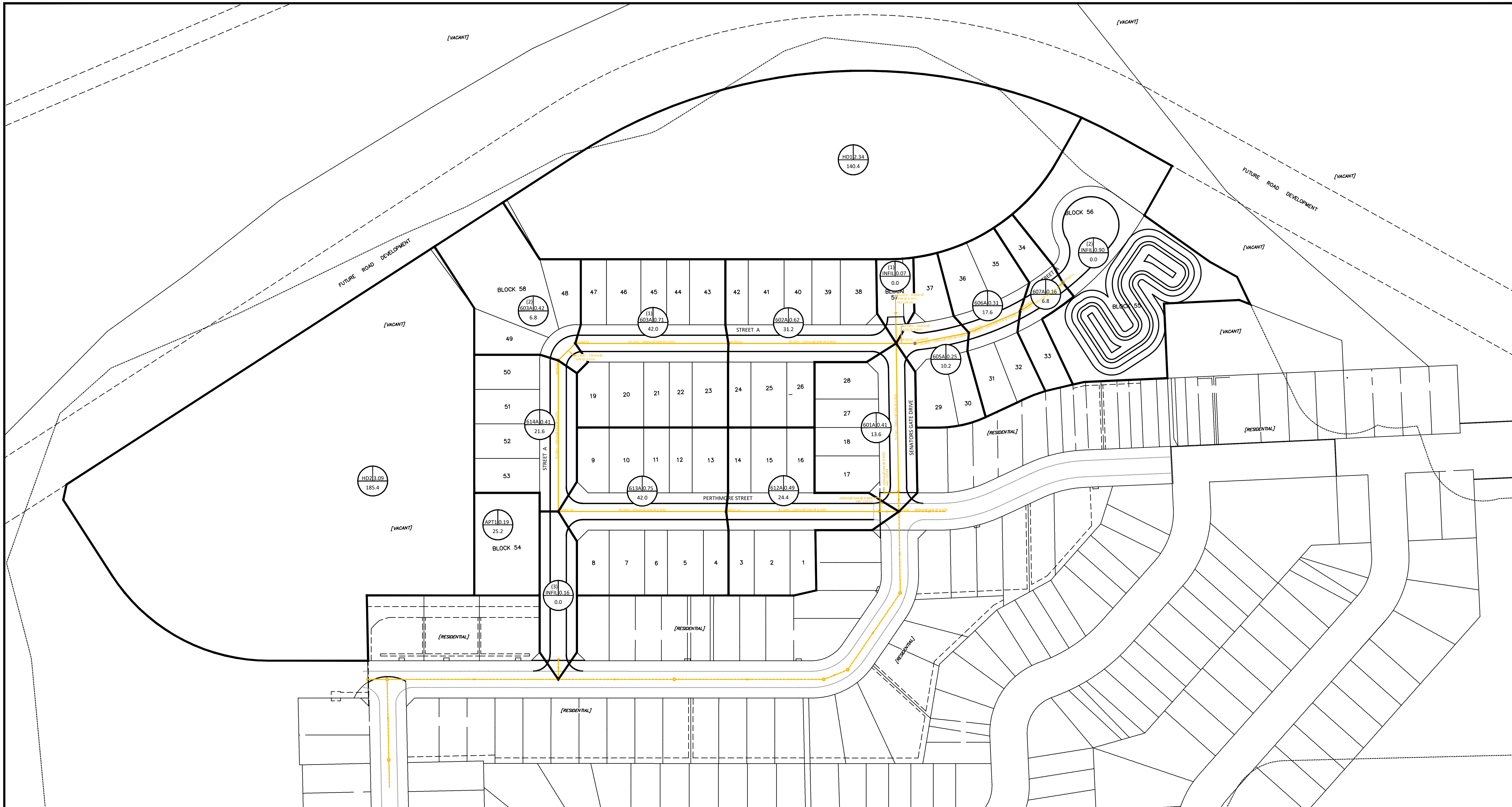
Population = 568.40 people

*Average Day Flow		Max. Day Flow		Peak Hourly Flow		
(L/s)	(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	
1.84	110.52	5.07	303.94	7.61	456.46	
1.84	**110.52**	**5.07**	**303.94**	**7.61**	**456.46**	**Total**

*Domestic flow was assumed to be 280L/(cap-day)

APPENDIX C
SANITARY SEWER DESIGN

MCINTOSH PERRY



LEGEND

LOCATION I.D.
AREA (ha)
123 0.25
6.8
POPULATION

SCALE 1 : 2000

0 50 100 150 200 Metres

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Client: PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

Project: PERTHMORE SUBDIVISION PHASE 6

Drawing Title: SANITARY DRAINAGE AREA PLAN

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale: 1:2000	Project Number: PP-13-9668-01

No.	Revisions	Date
2	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022
1	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020

Drawing Number: 500

FILENAME: U:\Ottawa\01 Project - Proposals\2013 Jobs\PP\PP-13-9668-01 Perthmore Development Co_Perthmore Subdivision\03-Drawings\Production\PP-13-9668-01_Drawings.dwg
LAST SAVED: Wednesday, August 03, 2022 LAST SAVED BY: c.hampel
LAST PLOTTED: Thursday, August 04, 2022 CTB FILE USED: ----

SANITARY SEWER DESIGN SHEET

McINTOSH PERRY

PROJECT: PERTHMORE SUBDIVISION PHASE 6
LOCATION: PERTH, ON
CLIENT: PERTHMORE DEVELOPMENT CO.

LOCATION				RESIDENTIAL									ICI AREAS							INFILTRATION ALLOWANCE			FLOW	SEWER DATA								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	30	31
				UNIT TYPES				AREA	POPULATION			PEAK	AREA (ha)						PEAK	AREA (ha)		FLOW	DESIGN	CAPACITY	LENGTH	DIA	SLOPE	VELOCITY	FLOW	VELOCITY	AVAILABLE CAPACITY	
													INSTITUTIONAL		COMMERCIAL		INDUSTRIAL															
STREET	AREA ID	FROM MH	TO MH	SF	SD	TH	APT	(ha)	IND	CUM	PEAK FACTOR	FLOW (L/s)	IND	CUM	IND	CUM	IND	CUM	FLOW (L/s)	IND	CUM	(L/s)	FLOW (L/s)	(L/s)	(m)	(mm)	(%)	(full) (m/s)	DEPTH (mm)	(actual) (m/s)	L/s	(%)
STREET A	603A(1)	603A	602A	6	8			0.71	42.0	42.0	4.00	0.54		0.00		0.00		0.00	0.00	0.71	0.71	0.23	0.78	27.59	82.10	200	0.65	0.851	24.7	0.378	26.81	97.18
	602A	602A	601A	6	4			0.62	31.2	73.2	4.00	0.95		0.00		0.00		0.00	0.00	0.62	1.33	0.44	1.39	21.64	90.00	200	0.40	0.667	36.3	0.379	20.25	93.59
SENATORS GATE DRIVE	HD1, INFIL(1)	BULKHEAD	601A					2.34	140.4	140.4	4.00	1.82		0.00		0.00		0.00	0.00	2.41	2.41	0.80	2.62	21.64	16.50	200	0.40	0.667	49.0	0.457	19.03	87.91
STREET A	INFIL(2), 607A	607A	606A	2				0.16	6.8	6.8	4.00	0.09		0.00		0.00		0.00	0.00	1.06	1.06	0.35	0.44	27.59	27.61	200	0.65	0.851	18.9	0.317	27.15	98.41
	606A	606A	605A	2	4			0.31	17.6	24.4	4.00	0.32		0.00		0.00		0.00	0.00	0.31	1.37	0.45	0.77	27.59	29.81	200	0.65	0.851	24.6	0.376	26.82	97.21
	605A	605A	604A	3				0.25	10.2	34.6	4.00	0.45		0.00		0.00		0.00	0.00	0.25	1.62	0.53	0.98	27.59	29.40	200	0.65	0.851	27.6	0.405	26.60	96.44
		604A	601A						0.0	34.6	4.00	0.45		0.00		0.00		0.00	0.00	0.00	1.62	0.53	0.98	27.59	10.08	200	0.65	0.851	27.6	0.405	26.60	96.44
SENATORS GATE DRIVE	601A	601A	*CAP*	4				0.41	13.6	261.8	4.00	3.39		0.00		0.00		0.00	0.00	0.41	5.77	1.90	5.30	21.64	79.13	200	0.40	0.667	68.9	0.556	16.34	75.52
		CAP	*S106*					0.00	0.0	261.8	4.00	3.39		0.00		0.00		0.00	0.00	0.00	5.77	1.90	5.30	21.64	*11.00*	*200*	*0.40*	0.667	68.9	0.556	16.34	75.52
STREET A	603A(2)	603A	614A	2				0.42	6.8	6.8	4.00	0.09		0.00		0.00		0.00	0.00	0.42	0.42	0.14	0.23	27.59	12.90	200	0.65	0.851	13.9	0.259	27.36	99.18
	614A	614A	613A		8			0.41	21.6	28.4	4.00	0.37		0.00		0.00		0.00	0.00	0.41	0.83	0.27	0.64	27.59	81.00	200	0.65	0.851	22.6	0.356	26.94	97.67
PERTHMORE STREET	HD2, APT1, INFIL(3), 613A	613A	612A	6	8		14	4.03	252.6	281.0	4.00	3.64		0.00		0.00		0.00	0.00	4.19	5.02	1.66	5.30	21.64	90.00	200	0.40	0.667	68.9	0.556	16.34	75.51
	612A	612A	*CAP*	4	4			0.49	24.4	305.4	4.00	3.96		0.00		0.00		0.00	0.00	0.49	5.51	1.82	5.78	21.64	81.68	200	0.40	0.667	71.9	0.569	15.86	73.30
		CAP	*S106*					0.00	0.0	305.4	4.00	3.96		0.00		0.00		0.00	0.00	0.00	5.51	1.82	5.78	21.64	*11.00*	*200*	*0.40*	0.667	71.9	0.569	15.86	73.30

Design Parameters:

Residential			ICI Areas			Peak Factor
SF	3.4	p/p/u	INST	28,000	L/Ha/day	1.5
SD	2.7	p/p/u	COM	28,000	L/Ha/day	1.5
TH	2.7	p/p/u	IND	35,000	L/Ha/day	MOE Chart
APT	1.8	p/p/u				
Other	60	p/p/Ha				

Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 280 L/day
3. Infiltration allowance: 0.33 L/s/Ha
4. Residential Peaking Factor:
   Harmon Formula = 1+(14/(4+P^0.5))
   where P = population in thousands

Designed: P.G.K.

Checked: B.S.C.

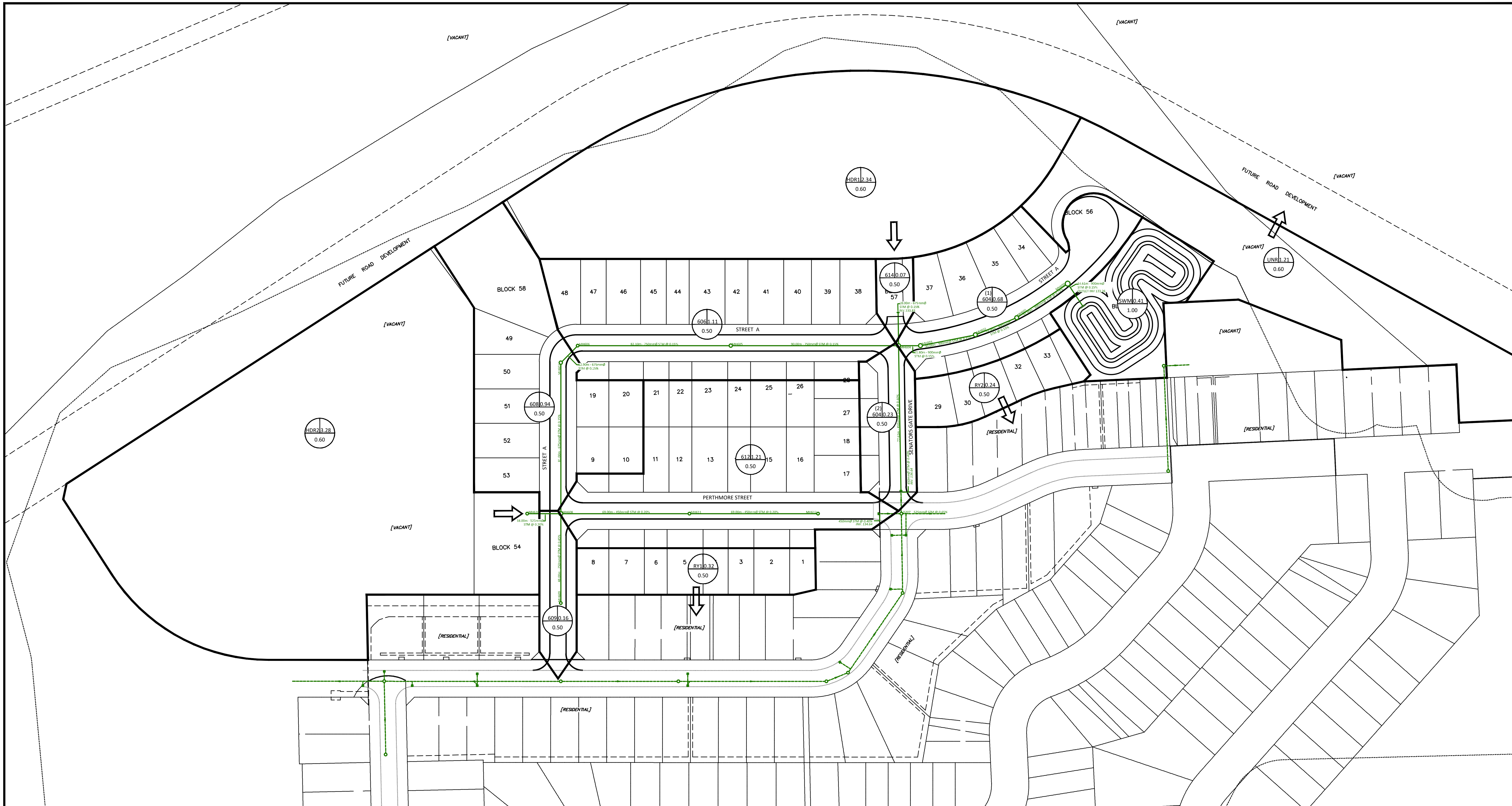
Project No.: PP-13-9668-01

No.	Revision	Date
1.	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020
2.	ISSUED FOR DRAFT PLAN APPROVAL	AUG.3, 2022

Sheet No: 1 of 1

APPENDIX D
STORM SEWER DESIGN

MCINTOSH PERRY



SCALE 1 : 2000

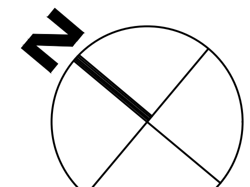
0 50 100 150 200 Metres

LEGEND

LOCATION I.D. — 123F | 0.25 — AREA (ha)

0.60

AVERAGE COEFFICIENT 5-year



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Client: PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

Project: PERTHMORE SUBDIVISION PHASE 6

Drawing Title: STORM DRAINAGE AREA PLAN

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale: 1:2000	Project Number: PP-13-9668-01

No.	Revisions	Date
2	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022
1	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020

Drawing Number: 501

FILENAME: U:\Ottawa\01 Project - Proposals\2013 Jobs\0PP-13-9668-01 Perthmore Development Co_Perthmore Subdivision\03-Drawings\Production\PP-13-9668-01_Drawings.dwg
LAST SAVED: Wednesday, August 03, 2022 LAST SAVED BY: c.hampel
LAST PLOTTED: Thursday, August 04, 2022 CTB FILE USED: ----

STORM SEWER DESIGN SHEET

McINTOSH PERRY

PROJECT: PERTHMORE SUBDIVISION PHASE 6
LOCATION: PERTH, ON
CLIENT: PERTHMORE DEVELOPMENT CO.

LOCATION				CONTRIBUTING AREA (ha)								RATIONAL DESIGN FLOW											SEWER DATA								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
STREET	AREA ID	FROM MH	TO MH	C-VALUE 0.20	0.40	0.50	0.60	0.80	1.00	INDIV AC	CUMUL AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	100yr PEAK FLOW (L/s)	FIXED FLOW (L/s)	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	W	H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	(%)
	HDR2	610	608				3.28			1.97	1.97	20.00	0.30	20.30	58.41	67.89	97.42	319.56				319.56	449.81	18.00	750			0.15	0.986	130.26	28.96
STREET A	609	609	608			0.16				0.08	0.08	20.00	0.97	20.97	58.41	67.89	97.42	12.99				12.99	41.62	48.00	250			0.45	0.821	28.63	68.79
PERTHMORE STREET	612	612	611			1.21				0.61	0.61	20.00	1.42	21.42	58.41	67.89	97.42	98.24				98.24	133.02	69.00	450			0.20	0.810	34.78	26.15
		611	608							0.00	0.61	21.42	1.42	22.84	55.68	64.71	92.86	93.64				93.64	133.02	69.00	450			0.20	0.810	39.38	29.60
STREET A	608	608	607			0.94				0.47	3.12	22.84	1.28	24.12	53.23	61.88	88.79	462.17				462.17	579.98	81.00	825			0.15	1.051	117.81	20.31
		607	606							0.00	3.12	24.12	0.20	24.33	51.24	59.55	85.46	444.83				444.83	579.98	12.90	825			0.15	1.051	135.15	23.30
	606	606	605			1.11				0.56	3.68	24.33	1.30	25.63	50.93	59.20	84.95	520.80				520.80	579.98	82.10	825			0.15	1.051	59.18	10.20
		605	604							0.00	3.68	25.63	1.43	27.06	49.11	57.09	81.91	502.16				502.16	579.98	90.00	825			0.15	1.051	77.82	13.42
SENATORS GATE DRIVE	614, HDR1	BULKHEAD	604			0.07	2.34			1.44	1.44	20.00	0.33	20.33	58.41	67.89	97.42	233.66				233.66	339.63	18.00	675			0.15	0.919	105.98	31.20
STREET A	604(1)	604	603			0.68				0.34	5.46	27.06	0.17	27.22	47.29	54.96	78.87	717.35				717.35	905.48	11.80	975			0.15	1.175	188.13	20.78
		603	602							0.00	5.46	27.22	0.43	27.65	47.08	54.73	78.53	714.27				714.27	905.48	30.00	975			0.15	1.175	191.22	21.12
		602	601							0.00	5.46	27.65	0.34	27.99	46.58	54.14	77.68	706.57				706.57	905.48	24.00	975			0.15	1.175	198.92	21.97
		601	600							0.00	5.46	27.99	0.47	28.46	46.18	53.68	77.02	700.55				700.55	905.48	32.90	975			0.15	1.175	204.94	22.63
		600	POND							0.00	5.46	28.46	0.21	28.66	45.65	53.06	76.14	692.50				692.50	905.48	14.61	975			0.15	1.175	212.99	23.52
SENATORS GATE DRIVE	604(2)	604	*BULKHEAD*			0.23				0.12	0.12	20.00	1.13	21.13	58.41	67.89	97.42	18.67				18.67	188.11	77.63	450			0.40	1.146	169.44	90.07
		BULKHEAD	*D207*							0.00	0.12	21.13	0.18	21.31	56.21	65.33	93.75	17.97				17.97	188.11	*12.50*	*450*			*0.40*	1.146	170.14	90.45
PERTHMORE STREET		*BULKHEAD*	*D207*							0.00	0.00	20.00	0.18	20.18	58.41	67.89	97.42	0.00				0.00	188.11	*12.50*	*450*			*0.40*	1.146	188.11	100.00

Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 27.1 * Tc^-0.699] 5 YEAR
[i = 31.5 * Tc^-0.699] 10 YEAR
[i = 45.2 * Tc^-0.699] 100 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

Designed: P.G.K.
Checked: B.S.C.
Project No.: PP-13-9668-01

No.	Revision	Date
1.	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020
2.	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 3, 2022

Sheet No: 1 of 1

APPENDIX E
EXISTING CONDITIONS MEMO

McINTOSH PERRY

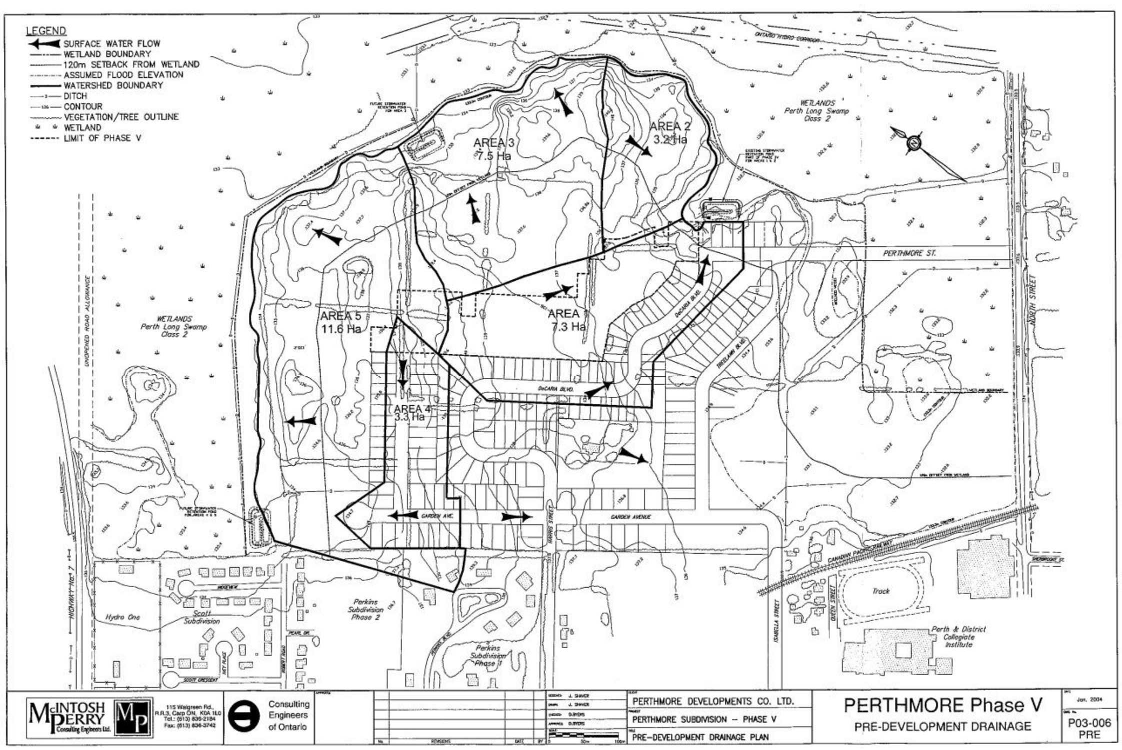
MEMORANDUM

To:	Ryan Kennedy, P. Eng., Practice Lead, Land Development
	Adam O'Connor, P.Eng., Assistant Vice President, Land Development
From:	John Price, P. Eng., Senior Water Resource Engineer
Cc:	Jason Sharp, P. Eng. Manager, Water Resources
Date:	December 2, 2020
Re:	Perthmore Subdivision

1.0 BACKGROUND

The Perthmore subdivision is located northwest of North Street in the Town of Perth. Various phases of the subdivision have been under development since the 1990s and the draft plan for a subsequent phase is now under consideration. The drainage and stormwater management infrastructure has also been constructed in phases over many years. The original pre-development flow values were first calculated in 1990s using the Rational Equation.

An existing stormwater management (SWM) pond is located on the northeast side of Perthmore Street as shown on the figure below. As part of development of this subsequent phase, this SWM facility will be reconstructed and expanded to address the water quality and quantity control requirements for the tributary drainage area. For the SWM design the pre-development flows, to be used as the target flows for the quantity control, were reassessed.



2.0 ANALYSIS

A Visual OTTHMO Version 5 (VO5) model was assembled for the analysis. As shown in the figure above, the pre-development tributary area to the SWM facility consists of Areas 1 and 2 and the total tributary pre-development drainage area is 10.5 ha. The VO5 hydrologic model requires various measured and calculated input parameters. The calculations of these input parameters area detailed below.

2.1 Parameters

2.1.1 General

Since the pre-development land use was rural the NASHYD command was employed in the VO5 model to calculate the runoff flows. NASHYD is used to simulate runoff flows with NASH instantaneous unit hydrograph. This hydrograph is made of a cascade of "n" linear reservoirs. The n (number of linear reservoirs) parameter was set at 3, in the model, and the rainfall losses were computed by the SCS CN procedure.

2.1.2 Time of Concentration/Time to Peak

The Time of Concentration (Tc), for the pre-development drainage basins, was calculated using the Airport Formula.

$T_c = 3.26 * (1.1 - C) *L^{0.5} * S_W^{-0.33}$

Where:

Tc = time of concentration in minutes
C = runoff coefficient
L = watershed length in metres
S_W = watershed slope in percentage

From the Tc value, the Time to Peak (Tp) value was calculated as 0.67 times Tc. The parameters employed in the calculation of Tc and Tp for the two drainage basins are show in Table 1.

Table 1 – Time to Peak

Catchment	Area	Flow Length	Fall	Slope	Tc[1]	Tp[2]
	ha	m	m	%	min	hrs
Area 1	7.3	435	7	1.61	58.1	0.65
Area 2	3.2	165	7	4.24	26.0	0.29

Notes: 1 – Airport Formula
2 – 0.67*Tc

2.1.3 SCS Curve Number

The Curve Number (CN) is the most important parameter in determining surface runoff when the SCS equation is used. Table 2 shows the parameters and the resulting CN value for Areas 1 and 2.

Table 2 – Curve Number

Catchment	Soil Type	Hydrologic	Land Use	Runoff	CN[3]	Ia
		Soil Group[1]	(0-5% Slope)	Coefficient[2]	(AMC II)	mm
Area 1	Sandy Loam	AB	Pasture	0.10	59	5
Area 2	Sandy Loam	AB	Pasture	0.10	59	5

Notes: 1 – MTO Drainage Management Manual – Design Chart 1.08
2 - MTO Drainage Management Manual – Design Chart 1.07
3 - MTO Drainage Management Manual – Design Chart 1.09 (Pasture, fair condition – average of A and B Hydrologic Soil Groups)

2.1.4 Rainfall

For the rainfall input to the VO5 model, the 12 hour SCS rainfall distribution, representing a high volume lower intensity storm, and a 4 hour Chicago rainfall distribution, representing a high intensity "thunder storm" type of rainfall event were used ion the analysis. The Intensity-Duration-Frequency (IDF) curve was obtained from the Ministry of Transportation (MTO) IDF Curve Lookup tool with the location centred over the property.

3.0 RESULTS

Employing the above noted parameters and the VO5 hydrologic model, Table 3 shows the calculated pre-development flow values for the 12 hour SCS and 4 hour Chicago rainfall hyetographs. It is recommended that these flow values be used for the water quantity control assessment of the reconstructed SWM facility. The redesign of the end of pipe facility will also include water quality control for the post-development tributary drainage area.

Table 3 – Calculated Flows

	12 hour SCS			4 hour Chicago		
Return Period	Area 1	Area 2	Total	Area 1	Area 2	Total
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.061	0.047	0.093	0.030	0.022	0.045
5	0.110	0.085	0.168	0.057	0.041	0.085
10	0.143	0.111	0.220	0.080	0.058	0.119
25	0.197	0.152	0.303	0.111	0.083	0.166
50	0.238	0.184	0.367	0.137	0.101	0.206
100	0.288	0.223	0.444	0.165	0.122	0.248

This memorandum is respectfully submitted by,
McIntosh Perry Consulting Engineers Ltd.

John Price, P. Eng.
Senior Water Resource Engineer
PH No. 613 714 5906
Email. J.Price@McIntoshPerry.com

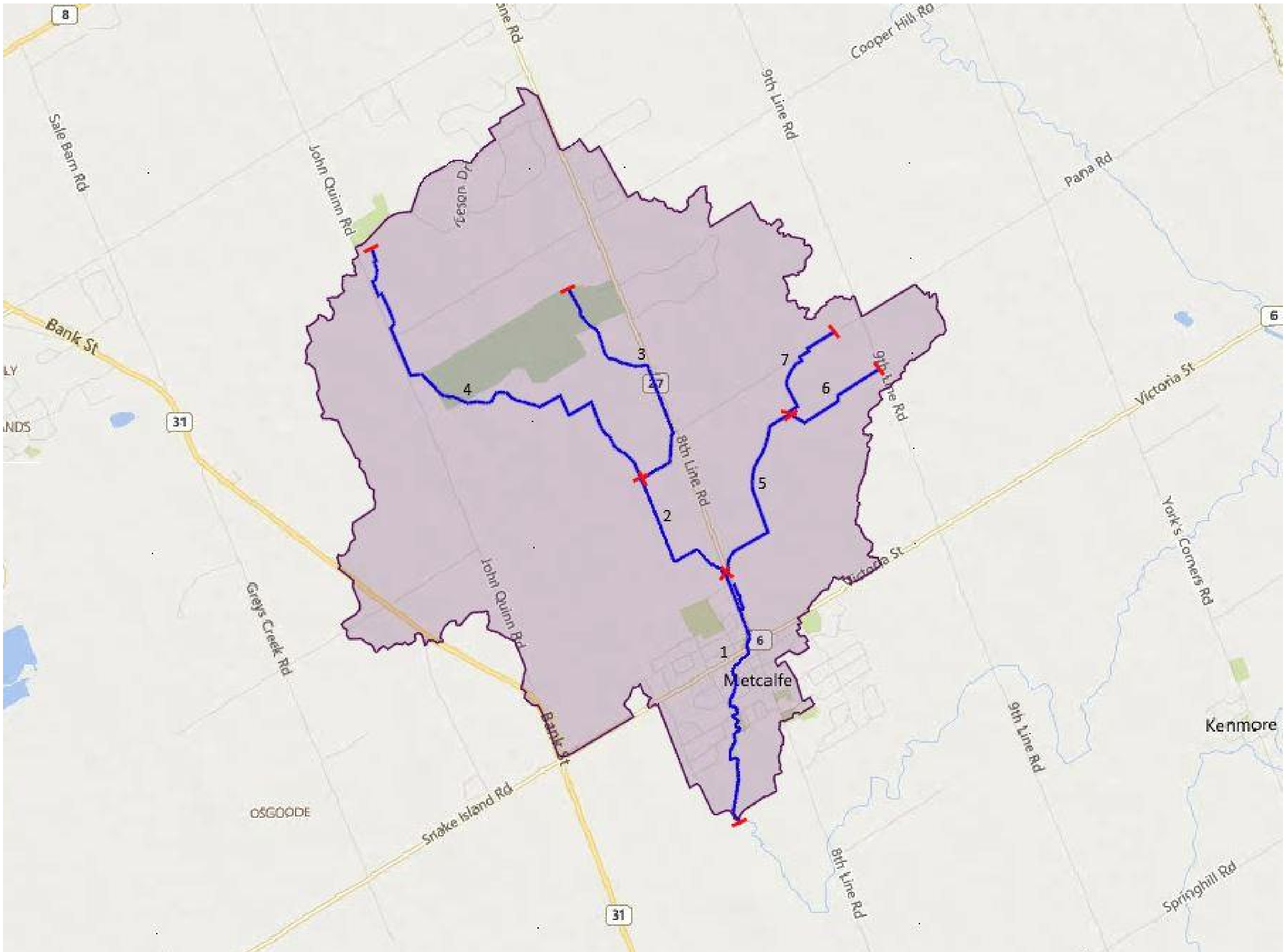


Figure 1 – Drain Reaches

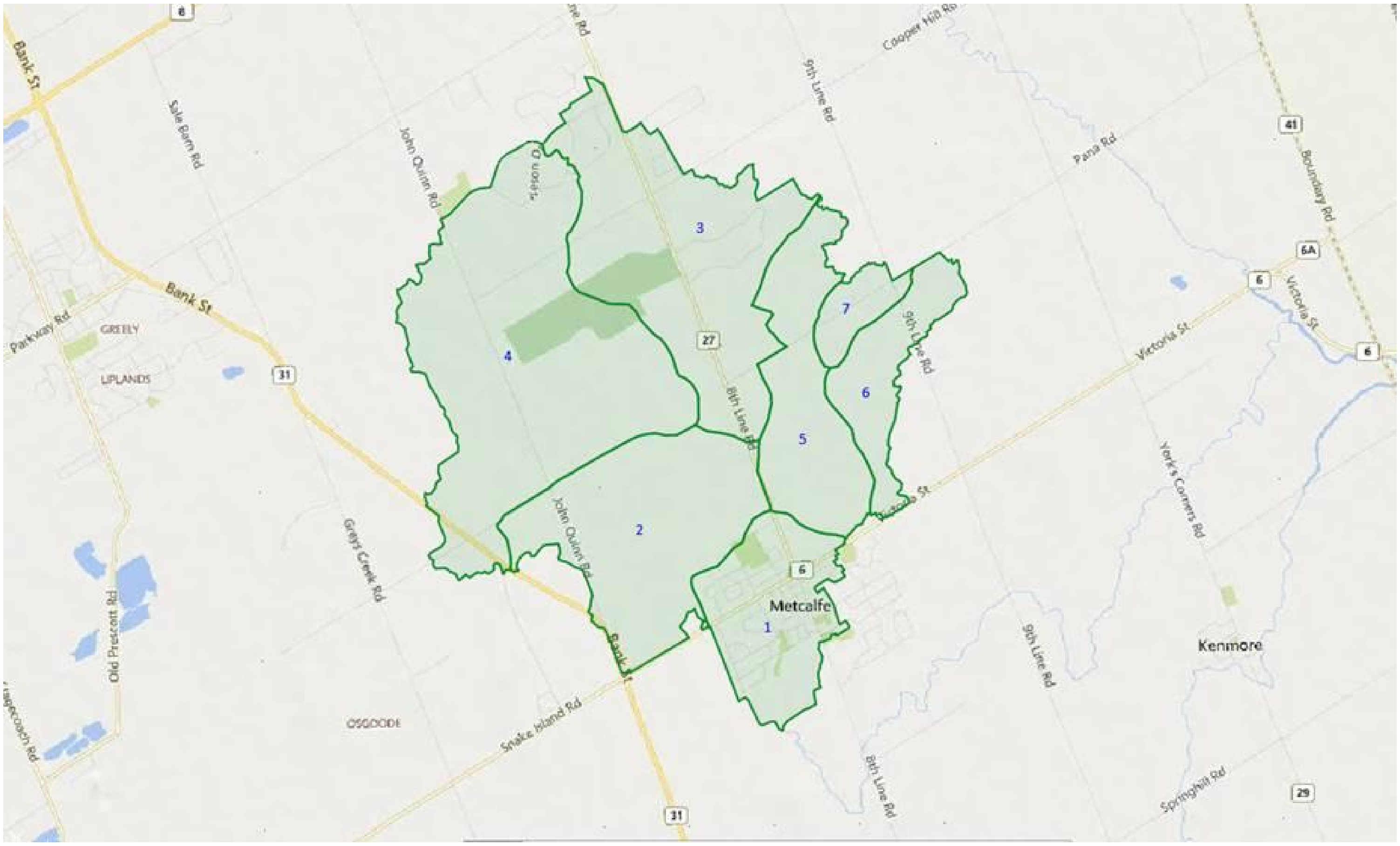


Figure 2 – Sub-catchments

Table 1 - Hydrologic Parameters					
Sub-Catchment ID	Area (ha)	CN Value (AMC II)	Runoff Coefficient (C)	Time to Peak (Tp) (hrs)	Initial Abstraction (Ia) (mm)
1	216.0	81.9	0.4	-	-
2	367.0	70.8	0.3	2.87	5
3	469.0	73.8	0.3	2.90	5
4	686.0	65.6	0.2	3.98	5
5	232.0	75.0	0.3	2.23	5
6	131.0	69.0	0.2	1.72	5
7	53.0	77.3	0.3	1.54	5

Note: Sub-catchment 1 was modelled using the Standhyd command with a total impervious value of 75% and directly connected value of 37.5%

Table 2 - Calculated Flows - Downstream End of Reach 7 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	0.15	0.38	0.50	0.50	0.66	0.66
5	0.27	0.64	0.83	0.83	1.03	1.03
10	0.37	0.85	1.07	1.07	1.31	1.31
25	0.50	1.10	1.37	1.37	1.67	1.67
50	0.61	1.29	1.60	1.60	1.92	1.92
100	0.72	1.52	1.85	1.85	2.18	2.18

* With Storage Reduction Factor

Table 3 - Calculated Flows - Downstream End of Reach 6 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	0.22	0.63	0.84	0.47	1.12	0.63
5	0.43	1.09	1.42	0.80	1.79	1.01
10	0.58	1.45	1.87	1.05	2.33	1.31
25	0.81	1.91	2.42	1.37	3.02	1.71
50	1.00	2.27	2.86	1.62	3.51	1.98
100	1.20	2.69	3.34	1.88	4.02	2.27

* With Storage Reduction Factor

Table 4 - Calculated Flows - Downstream End of Reach 5 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	0.68	2.04	2.71	1.58	3.59	2.09
5	1.30	3.51	4.57	2.66	5.71	3.33
10	1.79	4.66	5.97	3.48	7.39	4.31
25	2.49	6.10	7.70	4.49	9.39	5.47
50	3.07	7.23	8.98	5.23	10.75	6.27
100	3.68	8.49	10.31	6.01	12.11	7.06

* With Storage Reduction Factor

Table 5 - Calculated Flows - Downstream End of Reach 3 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	0.59	1.81	2.39	1.33	3.14	1.75
5	1.10	3.07	3.99	2.22	4.95	2.76
10	1.50	4.05	5.18	2.89	6.38	3.55
25	2.07	5.28	6.62	3.69	8.20	4.57
50	2.53	6.58	7.80	4.35	9.47	5.27
100	3.02	7.33	9.03	5.03	10.77	6.00

* With Storage Reduction Factor

Table 6 - Calculated Flows - Downstream End of Reach 4 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	0.44	1.49	2.06	1.13	2.73	1.50
5	0.85	2.58	3.50	1.93	4.40	2.42
10	1.17	3.46	4.61	2.53	5.74	3.16
25	1.63	4.57	5.96	3.28	7.49	4.12
50	2.01	5.44	7.09	3.90	8.73	4.80
100	2.42	6.46	8.27	4.55	10.02	5.51

* With Storage Reduction Factor

Table 7 - Calculated Flows - Downstream End of Reach 2 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	1.33	4.38	5.89	3.24	7.78	4.28
5	2.55	7.53	9.63	5.30	11.62	6.39
10	3.52	9.67	12.08	6.65	14.40	7.92
25	4.90	12.08	14.89	8.19	18.78	10.33
50	6.02	13.84	17.80	9.79	21.80	11.99
100	7.24	16.11	20.75	11.41	24.88	13.69

* With Storage Reduction Factor

Table 8 - Calculated Flows - Downstream End of Reach 1 (m3/s)						
	VO5 Flows					
Return Period (Yrs)	1 Hour AES	6 Hour SCS	12 Hour SCS	12 Hour SCS	24 Hour SCS	24 Hour SCS
2	5.63	8.33	9.49	5.29	11.71	6.52
5	9.19	12.76	16.03	8.93	17.70	9.86
10	11.32	16.51	18.76	10.45	21.97	12.24
25	14.98	20.30	22.94	12.78	28.14	15.67
50	17.32	23.95	27.06	15.07	31.91	17.77
100	20.57	27.27	30.62	17.05	35.64	19.85

* With Storage Reduction Factor

Table 9 - Cassidy Municipal Drain Channel Assessment								
Hydraulic Reach	5 year Design Flow (m^3/s)	Average Channel Parameters					Maximum Flow (m^3/s)	Conveys Design Flow?
		Bottom width (m)	Depth (m)	Side Slope (H:V)	Profile Slope (%)	Manning's n Value		
1	9.86	1.95	1.35	2.40	0.109%	0.035	5.61	NO
2	6.39	1.55	1.50	2.25	0.118%	0.035	6.39	YES
3	2.76	1.65	1.10	2.30	0.120%	0.035	3.38	YES
4	2.42	1.25	0.90	2.85	0.173%	0.035	2.62	YES
5	3.33	0.95	1.20	2.10	0.158%	0.035	3.50	YES
6	1.01	0.80	1.20	2.20	0.430%	0.035	5.66	YES
7	1.03	0.70	1.10	2.10	0.236%	0.035	3.16	YES

Table 10 - Cassidy Municipal Drain Crossing Assessment

Hydraulic Reach	5 year Design Flow (m^3/s)	Culvert No.	Reference Alignment	Start Station	End Station	Length (m)	Upstream invert (m)	Downstream Invert (m)	Culvert Type	Culvert Span/ Diameter (mm)	Culvert Height (m)	Minimum Top of Road (m)	Maximum Flow at Road Elevation (m^3/s)	Conveys Design Flow Prior to Road Overtopping?	Comment
1	9.86	C1	Cassidy Drain	0+185.3	0+180.2	5.1	79.18	79.1	CP	850	-	80.03	1.0	NO	
1	9.86	Byron Street	Cassidy Drain	1+550					Bridge						Bridge assume it can convey the 5 Year flow
1	9.86	Derby Street	Cassidy Drain	1+720					Bridge						Bridge assume it can convey the 5 Year flow
1	9.86	Bowen Street	Cassidy Drain	1+830					Bridge						Bridge assume it can convey the 5 Year flow
1	9.86	Victoria Street	Cassidy Drain	1+1910					Bridge						Bridge assume it can convey the 5 Year flow
1	9.86	C13/ Bruce Street	Cassidy Drain	2+034.6	2+013.3	21.3	81.49	81.42	SPCSPA	4900	2400	84.2	16.7	YES	Modelled as 4302 mm by 2672 mm
1	9.86	C16	Cassidy Drain	2+192.8	2+160.7	32.2	81.41	81.46	CP	2000		83.8	13.0	YES	Twin culvert under entrance
1		C17	Cassidy Drain	2+192.9	2+160.8	32.1	81.31	81.50	CP	2000		83.8			Twin culvert under entrance
1	9.86	C19	Cassidy Drain	2+418.7	2+369.2	49.5	82.06	81.96	CP	1700		84.0	7.0	NO	Twin culvert under entrance
1		C20	Cassidy Drain	2+418.7	2+369.2	49.5	82.09	82.01	CP	1700		84.0			Twin culvert under entrance
1	9.86	C22/ Andrew Simpson Drive	Cassidy Drain	2+533.4	2+518.6	14.8	78.54	78.34	RFB	4300	4300	83.7	11.0	YES	Assessed as embedded 3.53 m
2	6.39	C24	Cassidy Drain	2+955.3	2+949.1	6.2	81.70	81.78	CSP	500		82.4	0.5	NO	Twin culvert under crossing
2		C25	Cassidy Drain	2+955.4	2+949.3	6.1	81.57	81.77	CSP	500		82.4			Twin culvert under crossing
2	6.39	C26	Cassidy Drain	3+243.9	3+239.0	4.9	82.40	82.13	Boiler Drum	2000		84.4	6.8	YES	
2	6.39	C28	Cassidy Drain	3+649.7	3+640.8	8.9	81.27	81.20	CSP	3200		84.5	9.0	YES	
3	2.76	C30	Cassidy Drain	4+332.5	4+324.7	7.7	83.70	83.24	Boiler Drum	1700		85.4	4.5	YES	
3	2.76	C33	Cassidy Drain	4+739.2	4+729.3	9.9	84.00	83.95	CSP	1220		85.6	2.5	NO	
3	2.76	C34	Cassidy Drain	4+859.7	4+849.7	10.1	84.43	84.00	CSP	1100		85.8	2.0	NO	
3	2.76	C35	Cassidy Drain	4+959.8	4+954.9	4.9	84.48	84.48	CSP	1500		86.0	3.0	YES	
3	2.76	C37	Cassidy Drain	5+056.2	5+048.3	7.9	84.27	84.30	CSP	2000		86.4	4.0	YES	Mostly silted in effective in vert 85.0 m Assessed as embedded 0.7 m
3	2.76	C38	Cassidy Drain	5+077.6	5+068.4	9.2	85.04	84.88	CSP	1000		86.3	1.5	NO	
3	2.76	C39	Cassidy Drain	5+107.4	5+096.9	10.5	85.11	85.00	CSP	1200		86.8	2.7	NO	

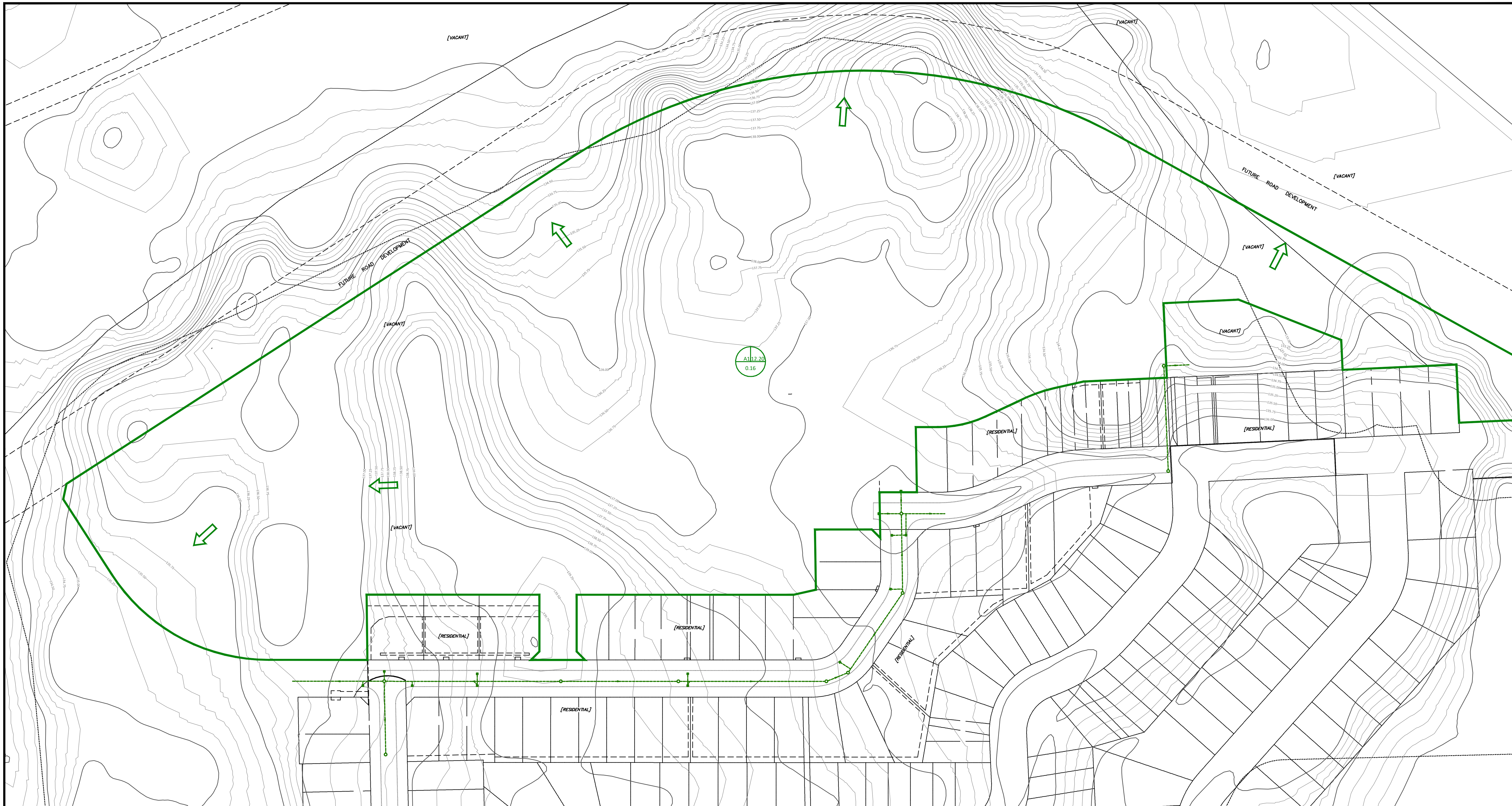
Table 10 - Cassidy Municipal Drain Crossing Assessment

Hydraulic Reach	5 year Design Flow (m^3/s)	Culvert No.	Reference Alignment	Start Station	End Station	Length (m)	Upstream invert (m)	Downstream Invert (m)	Culvert Type	Culvert Span/ Diameter (mm)	Culvert Height (m)	Minimum Top of Road (m)	Maximum Flow at Road Elevation (m^3/s)	Conveys Design Flow Prior to Road Overtopping?	Comment
3	2.76	C40	Cassidy Drain	5+128.6	5+119.5	9.2	84.78	84.97	CSP	1200		86.8	3.0	YES	
3	2.76	C41	Cassidy Drain	5+159.4	5+149.5	9.9	85.14	84.94	CSP	1200		87.0	2.8	NO	
3	2.76	C42	Cassidy Drain	5+204.4	5+193.9	10.5	84.26	85.48	CSP	1100		87.1	3.2	YES	Sever reverse slope on pipe
3	2.76	C43	Cassidy Drain	5+214.4	5+240.4	26.0	85.46	85.45	Boiler Drum	1200		87.0	2.0	NO	
3	2.76	C44	Cassidy Drain	5+420.2	5+414.3	5.9	85.81	85.71	CSP	1150		87.0	1.6	NO	
3	2.76	C45	Cassidy Drain	5+749.9	5+746.3	3.6	85.64	85.70	CSP	800		86.5	0.7	NO	
3	2.76	C46	Cassidy Drain	5+906.5	5+902.9	3.6	86.05	85.90	CSP	1000		87.1	1.0	NO	
3	2.76	C47	Cassidy Drain	5+995.7	5+989.0	6.6	85.70	85.58	Smooth Wall	900		87.1	1.6	NO	
3	2.76	C48	Cassidy Drain	6+086.5	6+080.7	5.8	85.73	85.74	CSP	850		86.8	1.0	NO	
3	2.76	C49	Cassidy Drain	6+149.0	6+143.8	5.2	85.47	85.30	CSP	1660		87.0	3.5	YES	Effective invert immediately d/s 86.5 m
3	2.76	C50	Cassidy Drain	6+241.5	6+234.9	6.5	85.64	85.41	CSP	1000		87.1	1.7	NO	
3	2.76	C51	Cassidy Drain	6+301.3	6+262.9	38.3	85.99	85.48	CSP	1000		87.0	1.2	NO	
3	2.76	C52	Cassidy Drain	6+346.9	6+341.1	5.9	85.85	85.85	CSP	1000		87.0	1.0	NO	
4	2.42	C29	McCooeye Branch	4+042.2	4+040.2	7.2	83.58	83.08	CSP	900		84.7	1.1	NO	At confluence with Cassidy Drain
4	2.42	C53	McCooeye Branch	7+492.1	7+485.8	6.3	84.21	84.30	CSP	1200		85.6	2.0	NO	
4	2.42	C54	McCooeye Branch	7+782.8	7+778.0	4.8	84.28	84.62	CSP	1200		85.9	2.4	NO	No cover
4	2.42	C55	McCooeye Branch	8+205.1	8+199.3	5.8	84.56	84.61	CSP	1000		85.8	3.8	YES	No cover - Twin culvert under crossing
4		C56	McCooeye Branch	8+205.1	8+199.3	5.8	84.66	84.56	CSP	1000		85.8			No cover - Twin culvert under crossing
4	2.42	C57	McCooeye Branch	8+851.8	8+845.6	6.2	85.70	85.68	HDPE	600		86.3	0.8	NO	No cover - Twin culvert ub=nder crossing
4		C58	McCooeye Branch	8+851.8	8+845.6	6.2	85.70	85.67	HDPE	600		86.3			No cover - Twin culvert ub=nder crossing
4	2.42	C59	McCooeye Branch	9+385.9	9+380.1	5.8	87.46	87.48	CSP	900		88.4	0.8	NO	No cover

Table 10 - Cassidy Municipal Drain Crossing Assessment

Hydraulic Reach	5 year Design Flow (m^3/s)	Culvert No.	Reference Alignment	Start Station	End Station	Length (m)	Upstream invert (m)	Downstream Invert (m)	Culvert Type	Culvert Span/ Diameter (mm)	Culvert Height (m)	Minimum Top of Road (m)	Maximum Flow at Road Elevation (m^3/s)	Conveys Design Flow Prior to Road Overtopping?	Comment
4	2.42	C60	McCooeye Branch	9+440.3	9+434.8	5.5	87.38	87.55	CSP	900		88.5	1.0	NO	No cover
4	2.42	C61	McCooeye Branch	9+563.7	9+558.4	5.3	87.96	87.98	CSP	750		89.2	0.9	NO	
4	2.42	C63/Cooper Hil Road	McCooeye Branch	10+241.0	10+229.7	11.3	88.70	88.65	CSP	800		89.9	1.0	NO	
4	2.42	C64	McCooeye Branch	10+561.1	10+557.0	4.1	89.00	88.92	HDPE	450		89.5	0.3	NO	No cover
4	2.42	C65	McCooeye Branch	10+844.9	10+840.7	4.1	89.57	89.65	CSP	400		90.1	0.2	NO	No cover
5	3.33	C23	Graham Branch	2+642.4	2+642.0	19.9	81.38	81.38	CSP	2100		84.0	9.0	YES	At confluence with Cassidy Drain
5	3.33	C66	Graham Branch	12+091.2	12+082.4	8.8	81.74	81.79	CSP	1600		83.9	5.0	YES	
5	3.33	C67	Graham Branch	12+980.6	12+971.0	9.5	83.07	82.99	CP	900		84.0	0.8	NO	No cover
5	3.33	C68	Graham Branch	13+309.0	13+303.1	5.9	83.43	83.46	CSP	1200		84.8	2.0	NO	
6	1.01	C69/Ninth Line Road	Graham Branch	14+804.3	14+790.4	13.9	88.57	88.59	CSP	750		90.0	1.0	NO	
7	1.03	C70	Walker Branch	15+307.6	15+301.7	5.9	85.08	85.36	CSP	700		86.0	0.6	NO	
7	1.03	C71/Pana Road	Walker Branch	15+763.5	15+750.4	13.1	86.29	86.36	CSP	800		89.2	1.8	YES	
	0.06	C18	Fitzsimmons Branch	2+277.0	2+284.1	19.8	82.10	81.94	CSP	1100		83.9	2.4	YES	At confluence with Cassidy Drain
	0.06	C72	Fitzsimmons Branch	17+106.1	17+100.5	5.6	81.49	81.81	CSP	600		83.3	0.8	YES	

APPENDIX F
STORMWATER MANAGEMENT DESIGN



SCALE 1 : 2000

0 50 100 150 200 Metres

LEGEND

LOCATION I.D. — AREA (ha)

123F | 0.25
0.60
0.75

AVERAGE COEFFICIENT
5-year
100-year

N

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Client:
PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

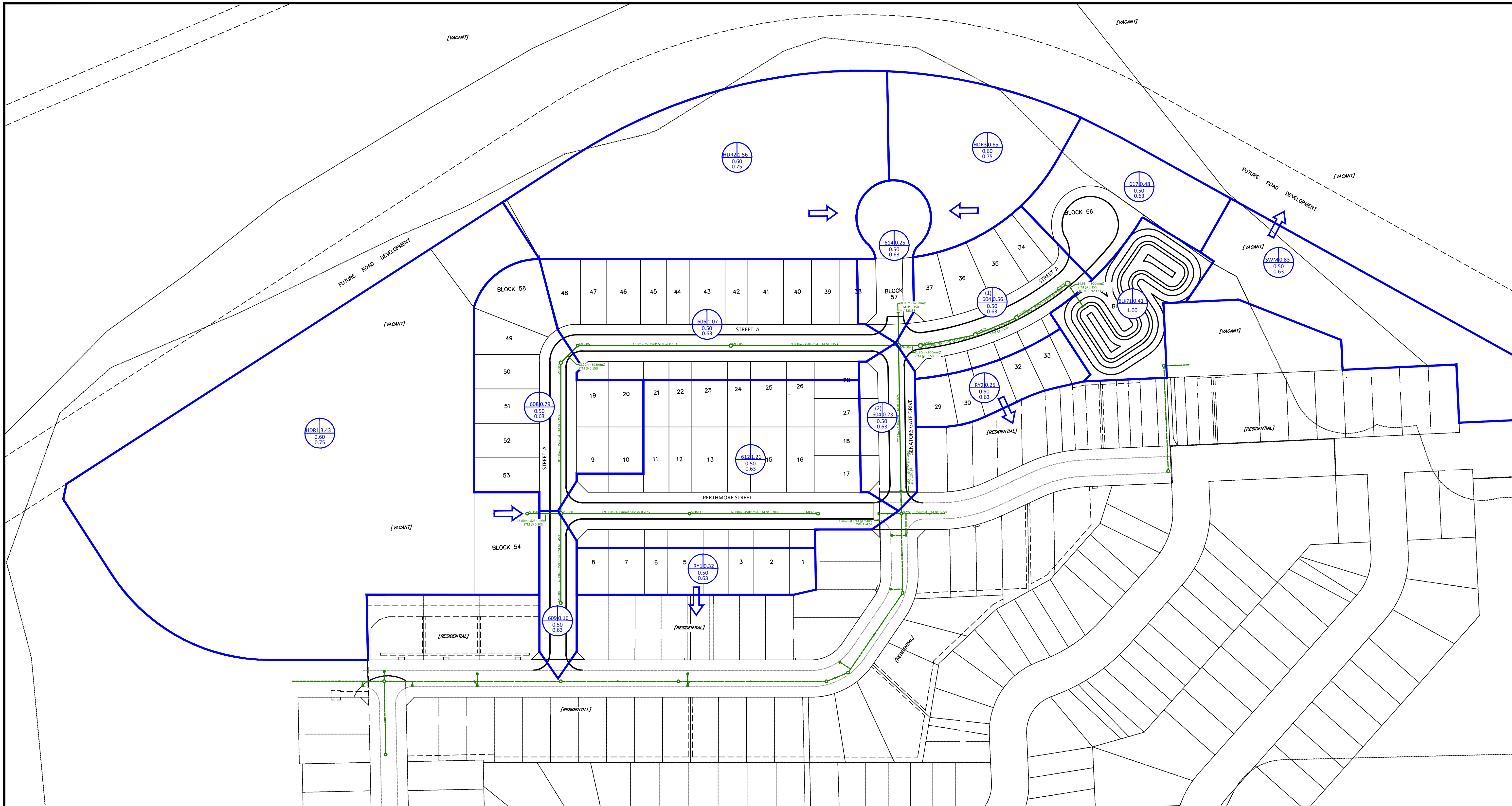
Project:
PERTHMORE SUBDIVISION PHASE 6

Drawing Title:
PRE-DEVELOPMENT DRAINAGE AREA PLAN

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale:	Project Number:
1:2000	PP-13-9668-01

No.	Revisions	Date
1	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022

Drawing Number:
PRE



SCALE 1 : 2000

0 50 100 150 200 Metres

LEGEND

LOCATION I.D. — AREA (ha)

123F | 0.25

0.60

0.75

AVERAGE COEFFICIENT
5-year
100-year

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Client: PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

Project: PERTHMORE SUBDIVISION PHASE 6

Drawing Title: POST-DEVELOPMENT DRAINAGE AREA PLAN

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale: 1:2000	Project Number: PP-13-9668-01

No.	Revisions	Date
1	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022

Drawing Number: POST

FILENAME: I:\Ottawa\01 Project - Proposals\2013 Jobs\PP\PP-13-9668-01 Perthmore Development Co_Perthmore Subdivision\03-Drawings\Production\PP-13-9668-01_Drawings.dwg
LAST SAVED: Wednesday, August 03, 2022 LAST SAVED BY: c.hampel
LAST PLOTTED: Thursday, August 04, 2022 CTB FILE USED: ----

LEGEND

139.40	FINISHED ELEVATION
138.28	EXISTING ELEVATION

SCALE 1 : 2000

0 50 100 150 200 Metres

FILENAME: U:\Ottawa\01 Project - Proposals\2013 Jobs\PP\PP-13-9668-01 Perthmore Development Co_Perthmore Subdivision\03-Drawings\Production\PP-13-9668-01_Drawings.dwg
LAST SAVED: Wednesday, August 03, 2022 LAST SAVED BY: c.hampel
LAST PLOTTED: Thursday, August 04, 2022 CTB FILE USED: ----

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Client:
PERTHMORE DEVELOPMENT CO.
80 DUFFERIN STREET PERTH, ON K7H 3M6

Project:
PERTHMORE SUBDIVISION PHASE 6

Drawing Title:
LOT GRADING & DRAINAGE PLAN

Drawn by:	Checked By:
P.G.K.	B.S.C.
Scale:	Project Number:
1:2000	PP-13-9668-01

No.	Revisions	Date
2	ISSUED FOR DRAFT PLAN APPROVAL	AUG. 03, 2022
1	ISSUED FOR DRAFT PLAN APPLICATION	DEC. 18, 2020

Drawing Number:
200

CCO-13-9668-01 - PERTHMORE SUBDIVISION - PRE-DEVELOPMENT

Values

Land Use	Pasture	Pasture	Forest	Forest
Hydrologic Soil Group	B	C	B	C
Runoff Coefficients*	0.1	0.28	0.08	0.25
CN Values**	59	75	60	73
IA (mm)	5	5	10	10

* Design Chart 1.07 MTO Drainage Management Manual
** Design Chart 1.09 MTO Drainage Management Manual

Land Use

Drainage Area ID	Total Area (ha)	Pasture	Pasture	Forest	Forest	Weighted CN Value	Weighted C Value	Weighted IA Value
		B	C	B	C			
		Sub-Area (ha)	Sub-Area (ha)	Sub-Area (ha)	Sub-Area (ha)			
A1	12.2	5.45	1.76	1.56	3.2	64.0	0.16	6.9

Airport Formula

For use when the runoff coefficient is less than 0.4

$$t_c = 3.26 * (1.1 - C) * L^{0.5} * S_w^{-0.33}$$

Where

tc = time of concentration in minutes
C = runoff coefficient
L = watershed length in metres
S_w = watershed slope in %

Source: MTO Drainage Manual 1997 - Chapter 8, page 28

A1

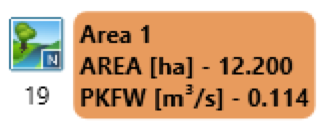
C =	0.16		T_c =	54.6	min	T_p =	36.6	min
L =	435	m	T_c =	0.91	hours	T_p =	0.61	hours
S_w =	1.61	%						

$T_p = 0.67\ T_c$

CCO-13-9668-01 - PERTHMORE SUBDIVISION - PRE-DEVELOPMENT RESULTS

	12 hour SCS	4 hour Chicago
Return Period	Area 1	Area 1
Yrs	m^3/s	m^3/s
2	0.11	0.05
5	0.21	0.11
10	0.28	0.15
25	0.38	0.21
50	0.46	0.26
100	0.56	0.32

Pre-Development



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info@mcintoshperry.com www.mcintoshperry.com

CCO-13-9668-01 - PERTHMORE SUBDIVISION - POST-DEVELOPMENT

Values

Land Use	Pasture	Pasture	Forest	Forest
Hydrologic Soil Group	B	C	B	C
Runoff Coefficients*	0.1	0.28	0.08	0.25
CN Values**	59	75	60	73
IA (mm)	5	5	10	10

* Design Chart 1.07 MTO Drainage Management Manual

** Design Chart 1.09 MTO Drainage Management Manual

					Pervious Area					Impervious Area				
	Sub-Catchment	Area	Total Imperviousness	Directly Connected	CN	Slope	Flow Length	Manning's n	Ia	Slope	Flow Length (measured)	Flow Length[3]	Manning's n	Depression Storage
		ha	%	%		%	m		mm	%	m			mm
1	West Block[6]	3.43	70.0	60.0	59.0	2.0	10.0	0.25	5.0	1.0	150.0	151.2	0.013	1.0
2	Central Block[6]	1.56	70.0	60.0	59.0	2.0	10.0	0.25	5.0	1.0	150.0	102.0	0.013	1.0
3	East Block[6]	0.65	70.0	60.0	75.0	2.0	10.0	0.25	5.0	1.0	100.0	65.8	0.013	1.0
4	Block 70	0.83	0.0	0.0	75.0	2.0	10.0	0.25	10.0	1.0	75.0	74.4	0.013	1.0
5	SWM Block[4,6]	0.41	0.0	0.0	75.0	2.0	10.0	0.25	5.0	1.0	50.0	52.3	0.013	1.0
6	Developed Portions[5,6]	5.32	50.0	35.0	59.0	2.0	10.0	0.25	5.0	1.0	350.0	188.3	0.013	1.0

Notes 1 -0 Airport Formula
2 - 0.67* Tc
3 - Flow Length = SquareRoot (Area/1.5) - (Area in square metres)
4 - Block 71
5 - 604(1) - 0.56ha, 604(2) - 0.23ha, 606 - 1.07ha, 608 - 0.79ha, 609 - 0.16ha, 612 - 1.21ha, 614 - 0.25ha, 617 - 0.48ha, RY1 - 0.32ha and RY2 - 0.25ha
6 - To Pond

Storage Requirements

Facility Type: Wet Pond
Level of Protection: Enhanced

%Imperviousness
46%

Req'd Permanent Pool Storage Volume

Vs = 85 m^3/ha
Vs = 966 m^3

(Table 3.2, p. 3-10, SWMP Manual - 165m3/ha - 80m3/ha)

Given the upstream individual storage requirements from Blocks 67, 68 and 69, the MECP SWMP Manual notes that the extended detention is increased to account for upstream storage)

Req'd Extended Detention Volume

Ved = 80 m^3/ha
Ved = 458 m^3

MECP SWMP Manual - Section 3.3.2.

It should be noted that the total drainage area contributing to the facility should be included in sizing (lumped imperviousness or separate calculations for internal and external drainage areas is permissible) in most cases. The exception occurs when an external drainage area is itself controlled by a separate water quality facility (and erosion and quantity control are either not required or provided separately). Modelling studies (Marshall Macklin Monaghan Limited, 1997) indicate comparable combined long-term removal rates for ponds in series and separate parallel ponds. More frequent overflows will occur from the most downstream pond, but this can be compensated for by doubling the water quality active storage volume from 40 to 80 m³/ha.

CCO-13-9668-01 - PERTHMORE SUBDIVISION - POST-DEVELOPMENT - RESULTS - UNCONTROLLED

12 hour SCS							
Return Period	West Block	Central Block	East Block	Block 70	Swm Block	Developed Portions	Total
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.215	0.17	0.08	0.02	0.01	0.18	0.68
5	0.306	0.23	0.11	0.04	0.02	0.28	0.99
10	0.384	0.27	0.13	0.06	0.03	0.36	1.23
25	0.481	0.34	0.16	0.08	0.04	0.45	1.54
50	0.551	0.38	0.18	0.09	0.04	0.54	1.79
100	0.634	0.44	0.20	0.11	0.05	0.63	2.06

4 hour Chicago							
Return Period	West Block	Central Block	East Block	Block 70	Swm Block	Developed Portions	Total
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.228	0.19	0.09	0.01	0.00	0.15	0.67
5	0.315	0.26	0.12	0.02	0.01	0.22	0.94
10	0.374	0.32	0.15	0.03	0.01	0.29	1.17
25	0.461	0.38	0.18	0.04	0.02	0.37	1.45
50	0.523	0.43	0.20	0.05	0.02	0.42	1.65
100	0.587	0.48	0.23	0.06	0.03	0.48	1.86

CCO-13-9668-01 - PERTHMORE SUBDIVISION - POST-DEVELOPMENT - RESULTS - CONTROLLED

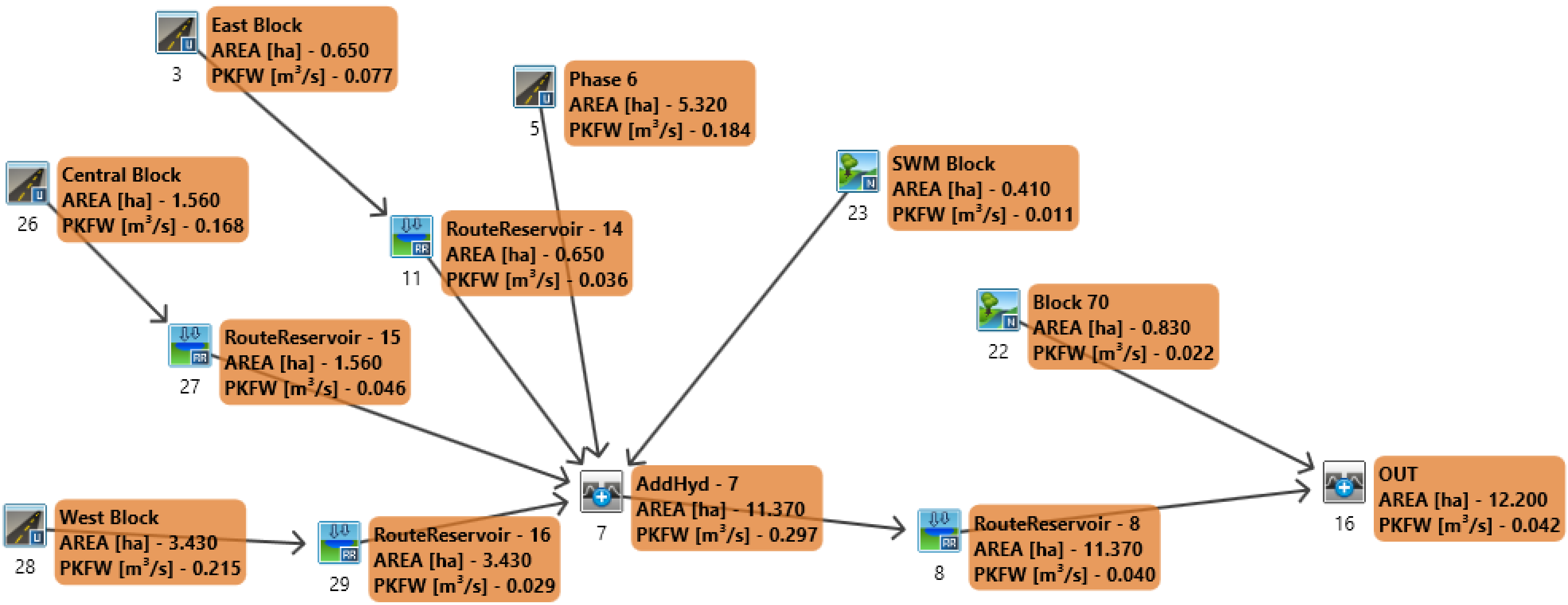
12 hour SCS								
Return Period	West Block[1]	Central Block[1]	East Block[1]	Block 70	Swm Block	Developed Portions	Outflow From Pond	Outflow From Site
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.03	0.05	0.08	0.02	0.01	0.18	0.04	0.04
5	0.04	0.06	0.11	0.04	0.02	0.28	0.11	0.11
10	0.05	0.07	0.13	0.06	0.03	0.36	0.16	0.17
25	0.06	0.09	0.16	0.08	0.04	0.45	0.24	0.25
50	0.07	0.10	0.18	0.09	0.04	0.54	0.29	0.30
100	0.08	0.12	0.20	0.11	0.05	0.63	0.33	0.35

4 hour Chicago								
Return Period	West Block[1]	Central Block[1]	East Block[1]	Block 70	Swm Block	Developed Portions	Outflow From Pond	Outflow From Site
Yrs	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
2	0.02	0.04	0.09	0.01	0.00	0.15	0.03	0.03
5	0.03	0.05	0.12	0.02	0.01	0.22	0.04	0.04
10	0.04	0.06	0.15	0.03	0.01	0.29	0.09	0.09
25	0.05	0.07	0.18	0.04	0.02	0.37	0.14	0.15
50	0.05	0.08	0.20	0.05	0.02	0.42	0.18	0.19
100	0.06	0.09	0.23	0.06	0.03	0.48	0.22	0.23

Notes

1. West, Central and East Blocks to be restricted.

Post-Development - V05



CCO-13-9668-01 - PERTHMORE SUBDIVISION - POST-DEVELOPMENT - RESULTS - CONTROLLED

12 hour SCS			
	POST	PRE	
Return Period	Outflow From Site	Outflow from Site	Post to Pre
Yrs	m^3/s	m^3/s	Δ
2	0.04	0.11	-0.07
5	0.11	0.21	-0.10
10	0.17	0.28	-0.11
25	0.25	0.38	-0.13
50	0.30	0.46	-0.17
100	0.35	0.56	-0.21

4 hour Chicago			
	POST	PRE	
Return Period	Outflow From Site	Outflow from Site	Post to Pre
Yrs	m^3/s	m^3/s	Δ
2	0.03	0.05	-0.02
5	0.04	0.11	-0.06
10	0.09	0.15	-0.06
25	0.14	0.21	-0.07
50	0.18	0.26	-0.08
100	0.23	0.32	-0.09

CCO-13-9668-01 - PERTHMORE SUBDIVISION - STAGE / STORAGE / DISCHARGE TABLE

VO6 Route Reservoir Input - Rating Curve

Stage (m)	Discharge (m^3/s)	Storage (ha.m)	Storage (m^3)	
133.36	0	0.0000	0	
133.46	0.004	0.0120	120	
133.56	0.005	0.0253	253	
133.66	0.006	0.0399	399	
133.76	0.007	0.0559	559	
133.86	0.008	0.0732	732	
133.96	0.024	0.0918	918	25mm Event
134.06	0.031	0.1116	1116	
134.16	0.036	0.1321	1321	
134.26	0.041	0.1535	1535	
134.36	0.045	0.1758	1758	
134.46	0.198	0.1989	1989	5year
134.56	0.263	0.2228	2228	
134.66	0.313	0.2476	2476	
134.76	0.356	0.2733	2733	100year
134.86	0.394	0.2998	2998	
134.96	0.429	0.3263	3263	
135.06	0.461	0.3528	3528	

For Orifice Flow, C =	0.60
For Weir Flow, C =	1.84

	Orifice 1	Orifice 2	Orifice 3
Invert Elevation	133.36	133.86	134.36
Center of Crest Elevation			
Orifice Width/Weir Length	75 mm	150 mm	475 mm
Orifice Height			
Orifice Area (m^2)	0.004	0.018	0.177

Elevation	Orifice 1		Orifice 2		Orifice 3		Total
	H [m]	Q [l/s]	H [m]	Q [l/s]	H [m]	Q [l/s]	Q [l/s]
133.36	0.00	0					0
133.46	0.10	4					4
133.56	0.20	5					5
133.66	0.30	6					6
133.76	0.40	7					7
133.86	0.50	8					8
133.96	0.60	9	0.10	15			24
134.06	0.70	10	0.20	21			31
134.16	0.80	11	0.30	26			36
134.26	0.90	11	0.40	30			41
134.36	1.00	12	0.50	33			45
134.46	1.10	12	0.60	36	0.10	149	198
134.56	1.20	13	0.70	39	0.20	211	263
134.66	1.30	13	0.80	42	0.30	258	313
134.76	1.40	14	0.90	45	0.40	298	356
134.86	1.50	14	1.00	47	0.50	333	394
134.96	1.60	15	1.10	49	0.60	365	429
135.06	1.70	15	1.20	51	0.70	394	461

Notes: 1. For Orifice Flow, User is to Input an Elevation Higher than Crown of Orifice.

*2. Orifice Equation: $Q = cA(2gh)^{1/2}$ (m^3/s *1000 = l/s)*

*3. Weir Equation: $Q = CLH^{3/2}$ (m^3/s *1000 = l/s)*

4. These Computations Do Not Account for Submergence Effects

5. H for orifice equations is depth of water above the centroide of the orifice.

6. H for weir equations is depth of water above the weir crest.

Reference: Urban Hydrology, Hydraulics and Stormwater Quality: engineering application and computer modeling / A. Akan, Robert J. Houghtalen, 2003.

CCO-13-9668-01 - PERTHMORE SUBDIVISION - EXTENDED DETENSION AND DRAWDOWN

Table E-3

As per the Section 4.6.2 (Wet Ponds) of the MECP Stormwater Management Planning and Design Manual, March 2003, a detention time of 24 hours should be targeted in all instances. The detention time can be easily solved if the relationship between pond surface area and pond depth is approximated using a linear regression equation as follows:

A1 **Drawdown Time Equation ---->**

$$t = \frac{0.66\, C_2\, h^{1.5} + 2\, C_3\, h^{0.5}}{2.75\, A_o}$$

Equation 4.11 (MECP SWM Planning Design Manual, 2003)

where,

t = Drawdown time in seconds

C_2 = Slope coefficient from the area-depth linear regression

C_3 = Intercept from the area-depth linear regression

h = Maximum water elevation above the orifice (m)

A_o = Cross-sectional area of the orifice (m^2)

The relationship between A and h using Linear Regression (i.e., $A = C_2 h + C_3$)

Orifice Details:

Orifice Diameter =	75 mm	150 mm
Orifice Invert Elevation =	133.36 m	133.86 m

Active Storage Pond Details:

Active Storage Elevation (m)	Max Water Elevation Above Orifice (m)	Surface area of the Pond (m^2)	
133.36	0.00	1,374.00	Permanent Pool Level
133.46	0.10	1,452.00	
133.76	0.40	1,691.00	Extended Detention
133.86	0.50	1,772.00	150mm orifice
133.96	0.60	1,852.00	25mm event

Drawdown Time Results (During Construction):	Extended Detention	25mm Event	
Orifices	75 mm	75 mm	150 mm
Slope (C_2) =	793	793	800
Intercept (C_3) =	1,373	1,373	1,372
Maximum Water Elevation Above Orifice (h) =	0.40 m	0.40 m	0.20 m
Therefore, A =	1,691	1,691	1,532
Cross-sectional area of the orifice (A_o) =	0.004 m2	0.004 m2	0.018 m2
Drawdown time	153,899 s	153,899 s	26,224 s
Drawdown Time	**43 hrs**	**43 hrs**	**8 hrs**
		51 hrs	

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CCO-13-9668-01 - PERTHMORE SUBDIVISION - STORMWATER MANAGEMENT POND FOREBAY AND PERMANENT POOL STORAGE VOLUME

Cell 1		
Elevation (m)	Total Storage (m^3)	
131.76	0	
131.86	9	
131.96	20	
132.06	32	
132.16	47	
132.26	64	
132.36	82	
132.46	103	
132.56	127	
132.66	153	
132.76	181	*Top of forebay*

Cell 2	
Elevation (m)	Total Storage (m^3)
131.26	0
131.36	6
131.46	14
131.56	23
131.66	34
131.76	46
131.86	60
131.96	76
132.06	93
132.16	113
132.26	134
132.36	158
132.46	183
132.56	211
132.66	241
132.76	274
132.86	353
132.96	441
133.06	535
133.16	638
133.26	747
133.36	867

Combined		
Elevation (m)	Total Storage (m^3)	
131.26	0	
131.36	6	
131.46	14	
131.56	23	
131.66	34	
131.76	46	
131.86	60	
131.96	76	
132.06	93	
132.16	113	
132.26	134	
132.36	158	
132.46	183	
132.56	211	
132.66	241	
132.76	454	
132.86	534	
132.96	621	
133.06	716	
133.16	818	
133.26	928	
133.36	1048	*Top of Permanent Pool*

1. Forebay Storage Volumes

A conservative estimate for forebay volume is equal to or greater than ten (10) years of sediment accumulation.
The conservative estimate for minimum forebay volume based on ten (10) times the sediment accumulation is 143 m3.
The total forebay volume is 181 m3.
Therefore, the forebay volume meets the conservative minimum requirements for total volume.

2. Permanent Pool Storage Volumes

Total Permanent Pool Volume Required = **966** m^3
Total Permanent Pool Volume Provided = 1048 m^3
Therefore, the permanent pool volume provided is greater than the required volume.

3. Settling Length

Distance = $\frac{rQ_p}{V_s}$ Equation 4.5 : Settling Length, MECP SMPDM, March 2003

Length-to-Width Ratio --->	r =	2	(recommended)
Peak Flow Rate --->	Q_p =	0.18 m^3/s	(quality storm outflow --- 25mm storm event)
Settling Velocity --->	V_s =	0.0003 m/s	(recommended)

Distance = 35 m Settling Length (based on settling particles of approx. 0.15mm diameter)

4. Dispersion Length

Distance = $\frac{(8Q)}{dV_f}$ Equation 4.6 : Dispersion Length, MECP SMPDM March 2003

Inlet Flow Rate --->	Q =	0.44 m^3/s	(5 year Post)
Depth of Permanent Pool --->	d =	1.00 m	(in Forebay)
Settling Velocity --->	V_f =	0.5 m/s	(recommended)

Distance = 7 m Length of dispersion (based on pipe full flow capacity)

The forebay should be 35 m long to settle particles and for pipe full flow dispersion.
The forebay length provided in the proposed pond design is 40 m long for particle settlement and dispersion.
Therefore, the forebay length meets the minimum requirements for particle settlement and dispersion

5. Forebay Width

Width =	$\frac{\text{Dist.}}{8}$	Equation 4.7 : Minimum Forebay Bottom Width	
Width =	$\frac{35}{8}$	=	4 m

The forebay deep zone should be at least 4 m wide.
The forebay deep zone width provided in the proposed pond design is 4 m wide.
Therefore, the forebay deep zone provided meets the minimum requirements for bottom width.

6. Forebay Surface Area

In all instances the forebay surface area should not exceed one-third (33.3 %) of the total permanent pool area:

Forebay surface area =	344	m^2
Permanent Pool surface area =	1374	m^2
The forebay surface area is	25.0%	of the pond surface area

Therefore, the pond surface area meets the MECP requirements.

7. Forebay Volume

In all instances the forebay volume should not exceed 20% of the total permanent pool volume:

Forebay volume =	181	m^3
Total Permanent Pool Volume =	1048	m^3
The forebay volume is --->	17%	of the total permanent pool volume

Therefore, the pond volume meets the MECP requirements.

CCO-13-9668-01 - PERTHMORE SUBDIVISION - STORMWATER MANAGEMENT POND CLEANOUT FREQUENCY

Catchment Imperviousness	Annual Loading (kg/ha)	Wet Density (kg/m^3)	Annual Loading (m^3/ha)
35%	770	1,230	0.6
55%	2,300	1,230	1.9
70%	3,495	1,230	2.8
85%	4,680	1,230	3.8

Requirements		Pond 1	Units
Catchment Imperviousness	=	50%	
Sediment Loading Per 1-Year	=	1.6	m^3/ha
Total Area to Pond	=	11.4	ha
Yearly Sediment to Pond	=	17.9	m^3
Initial Removal Efficiency	=	80%	
Yearly Accumulation in Pond	=	14.3	m^3
Required Quality Volume	=	*140*	m^3/ha
Required Permanent Pool Volume [(140 - 80 Extended Detention) x Total Area]	=	682	m^3
Permanent Pool Volume Provided	**=**	**1,048**	**m^3**
Required Quality Volume @ 5% less Efficient	=	*133*	m^3/ha
Required Permanent Pool Volume @ 5% less Efficient [(133 - 80 Extended Detention) x Total Area]	=	603	m^3
Total Sediment Accumlation Allowed Before Removal Required (Provided - Max Allowed 5% Reduction)	=	446	m^3
Total Approximate Number of Years Before Sediment Removal is Required	**=**	**32**	**years**

See Extended Detention and Permanent Pool Volumes

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CCO-13-9668-01 - PERTHMORE SUBDIVISION - STORMWATER MANAGEMENT POND EMERGENCY SPILLWAY

Outlet Control Device - Outlet Control Structure

For Orifice Flow, C =	0.60
For Weir Flow, C =	1.70

	Emergency Weir
Invert Elevation	134.76
Weir Length	7.50 m

Elevation	Weir		Total
	H [m]	Q [l/s]	Q [l/s]
134.76	x	x	0
134.86	0.10	403	403
134.96	0.20	1140	1140
135.06	0.30	2095	2095

Notes: 1. For Orifice Flow, User is to Input an Elevation Higher than Crown of Orifice.
2. Orifice Equation: $Q = cA(2gh)^{1/2}$ (m^3/s *1000 = l/s)
3. Weir Equation: $Q = CLH^{3/2}$ (m^3/s *1000 = l/s)
4. These Computations Do Not Account for Submergence Effects Within the Pond Riser.

Reference: Urban Hydrology, Hydraulics and Stormwater Quality: engineering application and computer modeling

APPENDIX G
WATER BALANCE

CCO-13-9668-01 - PERTHMORE SUBDIVISION - Water Balance Information - Monthly Review

The site exhibits five primary types of pervious land use / soil combinations:

	Values from Thornthwaite-Mather Table 10				Table 10 Values Applied to Site Conditions		
Pre-development / Post-development	Soil Type	Available Water (mm)	Root Zone (m)	Applicable Soil Moisture Rentention Table	Available Average Soil Depth (m)	Soil Moisture Retention Table Given Soil Depth (mm)	Values to use (mm)
Pasture overtopping sandy soils (class B soils)	Sandy Loam	150	1	150	0.6	90	100
Pasture overtopping sandy soils (class C soils)	Silty/Clay Loam	250	1	250	0.6	150	150
Forest overtopping sandy soils (class B soils)	Sandy Loam	150	2	300	0.6	180	200
Forest overtopping sandy soils (class C soils)	Silty/Clay Loam	250	1.6	400	0.6	240	250

Summary of data below:

Soil Moisture Storage	Surplus
75	398
100	391
125	387
150	384
200	380
250	377
350	373
400	371

Soil Moisture Storage Data

75mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		217	0	0	0	0	11	0	11	228
February	-8.1	0	0	54	54		271	0	0	0	0	5	0	5	276
March	-2.3	0	0	64	64		336	0	0	0	0	2	0	2	338
April	6.3	1.4	32	75	43		75	0	32	0	43	22	26	48	166
May	13.3	4.4	79	80	2		75	0	79	0	2	12	117	129	206
June	18.5	7.2	112	93	-19	-19	57	-18	111	1	0	6	59	65	122
July	21	8.8	133	92	-41	-60	33	-24	116	17	0	3	29	32	65
August	19.8	8.0	114	86	-29	-88	22	-11	97	18	0	2	15	17	39
September	15	5.3	73	90	17		39	17	73	0	0	1	7	8	47
October	8	2.0	34	86	52		75	36	34	0	17	9	4	13	105
November	1.5	0.2	5	82	77		75	0	5	0	77	43	2	45	197
December	-6.2	0	0	76	76		151	0	0	0	0	22	1	23	174
		37.4	580	944				0	545	35	138	138	260	398	

Monthly T and P from Environment Canada — Table 25 - 75mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

100mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		241	0	0	0	0	11	0	11	252
February	-8.1	0	0	54	54		296	0	0	0	0	5	0	5	301
March	-2.3	0	0	64	64		360	0	0	0	0	2	0	2	362
April	6.3	1.4	32	75	43		100	0	32	0	43	22	26	48	191
May	13.3	4.4	79	80	2		100	0	79	0	2	12	117	129	231
June	18.5	7.2	112	93	-19	-19	82	-18	111	1	0	6	59	65	147
July	21	8.8	133	92	-41	-60	54	-28	120	13	0	3	29	32	86
August	19.8	8.0	114	86	-29	-88	40	-14	100	15	0	2	15	17	57
September	15	5.3	73	90	17		57	17	73	0	0	1	7	8	65
October	8	2.0	34	86	52		100	43	34	0	10	5	4	9	119
November	1.5	0.2	5	82	77		100	0	5	0	77	41	2	43	220
December	-6.2	0	0	76	76		176	0	0	0	0	21	1	22	198
		37.4	580	944				0	552	28	131	131	260	391	

Monthly T and P from Environment Canada

Table 26 - 100mm soil moisture retention in Thornthwaite [1957]

Heat Index (I)

a: 37.4

125mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		267	0	0	0	0	10	0	10	277
February	-8.1	0	0	54	54		321	0	0	0	0	5	0	5	326
March	-2.3	0	0	64	64		386	0	0	0	0	2	0	2	388
April	6.3	1.4	32	75	43		125	0	32	0	43	23	26	49	217
May	13.3	4.4	79	80	2		125	0	79	0	2	12	117	129	256
June	18.5	7.2	112	93	-19	-19	106	-19	112	0	0	6	59	65	171
July	21	8.8	133	92	-41	-60	76	-30	122	11	0	3	29	32	108
August	19.8	8.0	114	86	-29	-88	61	-15	101	14	0	2	15	17	78
September	15	5.3	73	90	17		78	17	73	0	0	1	7	8	86
October	8	2.0	34	86	52		125	47	34	0	6	3	4	7	138
November	1.5	0.2	5	82	77		125	0	5	0	77	40	2	42	244
December	-6.2	0	0	76	76		201	0	0	0	0	20	1	21	222
		37.4	580	944				0	556	24	127	127	260	387	

Monthly T from Environment Canada

Table 27 - 100mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

150mm

Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		292	0	0	0	0	10	0	10	302
February	-8.1	0	0	54	54		346	0	0	0	0	5	0	5	351
March	-2.3	0	0	64	64		411	0	0	0	0	2	0	2	413
April	6.3	1.4	32	75	43		150	0	32	0	43	23	26	49	242
May	13.3	4.4	79	80	2		150	0	79	0	2	12	117	129	281
June	18.5	7.2	112	93	-19	-19	132	-18	111	1	0	6	59	65	197
July	21	8.8	133	92	-41	-60	100	-32	124	9	0	3	29	32	132
August	19.8	8.0	114	86	-29	-88	83	-17	103	12	0	2	15	17	100
September	15	5.3	73	90	17		100	17	73	0	0	1	7	8	108
October	8	2.0	34	86	52		150	50	34	0	3	2	4	6	159
November	1.5	0.2	5	82	77		150	0	5	0	77	39	2	41	268
December	-6.2	0	0	76	76		226	0	0	0	0	19	1	20	246
		37.4	580	944				0	559	21	124	124	260	384	

Monthly T from Environment Canada

Table 28 - 150mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

200mm

Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		341	0	0	0	0	10	0	10	351
February	-8.1	0	0	54	54		396	0	0	0	0	5	0	5	401
March	-2.3	0	0	64	64		460	0	0	0	0	2	0	2	462
April	6.3	1.4	32	75	43		200	0	32	0	43	22	26	48	291
May	13.3	4.4	79	80	2		200	0	79	0	2	12	117	129	331
June	18.5	7.2	112	93	-19	-19	182	-18	111	1	0	6	59	65	247
July	21	8.8	133	92	-41	-60	148	-34	126	7	0	3	29	32	180
August	19.8	8.0	114	86	-29	-88	128	-20	106	9	0	2	15	17	145
September	15	5.3	73	90	17		145	17	73	0	0	1	7	8	153
October	8	2.0	34	86	52		198	52	34	0	0	0	4	4	202
November	1.5	0.2	5	82	77		200	2	5	0	75	38	2	40	315
December	-6.2	0	0	76	76		276	0	0	0	0	19	1	20	296
		37.4	580	944				0	564	16	120	120	260	380	

Monthly T from Environment Canada

Table 29 - 200mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

250mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		392	0	0	0	0	9	0	9	401
February	-8.1	0	0	54	54		446	0	0	0	0	5	0	5	451
March	-2.3	0	0	64	64		511	0	0	0	0	2	0	2	513
April	6.3	1.4	32	75	43		250	0	32	0	43	23	26	49	342
May	13.3	4.4	79	80	2		250	0	79	0	2	12	117	129	381
June	18.5	7.2	112	93	-19	-19	231	-19	112	0	0	6	59	65	296
July	21	8.8	133	92	-41	-60	196	-35	127	6	0	3	29	32	228
August	19.8	8.0	114	86	-29	-88	175	-21	107	8	0	2	15	17	192
September	15	5.3	73	90	17		192	17	73	0	0	1	7	8	200
October	8	2.0	34	86	52		245	52	34	0	0	0	4	4	249
November	1.5	0.2	5	82	77		250	5	5	0	72	36	2	38	360
December	-6.2	0	0	76	76		326	0	0	0	0	18	1	19	345
		37.4	580	944				0	567	13	117	117	260	377	

Monthly T from Environment Canada

Table 30 - 250mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

350mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		492	0	0	0	0	9	0	9	501
February	-8.1	0	0	54	54		546	0	0	0	0	4	0	4	550
March	-2.3	0	0	64	64		611	0	0	0	0	2	0	2	613
April	6.3	1.4	32	75	43		350	0	32	0	43	23	26	49	442
May	13.3	4.4	79	80	2		350	0	79	0	2	12	117	129	481
June	18.5	7.2	112	93	-19	-19	331	-19	112	0	0	6	59	65	396
July	21	8.8	133	92	-41	-60	294	-37	129	4	0	3	29	32	326
August	19.8	8.0	114	86	-29	-88	271	-23	109	6	0	2	15	17	288
September	15	5.3	73	90	17		288	17	73	0	0	1	7	8	296
October	8	2.0	34	86	52		341	52	34	0	0	0	4	4	345
November	1.5	0.2	5	82	77		350	9	5	0	68	34	2	36	454
December	-6.2	0	0	76	76		426	0	0	0	0	17	1	18	444
		37.4	580	944				0	571	9	113	113	260	373	

Monthly T from Environment Canada

Table 32 - 350mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

400mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		542	0	0	0	0	8	0	8	550
February	-8.1	0	0	54	54		596	0	0	0	0	4	0	4	600
March	-2.3	0	0	64	64		661	0	0	0	0	2	0	2	663
April	6.3	1.4	32	75	43		400	0	32	0	43	23	26	49	492
May	13.3	4.4	79	80	2		400	0	79	0	2	12	117	129	531
June	18.5	7.2	112	93	-19	-19	381	-19	112	0	0	6	59	65	446
July	21	8.8	133	92	-41	-60	344	-37	129	4	0	3	29	32	376
August	19.8	8.0	114	86	-29	-88	320	-24	110	5	0	2	15	17	337
September	15	5.3	73	90	17		337	17	73	0	0	1	7	8	345
October	8	2.0	34	86	52		390	52	34	0	0	0	4	4	394
November	1.5	0.2	5	82	77		400	10	5	0	66	33	2	35	501
December	-6.2	0	0	76	76		476	0	0	0	0	17	1	18	494
		37.4	580	944				0	572	8	111	111	260	371	

Monthly T from Environment Canada

Table 33 - 450mm soil moisture retention in Thornthwaite [1957]

Heat Index (I)	37.4
a:	1.06

CCO-13-9668-01 - PERTHMORE SUBDIVISION - WATER BUDGET - PRE-DEVELOPMENT

Water Balance / Water Budget Assessment

	Development Lands to Perth Long Swamp (A1)						
Land Use	**Forest**		**Pasture**		**Gravel**	**Asphalt**	**Total**
Soil (HSG)	**C**	**B**	**C**	**B**			
Soil Characterization	***Silt/Clay Loam (250)***	***Sandy Loam (200)***	***Silt/Clay Loam (150)***	***Sandy Loam (100)***			
Area (m^2)	34300	15600	17600	54500	-	-	122000
Pervious Area (m^2)	34300	15600	17600	54500	-	-	122000
Impervious Area (m^2)	-	-	-	-	-	-	-
Infiltration Factors							
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	-	-	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	-	-	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	-	-	
MOE infiltration Factor	0.522	0.572	0.422	0.472	-	-	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	-	-	
Run-off Coefficient	0.478	0.428	0.578	0.528	-	-	
Runoff from Impervious Surfaces*	0	0	0	0	-	-	
Inputs (per Unit Area)							
Precipitation (mm/year)	944	944	944	944	-	-	944
Run-on (mm/year)	0	0	0	0	-	-	0
Other Inputs (mm/year)	0	0	0	0	-	-	0
Total Inputs (mm/year)	944	944	944	944	-	-	944
Outputs (per Unit Area)							
Precipitation Surplus (mm/year)	377	380	384	391	-	-	385
Net Surplus (mm/year)	377	380	384	391	-	-	385
Evapotranspiration (mm/year)	567	564	560	553	-	-	559
Infiltration (mm/year)	197	217	162	185	-	-	189
Rooftop Infiltration (mm/year)	0	0	0	0	-	-	0
Total Infiltration (mm/year)	197	217	162	185	-	-	189
Runoff Pervious Areas	180	163	222	206	-	-	771
Runoff Impervious Areas	0	0	0	0	-	-	0
Total Runoff (mm/year)	180	163	222	206	-	-	196
Total Outputs (mm/year)	944	944	944	944	-	-	944
Difference (Inputs - Outputs)	0	0	0	0	-	-	0
Inputs (Volume)							
Precipitation (m^3/year)	32379	14726	16614	51448	-	-	115168
Run-on (m^3/year)	0	0	0	0	-	-	0
Other Inputs m^3/year)	0	0	0	0	-	-	0
Total Inputs (m^3/year)	32379	14726	16614	51448	-	-	115168
Outputs (Volume)							
Precipitation Surplus (m^3/year)	12931	5928	6758	21310	-	-	46927
Net Surplus (m^3/year)	12931	5928	6758	21310	-	-	46927
Evapotranspiration (m^3/year)	19448	8798	9856	30139	-	-	68241
Infiltration (m^3/year)	6750	3391	2852	10058	-	-	23051
Rooftop infiltration (m^3/year)	0	0	0	0	-	-	0
Total Infiltration (m^3/year)	6750	3391	2852	10058	-	-	23051
Runoff Pervious Areas (m^3/year)	6181	2537	3906	11251	-	-	23876
Runoff Impervious Areas (m^3/year)	0	0	0	0	-	-	0
Total Runoff (m^3/year)	6181	2537	3906	11251	-	-	23876
Total Outputs (m^3/year)	**32379**	**14726**	**16614**	**51448**	-	-	**115168**
Difference (Inputs - Outputs)	0	0	0	0	-	-	0

CCO-13-9668-01 - PERTHMORE SUBDIVISION - WATER BUDGET - POST-DEVELOPMENT

Water Balance / Water Budget Assessment

	Development Lands to Perth Long Swamp (Block 70, SWM Block, Residential Lots and Roadway)							
Land Use	**Forest**		**Pasture**					
Soil (HSG)	**C**	**B**	**C**	**B**				
Soil Characterization	***Silt/Clay Loam (250)***	***Sandy Loam (200)***	***Silt/Clay Loam (150)***	***Sandy Loam (100)***	***Sand (75)***	**Gravel**	**Asphalt**	**Total**
Area (m^2)	8300	0	17400	13300	0	0	26600	65600
Pervious Area (m^2)	8300	0	17400	13300	0	-	-	39000
Impervious Area (m^2)	-	-	-	-	-	0	26600	26600
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	573
Net Surplus (mm/year)	377	380	384	391	398	398	850	573
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	371
Infiltration (mm/year)	197	217	162	185	227	88	85	140
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	197	217	162	185	227	88	85	140
Runoff Pervious Areas	180	163	222	206	171	0	0	942
Runoff Impervious Areas	0	0	0	0	0	310	765	1075
Total Runoff (mm/year)	180	163	222	206	171	310	765	434
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	7835	0	16426	12555	0	0	25110	61926
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	7835	0	16426	12555	0	0	25110	61926
Outputs (Volume)								
Precipitation Surplus (m^3/year)	3129	0	6682	5200	0	0	22599	37610
Net Surplus (m^3/year)	3129	0	6682	5200	0	0	22599	37610
Evapotranspiration (m^3/year)	4706	0	9744	7355	0	0	2511	24316
Infiltration (m^3/year)	1633	0	2820	2455	0	0	2260	9168
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	1633	0	2820	2455	0	0	2260	9168
Runoff Pervious Areas (m^3/year)	1496	0	3862	2746	0	0	0	8103
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	20339	20339
Total Runoff (m^3/year)	1496	0	3862	2746	0	0	20339	28443
Total Outputs (m^3/year)	**7835**	**0**	**16426**	**12555**	**0**	**0**	**25110**	**61926**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

	Development Lands to Perth Long Swamp (West Block)							
Land Use	**Forest**		**Pasture**					
Soil (HSG)	**C**	**B**	**C**	**B**				
Soil Characterization	***Silt/Clay Loam (250)***	***Sandy Loam (200)***	***Silt/Clay Loam (150)***	***Sandy Loam (100)***	***Sand (75)***	**Gravel**	**Asphalt**	**Total**
Area (m^2)	0	0	0	10290	0	0	24010	34300
Pervious Area (m^2)	0	0	0	10290	0	-	-	10290
Impervious Area (m^2)	-	-	-	-	-	0	24010	24010
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.3	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.48	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	712
Net Surplus (mm/year)	377	380	384	391	398	398	850	712
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	232
Infiltration (mm/year)	197	217	162	185	207	88	0	55
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	197	217	162	185	207	88	0	55
Runoff Pervious Areas	180	163	222	206	191	0	0	962
Runoff Impervious Areas	0	0	0	0	0	310	850	1160
Total Runoff (mm/year)	180	163	222	206	191	310	850	657
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	0	0	9714	0	0	22665	32379
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	0	0	9714	0	0	22665	32379
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	0	0	4023	0	0	20399	24422
Net Surplus (m^3/year)	0	0	0	4023	0	0	20399	24422
Evapotranspiration (m^3/year)	0	0	0	5690	0	0	2267	7957
Infiltration (m^3/year)	0	0	0	1899	0	0	0	1899
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	0	0	0	1899	0	0	0	1899
Runoff Pervious Areas (m^3/year)	0	0	0	2124	0	0	0	2124
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	20399	20399
Total Runoff (m^3/year)	0	0	0	2124	0	0	20399	22523
Total Outputs (m^3/year)	**0**	**0**	**0**	**9714**	**0**	**0**	**22665**	**32379**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

	Development Lands to Perth Long Swamp (Central Block)							
Land Use	**Forest**		**Pasture**					
Soil (HSG)	**C**	**B**	**C**	**B**				
Soil Characterization	***Silt/Clay Loam (250)***	***Sandy Loam (200)***	***Silt/Clay Loam (150)***	***Sandy Loam (100)***	***Sand (75)***	**Gravel**	**Asphalt**	**Total**
Area (m^2)	0	1560	0	3120	0	0	10920	15600
Pervious Area (m^2)	0	1560	0	3120	0	-	-	4680
Impervious Area (m^2)	-	-	-	-	-	0	10920	10920
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.3	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.48	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	711
Net Surplus (mm/year)	377	380	384	391	398	398	850	711
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	233
Infiltration (mm/year)	197	217	162	185	207	88	0	59
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	197	217	162	185	207	88	0	59
Runoff Pervious Areas	180	163	222	206	191	0	0	962
Runoff Impervious Areas	0	0	0	0	0	310	850	1160
Total Runoff (mm/year)	180	163	222	206	191	310	850	652
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	1473	0	2945	0	0	10308	14726
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	1473	0	2945	0	0	10308	14726
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	593	0	1220	0	0	9278	11090
Net Surplus (m^3/year)	0	593	0	1220	0	0	9278	11090
Evapotranspiration (m^3/year)	0	880	0	1725	0	0	1031	3636
Infiltration (m^3/year)	0	339	0	576	0	0	0	915
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	0	339	0	576	0	0	0	915
Runoff Pervious Areas (m^3/year)	0	254	0	644	0	0	0	898
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	9278	9278
Total Runoff (m^3/year)	0	254	0	644	0	0	9278	10175
Total Outputs (m^3/year)	**0**	**1473**	**0**	**2945**	**0**	**0**	**10308**	**14726**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

	Development Lands to Perth Long Swamp (East Block)							
Land Use	**Forest**		**Pasture**					
Soil (HSG)	**C**	**B**	**C**	**B**				
Soil Characterization	***Silt/Clay Loam (250)***	***Sandy Loam (200)***	***Silt/Clay Loam (150)***	***Sandy Loam (100)***	***Sand (75)***	**Gravel**	**Asphalt**	**Total**
Area (m^2)	650	0	1300	0	0	0	4550	6500
Pervious Area (m^2)	650	0	1300	0	0	-	-	1950
Impervious Area (m^2)	-	-	-	-	-	0	4550	4550
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.3	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.48	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	709
Net Surplus (mm/year)	377	380	384	391	398	398	850	709
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	235
Infiltration (mm/year)	197	217	162	185	207	88	0	52
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	197	217	162	185	207	88	0	52
Runoff Pervious Areas	180	163	222	206	191	0	0	962
Runoff Impervious Areas	0	0	0	0	0	310	850	1160
Total Runoff (mm/year)	180	163	222	206	191	310	850	657
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	614	0	1227	0	0	0	4295	6136
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	614	0	1227	0	0	0	4295	6136
Outputs (Volume)								
Precipitation Surplus (m^3/year)	245	0	499	0	0	0	3866	4610
Net Surplus (m^3/year)	245	0	499	0	0	0	3866	4610
Evapotranspiration (m^3/year)	369	0	728	0	0	0	430	1526
Infiltration (m^3/year)	128	0	211	0	0	0	0	339
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	128	0	211	0	0	0	0	339
Runoff Pervious Areas (m^3/year)	117	0	289	0	0	0	0	406
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	3866	3866
Total Runoff (m^3/year)	117	0	289	0	0	0	3866	4271
Total Outputs (m^3/year)	**614**	**0**	**1227**	**0**	**0**	**0**	**4295**	**6136**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

CCO-13-9668-01 - PERTHMORE SUBDIVISION - WATER BUDGET - POST-DEVELOPMENT WITH MITIGATION

Water Balance / Water Budget Assessment

Development Lands to Perth Long Swamp (Block 70, SWM Block, Residential Lots and Roadway)

Land Use	Forest		Pasture					
Soil (HSG)	C	B	C	B				
Soil Characterization	*Silt/Clay Loam (250)*	*Sandy Loam (200)*	*Silt/Clay Loam (150)*	*Sandy Loam (100)*	*Sand (75)*	Gravel	Asphalt	Total
Area (m^2)	8300	0	17400	13300	0	0	26600	65600
Pervious Area (m^2)	8300	0	17400	13300	0	-	-	39000
Impervious Area (m^2)	-	-	-	-	-	0	26600	26600
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	573
Net Surplus (mm/year)	377	380	384	391	398	398	850	573
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	371
Infiltration (mm/year)	197	217	162	185	227	88	85	140
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	108	44
Total Infiltration (mm/year)	197	217	162	185	227	88	193	184
Runoff Pervious Areas	180	163	222	206	171	0	0	942
Runoff Impervious Areas	0	0	0	0	0	310	657	967
Total Runoff (mm/year)	180	163	222	206	171	310	657	390
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	7835	0	16426	12555	0	0	25110	61926
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	7835	0	16426	12555	0	0	25110	61926
Outputs (Volume)								
Precipitation Surplus (m^3/year)	3129	0	6682	5200	0	0	22599	37610
Net Surplus (m^3/year)	3129	0	6682	5200	0	0	22599	37610
Evapotranspiration (m^3/year)	4706	0	9744	7355	0	0	2511	24316
Infiltration (m^3/year)	1633	0	2820	2455	0	0	2260	9168
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	2873	2873
Total Infiltration (m^3/year)	1633	0	2820	2455	0	0	5133	12040
Runoff Pervious Areas (m^3/year)	1496	0	3862	2746	0	0	0	8103
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	17467	17467
Total Runoff (m^3/year)	1496	0	3862	2746	0	0	17467	25570
Total Outputs (m^3/year)	**7835**	**0**	**16426**	**12555**	**0**	**0**	**25110**	**61926**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

Development Lands to Perth Long Swamp (West Block)

Land Use	Forest		Pasture					
Soil (HSG)	C	B	C	B				
Soil Characterization	*Silt/Clay Loam (250)*	*Sandy Loam (200)*	*Silt/Clay Loam (150)*	*Sandy Loam (100)*	*Sand (75)*	Gravel	Asphalt	Total
Area (m^2)	0	0	0	10290	0	0	24010	34300
Pervious Area (m^2)	0	0	0	10290	0	-	-	10290
Impervious Area (m^2)	-	-	-	-	-	0	24010	24010
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	712
Net Surplus (mm/year)	377	380	384	391	398	398	850	712
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	232
Infiltration (mm/year)	197	217	162	185	227	88	85	115
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	108	76
Total Infiltration (mm/year)	197	217	162	185	227	88	193	190
Runoff Pervious Areas	180	163	222	206	171	0	0	942
Runoff Impervious Areas	0	0	0	0	0	310	657	967
Total Runoff (mm/year)	180	163	222	206	171	310	657	522
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	0	0	9714	0	0	22665	32379
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	0	0	9714	0	0	22665	32379
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	0	0	4023	0	0	20399	24422
Net Surplus (m^3/year)	0	0	0	4023	0	0	20399	24422
Evapotranspiration (m^3/year)	0	0	0	5690	0	0	2267	7957
Infiltration (m^3/year)	0	0	0	1899	0	0	2040	3939
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	2593	2593
Total Infiltration (m^3/year)	0	0	0	1899	0	0	4633	6532
Runoff Pervious Areas (m^3/year)	0	0	0	2124	0	0	0	2124
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	15766	15766
Total Runoff (m^3/year)	0	0	0	2124	0	0	15766	17890
Total Outputs (m^3/year)	**0**	**0**	**0**	**9714**	**0**	**0**	**22665**	**32379**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

Development Lands to Perth Long Swamp (Central Block)

Land Use	Forest		Pasture					
Soil (HSG)	C	B	C	B				
Soil Characterization	*Silt/Clay Loam (250)*	*Sandy Loam (200)*	*Silt/Clay Loam (150)*	*Sandy Loam (100)*	*Sand (75)*	Gravel	Asphalt	Total
Area (m^2)	0	1560	0	3120	0	0	10920	15600
Pervious Area (m^2)	0	1560	0	3120	0	-	-	4680
Impervious Area (m^2)	-	-	-	-	-	0	10920	10920
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	711
Net Surplus (mm/year)	377	380	384	391	398	398	850	711
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	233
Infiltration (mm/year)	197	217	162	185	227	88	85	118
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	108	76
Total Infiltration (mm/year)	197	217	162	185	227	88	193	194
Runoff Pervious Areas	180	163	222	206	171	0	0	942
Runoff Impervious Areas	0	0	0	0	0	310	657	967
Total Runoff (mm/year)	180	163	222	206	171	310	657	517
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	1473	0	2945	0	0	10308	14726
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	1473	0	2945	0	0	10308	14726
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	593	0	1220	0	0	9278	11090
Net Surplus (m^3/year)	0	593	0	1220	0	0	9278	11090
Evapotranspiration (m^3/year)	0	880	0	1725	0	0	1031	3636
Infiltration (m^3/year)	0	339	0	576	0	0	928	1843
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	1179	1179
Total Infiltration (m^3/year)	0	339	0	576	0	0	2107	3022
Runoff Pervious Areas (m^3/year)	0	254	0	644	0	0	0	898
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	7171	7171
Total Runoff (m^3/year)	0	254	0	644	0	0	7171	8068
Total Outputs (m^3/year)	**0**	**1473**	**0**	**2945**	**0**	**0**	**10308**	**14726**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

Development Lands to Perth Long Swamp (East Block)

Land Use	Forest		Pasture					
Soil (HSG)	C	B	C	B				
Soil Characterization	*Silt/Clay Loam (250)*	*Sandy Loam (200)*	*Silt/Clay Loam (150)*	*Sandy Loam (100)*	*Sand (75)*	Gravel	Asphalt	Total
Area (m^2)	650	0	1300	0	0	0	4550	6500
Pervious Area (m^2)	650	0	1300	0	0	-	-	1950
Impervious Area (m^2)	-	-	-	-	-	0	4550	4550
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	377	380	384	391	398	398	850	709
Net Surplus (mm/year)	377	380	384	391	398	398	850	709
Evapotranspiration (mm/year)	567	564	560	553	546	546	94	235
Infiltration (mm/year)	197	217	162	185	227	88	85	112
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	108	76
Total Infiltration (mm/year)	197	217	162	185	227	88	193	187
Runoff Pervious Areas	180	163	222	206	171	0	0	942
Runoff Impervious Areas	0	0	0	0	0	310	657	967
Total Runoff (mm/year)	180	163	222	206	171	310	657	522
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	614	0	1227	0	0	0	4295	6136
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	614	0	1227	0	0	0	4295	6136
Outputs (Volume)								
Precipitation Surplus (m^3/year)	245	0	499	0	0	0	3866	4610
Net Surplus (m^3/year)	245	0	499	0	0	0	3866	4610
Evapotranspiration (m^3/year)	369	0	728	0	0	0	430	1526
Infiltration (m^3/year)	128	0	211	0	0	0	387	725
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	491	491
Total Infiltration (m^3/year)	128	0	211	0	0	0	878	1217
Runoff Pervious Areas (m^3/year)	117	0	289	0	0	0	0	406
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	2988	2988
Total Runoff (m^3/year)	117	0	289	0	0	0	2988	3393
Total Outputs (m^3/year)	**614**	**0**	**1227**	**0**	**0**	**0**	**4295**	**6136**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

CCO-13-9668-01 - PERTHMORE SUBDIVISION - WATER BUDGET - SUMMARY

Water Balance / Water Budget Assessment

Development Lands to Perth Long Swamp Pre = Post					
Characteristic	Pre-Development	Post-Development	Change (Pre- to Post)	Post-Development with Mitigation	Change (Pre- to Post-with Mitigation
Inputs (Volumes)					
Precipitation (m^3/year)	115168	115168	0%	115168	0%
Run-on (m^3/year)	0	0	0%	0	0%
Other Inputs m^3/year)	0	0	0%	0	0%
Total Inputs (m^3/year)	115168	115168	0%	115168	0%
Outputs (Volumes)					
Precipitation Surplus (m^3/year)	46927	77733	66%	77733	66%
Net Surplus (m^3/year)	46927	77733	66%	77733	66%
Evapotranspiration (m^3/year)	68241	37435	-45%	37435	-45%
Infiltration (m^3/year)	23051	12320	-47%	15674	-32%
Rooftop infiltration (m^3/year)	0	0	0%	7137	0%
Total Infiltration (m^3/year)	23051	12320	-47%	22811	-1%
Runoff Pervious Areas (m^3/year)	23876	11531	-52%	11531	-52%
Runoff Impervious Areas (m^3/year)	0	53882	0%	43391	0%
Total Runoff (m^3/year)	23876	65413	174%	54922	130%
Total Outputs (m^3/year)	115168	115168	0%	115168	0%

CCO-13-9668-01 - PERTHMORE SUBDIVISION - WATER BUDGET - MITIGATION REQUIRED

Water Balance / Water Budget Assessment

Data Input	
944	mm of precipitation per year avg.
118.4	days with precipitation per year avg.
10	mm design rainfall event

1981 to 2010 Canadian Climate Normals station data

Days with Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
>= 0.2 mm	4.4	3.9	6.7	10.9	13.4	13.2	11.9	11	12.3	13.7	11	6	118.4	A
>= 5 mm	1.6	1.2	2.1	4	4.9	5.8	5.4	4.8	5.1	5	4.2	2.3	46.5	A
>= 10 mm	0.87	0.57	1	2	2.7	2.9	3.1	2.8	3.2	2.7	2.1	1.2	25.2	A
>= 25 mm	0.13	0.07	0.10	0.33	0.47	0.73	0.77	0.67	0.60	0.47	0.43	0.13	4.9	A

Environment Canada	Days exceeding rainfall noted	Days per section	Minimum volume of rain (mm)
0.2 mm	118.4	71.9	14
5 mm	46.5	21.3	107
10 mm	25.2	25.2	252
		Total	373

*Example - Days per section over 5mm = 46.5 - 25.2 = 21.3 days (which are more than 5 mm but, less than 10 mm).
21.3 days x 5 mm = 107 mm

	Development Lands to Perth Long Swamp (Block 70, SWM Block, Residential Lots and Roadway)	Development Lands to Perth Long Swamp (Block 67)	Development Lands to Perth Long Swamp (Block 68)	Development Lands to Perth Long Swamp (Block 69)
Area of Asphalt (m^2)	26600	24010	10920	4550
Asphalt Runoff Coefficient	0.9	0.9	0.9	0.9
Volume of Runoff in 5 mm Event (m^3) to be infiltrated	120	108	49	20
Mitigation Required (m^3/year)	2873	2593	1179	491
Annual Volume to be infiltrated by designing for 5 mm Event	2897	2615	1189	495

By installing trenches sized for the 5 mm event, the annual volume to be infiltrated will exceed that of the mitigation required by the water balance mitigation.