CONCEPTUAL STORMWATER MANAGEMENT REPORT GARDINER'S GROVE SUBDIVISION

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1.0 PURPOSE

McIntosh Perry Consulting Engineers Limited (McIntosh Perry) has prepared this Conceptual Stormwater Management Report in support of the application for Draft Plan of Subdivision for the development known as Gardner's Grove.

The main purposes of this report is to provide a conceptual stormwater management design plan in accordance with the recommendations and guidelines provided by the Ministry of the Environment Conservation and Parks (MECP) and the Ministry of Natural Resources and Forestry (MNRF). These guidelines encourage the implementation of Best Management Practices (BMPs) for treating and controlling stormwater runoff.

The Mississippi Valley Conservation Authority (MVCA) and Township of Beckwith will be agencies reviewing this report and all subsequent drawings and calculations. The Township and MVCA were pre-consulted on October 6, 2020 prior to the preparation of this report to discuss servicing constraints, design criteria, municipal standards and project specific quality and quantity control objectives.

During the detailed design stage, further information will be provided regarding the post-development peak flow rates entering the proposed stormwater outlet swales discharging to the various adjacent ditches and outlet points.

2.0 SITE DESCRIPTION

The proposed development is located between 10th Line and 9th Line, in the Township of Beckwith directly east of Mississippi Lake. The legal description of the lands is Parts of Lots 8 and 9, Concession 9, Township of Beckwith, County of Lanark. The site is bounded by residential properties, bordering Mississippi Lake to the west, 10th Line and 9th Line to the north and south respectively and an undeveloped property to the east. Refer to Appendix A for a copy of the Location Plan. There is also a rural residential property at the south end of the subject site, fronting on 9th Line that is not part of this proposed development, but, is included in the analysis.

Gardner's Grove encompasses approximately eighty hectares and the proposed development includes 120 estate lots and approximately 3250 metres of proposed new roadway. Also, beyond the southwest corner boundary of the property is the McGibbon's Creek wetland.

The current vacant land is predominantly, 60%, agricultural land with the remainder forested or grass/shrub land. Aerial mapping from previous years shows Similar land uses on the property. Runoff from the existing undeveloped site is conveyed via overland sheet flow toward 10th Line, 9th Line and Mississippi Lake.

2.1 SOIL CONDITIONS

Based on the Soil Survey of Lanark County the majority of the subject site is underlaid by Farmington Sandy Loam soil. There are also smaller areas of North Gower Clay Loam, Granby Sandy Loam, Innisville Sandy Loam, Kars Gravelly Sandy Loam and Muck. The break down of Hydrologic Soil Groups for the site is:

- 13.8% Hydrologic Soil Group A
- 52.1% Hydrologic Soil Group B
- 16.8% Hydrologic Soil Group C
- 17.3% Hydrologic Soil Group D

2.2 DOWNSTREAM RECEIVERS

As stated previously, runoff from the existing undeveloped site is conveyed via overland sheet flow toward 10th Line, 9th Line and Mississippi Lake.

2.3 SOURCE WATER PROTECTION

In preparing this report, a review of the Mississippi-Rideau Source Protection data was performed. The proposed development is not located within any intake protection zones, or within any wellhead protection areas. The majority of the property is however within a "significant groundwater recharge area". Furthermore, the property is considered to be "highly vulnerable aquifer", as the majority of Eastern Ontario is so considered. Given that the development is limited to rural estate lots for residential purposes, and there are no intentions for commercial or industrial uses, this is not expected to be a concern for this development. It is however recommended that no in ground source heat pumps be permitted for use on this development. A map has been included in Appendix B, highlighting the source protection information as taken from the MOECC's Source Water Protection Information Atlas.

3.0 PROPOSED STORMWATER MANAGEMENT

3.1 DESIGN CRITERIA AND METHODOLOGY

The proposed development forms part of the Mississippi River watershed. Although the MVCA is in the process of developing a Mississippi River Watershed Plan, there is not an existing document that specifies specific stormwater management design criteria or considerations. As such, the MECP Stormwater Management Planning and Design Manual (March 2003) has been referenced to govern the management of stormwater. Their methodology promotes water management from an environmentally sustainable perspective. The intent of this 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 will be explained further in Section 6.0. To summarize, roof water will be directed to grass surfaces that in turn will be collected in grassed swales or roadside ditches prior to entering into the stormwater offtake swales. The stormwater management facilities are anticipated to be limited to storage within the roadside ditches and conveyance through various offtake swales throughout the site.

The intent is to design the site to meet an **enhanced** level of quality control (80% Total Suspended Solids (TSS) removal) as mandated by the MVCA. It is anticipated that this will be achieved through the use of enhanced grass swales when used in combination with lot level BMP measures intended to reduce runoff and promote infiltration at the lot level. The intent is also to design post-development peak flow rates so as not to negatively impact the downstream receivers. It is proposed that the quantity control be approached with the intent of maximizing on-site storage through temporary ponding within the roadside ditches and through offtake swales. Given the desire to minimize disturbance, the intent will be to avoid the use of large retention basins that require clearing and significant disturbance to the natural features.

3.2 RUNOFF CALCULATIONS

Runoff calculations were completed with the aid of a computer modelling program, Visual OTTHYMO (Version 6.0) (VO6). The proposed model was developed as a rural development and therefore employed NASHYD routines for the majority of the site for calculating hydrographs.

The overland travel time of concentration for each of the drainage areas was derived using the SCS Lag equation:

$$T_c = 60\left(L^{0.8} \frac{(S'+25.4)^{0.7}}{4238\, S^{0.33}} \right) \text{ (min)}$$

Where:

L = Flow length (m)

S' = Potential maximum retention ($S' = \frac{25400}{CN} - 254$)

CN = Curve Number

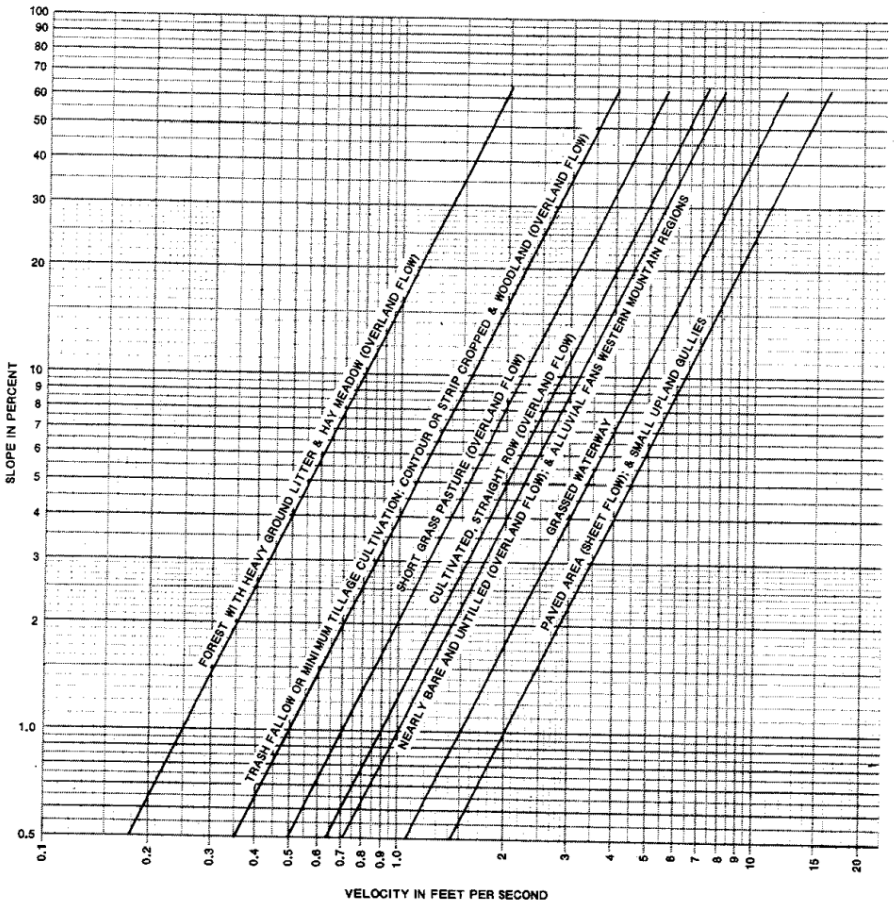
S = Average watershed land slope (%)

A maximum value of 30m was used in calculating the overland sheet flow time of concentration. The remaining overland sheet flow is assumed to form shallow concentrated flows after these conditions and was calculated as such. The velocity for the shallow concentrated flow was calculated using the following formula:

$$V = K(S)^{0.5}\ (m/s)$$

Where: k = constant (referenced from the National Engineering Handbook, Table 15-3)
V = Velocity of water (m/s)
S = Average watershed land slope (%)

For pre-development shallow concentrated flows were calculated using a k-value of 0.213 as applicable for short grass pasture (overland flow). For post-development a k-value of 0.213 was again used. In areas where shallow concentrated flow would be flow over manicured lawns. The velocity for channelized ditch flow was also calculated using the above equation, substituting k=0.457. These values were taken from the National Engineering Handbook Figure 15-2 below (converting the velocity equation from imperial to metric units). The resulting time of concentration was then determined using the velocity method which assumes the time of concentration is the sum of the travel times for segments along the hydraulically most distant flow path.



Source: Figure 15.2 – National Engineering Handbook – Section 4

The time of concentration was used to estimate the Time to Peak through the relationship that the time to peak occurs at approximately 67% of the time of concentration. The input value for the simulation time step (DT) in VO6 was taken as 5 minutes.

The following values were used to develop a composite curve number and initial abstraction value.

Table 1: Curve Numbers and Initial Abstraction Values

Land Use	Hydrologic Soil Group	Curve Number	Initial Abstraction (mm)
Pre-Development			
Impervious		98	2
Agriculture	A	67	8
Agriculture	B	78	8
Agriculture	C	85	8
Agriculture	D	89	8
Forested	A	36	10
Forested	B	60	10
Forested	C	73	10
Forested	D	79	10
Grass/Shrub	A	49	8
Grass/Shrub	B	69	8
Grass/Shrub	C	79	8
Grass/Shrub	D	84	8
Post-Development			
Impervious		98	2
Manicured Lawns	A	49	5
Manicured Lawns	B	69	5
Manicured Lawns	C	79	5
Manicured Lawns	D	84	5

As described in Section 2.1, the existing soils include a percentage of four different hydrologic soil groups. A weighted CN values, based on percentage of land use on each hydrologic soil group was calculated. In post-development conditions, it is assumed, as a conservative approach that only the impervious area of houses, driveways, roads and the impervious area of manicured lawns were present.

The CN values shown in Table 2 are derived from the following sources:

- Grass/Shrubs – MTO Design Chart 1.09 for Pasture or Range, fair condition;
- Agriculture – MTO Design Chart 1.09 for Row Crops, good condition;
- Forest – MTO Design Chart 1.09 for Woods, fair condition; and

- Manicured Lawns – City of Ottawa Sewer Design Guideline Table 5.9 for Open Space, fair condition (grass cover 50% to 75%)

The initial abstraction values used for each sub-catchment input in VO6 were taken from the following table (Table 7.5: Initial Abstraction/Depression Storage – Adapted from UNESCO, Manual on Drainage in Urbanized Areas, 1987):

Table 2: Initial Abstraction Reference Table

Ground Cover	Depth (mm)
Woods	10
Meadows	8
Cultivated	7
Lawns	5
Impervious Areas	2

Given the proximity to the City of Ottawa, the design is based on the hyetographs for the City of Ottawa. The SCS Type II distribution (12-hour- and 24-hour) and the 4-hour Chicago distribution were all reviewed in preparing the proposed design. The 12-hour and 24-hour SCS Type II distributions was input using a 15 minute time step, while the 4-hour Chicago distribution was determined using a 10 minute time step.

3.3 PRE-DEVELOPMENT DRAINAGE

The pre-development boundary encompasses five drainage areas. Appendix C includes a drawing, which illustrates the pre-development drainage areas in for the subject lands, noted as A1 through A5. Also included in Appendix C is the pre-development drainage calculations and associated model output results. The results are summarized below.

3.3.1 10th LINE DITCH OUTLET – PRE-DEVELOPMENT DRAINAGE AREA A1

Pre-development drainage area A1 encompasses a relatively small portion of the northeast corner of the property, encompassing a high point that directs runoff to the north, towards 10th Line Road. The 6.35 ha area ranges in elevation from 144.0 m at the southern high point of the catchment area to 138 m near the 10th Line Road. The area is almost entirely open agricultural land. Runoff general flows from south to north.

The area has a composite curve number of 87.1, an initial abstraction of 8.0 mm, and an estimated time of concentration of 39 minutes. Results for the various storm events and distributions are provided in the following table.

Table 3: Pre-Development Drainage Area A1 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.30	0.33	0.22
100-Year (m^3/s)	0.69	0.71	0.58

3.3.2 10th LINE CULVERT OUTLET – PRE-DEVELOPMENT DRAINAGE AREAS A2

Pre-development drainage areas A2 encompass the central part of the property. The 38.4 ha area ranges in elevation from 143.0 m to 137.5 m near the 10th Line Road. The area is approximately 2/3 agricultural land and 1/3 forest and grass/shrub land use. Runoff general flows from south to north.

The area has a composite curve number of 76.3, an initial abstraction of 8.4 mm, and an estimated time of concentration of 845 minutes. Results for the various storm events and distributions are provided in the following table.

Table 4: Pre-Development Drainage Area A2 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.65	0.72	0.48
100-Year (m^3/s)	1.71	1.80	1.37

3.3.3 MISSISSIPPI LAKE OUTLET – PRE-DEVELOPMENT DRAINAGE AREA A3

Pre-development drainage area A3 encompasses the western portion of the property and represents the area of runoff that is conveyed as overland flow ultimately to Mississippi Lake. The 10.67 ha area has a less than 1% overall slope and ranges in elevation from 143 m to approximately 140 m at the western limit of the property. Runoff generally flows from east to west and area is predominately forest and grass/shrub land.

The area has a composite curve number of 70.2, an initial abstraction of 8.3 mm and an estimated time of concentration of 30 minutes. Results for the various storm events and distributions are provided in the following table.

Table 5: Pre-Development Drainage Area A3 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.31	0.35	0.21
100-Year (m^3/s)	0.85	0.91	0.65

3.3.4 WETLAND OFFSITE TO THE SOUTHWEST – PRE-DEVELOPMENT DRAINAGE AREAS A4

Pre-development drainage areas A4 encompass a long swath of land directed into the McGibbon's Creek wetland at the southern boundary of the property. The 36.6 ha area, again has just under a 1% overall slope and ranges in elevation from 146 m to approximately 136 m. Runoff is conveyed as overland flow generally from the northeast to the southwest and area is approximately half agricultural and half forest and grass/shrub land. This drainage area also includes the rural residential property at the south end of the subject site, fronting on 9th Line, that is not part of this proposed development, but, part of the overall drainage network and thus is included in the analysis.

The area has a composite curve number of 70.6, an initial abstraction of 8.4 mm and an estimated time of concentration of 95 minutes. Results for the various storm events and distributions are provided in following table.

Table 6: Pre-Development Drainage Areas A4 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.46	0.51	0.34
100-Year (m^3/s)	1.26	1.34	1.00

3.3.5 9th LINE DITCH OUTLET – PRE-DEVELOPMENT DRAINAGE AREAS A5

Pre-development drainage areas A5 encompass a small parcel of land at the southeast boundary of the property. The 3.13 ha area, ranges in elevation from 148.5 m to approximately 144.5 m at the 9th Line road. Runoff is conveyed in a southwest direction toward 9th Line and area is almost entirely agricultural land.

The area has a composite curve number of 68.5, an initial abstraction of 8.1 mm and an estimated time of concentration of 11 minutes. Results for the various storm events and distributions are provided in the following table

Table 7: Pre-Development Drainage Areas A5 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.16	0.18	0.09
100-Year (m^3/s)	0.42	0.47	0.31

3.3.6 PRE-DEVELOPMENT SUMMARY

The input parameters and results have been summarized in the following tables, while the full detailed output results can be found in Appendix C.

Table 8: Pre-Development Input Parameters.

Catchment ID	Area (ha)	CN	Ia(mm)	tp (hr)
A1	6.35	87.1	8.0	0.43
A2	38.42	76.3	8.4	0.94
A3	10.67	70.2	8.3	0.33
A4	36.60	70.6	8.4	1.06
A5	3.13	68.5	8.1	0.13
Total	**95.17**			

Table 9: Pre-Development Results.

	12-hour SCS		24-hour SCS		4-hour Chicago	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
A1	0.30	0.69	**0.33**	**0.71**	0.22	0.58
A2	0.65	1.71	**0.72**	**1.80**	0.48	1.37
A3	0.31	0.85	**0.35**	**0.91**	0.21	0.65
A4	0.46	1.26	**0.51**	**1.34**	0.34	1.00
A5	0.16	0.42	**0.18**	**0.47**	0.09	0.31

3.4 POST-DEVELOPMENT DRAINAGE

Since the grading plan for the subdivision has not yet been developed, the lot layout was overlaid on the same drainage areas as used in the pre-development analysis. The post-development boundary encompasses 5 sub-catchments, all assumed to outlet to the same five outlets as pre-development conditions. Appendix D includes a drawing, which illustrates the post-development sub-catchments for the subject lands, noted as B1 through B5. Also included in Appendix D are the post-development drainage calculations and associated model output results. The results have been summarized below. Since all the sub-catchments have an imperviousness of less than 20%, the NASHYD routine, with the CN calculated considering the impervious

values, was employed for the post-development analysis. It was also assumed, for the hydrologic model, that the lots consisted of the impervious area (house and driveways) and that the remainder of the lots were manicured lawn. The road area was then added to the impervious area to calculate the parameters for each sub-catchment.

3.4.1 10th LINE DITCH OUTLET – POST-DEVELOPMENT DRAINAGE AREA B1

Post-development drainage area B1 encompasses all of parts of 12 proposed new lots and a small stretch of the new Street A and represents the sub-catchment outletting to the 10th Line ditch. The 6.35 ha area will see runoff overland sheet flow across manicured lawns, into the roadside ditch along Street A, where runoff will continue to the north to 10th Line.

The area has a composite curve number of 83.5, an initial abstraction of 4.7 mm and an estimated time of concentration of 27 minutes. The uncontrolled runoff results for the various storm events and distributions are provided in the following table.

Table 10: Post-Development Drainage Area B1 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.36	0.39	0.28
100-Year (m^3/s)	0.82	0.84	0.69

3.4.2 10th LINE CULVERT OUTLET – POST-DEVELOPMENT DRAINAGE AREA B2

Post-development sub-catchments B2 encompass the central portion of the site. Runoff will be conveyed via overland sheet flow and roadside ditches. The area will be comprised of new impervious surfaces (parts of Street C and D, driveways, houses), manicured lawns (immediately surrounding the new houses and overtop the proposed septic locations).

The sub-catchment B2 has an area of 38.42 ha, a composite curve number of 75.7, initial abstraction value of 4.7 mm and estimated time of concentration of 50 minutes. A summary of the uncontrolled runoff results is provided in following table.

Table 11: Post-Development Drainage Area B2 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	1.07	1.15	0.81
100-Year (m^3/s)	2.61	2.71	2.16

3.4.3 MISSISSIPPI LAKE OUTLET – POST-DEVELOPMENT DRAINAGE AREAS B3

Post-development sub-catchment B3 encompass the southwest area of the site and represent the lands that will be conveyed will be conveyed via overland sheet flow, roadside ditches and offtake swales. The ultimate outlet of this sub-catchment will be determined during detailed design. The area will be comprised of new impervious surfaces (sections of Streets A and D, driveways, houses), manicured lawns (immediately surrounding the new houses and overtop the proposed septic locations).

Sub-catchment B3 is 10.67 ha in size, has a composite curve number of 72.5, an initial abstraction value of 4.6 mm and an estimated time of concentration of 21 minutes.

Results for the various storm events and distributions for uncontrolled runoff is provided in the following table.

Table 12: Post-Development Drainage Area B3 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.48	0.53	0.35
100-Year (m^3/s)	1.21	1.28	0.96

3.4.4 WETLAND OFFSITE TO THE SOUTHWEST – POST-DEVELOPMENT DRAINAGE AREAS B4

Post-development sub-catchment B4 encompass the swath of land directed into the McGibbon's Creek wetland at the southern boundary of the property. Runoff is to be conveyed via overland sheet flow, roadside ditches and offtake swales. The intermediate and ultimate outlet of this sub-catchment will be determined during detailed design. The area will be comprised of new impervious surfaces (sections of Streets A, B and D, driveways, houses), manicured lawns (immediately surrounding the new houses and overtop the proposed septic locations) this sub-catchment also includes the existing rural lot that is not part of this development and will stay in existing conditions.

The sub-catchment has an area of 36.6 ha, a composite curve number of 71.9, initial abstraction value of 4.8 mm and estimated time of concentration of 52 minutes.

Results for the various storm events and distributions is provided in the following table.

Table 13: Post-Development Drainage Area B4 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.88	0.94	0.66
100-Year (m^3/s)	2.19	2.29	1.79

3.4.5 9th LINE DITCH OUTLET – POST-DEVELOPMENT DRAINAGE AREAS B5

Post-development sub-catchment B5 consists of the small tributary to the 9th Line ditch. Runoff will be conveyed via overland sheet flow and roadside ditches. The area will be comprised of new impervious surfaces (a small section of Streets B, driveways, houses), manicured lawns (immediately surrounding the new houses and overtop the proposed septic locations) this sub-catchment also includes the existing rural lot that is not part of this development and will stay in existing conditions.

The sub-catchment has an area of 3.13 ha, a composite curve number of 56.7, initial abstraction value of 4.8 mm and estimated time of concentration of 19 minutes.

Results for the various storm events and distributions is provided in the following table.

Table 14: Post-Development Drainage Area B4 Runoff Results

	12-hr SCS	24-hr SCS	4-hr Chicago
5-Year (m^3/s)	0.09	0.10	0.06
100-Year (m^3/s)	0.24	0.26	0.18

3.4.6 POST-DEVELOPMENT SUMMARY

The input parameters and results have been summarized in the following tables, while the full detailed output results can be found in Appendix D.

Table 15: Post-Development Input Parameters.

Catchment ID	Area (ha)	CN	Ia (mm)	tp (hr)
B1	6.35	83.5	4.7	0.31
B2	38.42	75.7	4.7	0.56
B3	10.67	72.5	4.6	0.24
B4	36.60	72.1	4.8	0.58
B5	3.13	56.7	4.9	0.21
Total	**95.17**			

Table 16: Post-Development Uncontrolled Results.

	12-hour SCS		24-hour SCS		4-hour Chicago	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
B1	0.36	0.82	**0.39**	**0.84**	0.28	0.69
B2	1.07	2.61	**1.15**	**2.71**	0.81	2.16
B3	0.48	1.21	**0.53**	**1.28**	0.35	0.96
B4	0.88	2.19	**0.94**	**2.29**	0.66	1.79
B5	0.09	0.24	**0.10**	**0.26**	0.06	0.18

4.0 MAJOR DRAINAGE ROUTES

The proposed roadside ditches and offtake swales will have an important role in site drainage. They will act as the major drainage routes and will be sized to manage the required flow rate. The driveway culverts will be sized for the 5-year storm; however, flows during the 100-year storm will not overtop the driveways greater than 0.30 m. It is the intent that the proposed side yard offtake swales will also act as the major drainage routes and will adhere to the MECP guidelines for enhanced grass swales as much as possible. For example, the swale will be sized accordingly to handle the 25mm storm quality storm event with velocities not to exceed 0.5 m/s. Further details will be provided during detailed design. The site will be designed such that the proposed dwelling will not be adversely affected by any 100-year ponding limits, nor by the adjacent wetlands.

5.0 STORMWATER QUANTITY CONTROL

The following is provided as a summary of pre-development peak flow rates in comparison to uncontrolled post- development peak flow rates.

Table 17: Pre- and Post-Development Uncontrolled Results.

Peak Flows (m^3/s)									
Design Storm (yr)	12-hour SCS			24-hour SCS			4-hour Chicago		
	Pre.	Post.	Δ	Pre.	Post.	Δ	Pre.	Post.	Δ
Catchment A1/B1									
5	0.30	0.36	**0.06**	0.33	0.39	**0.06**	0.22	0.28	**0.05**
100	0.69	0.82	**0.13**	0.71	0.84	**0.14**	0.58	0.69	**0.11**
Catchment A2/B2									
5	0.65	1.07	**0.42**	0.72	1.15	**0.43**	0.48	0.81	**0.34**
100	1.71	2.61	**0.90**	1.80	2.71	**0.92**	1.37	2.16	**0.79**

Peak Flows (m^3/s)									
Design Storm (yr)	12-hour SCS			24-hour SCS			4-hour Chicago		
	Pre.	Post.	Δ	Pre.	Post.	Δ	Pre.	Post.	Δ
Catchment A3/B3									
5	0.31	0.48	**0.17**	0.35	0.53	**0.18**	0.21	0.35	**0.14**
100	0.85	1.21	**0.35**	0.91	1.28	**0.37**	0.65	0.96	**0.30**
Catchment A4/B4									
5	0.46	0.88	**0.41**	0.51	0.94	**0.43**	0.34	0.66	**0.31**
100	1.26	2.19	**0.93**	1.34	2.29	**0.96**	1.00	1.79	**0.79**
Catchment A5/B5									
5	0.16	0.09	**-0.07**	0.18	0.10	**-0.08**	0.09	0.06	**-0.03**
100	0.42	0.24	**-0.18**	0.47	0.26	**-0.20**	0.31	0.18	**-0.13**

As is evident from the results, the post-development peak flow rates, except for sub-catchment B5, show an increase compared to pre-development conditions. This suggests the requirement for stormwater management controls to manage runoff and offer restriction of these peak flow rates. The proposed stormwater design seeks to make use of the temporary storage within the roadside ditches and offtake swales through the implementation of a combination of outlet control structures, rock flow check dams and infiltration trenches.

It is anticipated that the on-site drainage ditches will be constructed at a minimum of 0.1% for rear yards, 0.3% for side yards and 0.5% for roadside ditches. Given the size of the site and the limited opportunities for restriction, it is anticipated that roadside ditches will be used for short term storage resulting in temporary ponding during major storm events. Additional storage facilities such as infiltration trenches and flow spreaders will also be explored, as required. Detailed calculations will be provided during the final design stage.

Considering the following roadside ditch parameters:

- Bottom width – 1.0 m
- Side slopes – 3:1
- Ponding depth 0.5 m

for every 100 m reach of the roadside ditch a volume of 62 m^3 can be achieved by installing a check dam at a 100 m spacing.

During the final design process, opportunities to alter the slope of the ditches will be explored considering additional topographic information and final road and lot grading plans.

Driveway culverts will be sized for the 5-year storm while road crossing culverts will be sized for the 10-year storm. Flows during the 100-year storm will be reviewed to confirm they do not overtop the driveways/roads greater than 0.30 m. Since the proposed grading plan has not yet been developed these culverts will be design during the detailed design process.

The stormwater management plan will be further developed, along with the grading plan, during the detailed design process, however the following sections speak to preliminary calculations completed with regard to the required detention storage and initial anticipated peak flow controlled rates.

5.1 10th LINE DITCH OUTLET– AREA A1/B1

Based on the VO6 post-development hydrologic model, the rating curve shown below was inserted in the model to restrict the uncontrolled post-development flow to existing levels.

Table 18: **VO5 Reservoir Rating Curve – Area B1**

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.300	0.0300	300.0
0.700	0.0750	750.0

Based on the roadside ditch parameters detailed above and the length of Street A within the B1 sub-catchment, a storage volume of approximately 345 m^3 is achievable within the ditch profile. During detailed design opportunities to install additional storage and/or storage areas will be employed and implemented to achieve the required detention storage.

5.2 10th LINE CULVERT OUTLET– AREAS A2/B2

Based on the VO6 post-development hydrologic model, the rating curve shown below was inserted in the model to restrict the uncontrolled post-development flow to existing levels.

Table 19: **VO5 Reservoir Rating Curve – Area B2**

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.700	0.2500	2500.0
1.800	0.6000	6000.0

Based on the roadside ditch parameters detailed above and the length of Streets A, C and D within the B2 sub-catchment, a storage volume of approximately 2260 m^3 is achievable within the ditch profile. During detailed design opportunities to install additional storage and/or storage areas will be employed and implemented to achieve the required detention storage.

5.3 MISSISSIPPI LAKE OUTLET– AREA A3/B3

Based on the VO6 post-development hydrologic model, the rating curve shown below was inserted in the model to restrict the uncontrolled post-development flow to existing levels.

Table 20: **VO5 Reservoir Rating Curve – Area B3**

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.350	0.0500	500.0
0.900	0.1100	1100.0

Based on the roadside ditch parameters detailed above and the length of Streets A and D within the B3 sub-catchment, a storage volume of approximately 765 m^3 is achievable within the ditch profile. During detailed design opportunities to install additional storage and/or storage areas will be employed and implemented to achieve the required detention storage.

5.4 WETLAND OFFSITE TO THE SOUTHWEST – AREAS A4/B4

Based on the VO6 post-development hydrologic model, the rating curve shown below was inserted in the model to restrict the uncontrolled post-development flow to existing levels.

Table 21: **VO5 Reservoir Rating Curve – Area B4**

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.500	0.2500	2500.0
1.300	0.6100	6100.0

Based on the roadside ditch parameters detailed above and the length of Streets A, B and D within the B4 sub-catchment, a storage volume of approximately 1035 m^3 is achievable within the ditch profile. During detailed design opportunities to install additional storage and/or storage areas will be employed and implemented to achieve the required detention storage.

5.5 9th LINE DITCH OUTLET– AREAS A5/B5

As shown in Table 17, the post-development flows are less the pre-development flows. This is due to the agriculture and forest areas, from the pre-development analysis being assumed to be manicured lawn for the post-development analysis.

5.6 POST-DEVELOPMENT PEAK FLOW RATES SUMMARY

Based on the detention storage indicated the tables above, the following table summarizes the anticipated Controlled peak flow rates.

Table 22: Pre- and Post-Development Controlled Results.

Design Storm (yr)	Peak Flows (m^3/s)								
	12-Hour SCS			24-Hour SCS			4-Hour Chicago		
	Pre.	Post.	Δ	Pre.	Post.	Δ	Pre.	Post.	Δ
Area A1/B1									
5	0.30	0.28	-0.03	0.33	0.30	-0.03	0.22	0.22	-0.005
100	0.69	0.61	-0.08	0.71	0.63	-0.08	0.58	0.53	-0.053
Area A2/B2									
5	0.65	0.63	-0.02	0.72	0.68	-0.04	0.48	0.49	0.01
100	1.71	1.60	-0.11	1.80	1.67	-0.13	1.37	1.32	-0.06
A3/B3									
5	0.31	0.30	-0.01	0.35	0.33	-0.02	0.21	0.23	0.02
100	0.85	0.82	-0.04	0.91	0.86	-0.05	0.65	0.66	0.00
A4/B4									
5	0.46	0.46	-0.00	0.51	0.49	-0.02	0.34	0.35	0.01
100	1.26	1.18	-0.08	1.34	1.24	-0.10	1.00	0.97	-0.04
A5/B5									
5	0.16	0.09	-0.07	0.18	0.10	-0.08	0.09	0.06	-0.03
100	0.42	0.24	-0.18	0.47	0.26	-0.20	0.31	0.18	-0.13

Supporting calculations for the above described storage conditions are provided in Appendix E.

6.0 STORMWATER QUALITY CONTROL

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. The stormwater BMPs will be implemented at the lot and conveyance 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 used in the subdivision is natural overland sheet flow and a combination of roadside ditches and side yard offtake swales. All swales and ditches 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, minimizing standing water. To aid in achieving the quality control objective, additional measures such as infiltration trenches and permanent rock flow check dams within the ditches and swales will be explored during the detailed design stage. Rip rap will be placed at erosion-prone areas and all disturbed areas shall be landscaped as soon as possible.

Given the significant length of open ditch, relatively low percentage of hard surfaced area, the proposed works to be constructed are believed to achieve an **enhanced** level of quality treatment (80% TSS removal). Details will be provided during the detailed design stage to further address this.

7.0 McGIBBON'S CREEK WETLAND

As detailed previously, the McGibbon's Creek wetland is located at the southwest boundary of the property. Sub-catchment A4, within the subject site is tributary to the wetland. McGibbon's Creek wetland is a riverine wetland and there for most of the water supporting the wetland comes from the upstream tributary watershed. Using the Ontario Flow Assessment Tool (OFAT) created and supported by the Ministry of Natural Resources and Forestry (MNRF) the total watershed are on McGibbon's Creek is approximately 2100 ha and wetland area is approximately 950 ha. The drainage area of sub-catchment A4 is 36.6 ha which is less than 2.0 % of the total watershed area. Approximately 15.0 % this sub-catchment also includes the rural residential property, which will not change as part of this development. Therefore, the proposed development will have minimal impact on the wetland.

8.0 PROVINCAL POLICY STATEMENT

The revised Provincial Policy Statement, which came into effect on May 1, 2020, (replacing the PPS issued April 30, 2014) and issued under Section 3 of the Planning Act, notes that Planning authorities shall protect, improve or restore the quality and quantity of water by:

a. using the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development;
b. minimizing potential negative impacts, including cross-jurisdictional and cross-watershed impacts;
c. evaluating and preparing for the impacts of a changing climate to water resource systems at the watershed level;
d. identifying water resource systems consisting of ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas, which are necessary for the ecological and hydrological integrity of the watershed;

e. maintaining linkages and related functions among ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas;
f. implementing necessary restrictions on development and site alteration to:
    a. protect all municipal drinking water supplies and designated vulnerable areas; and
    b. protect, improve or restore vulnerable surface and ground water, sensitive surface water features and sensitive ground water features, and their hydrologic functions;
g. planning for efficient and sustainable use of water resources, through practices for water conservation and sustaining water quality.
h. ensuring consideration of environmental lake capacity, where applicable; and
i. ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces.

The following table summarizes how many of the above noted sub-sections have been met:

Table 23: Provincial Policy Statement

Sub-section	Applicability
b	The development proposed to limit disturbance as much as possible, maintaining much of the land in its natural state. The percent imperviousness is estimated at only 8%, supporting that impacts are minimized by maintaining natural features.
d	The proposed stormwater management plan provides that post-development drainage patterns will be consistent with pre-development patterns such that natural features existing within the site are not negatively impacted by altered drainage flows.
e	The proposed stormwater management plan provides that post-development drainage patterns will be consistent with pre-development patterns such that natural features existing within the site are not negatively impacted by altered drainage flows.
f	The proposed stormwater management plan will provide an enhanced level of quality control. This will ensure that the proposed development does not have any negative impacts from a quality perspective, and through temporary ponding, etc., to achieve the necessary quality objectives.
g	As the proposed development has a total percent imperviousness of only 8%, sediment loading is not expected to be a large concern. Lot development will be done in such a manner as to limit disturbance to the existing natural features. Impervious areas such as roads are anticipated the be the biggest risk for sediment loading, and appropriate measures will be implemented immediately surrounding these features to ensure that sediment loading does not impact the surrounding natural features.

9.0 EROSION AND SEDIMENT CONTROL

An Erosion and Sediment Control Plan, delineating the proposed features to be implemented on-site as temporary and permanent means of managing erosion and sediment control will be developed as part of the detailed design process. Below are measures that will be implemented as part of this plan.

9.1 TEMPORARY MEASURES

Before construction begins, temporary silt fence, straw bale and rock flow check dams will 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 Township, Conservation Authority 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 offsite. Measures shall be inspected weekly and after all 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.

9.2 PERMANENT MEASURES

Rip rap will be placed at all locations that have the potential for concentrated flow, particularly at the outflow of all proposed offtake swales. In addition, rip rap and geotextile shall be placed at the inlet and outlet of the road crossing culverts. 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 / Township or MVCA.

It is expected that the Contractor will promptly ensure that all disturbed areas receive topsoil and seed, 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 the wetlands to ensure that no sediment is washed out into the wetlands. As the vegetation growth along the proposed roadside and offtake swales provides a key component to the control of sediment for the site, it must be properly maintained once established. As the lots are sold it will be up to the landowners to maintain that section of vegetation and ensure that they are not overgrown or impeded by foreign objects.

10.0 SUMMARY

- Rainfall will be conveyed by overland sheet flow towards the roadside ditches and/or offtake swales, ultimately outletting to 9th Line , 10th Line and Mississippi Lake.
- Preliminary calculations demonstrate an increase in net peak flows as a result of the development. Restriction of these peak flows is proposed as much as feasibly possible while minimizing disturbance to the natural features. In an effort to maintain as much of the land in its natural state, large stormwater facilities such as retention areas and ponds are not proposed. The stormwater management and control features will be further developed during the detailed design process.
- Best Management Practices will be implemented to provide adequate quality control. Several lot level and conveyance measures shall be implemented to ensure that the runoff from the site achieves its targeted quality control objective. Additional details will be provided during the detailed design stage.

11.0 RECOMMENDATIONS

Based on the information presented in this report, we recommend that Beckwith Township and the Mississippi Valley Conservation Authority approve this *Conceptual Stormwater Management Report* in support of the proposed Gardiner's Grove development.

Sincerely,
McIntosh Perry Consulting Engineers Ltd.

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Senior Water Resources Engineer
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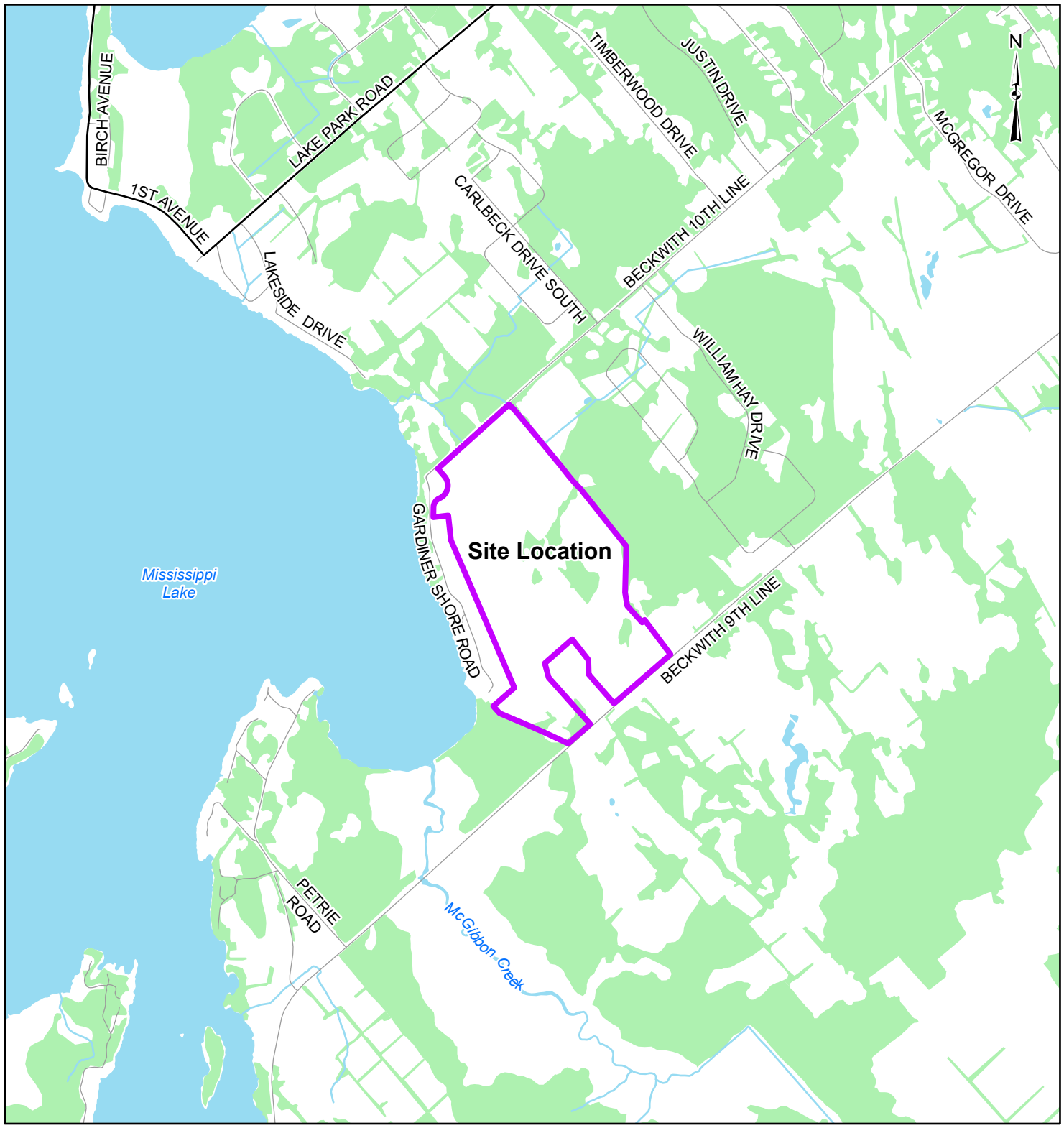
CONCEPTUAL STORMWATER MANAGEMENT REPORT
GARDINER'S GROVE SUBDIVISION

APPENDIX A
LOCATION PLAN

McINTOSH PERRY



800 400 0 800

Scale 1:25,000 Metres

LEGEND

- Approximate Property Boundary
- Local Road
- Major Road
- Watercourse
- Waterbody
- Wooded Area

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2021.

CLIENT: GARDINER'S GROVE INC.

PROJECT: GARDINER'S GROVE

TITLE: SITE LOCATION

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

PROJECT NO:CCO-20-0203		FIGURE:
Date	May., 20, 2021	1
GIS	EU	
Checked By	MS	

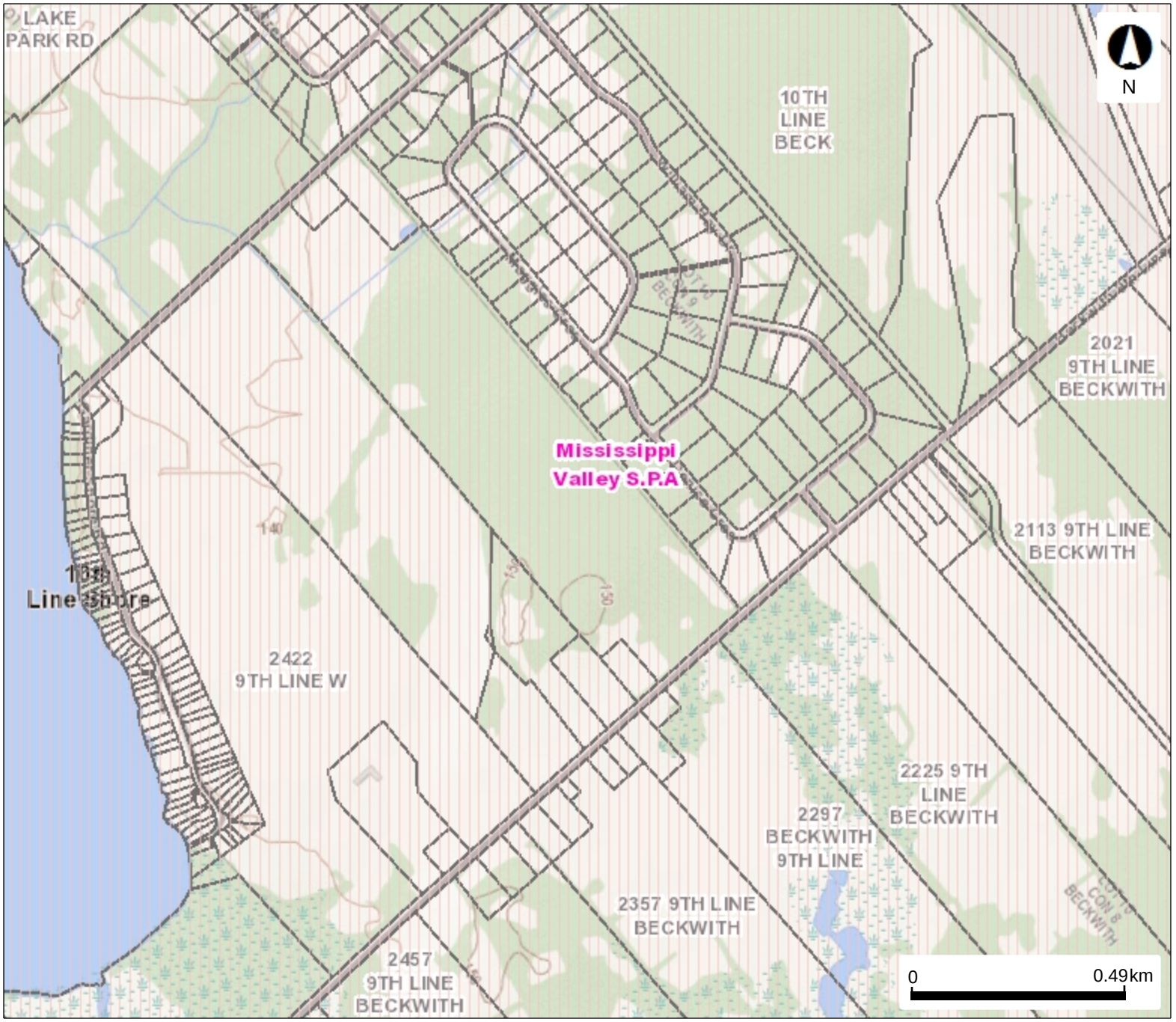
C:\Users\e.ungun\McIntosh Perry\GIS - Documents\Projects\2020\CCO\CCO-20-0203 Tweedsmuir Land Dev - Gardiner Property\aprx\Land Development\CCO-20-0203_LandDevelopment.aprx

CONCEPTUAL STORMWATER MANAGEMENT REPORT
GARDINER'S GROVE SUBDIVISION

APPENDIX B
REFERENCE SUPPORT FILES

McINTOSH PERRY

-Map Title-



Legend

- Source Protection Areas
- Issue Contributing Areas
- Highly Vulnerable Aquifers
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Assessment Parcel

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

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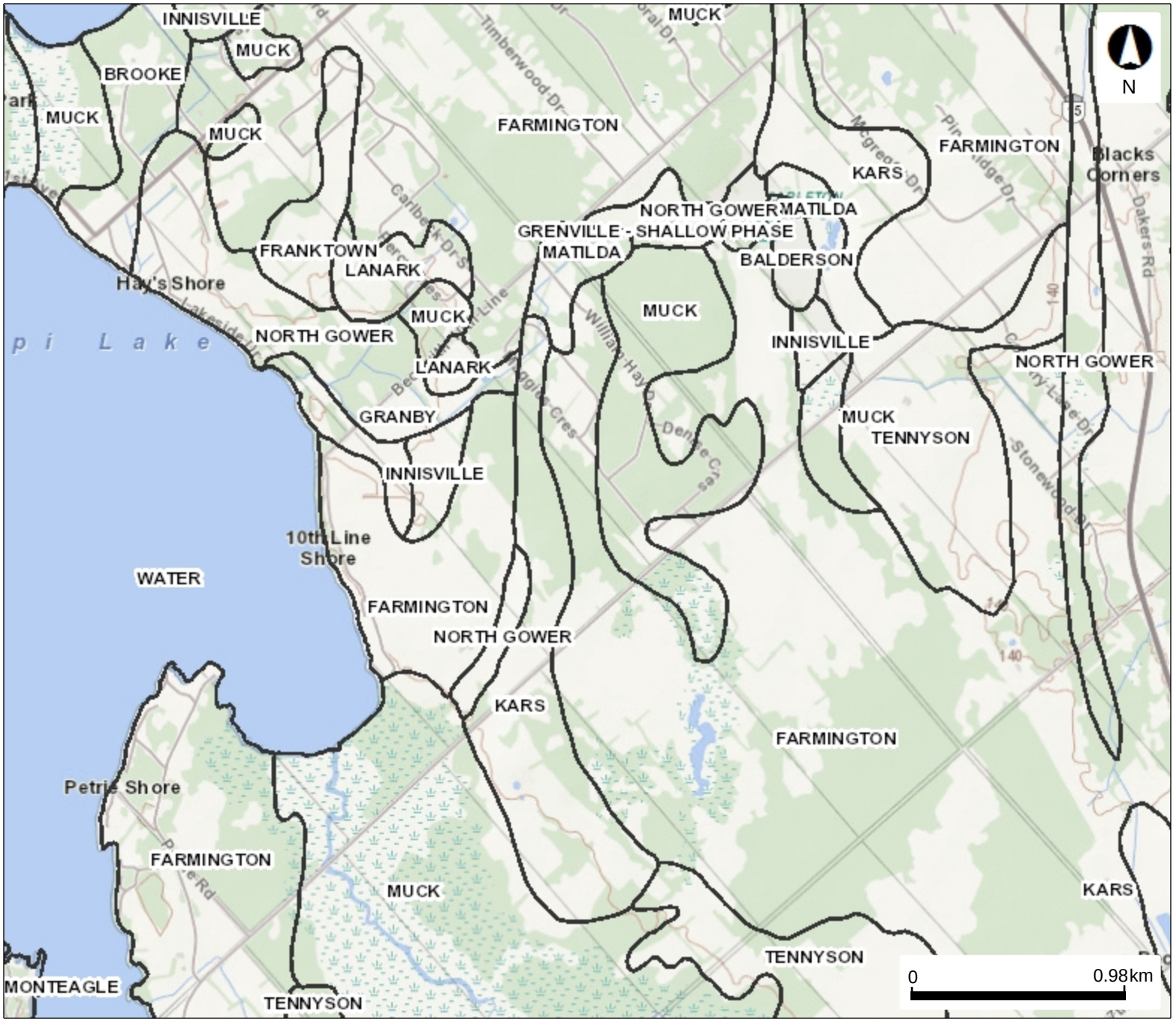
Map Created: 5/13/2021
Map Center: 45.09352 N, -76.13629 W

-Map Title-



Legend

- @language-layer-soil-name

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Map Created: 5/13/2021
Map Center: 45.09369 N, -76.13561 W

Design Chart 1.09: Soil/Land Use Curve Numbers

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

For average anticedent soil moisture condition (AMC II)

[2] Close-drilled or broadcast.

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

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

Table 5.9 CN Values for Various Soil Groups

Cover Type and Hydrologic Condition	Hydrologic Soil Group			
	A	**B**	**C**	**D**
Fully developed urban areas (vegetation established)				
Open space: (lawns, parks, golf courses, cemeteries)				
Poor condition (grass cover < 50%)	68	79	86	89
Fair condition (grass cover 50% to 75%)	49	69	79	84
Good condition (grass cover >75%)	39	61	74	80
Impervious areas:				
Paved parking lots, roofs, driveways, etc.	98	98	98	98
(excluding right-of-way)				
Streets and roads:				
Paved; curbs and storm sewers excluding ROW	98	98	98	98
Paved; open ditches (including right-of-way)	83	89	92	93
Gravel (including right-of-way)	76	85	89	91
Dirt (including right-of-way)	72	82	87	89

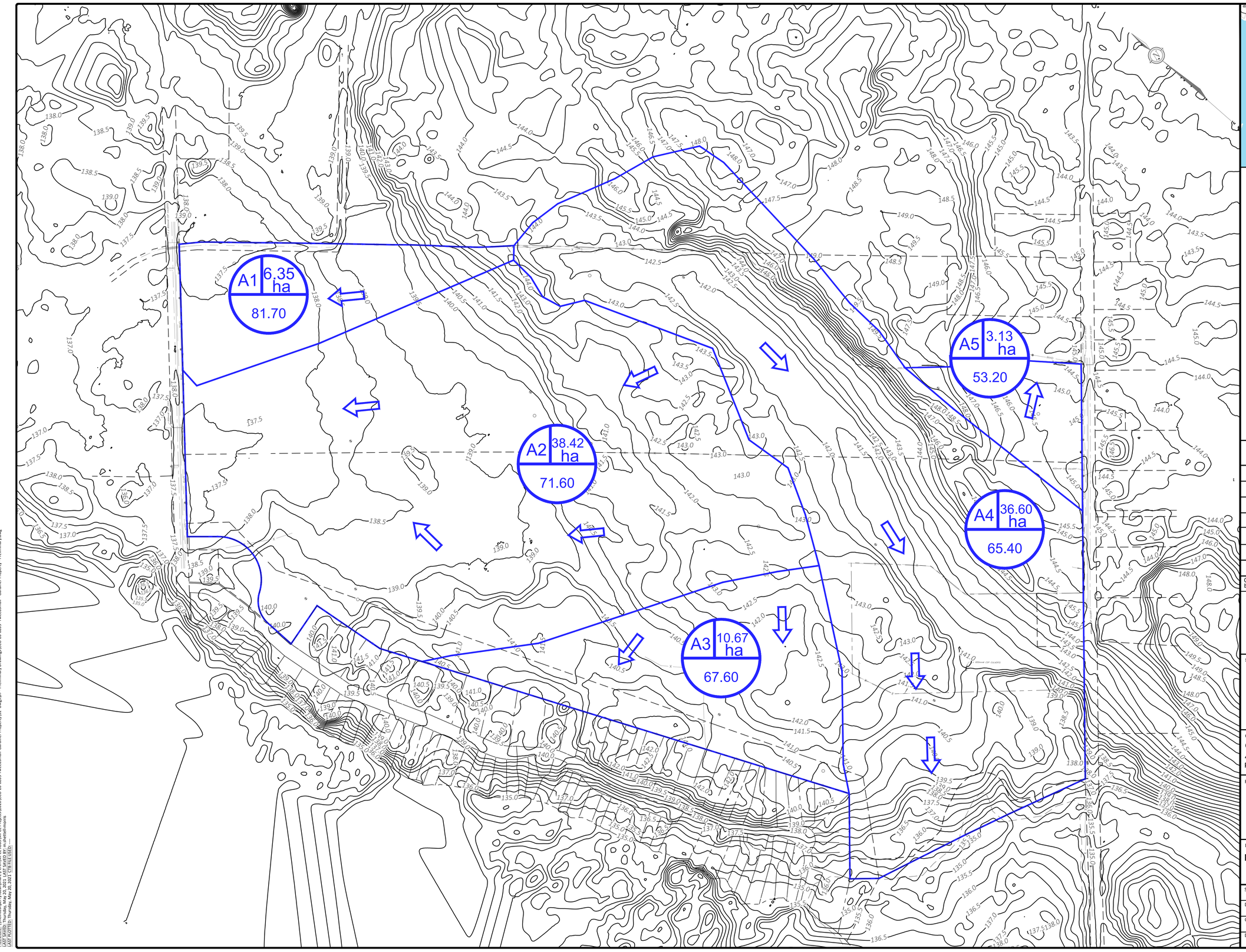
Source:
Hydrology, Engineering Handbook, USDA, Soil Conservation Services (1968)

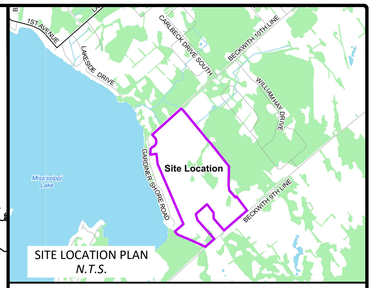
NOTE: Assumes AMC II and I_a = 0.2S **(See Section 5.4.4.3 for further information on CN and I_a)**

CONCEPTUAL STORMWATER MANAGEMENT REPORT
GARDINER'S GROVE SUBDIVISION

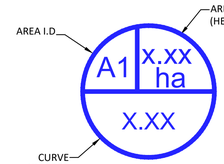
APPENDIX C
PRE-DEVELOPMENT DRAINAGE PLAN, MODEL SCHEMATIC AND CALCULATIONS

McINTOSH PERRY





SITE LOCATION PLAN
N.T.S.



SCALE 1 : 2500

0 50 100 150 200 250 Metres

No.	Revision/Issue	Date
00	ISSUED FOR REVIW	XX/XX/XXXX

Check and verify all dimensions before proceeding with the work

Do not scale drawings

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Stamp:

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Client:
GARDINER'S GROVE INC.
48 WILSON ST WEST
PERTH, ONTARIO, K7H 2N4

Project:
GARDINER'S GROVE
BECKWITH ONTARIO

Drawing Title:
PRE-DEVELOPMENT DRAINAGE PLAN

Scale: 1:2500	Project Number: CCO-20-0203
Drawn by: M.M.	
Checked By:	Drawing Number: 01
Designed By: J.P.	

FILENAME: \\mcintoshperry.local\Share\Projects\MPCE JOBS\MPCE Project Folders\2020\CCO-20-0203-Tweedsmuir-Gardiner Property\12 Dwg\07 - Preliminary Drawings\CCO-20-0203 - Tweedsmuir - Gardiner Property - Preliminary.dwg
LAST SAVED: Thursday, May 20, 2021 LAST SAVED BY: m.isenteil-morin
LAST PLOTTED: Thursday, May 20, 2021 CTB FILE USED: ---

CCO-20-0203 Gardiner's Grove Subdivision

CURVE NUMBERS AND INITIAL ABSTRACTION VALUES

Design Coefficients

Land Use	Hydrologic Soil Group	Curve Number	Initial Abstraction (mm)
Pre-Development			
Impervious		98	2
Agriculture	A	67	8
Agriculture	B	78	8
Agriculture	C	85	8
Agriculture	D	89	8
Forested	A	36	10
Forested	B	60	10
Forested	C	73	10
Forested	D	79	10
Grass/Shrub	A	49	8
Grass/Shrub	B	69	8
Grass/Shrub	C	79	8
Grass/Shrub	D	84	8
Post-Development			
Impervious		98	2
Manicured Lawns	A	49	5
Manicured Lawns	B	69	5
Manicured Lawns	C	79	5
Manicured Lawns	D	84	5

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CCO-20-0203 Gardiner's Grove Subdivision PRE-DEVELOPMENT DRAINAGE AREA INFORMATION

Land Use Breakdown

Catchment ID	Area (m^2)	Impervious (m^2)	Agriculture (m^2)	Forested (m^2)	Grass/Srubs (m^2/s)	CN	Ia (mm)	% Imperviousness	Outlet
A1	63496	0	63145	352	0	87.1	8.0	0.0%	Northeast - 10th Line Ditch
A2	384158	1123	245286	73907	63841	76.3	8.4	0.3%	Culvert under 10th Line
A3	106655	0	30358	16388	59909	70.2	8.3	0.0%	Mississippi Lake
A4	366027	7545	190942	94789	72752	70.6	8.4	2.1%	Wetland off-site to southwest
A5	31344	0	30059	1285	0	68.5	8.1	0.0%	Southeast - 9th Line Ditch
Total	**951680**	**8668**	**559790**	**186721**	**196502**				

Time of Concentration

Catchment ID	Total Overland Flow Distance (m)	Slope of Land (%)	Sheet Flow Distance (m)	Sheet Flow Tc (min)	Shallow Concentrated Flow Distance (m)	Shallow Concentrated Flow Velocity (m/s)	Shallow Concentrated Tc (min)	Total Tc (min)
A1	500	1.10	30	4	470	0.22	35	39
A2	835	0.66	30	7	805	0.17	78	84
A3	295	0.85	30	7	265	0.20	23	30
A4	1100	0.91	30	7	1070	0.20	88	95
A5	165	2.42	30	4	135	0.33	7	11

Hydrologic Model Parameters

Catchment ID	Area (ha)	CN	Ia (mm)	tc (min)	tp (hr)	Outlet
A1	6.35	87.1	8.0	39	0.43	Northeast - 10th Line Ditch
A2	38.42	76.3	8.4	84	0.94	Culvert under 10th Line
A3	10.67	70.2	8.3	30	0.33	Mississippi Lake
A4	36.60	70.6	8.4	95	1.06	Wetland off-site to southwest
A5	3.13	68.5	8.1	11	0.13	Southeast - 9th Line Ditch
Total	**95.17**					

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CCO-20-0203 Gardiner's Grove Subdivision PRE-DEVELOPMENT HYDROLOGICAL RESULTS

	12-hour SCS		24-hour SCS		4-hour Chicago		Max	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
A1	0.30	0.69	**0.33**	**0.71**	0.22	0.58	**0.33**	**0.71**
A2	0.65	1.71	**0.72**	**1.80**	0.48	1.37	**0.72**	**1.80**
A3	0.31	0.85	**0.35**	**0.91**	0.21	0.65	**0.35**	**0.91**
A4	0.46	1.26	**0.51**	**1.34**	0.34	1.00	**0.51**	**1.34**
A5	0.16	0.42	**0.18**	**0.47**	0.09	0.31	**0.18**	**0.47**

	Outlet
A1	Northeast - 10th Line Ditch
A2	Culvert under 10th Line
A3	Mississippi Lake
A4	Wetland off-site to southwest
A5	Southeast - 9th Line Ditch

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CONCEPTUAL STORMWATER MANAGEMENT REPORT
GARDINER'S GROVE SUBDIVISION

APPENDIX D
POST-DEVELOPMENT DRAINAGE PLAN, MODEL SCHEMATIC AND CALCULATIONS

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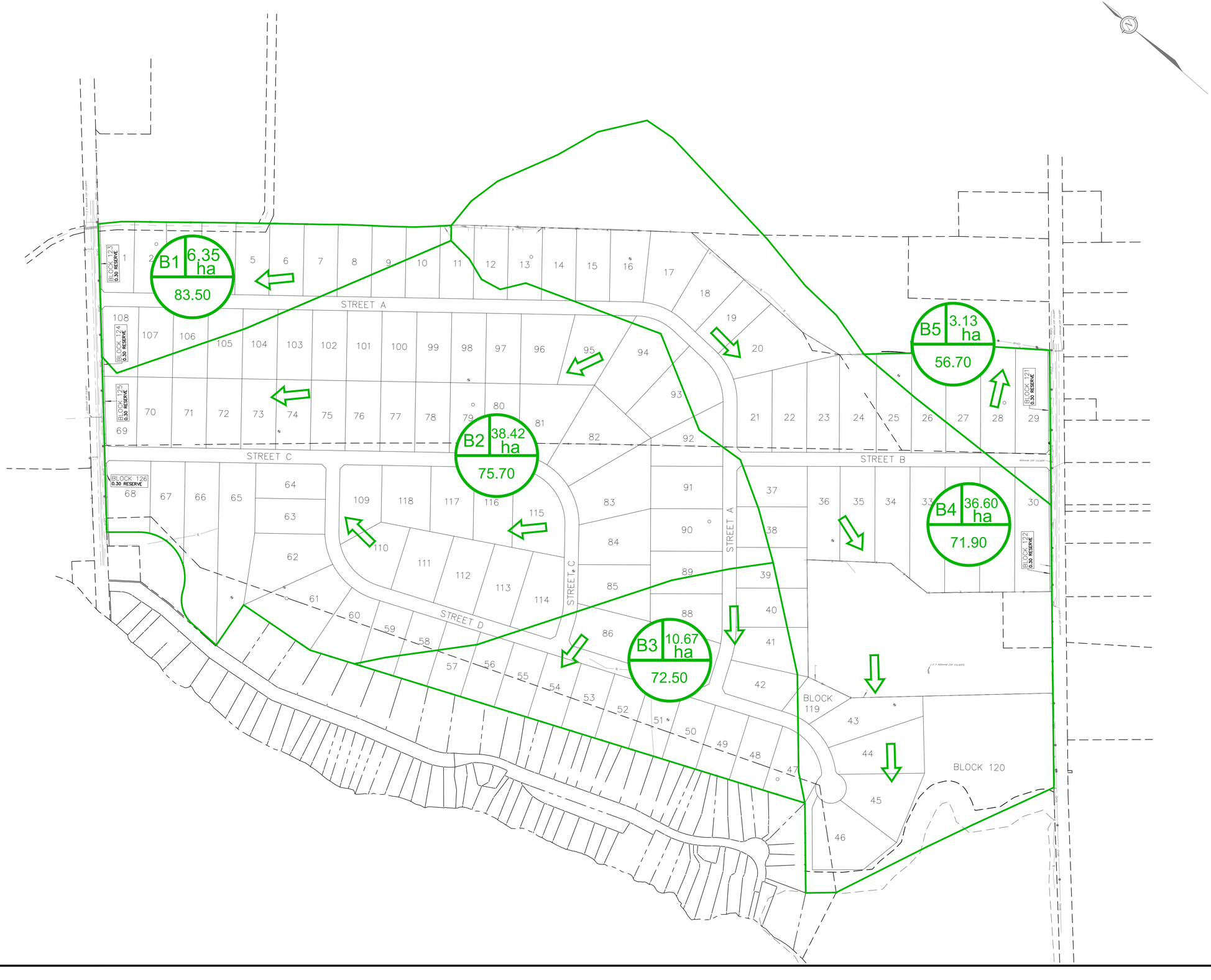

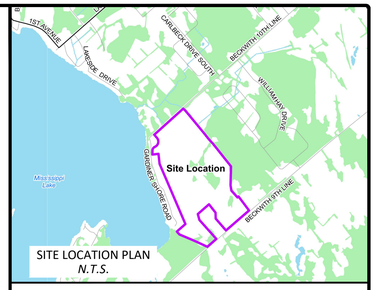

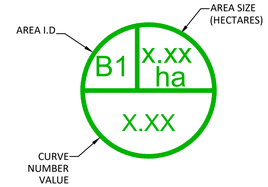

SCALE 1 : 2500

0 50 100 150 200 250 Metres

No.	Revision/Issue	Date
00	ISSUED FOR REVIW	XX/XX/XXXX

Check and verify all dimensions before proceeding with the work

Do not scale drawings

McINTOSH PERRY
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Stamp:

Client:
GARDINER'S GROVE INC.
48 WILSON ST WEST
PERTH, ONTARIO, K7H 2N4

Project:
GARDINER'S GOVE
BECKWITH ONTARIO

Drawing Title:
POST-DEVELOPMENT DRAINAGE PLAN

Scale: 1:2500	Project Number: CCO-20-0203
Drawn by: M.M.	
Checked By:	Drawing Number: 01
Designed By: J.P.	

FILENAME: \\mcintosh-ny-ho\Share\Perth\MPCE JOBS\MPCE Projects\2020\CCO-20-0203-Tweedsmuir-Gardiner Property\12 Dwg\01 - Preliminary Drawings\CCO-20-0203 - Tweedsmuir - Gardiner Property - Preliminary.dwg
LAST SAVED: Thursday, May 20, 2021 LAST SAVED BY: m.olsthoorn
LAST PLOTTED: Thursday, May 20, 2021 CTB FILE USED: —

CCO-20-0203 Gardiner's Grove Subdivision POST-DEVELOPMENT DRAINAGE AREA INFORMATION

Land Use Breakdown

Catchment ID	Area (m^2)	Impervious (m^2)	Manicured Lawns (m^2)	CN	Ia (mm)	% Imperviousness	Outlet
B1	63496	7075	56421	83.5	4.7	11%	Northeast - 10th Line Ditch
B2	384158	38735	345423	75.7	4.7	10%	Culvert under 10th Line
B3	106655	12720	93935	72.5	4.6	12%	Mississippi Lake
B4	366027	19475	346552	72.1	4.8	5%	Wetland off-site to southwest
B5	31344	2100	29244	56.7	4.8	7%	Southeast - 9th Line Ditch
Sub-Total	951680	80105	871575			8%	

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CCO-20-0203 Gardiner's Grove Subdivision POST-DEVELOPMENT DRAINAGE AREA INFORMATION

Time of Concentration

Catchment ID	Total Overland Flow Distance (m)	Slope of Land (%)	Sheet Flow Distance (m)	Sheet Flow Tc (min)	Shallow Concentrated Flow Distance (m)	Shallow Concentrated Flow Velocity (m/s)	Shallow Concentrated Tc (min)	Ditch Length (m)	Ditch Slope (%)	Ditch Velocity (m/s)	Ditch Tc (min)	Total Tc (min)
B1	225	2.22	30	3	195	0.32	10	275.0	0.5	0.32	14	27
B2	195	1.03	30	6	165	0.22	13	615.0	0.5	0.32	32	50
B3	100	1.00	30	6	70	0.21	5	185.0	0.5	0.32	10	21
B4	250	2.20	30	4	220	0.32	12	700.0	0.5	0.32	36	52
B5	165	2.12	30	6	135	0.31	7	100.0	0.5	0.32	5	19

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CCO-20-0203 Gardiner's Grove Subdivision POST-DEVELOPMENT DRAINAGE AREA INFORMATION

Hydrologic Model Parameters

Catchment ID	Area (ha)	CN	Ia (mm)	tc (min)	tp (hr)	Outlet
B1	6.35	83.5	4.7	27	0.31	Northeast - 10th Line Ditch
B2	38.42	75.7	4.7	50	0.56	Culvert under 10th Line
B3	10.67	72.5	4.6	21	0.24	Mississippi Lake
B4	36.60	72.1	4.8	52	0.58	Wetland off-site to southwest
B5	3.13	56.7	4.8	19	0.21	Southeast - 9th Line Ditch
Total	95.17					

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CCO-20-0203 Gardiner's Grove Subdivision POST-DEVELOPMENT UNCONTROLLED HYDROLOGICAL RESULTS

	12-hour SCS		24-hour SCS		4-hour Chicago		Max	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
B1	0.36	0.82	0.39	0.84	0.28	0.69	0.39	0.84
B2	1.07	2.61	1.15	2.71	0.81	2.16	1.15	2.71
B3	0.48	1.21	0.53	1.28	0.35	0.96	0.53	1.28
B4	0.88	2.19	0.94	2.29	0.66	1.79	0.94	2.29
B5	0.09	0.24	0.10	0.26	0.06	0.18	0.87	0.26

		Outlet
A1	B1	Northeast - 10th Line Ditch
A2	B2	Culvert under 10th Line
A3	B3	Mississippi Lake
A4	B4	Wetland off-site to southwest
A5	B5	Southeast - 9th Line Ditch

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CONCEPTUAL STORMWATER MANAGEMENT REPORT
GARDINER'S GROVE SUBDIVISION

APPENDIX E
STORMWATER MANAGEMENT STORAGE CALCULATIONS

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CCO-20-0203 Gardiner's Grove Subdivision PRE & POST UNCONTROLLED HYDROLOGICAL RESULTS SUMMARY

Peak Flows (m^3/s)											
Design Storm (yr)	12-hour SCS				24-hour SCS				4-hour Chicago		
	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ
Catchment A1/B1											
5	0.30	0.36	0.06	20%	0.33	0.39	0.06	19%	0.22	0.28	0.05
100	0.69	0.82	0.13	18%	0.71	0.84	0.14	19%	0.58	0.69	0.11
Catchment A2/B2											
5	0.65	1.07	0.42	64%	0.72	1.15	0.43	60%	0.48	0.81	0.34
100	1.71	2.61	0.90	52%	1.80	2.71	0.92	51%	1.37	2.16	0.79
Catchment A3/B3											
5	0.31	0.48	0.17	56%	0.35	0.53	0.18	53%	0.21	0.35	0.14
100	0.85	1.21	0.35	41%	0.91	1.28	0.37	41%	0.65	0.96	0.30
Catchment A4/B4											
5	0.46	0.88	0.41	89%	0.51	0.94	0.43	85%	0.34	0.66	0.32
100	1.26	2.19	0.93	74%	1.34	2.29	0.96	72%	1.00	1.79	0.79
Catchment A5/B5											
5	0.16	0.09	-0.07	-43%	0.18	0.10	-0.08	-44%	0.09	0.06	-0.03
100	0.42	0.24	-0.18	-43%	0.47	0.26	-0.20	-43%	0.31	0.18	-0.13

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CCO-20-0203 Gardiner's Grove Subdivision STORAGE REQUIREMENTS - AREAS A1/B1

Outlet: Northeast - 10th Line Ditch
Post-Development to Pre-Development Restriction

VO5 Route Reservoir Input - Rating Curve

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.300	0.0300	300.0
0.700	0.0750	750.0

VO5 Output - Route Reservoir Results - Limit Post-Development Peak Flow Rates to Pre-Development Levels

Distribution (hr)	5-Year Restricted Flow (m^3/s)	5-Year Required Storage (ha.m)	5-Year Required Storage (m^3)	100-Year Restricted Flow (m^3/s)	100-Year Required Storage (ha.m)	100-Year Required Storage (m^3)
12-Hour SCS	0.216	0.0432	**432**	0.510	0.0948	**948**
24-Hour SCS	0.228	0.0458	**458**	0.523	0.0969	**969**
4-Hour Chicago	0.167	0.0315	**315**	0.432	0.0814	**814**

	5-Year	100-Year
Required Storage (m^3)	**458**	**969**

Available Site Storage

Post-Development Catchment ID	Assumed Available Storage per Check Dam (m^3)	Total Available Storage (m^3)	Storage Type	Approximate Length (m)	Number of Check Dams
B1	62	172	Ditch - Right	275	3
	62	172	Ditch - Left	275	3
Total		**344**			

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CCO-20-0203 Gardiner's Grove Subdivision STORAGE REQUIREMENTS - AREAS A2/B2

Outlet: Southeast Culvert under 10th Line
Post-Development to Pre-Development Restriction

VO5 Route Reservoir Input - Rating Curve

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.700	0.2500	2500.0
1.800	0.6000	6000.0

VO5 Output - Route Reservoir Results - Limit Post-Development Peak Flow Rates to Pre-Development Levels

Distribution (hr)	5-Year Restricted Flow (m^3/s)	5-Year Required Storage (ha.m)	5-Year Required Storage (m^3)	100-Year Restricted Flow (m^3/s)	100-Year Required Storage (ha.m)	100-Year Required Storage (m^3)
12-Hour SCS	0.492	0.2872	**2872**	1.318	0.6693	**6693**
24-Hour SCS	0.531	0.3102	**3102**	1.383	0.6978	**6978**
4-Hour Chicago	0.384	0.2239	**2239**	1.072	0.5604	**5604**

	5-Year	100-Year
Required Storage (m^3)	**3102**	**6978**

Available Site Storage

Post-Development Catchment ID	Assumed Available Storage per Check Dam (m^3)	Total Available Storage (m^3)	Storage Type	Approximate Length (m)	Number of Check Dams
B2	62	506	Ditch - Right	810	9
	62	506	Ditch - Left	810	9
	62	241	Ditch - Right	385	4
	62	241	Ditch - Left	385	4
	62	381	Ditch - Right	610	7
	62	381	Ditch - Left	385	7
Total		**2256**			

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CCO-20-0203 Gardiner's Grove Subdivision STORAGE REQUIREMENTS - AREAS A3/B3

Outlet: Mississippi Lake
Post-Development to Pre-Development Restriction

VO5 Route Reservoir Input - Rating Curve

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.350	0.0500	500.0
0.900	0.1100	1100.0

VO5 Output - Route Reservoir Results - Limit Post-Development Peak Flow Rates to Pre-Development Levels

Distribution (hr)	5-Year Restricted Flow (m^3/s)	5-Year Required Storage (ha.m)	5-Year Required Storage (m^3)	100-Year Restricted Flow (m^3/s)	100-Year Required Storage (ha.m)	100-Year Required Storage (m^3)
12-Hour SCS	0.240	0.0562	**562**	0.693	0.1293	**1293**
24-Hour SCS	0.260	0.0609	**609**	0.731	0.1353	**1353**
4-Hour Chicago	0.180	0.0420	**420**	0.548	0.1072	**1072**

	5-Year	100-Year
Required Storage (m^3)	**609**	**1353**

Available Site Storage

Post-Development Catchment ID	Assumed Available Storage per Check Dam (m^3)	Total Available Storage (m^3)	Storage Type	Approximate Length (m)	Number of Check Dams
B3	62	116	Ditch - Right	185	2
	62	116	Ditch - Left	185	2
	62	266	Ditch - Right	425	5
	62	266	Ditch - Left	425	5
Total		**762**			

CCO-20-0203 Gardiner's Grove Subdivision STORAGE REQUIREMENTS - AREAS A4/B4

Outlet: Wetland
Post-Development to Pre-Development Restriction

VO5 Route Reservoir Input - Rating Curve

Discharge (m^3/s)	Storage (ha-m)	Storage (m^3)
0.000	0.0000	0.0
0.500	0.2500	2500.0
1.300	0.6100	6100.0

VO5 Output - Route Reservoir Results - Limit Post-Development Peak Flow Rates to Pre-Development Levels

Distribution (hr)	5-Year Restricted Flow (m^3/s)	5-Year Required Storage (ha.m)	5-Year Required Storage (m^3)	100-Year Restricted Flow (m^3/s)	100-Year Required Storage (ha.m)	100-Year Required Storage (m^3)
12-Hour SCS	0.344	0.2663	**2663**	0.970	0.6359	**6359**
24-Hour SCS	0.374	0.2900	**2900**	1.029	0.6692	**6692**
4-Hour Chicago	0.268	0.2077	**2077**	0.782	0.5286	**5286**

	5-Year	100-Year
Required Storage (m^3)	**2900**	**6692**

Available Site Storage

Post-Development Catchment ID	Assumed Available Storage per Check Dam (m^3)	Total Available Storage (m^3)	Storage Type	Approximate Length (m)	Number of Check Dams
B4	62	209	Ditch - Right	335	4
	62	209	Ditch - Left	335	4
	62	228	Ditch - Right	365	4
	62	228	Ditch - Left	365	4
	62	78	Ditch - Right	125	2
	62	78	Ditch - Left	125	2
Total		**1031**			

CCO-20-0203 Gardiner's Grove Subdivision PRE & POST CONTROLLED HYDROLOGICAL RESULTS SUMMARY

Peak Flows (m^3/s)									
Design Storm (yr)	12-Hour SCS			24-Hour SCS			4-Hour Chicago		
	Pre.	Post.	Δ	Pre.	Post.	Δ	Pre.	Post.	Δ
Area A1/B1									
5	0.30	0.28	-0.03	0.33	0.30	-0.03	0.22	0.22	-0.005
100	0.69	0.61	-0.08	0.71	0.63	-0.08	0.58	0.53	-0.053
Area A2/B2									
5	0.65	0.63	-0.02	0.72	0.68	-0.04	0.48	0.49	0.01
100	1.71	1.60	-0.11	1.80	1.67	-0.13	1.37	1.32	-0.06
A3/B3									
5	0.31	0.30	-0.01	0.35	0.33	-0.02	0.21	0.23	0.02
100	0.85	0.82	-0.04	0.91	0.86	-0.05	0.65	0.66	0.00
A4/B4									
5	0.46	0.46	-0.01	0.51	0.49	-0.02	0.34	0.35	0.01
100	1.26	1.18	-0.08	1.34	1.24	-0.10	1.00	0.97	-0.04
A5/B5									
5	0.16	0.09	-0.07	0.18	0.10	-0.08	0.09	0.06	-0.03
100	0.42	0.24	-0.18	0.47	0.26	-0.20	0.31	0.18	-0.13

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