PROPOSED RESIDENTIAL DEVELOPMENT

COUNTY ROAD 49

TRENT LAKES

PRELIMINARY STORMWATER MANAGEMENT REPORT

Prepared for:

TD Consulting Inc.

Prepared By:

BaseTech Consulting Inc.
309 Roywood Crescent
Newmarket, Ontario
L3Y 1A6

BCI Project No. 23-32

February, 2024

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1. INTRODUCTION

The site is located on the east side of County Road 49 in the town of Trent Lakes.

It is proposed to develop the site with large residential lots. The southern part of the site will remain undeveloped.

This report examines the impacts the proposed development will have on the run-off and sedimentation from the site and measures to mitigate those impacts.

The Report has used the following documentation in its preparation:

1. Draft Plan of Condominium prepared by TD Consulting Inc.
2. County of Peterborough Design Criteria and Standard Detail Drawings.
3. Geotechnical and Hydrogeological Report by PRI Engineering dated October 5, 2023.
4. Stormwater Management Planning and Design Manual by the Ministry of Environment, dated March 2003.

2. EXISTING SITE CONDITIONS

The proposed development site measures 10.1046 ha. and is currently vacant.

It is proposed to develop the north 8.5370 ha as residential lots with the remaining south area, 1.5676 ha., remaining undevelopedl.

The site mainly drains to the south and east with the low point in the southeast corner. A portion of the site in the southwest corner drains toward County Road 49.

An external area of 5.93ha drains on to the site from the north (see Figure 1).

It is proposed to capture the runoff from the site and provide quality and quantity controls in the southeast corner of the site.

Details of the existing and proposed drainage areas are shown on Drawing DR-1.

3. LOW IMPACT DESIGN

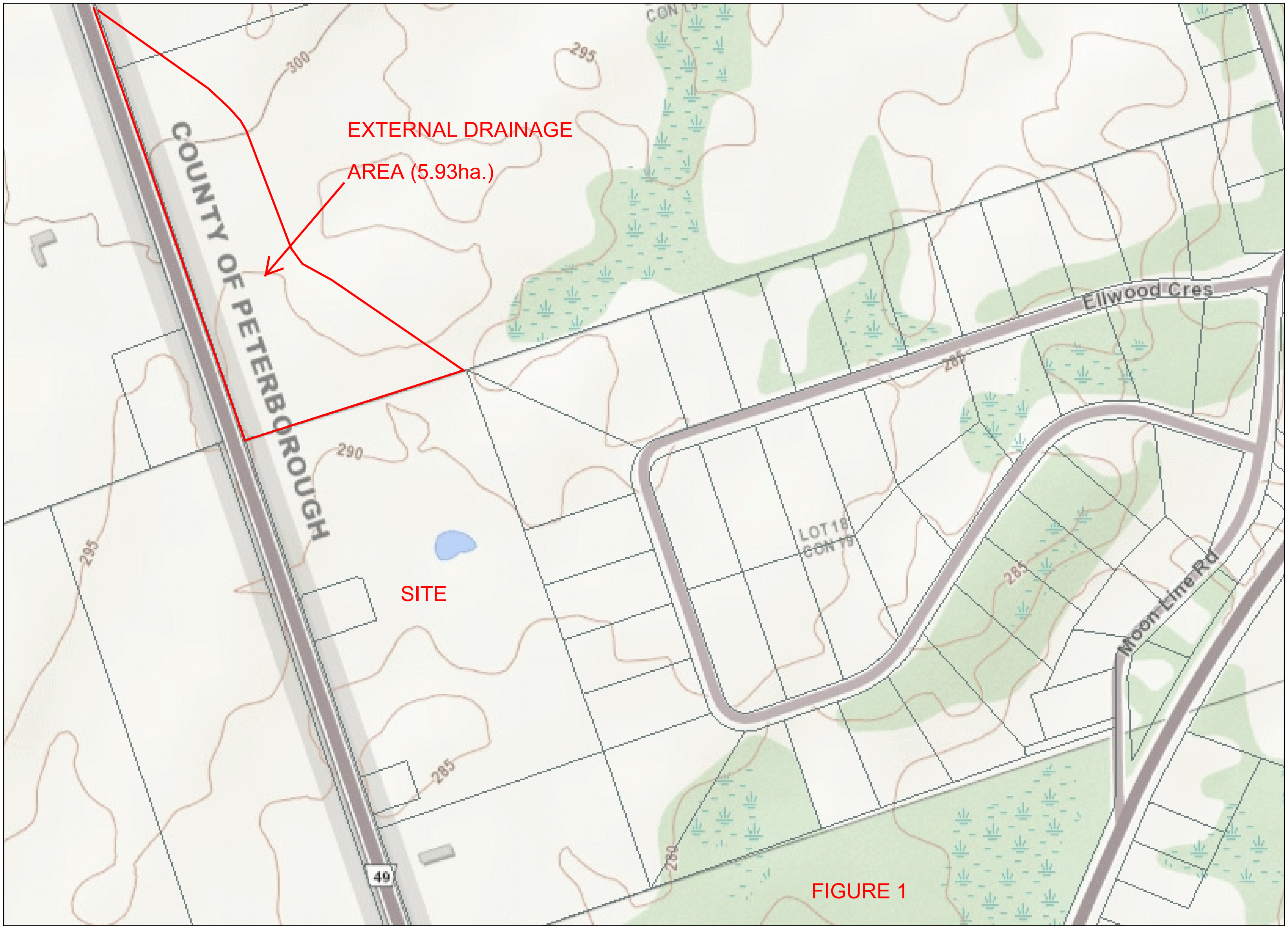
The City of Peterborough and Otonabee Conservation Authority require that the facilities designed to control the runoff from the site be designed using Low Impact Design (LID) practices where possible.

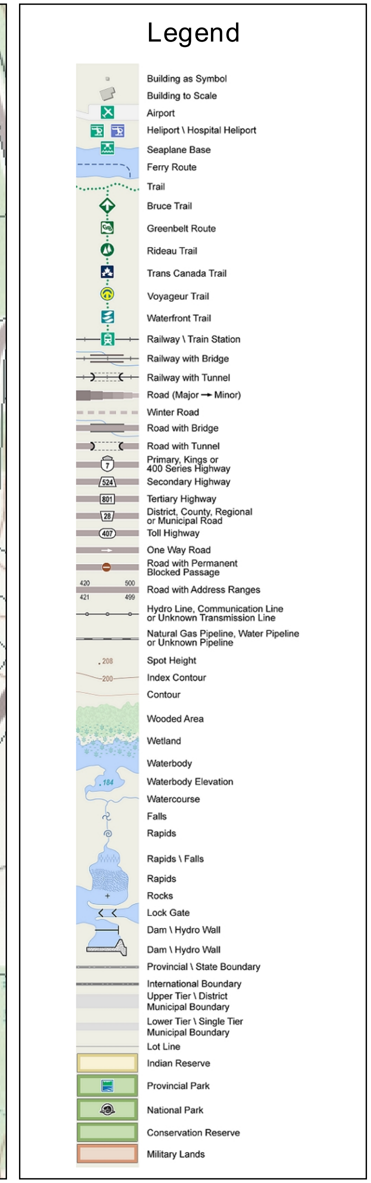
Ontario

MINISTRY OF NATURAL RESOURCES AND FORESTRY

Make a Topographic Map

Notes:





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Projection: Web Mercator

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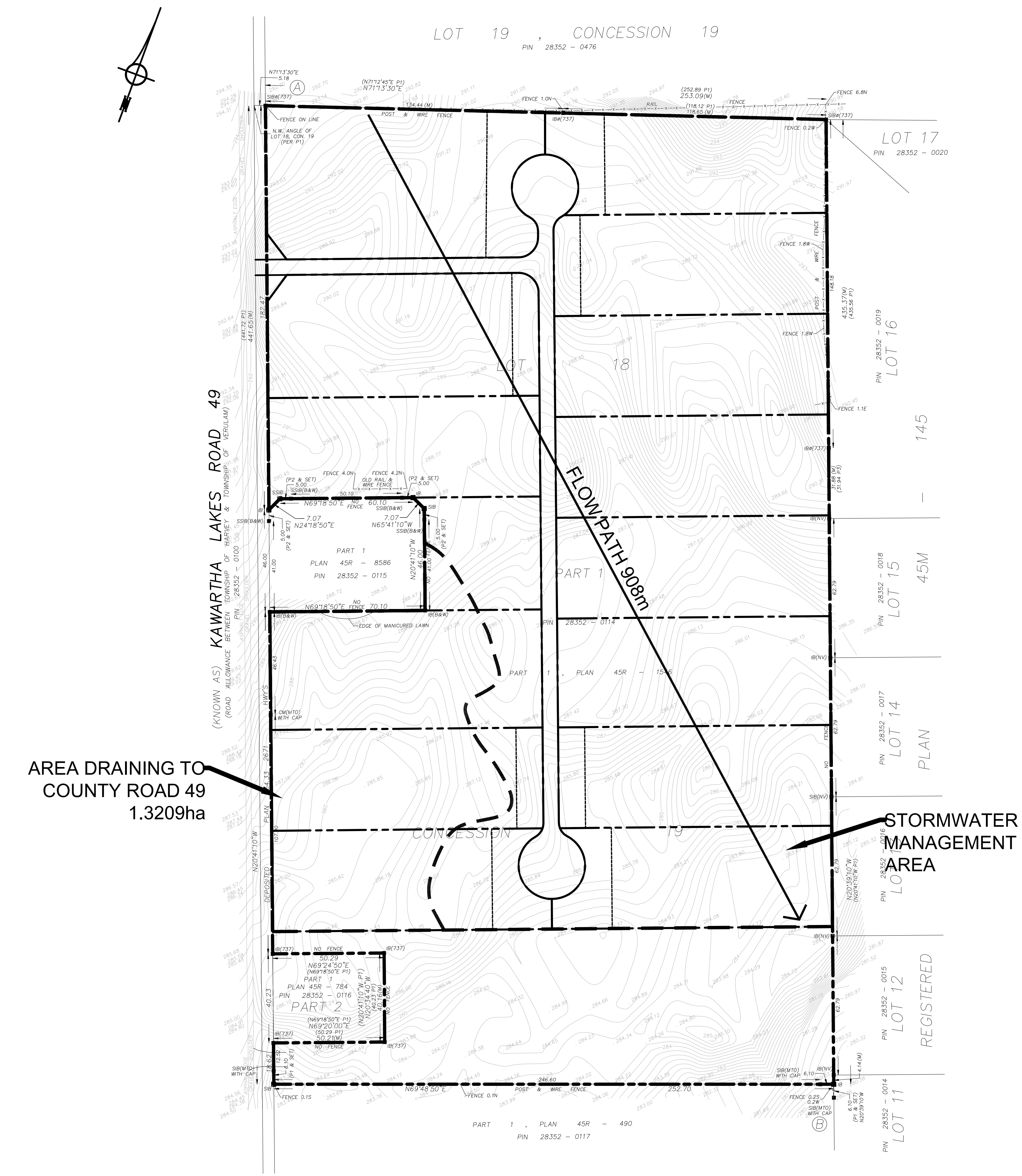

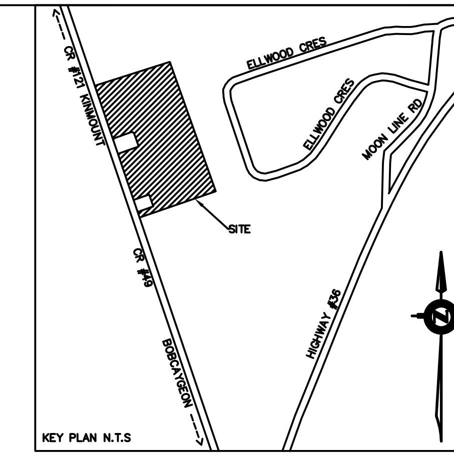

LEGEND

- - - - DRAINAGE AREA

SURVEY INFORMATION PROVIDED BY:

IBW SURVEYORS

IBWSURVEYORS.COM | 1.800.667.0696

BOUNDARY INFORMATION –
PARTY CHIEF: SK | DRAWN BY: MSJ | CHECKED BY: IBW | PLOT DATE: AUG. 11/21
FILE NAME: A-027651-Rv4 | copies available at LandSurveyRecords.com
TOPOGRAPHIC INFORMATION –
PARTY CHIEF: ML | DRAWN BY: AB | CHECKED BY: KV | PLOT DATE: AUG. 30/23
FILE NAME: A-041393-TOPO_V3 | copies available at LandSurveyRecords.com

Nº:	DATE	DESCRIPTION	BY

REVISIONS

APPROVAL:

ENGINEER'S SEAL: W.M.P. FEHERTY, FEB. 26, 2024, LICENSED PROFESSIONAL ENGINEER, PROVINCE OF ONTARIO

PROJECT TITLE:
00 COUNTY ROAD 49, TRENT LAKES
COUNTY OF PETERBROUGH
ROLL# 154201000410603

DRAWING TITLE:
DRAINAGE AREA

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DRAWN BY: KM	PROJECT Nº: 23-32
DESIGNED BY: WMPF	
APPROVED BY: WMPF	DRAWING Nº: DR-1
DATE: FEB 2024	SCALE: 1:200

LAST REVISED FEB 22-2024

The goal of LID is to minimize the generation of storm water runoff and to treat pollutant loads where they are generated. This is accomplished by directing storm water towards small-scale systems within the site with the purpose of managing the storm water on site and eliminating storm water ponds, curbs and gutters thus saving on infrastructure and storm conveyance costs.

The proposed system includes grassed roadside ditches, a grass retention area, vegetated filter strip and an infiltration bed to provide water balance for the site.

4. HYDROLOGY

The City of Peterborough and Otonabee Conservation Authority require that pre-development run-off conditions be maintained for the 2-100 year storm events.

Rainfall Distributions and Flows

Rainfall intensities have been based on the City of Peterborough IDF curves and are defined by the following equation.

$$I = \frac{A}{(T+B)^C} \text{ mm/hr}$$

Storm	A	B	C
2 year	858	6.8	0.822
5 year	1214	9.0	0.847
10 year	1487	10.2	0.858
25 year	1898	11.7	0.871
50 year	2110	12.0	0.870
100 year	2518	13.2	0.882

and t_d = duration (min.).
The flows generated using the IDF curves will give conservative estimates for the flows which are sufficient for this preliminary report. More detailed analysis in line with the City and Conservation Authority criteria will be required at detailed design.

Calculation of the pre and post-development runoff coefficients for the site has been based on the following runoff coefficients:

	2–10 Year	25 Year	50 Year	100 Year
Buildings	0.90	0.95	0.95	0.95
Paving	0.90	0.95	0.95	0.95
Grass/Landscape	0.30	0.33	0.36	0.38

The impermeability factors for the lower figures have been increased for the 25, 50 and 100 year storms by 10%, 20% and 25% respectively as recommended by MTO Design Chart 1.07.

The time of concentration for Pre-Development Flows has been calculated using the Airport Method using the equation:

$$Tc = \frac{3.26\,(1.1-C)\,L^{0.5}}{S_w^{0.33}}$$

It is proposed to provide a grassed retention area in the southeast corner of the site.

The total area for the residential portion and the external area is 14.5030 ha. A portion of the residential development area (1.3209ha.) currently drains to County Road 49.
Therefore, the pre-development area draining to the southeast is 13.1461 ha.
The post-development area draining to the southeast will be 14.5030ha.

Based on a flow path length of 908m and a slope of 2.1% and a runoff coefficient of 0.30 (including the external area), the time of concentration will be 61.5 minutes. The flow path is shown on Drawing DR-1.

The rainfall intensities for the 2 – 100 year storms during Pre-Development conditions are;

2 Year Storm	23.34 mm/hr
5 Year Storm	31.70 mm/hr
10 Year Storm	38.29 mm/hr
25 Year Storm	44.73 mm/hr
50 Year Storm	50.77 mm/hr
100 Year Storm	55.28 mm/hr

The existing site and external area will have a pre-development runoff coefficient of 0.30.
The 25 year, 50 year and 100 year pre-development runoff coefficients increase to 0.33, 0.36 and 0.38 respectively.
The post-development residential and external drainage area draining to the southeast is made up as follows:

Asphalt Paving	6131m^2
Houses	3666m^2
Landscape	135233m^2

The 2 – 10 year post-development characteristics for the site are as follows:

Asphalt Paving	$6131m^2$	@ 0.90	= 5517.9
Houses	$3666m^2$	@ 0.95	= 3299.4
Landscape	$135233m^2$	@ 0.30	= 40569.9
	TOTAL		49387.2

The 2-10 year post-development runoff coefficient $= \frac{49387.2}{145030} = 0.34$

The 25 year, 50 year and 100 year post-development runoff coefficients increase to 0.37, 0.40 and 0.41 respectively.

Discharges have been calculated using the formula Q = 0.00278ACi

where Q = discharge (m^3/sec)
A = area (ha)
C = impermeability factor
i = rainfall intensity (mm/hr)

Retention volumes have been calculated based on the equation.

V = (Post-Development Flow – Pre-Development Flow) x T x 60 cu.m.

The 2 year Pre-Development Flow from the residential and external area, based on a time of concentration of 61.5 min., will be;

Q_{Pre2} = 0.00278 x 13.1461 x 0.30 x 23.34
= $0.2559m^3$/sec.

Post-Development flows were calculated for the site for various times of concentration and the maximum retention volume for each storm was found. Details are shown in Appendix 1.

Table 1 shows details of the retention volumes for each storm:

TABLE 1

STORM	ALLOWABLE FLOW (m^3/sec.)	RETENTION VOLUME (m^3)
2 Year	0.2559	488.84
5 Year	0.3476	658.10
10 Year	0.4198	775.46
25 Year	0.5695	981.52
50 Year	0.6680	1166.65
100 Year	0.7677	1280.22

The grassed retention area will be sized to retain the volumes required.

5. CONVEYANCE

Runoff from the drainage area will be collected in the roadside ditches and will be directed to a grassed retention area in the southeast corner of the site via a swale at the end of the proposed road.

Prior to leaving the retention areas, the runoff will discharge through “V”-notch weirs to restrict the flows to the allowable values.

The size of the ‘v’ notch is calculated using the formula:

$$Q = Cd \frac{8}{15} \sqrt{2g} \, Tan \frac{\propto}{2} H^{5/2}$$

where, Q = discharge (m^3/sec.)
Cd = 0.60
H = head (m)
$\propto$ = angle of the notch

This calculation will be carried out for all storm events to determine the storm requiring the lowest weir angle required. This will used to design the control weir outlets and will result in larger retention volumes for the other storms.
The major flow route will be via the proposed road.

6. QUALITY CONTROL

The City of Peterborough and Otonabee Conservation Authority require that all paved and access areas be provided with a facility to prevent fuel spills and sediment from entering the storm sewer system.

Runoff from the roofs and landscaped areas does not require any quality control. Runoff from the driveways, road and paved areas will require quality control to remove any fuel spills or sediment deposited on the asphalt areas.

It is proposed to provide a vegetated filter strip at the exit from the grass retention area to provide quality control. The grass roadside ditches and retention area will also assist in sediment/pollutant removal.

The vegetated filter strip will be a level grass/planted area with a low-level dam at the end to act as a level flow spreader.

The vegetated filter strip will have a slope of 0.5%. The length of the filter strip will be determined by the volume to be infiltrated.

The level flow spreader will be designed so that the peak flow from the 4 Hour Chicago 10 mm Storm results in a minimum flow depth of 50 mm.

The peak rainfall from the 4 Hour Chicago 10 mm Storm is 34.04 mm/hr (see Appendix 3).

The flow over the spreader is given by the equation;

$$Q = C\ L\ H^{3/2}$$

Where,

Q = Flow (c.m.s.)
C = 1.6
L = Length of spreader (m)
H = Head over the spreader (m)

Therefore, the length of flow spreader can be determined, and this will be the width of the vegetated filter strip. The volume requirement for each vegetated filter strip is determined by Table 3.2 of the MOE Stormwater Management Planning and Design Manual for Enhanced 80% long-term S.S. removal.

7. WATER BALANCE

It is proposed to provide an infiltration bed to provide groundwater re-charge. Water balance deficit calculations are shown in Appendix 4. In-situ percolation tests for the soils underlying the site will be required to determine the size of the infiltration bed. The bed will be placed at the end of the vegetated filter strip.

8. PHOSPHOROUS LOADING

The proposed stormwater management for the proposed development will result in close to a net zero removal for the site as shown in Appendix 5. The final design, especially for the commercial site, can be adjusted to achieve a net zero removal.

9. SEDIMENTATION AND EROSION CONTROL

Sedimentation and erosion controls should be provided during construction using the following techniques depending on site development phasing and seasonal considerations:

1) Minimizing the amount of disturbance to the site
2) Grading and vegetating disturbed areas as soon as possible after disturbance
3) Place a Silt Fence around the entire property
4) Mud mat at the construction entrance
5) Place rock check dams in all swales

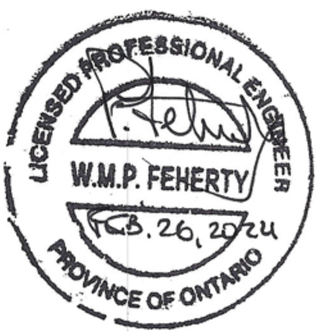
All sedimentation and erosion control measured should be carried out in accordance with current City of Kawartha Lakes, Kawartha Conservation Authority and Ministry of Natural Resources guidelines.

10. SUMMARY

This Report has presented stormwater management details for the development and is to be used as the basis for the detailed project design.

The key points are:

1. Flows from the proposed development will be controlled to at least pre-development values for the 2 – 100 year storms.
2. Excess run-off will be directed to dry a detention pond and released at pre-development values.
3. Quality control is provided by a vegetated filter strip and grassed swales.
4. The water balance for the site will be maintained.
5. The proposed development will have close to a net zero phosphorous loading.
6. Sedimentation and erosion controls will be provided during and after construction.



Peter Feherty, M.Sc., P.Eng.
BaseTech Consulting Inc.

APPPENDIX 1

RETENTION VOLUME CALCULATIONS

COUNTY ROAD 49
TRENT LAKES
RESIDENTIAL AREA
RAINFALL, RETENTION CALCULATIONS
February, 2024

$$\text{Rainfall, } I = \frac{A}{(T+B)^C} \text{ mm./hr.}$$

2 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	662.0	7.5	27.50	0.790	13.71	48.28	0.2559	0.6619	0.4060	487.26
21	662.0	7.5	28.50	0.790	14.10	46.94	0.2559	0.6435	0.3876	488.41
22	662.0	7.5	29.50	0.790	14.49	45.68	0.2559	0.6262	0.3703	488.84
23	662.0	7.5	30.50	0.790	14.88	44.49	0.2559	0.6100	0.3541	488.60
24	662.0	7.5	31.50	0.790	15.26	43.37	0.2559	0.5946	0.3387	487.74
25	662.0	7.5	32.50	0.790	15.65	42.31	0.2559	0.5801	0.3242	486.31
26	662.0	7.5	33.50	0.790	16.02	41.31	0.2559	0.5664	0.3105	484.35
27	662.0	7.5	34.50	0.790	16.40	40.36	0.2559	0.5534	0.2975	481.91
28	662.0	7.5	35.50	0.790	16.78	39.46	0.2559	0.5410	0.2851	479.01

5 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	1098.0	10.1	30.10	0.830	16.87	65.07	0.3476	0.8921	0.5445	653.44
21	1098.0	10.1	31.10	0.830	17.34	63.33	0.3476	0.8683	0.5207	656.03
22	1098.0	10.1	32.10	0.830	17.80	61.69	0.3476	0.8457	0.4981	657.55
23	1098.0	10.1	33.10	0.830	18.26	60.14	0.3476	0.8245	0.4769	658.10
24	1098.0	10.1	34.10	0.830	18.71	58.67	0.3476	0.8044	0.4568	657.74
25	1098.0	10.1	35.10	0.830	19.17	57.28	0.3476	0.7853	0.4377	656.55
26	1098.0	10.1	36.10	0.830	19.62	55.96	0.3476	0.7672	0.4196	654.58
27	1098.0	10.1	37.10	0.830	20.07	54.70	0.3476	0.7500	0.4024	651.88
28	1098.0	10.1	38.10	0.830	20.52	53.51	0.3476	0.7336	0.3860	648.52

10 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	1560.0	13.0	33.00	0.860	20.23	77.13	0.4198	1.0574	0.6376	765.12
21	1560.0	13.0	34.00	0.860	20.75	75.17	0.4198	1.0306	0.6108	769.61
22	1560.0	13.0	35.00	0.860	21.28	73.32	0.4198	1.0052	0.5854	772.76
23	1560.0	13.0	36.00	0.860	21.80	71.57	0.4198	0.9812	0.5614	774.68
24	1560.0	13.0	37.00	0.860	22.32	69.90	0.4198	0.9583	0.5385	775.46
25	1560.0	13.0	38.00	0.860	22.84	68.31	0.4198	0.9366	0.5168	775.18
26	1560.0	13.0	39.00	0.860	23.35	66.81	0.4198	0.9159	0.4961	773.91
27	1560.0	13.0	40.00	0.860	23.87	65.37	0.4198	0.8962	0.4764	771.72
28	1560.0	13.0	41.00	0.860	24.38	63.99	0.4198	0.8773	0.4575	768.67

25 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	2010.0	14.0	34.00	0.880	22.27	90.26	0.5395	1.3467	0.8072	968.61
21	2010.0	14.0	35.00	0.880	22.84	87.99	0.5395	1.3128	0.7733	974.31
22	2010.0	14.0	36.00	0.880	23.42	85.83	0.5395	1.2806	0.7411	978.27
23	2010.0	14.0	37.00	0.880	23.99	83.79	0.5395	1.2501	0.7106	980.64
24	2010.0	14.0	38.00	0.880	24.56	81.84	0.5395	1.2211	0.6816	981.52
25	2010.0	14.0	39.00	0.880	25.13	79.99	0.5395	1.1935	0.6540	981.02
26	2010.0	14.0	40.00	0.880	25.69	78.23	0.5395	1.1672	0.6277	979.24
27	2010.0	14.0	41.00	0.880	26.26	76.55	0.5395	1.1421	0.6026	976.26
28	2010.0	14.0	42.00	0.880	26.82	74.94	0.5395	1.1182	0.5787	972.16

50 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	2200.0	14.6	34.60	0.870	21.83	100.79	0.6680	1.6258	0.9578	1149.33
21	2200.0	14.6	35.60	0.870	22.37	98.32	0.6680	1.5860	0.9180	1156.64
22	2200.0	14.6	36.60	0.870	22.92	95.98	0.6680	1.5482	0.8802	1161.87
23	2200.0	14.6	37.60	0.870	23.46	93.76	0.6680	1.5123	0.8443	1165.16
24	2200.0	14.6	38.60	0.870	24.01	91.64	0.6680	1.4782	0.8102	1166.65
25	2200.0	14.6	39.60	0.870	24.55	89.62	0.6680	1.4456	0.7776	1166.47
26	2200.0	14.6	40.60	0.870	25.09	87.70	0.6680	1.4146	0.7466	1164.73
27	2200.0	14.6	41.60	0.870	25.62	85.86	0.6680	1.3850	0.7170	1161.52
28	2200.0	14.6	42.60	0.870	26.16	84.11	0.6680	1.3567	0.6887	1156.95

100 YEAR STORM

T	A	B	T+B	C	$(T+B)^C$	I	PRE Q	POST Q	POST-PRE	RET. VOL.
min						mm/hr	m^3/sec	m^3/sec	m^3/sec	cu m
20	2507.0	14.8	34.80	0.880	22.73	110.30	0.7677	1.8232	1.0555	1266.62
21	2507.0	14.8	35.80	0.880	23.30	107.58	0.7677	1.7783	1.0106	1273.38
22	2507.0	14.8	36.80	0.880	23.88	105.00	0.7677	1.7357	0.9680	1277.79
23	2507.0	14.8	37.80	0.880	24.45	102.56	0.7677	1.6953	0.9276	1280.02
24	2507.0	14.8	38.80	0.880	25.01	100.23	0.7677	1.6567	0.8890	1280.22
25	2507.0	14.8	39.80	0.880	25.58	98.01	0.7677	1.6201	0.8524	1278.53
26	2507.0	14.8	40.80	0.880	26.14	95.89	0.7677	1.5851	0.8174	1275.08
27	2507.0	14.8	41.80	0.880	26.71	93.87	0.7677	1.5516	0.7839	1269.99
28	2507.0	14.8	42.80	0.880	27.27	91.94	0.7677	1.5197	0.7520	1263.35

APPPENDIX 2

4 HOUR CHICAGO HYETOGRAPH

CHICAGO STORM HYETOGRAPH - COUNTY ROAD 29

The Chicago Storm Hyetograph has been derived based on the following

$$i_a = \frac{a(((1-c) \times t_a/(1-r)) + b)}{(((t_a/(1-r)) + b))^{(1+c)}} \quad \text{mm/hr}$$

$$i_b = \frac{a(((1-c) \times t_b)/r) + b)}{((t_b/r) + b)^{(1+c)}} \quad \text{mm/hr}$$

Where i_a = Rainfall after peak (mm/hr)

i_b = Rainfall before peak (mm/hr)

t_a = Time after peak (min.)

t_b= Time before peak (min.)

r = The ratio of time before the peak occurs to the total duration time (assumed at 0.40)

a, b & c = IDF curve parameters

4 HOUR CHICAGO STORM HYETOGRAPH
COUNTY ROAD 29
2 YEAR STORM

a	b	c	1-c	r	1-r	t_a	t_b	i_a	i_b	Time (hr)	Rain(mm)
858	6.8	0.822	0.178	0.4	0.6		60		2.87	0.17	0.49
858	6.8	0.822	0.178	0.4	0.6		50		3.42	0.33	0.55
858	6.8	0.822	0.178	0.4	0.6		40		4.25	0.50	0.72
858	6.8	0.822	0.178	0.4	0.6		30		5.66	0.67	0.96
858	6.8	0.822	0.178	0.4	0.6		20		8.57	0.83	1.37
858	6.8	0.822	0.178	0.4	0.6		10		17.67	1.00	3.00
858	6.8	0.822	0.178	0.4	0.6		0		177.49	1.17	30.17
858	6.8	0.822	0.178	0.4	0.6	10		26.69		1.33	4.27
858	6.8	0.822	0.178	0.4	0.6	20		13.09		1.50	2.22
858	6.8	0.822	0.178	0.4	0.6	30		8.57		1.67	1.46
858	6.8	0.822	0.178	0.4	0.6	40		6.38		1.83	1.02
858	6.8	0.822	0.178	0.4	0.6	50		5.09		2.00	0.87
858	6.8	0.822	0.178	0.4	0.6	60		4.25		2.17	0.72
858	6.8	0.822	0.178	0.4	0.6	70		3.66		2.33	0.59
858	6.8	0.822	0.178	0.4	0.6	80		3.22		2.50	0.55
858	6.8	0.822	0.178	0.4	0.6	90		2.87		2.67	0.49
858	6.8	0.822	0.178	0.4	0.6	100		2.60		2.83	0.42
858	6.8	0.822	0.178	0.4	0.6	110		2.38		3.00	0.40
858	6.8	0.822	0.178	0.4	0.6	120		2.20		3.17	0.37
858	6.8	0.822	0.178	0.4	0.6	130		2.04		3.33	0.33
858	6.8	0.822	0.178	0.4	0.6	140		1.91		3.50	0.32
858	6.8	0.822	0.178	0.4	0.6	150		1.79		3.67	0.30
858	6.8	0.822	0.178	0.4	0.6	160		1.69		3.83	0.27
858	6.8	0.822	0.178	0.4	0.6	170		1.60		4.00	0.27
						TOTAL RAIN					52.14

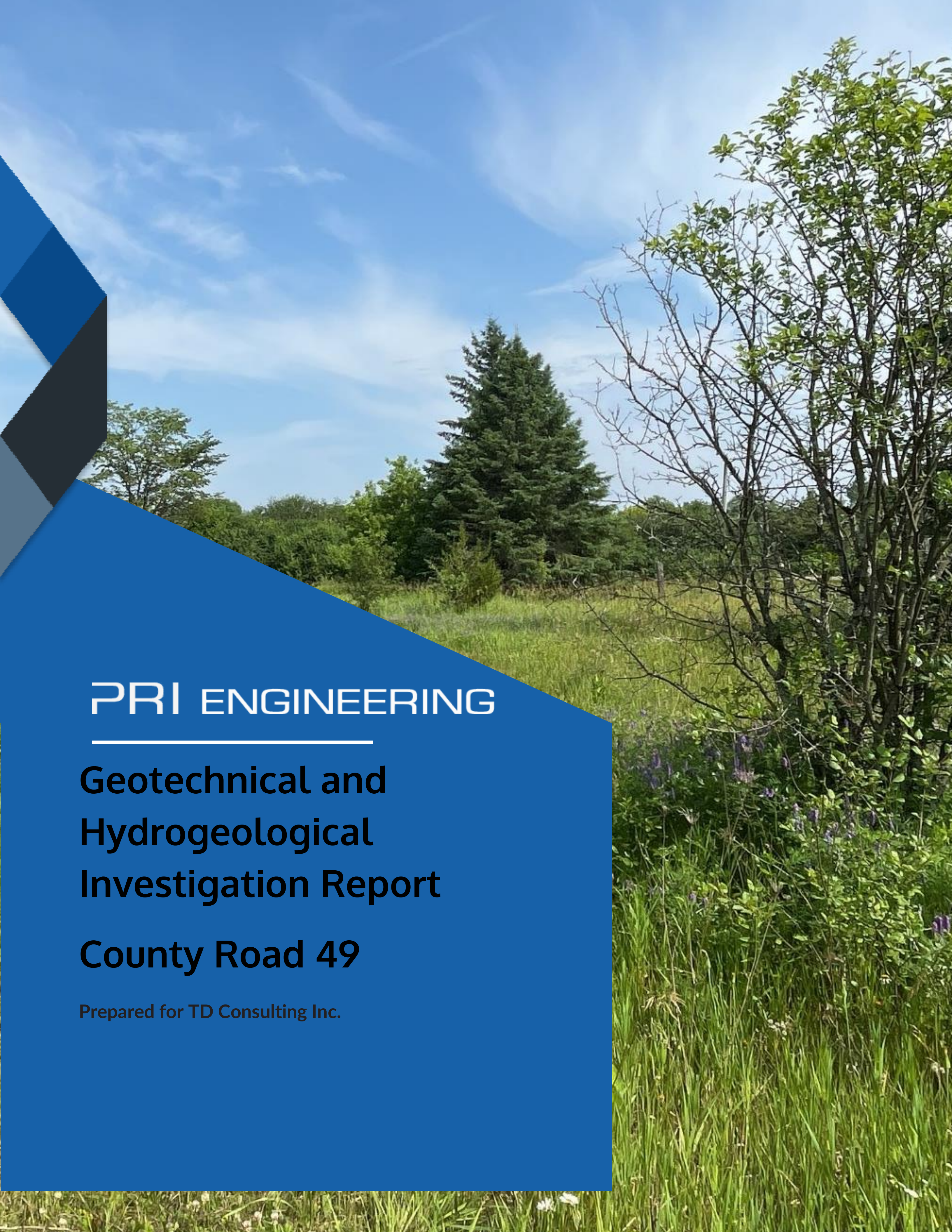
4 HOUR CHICAGO STORM HYETOGRAPH
COUNTY ROAD 29
10 mm STORM

The 10mm rainfall intensities have been pro-rated from the 2 year intensities to give a total rain of 10mm.

a	b	c	1-c	r	1-r	t_a	t_b	i_a	i_b	Time (hr)	Rain(mm)
858	6.8	0.822	0.178	0.4	0.6		60		0.55	0.17	0.09
858	6.8	0.822	0.178	0.4	0.6		50		0.66	0.33	0.10
858	6.8	0.822	0.178	0.4	0.6		40		0.82	0.50	0.14
858	6.8	0.822	0.178	0.4	0.6		30		1.09	0.67	0.18
858	6.8	0.822	0.178	0.4	0.6		20		1.64	0.83	0.26
858	6.8	0.822	0.178	0.4	0.6		10		3.39	1.00	0.58
858	6.8	0.822	0.178	0.4	0.6		0		34.04	1.17	5.79
858	6.8	0.822	0.178	0.4	0.6	10		5.12		1.33	0.82
858	6.8	0.822	0.178	0.4	0.6	20		2.51		1.50	0.43
858	6.8	0.822	0.178	0.4	0.6	30		1.64		1.67	0.28
858	6.8	0.822	0.178	0.4	0.6	40		1.22		1.83	0.20
858	6.8	0.822	0.178	0.4	0.6	50		0.98		2.00	0.17
858	6.8	0.822	0.178	0.4	0.6	60		0.82		2.17	0.14
858	6.8	0.822	0.178	0.4	0.6	70		0.70		2.33	0.11
858	6.8	0.822	0.178	0.4	0.6	80		0.62		2.50	0.10
858	6.8	0.822	0.178	0.4	0.6	90		0.55		2.67	0.09
858	6.8	0.822	0.178	0.4	0.6	100		0.50		2.83	0.08
858	6.8	0.822	0.178	0.4	0.6	110		0.46		3.00	0.08
858	6.8	0.822	0.178	0.4	0.6	120		0.42		3.17	0.07
858	6.8	0.822	0.178	0.4	0.6	130		0.39		3.33	0.06
858	6.8	0.822	0.178	0.4	0.6	140		0.37		3.50	0.06
858	6.8	0.822	0.178	0.4	0.6	150		0.34		3.67	0.06
858	6.8	0.822	0.178	0.4	0.6	160		0.32		3.83	0.05
858	6.8	0.822	0.178	0.4	0.6	170		0.31		4.00	0.05
						TOTAL RAIN					10.00

APPPENDIX 3

EXTRACTS FROM HYDROGEOLOGICAL REPORT



PRI ENGINEERING

Geotechnical and Hydrogeological Investigation Report

County Road 49

Prepared for TD Consulting Inc.

4 Subsurface Conditions

The inferred subsurface profiles are based on the borehole logs from the field investigation program. While we believe conditions are representative of actual site conditions, if future findings differ from those encountered at the completed boreholes, we should be consulted to revise our recommendations based on actual conditions at the time of construction. The following are the specific subsurface conditions encountered at borehole locations. Borehole logs are attached as **Appendix A**.

4.1 Topsoil

Surficial topsoil was encountered at all of the boreholes, varying in depths between 100 mm to 800 mm. Assessment of organic matter content or other topsoil quality tests were beyond the scope of this current study.

4.2 Gravel and Sand

Stratum of gravel and sand mixture was encountered in all seven (7) boreholes, at depths ranging from 0.1 mBGS to 0.8 mBGS. The material contained trace to some amounts of silt and clay. Organic material was noted at a depth of 2.4 mBGS at borehole BH23-05. The SPT blow counts varied from 10 to greater than 50 blows per 300 mm of soil penetration and were interpreted as compact to very dense. The gravel and sand were described as moist to saturated, and the lab determined moisture content varied from 2% to 14%.

Five (5) laboratory particle size distribution analysis was completed on a select sample of the silty sand. The test results are attached in **Appendix B** and are summarized in **Table 4** (below), as per the Unified Soil Classification System:

Table 4: Summary of Laboratory Particle Size Analyses – Gravel and Sand

Borehole ID	Sample No.	Depth (mBGS)	Gravel*		Sand**	Silt***	Clay****
BH23-01	SS2	0.8 - 1.4	35		35	30	
BH23-01	SS3	1.5 - 2.1	43		34	23	
BH23-03	SS2	0.8 - 1.4	38		38	18	6
BH23-05	SS3	1.5 - 2.1	44		38	14	4
BH23-07	SS4	2.2 - 2.9	36		39	18	7

*Material passing 3-inch sieve opening and retained by No. 4 sieve.
**Material passing No. 4 sieve and retained by No. 200 sieve.
***Material passing No. 200 sieve and greater than 0.002 mm (based on hydrometer results).
****Material smaller than 0.002 mm (based on hydrometer results).

4.3 Bedrock and Other Observations

Practical refusal to further borehole advancement was encountered in all the seven (7) boreholes. The cause of refusal was inferred to be bedrock refusal, where grinding was observed with no further advancement of auger. Historic data suggests the bedrock in the region is limestone. Assessment of bedrock quality was outside the current scope of work. A summary of bedrock termination depths is provided in **Table 5** (below).

Table 5: Bedrock Summary

Borehole ID	Bedrock Depth (mBGS)	Additional Observations
BH23-01	2.9	Difficult to advance, continuous spinning, Auger refusal
BH23-02	2.4	
BH23-03	2.1	
BH23-04	2.1	
BH23-05	2.7	
BH23-06	2.9	
BH23-07	5.2	

4.4 Groundwater and Borehole Stability Observations

Upon completion of drilling, water level was observed in one (1) borehole/monitoring well (BH23-01/MW-23-01). The remaining boreholes/monitoring wells were dry both prior to and post installation of polyvinylchloride pipe for the day of investigation (August 9, 2023).

Two (2) boreholes were observed to cave in after completion of drilling, while the others remained opened and stable. **Table 6** (below) summarizes the groundwater level measured and remark on stability of boreholes upon completion.

Table 6: Groundwater Conditions Summary

Borehole ID	Groundwater Level Measurements	Stability of Borehole Upon Completion
BH23-01 / MW23-01	1.3	Hole opened at 2.9 mBGS
BH23-02	N/A	Hole caved
BH23-03 / MW23-03	Dry	Hole opened and stable
BH23-04	Dry	Hole opened and stable
BH23-05 / MW23-05	Dry	Hole opened and stable
BH23-06	Dry	Hole opened and stable
BH23-07 / MW23-07	N/A	Hole caved at 3.5 mBGS

As most of the monitoring wells (with the exception of MW23-01) were dry, an attempt was made to obtain relevant information from the MCEP published document and grainsize distribution for further delineation of the hydrogeological properties for the study area.

205 St. George Street, Unit 2 | Lindsay, ON K9V 5Z9 | 705.702.3921

KEY MAP
N.T.S

APPROXIMATE SITE LOCATION

BOREHOLE LOCATION AND ID		
ID	EASTING	NORTHING
BH23-01/MW23-01	44.561136	-78.547456
BH23-02	44.560908	-78.546334
BH23-03/MW23-03	44.559205	-78.546055
BH23-04	44.558384	-78.547033
BH23-05/MW23-05	44.558242	-78.545182
BH23-06	44.557609	-78.546663
BH23-07/MW23-07	44.557386	-78.545936

LEGEND

BH23-## APPROXIMATE BOREHOLE LOCATION AND ID

0 25 50 Meters

PRI ENGINEERING
205 ST. GEORGE STREET, UNIT 2
LINDSAY, ON K9V 5Z9
TEL: 705-702-3921
www.priengineering.com

NOTES:
1. KEY MAP FROM GOOGLE MAPS AND USED FOR REFERENCE PURPOSES ONLY.
2. BOREHOLE LOCATIONS OBTAINED FROM HANDHELD GPS UNIT.

REV NO.	ISSUANCE	DATE
00	ISSUED FOR REPORT	29SEP23

PROJECT NAME: COUNTY RD 49

DRAWING NAME: BOREHOLE AND MONITORING WELL LOCATION PLAN

PROJ. NO.:	DWG. BY:	CHKD. BY:	APPR. BY:
23-075	SD	MW	VG

DRAWING NUMBER: F-01

APPPENDIX 4

WATER BALANCE CALCULATIONS

WATER BALANCE CALCULATIONS

The site is currently vacant.

Details of the topography of the site are shown on the Draft Plan of Condominium prepared by TD Consulting Inc.

It is proposed to provide infiltration facilities within the project to address the water balance for the site. Infiltration will be provided at the exit from the vegetated filter strip and will address the water balance for the drainage areas including the road, driveways and paving.

RESIDENTIAL SITE

The existing and proposed surfaces for the residential area are as follows;

SURFACE	EXISTING (m^2)	PROPOSED (m^2)
Grass	85370	75573
Paving	0	9797

Based on Environment Canada Climate Normals 1981-2010 for Lindsay Frost the annual precipitation is 897 mm. Details of the annual precipitation are attached along with Table A showing the Climatic Water Budget.

The infiltration factor for the water balance calculations has been calculated as follows:

Topography:	Rolling Land, average slope 2.8 to 3.8 m/km	0.2
Soils:	Open sandy loam	0.4
Cover:	Cultivated Land	0.1
	Infiltration Factor	0.7

The attached Water Budget Assessment sheets show that the water balance deficit is 1499m^3 13062-11563m^3).

In-situ percolation tests for the soils underlying the site will be required to determine the size of the infiltration beds. The beds will be placed at the end of the vegetated filter strip.

The Stormwater Management Planning and Design Manual by the Ministry of Environment requires that the bottom of the infiltration gallery is a minimum 1.0 m above groundwater level. Monitoring well MW 23-05 was dry at a depth of 2.7m where bedrock was encountered. The bottom of the infiltration bed should be more than 1.0m above the groundwater level.

TABLE A
CLIMACTIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (LINDSAY FROST)
POTENTIAL EVAPOTRANSPIRATION
Conny Road 49, February, 2024

Month	Mean Temp. (^{0}C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)
January	-8.4	0.00	0.0	0.80	0.0	66.8	66.8
February	-6.8	0.00	0.0	0.82	0.0	54.9	54.9
March	-1.8	0.00	0.0	1.04	0.0	55.7	55.7
April	6.0	1.32	27.8	1.13	31.4	65.2	33.8
May	12.5	4.00	60.8	1.27	77.2	87.3	10.1
June	17.7	6.78	88.0	1.25	110.0	82.6	-27.4
July	20.3	8.34	101.8	1.27	129.3	75.8	-53.5
August	19.2	7.67	96.0	1.22	117.1	85.7	-31.4
September	14.8	5.17	72.7	1.09	79.2	88.2	9.0
October	8.2	2.11	38.8	0.92	39.3	76.6	37.3
November	2.0	0.25	8.7	0.81	7.0	89.8	82.8
December	-4.4	0.00	0.0	0.76	0.0	68.5	68.5
TOTALS		**35.64**			**590.6**	**897.1**	**306.5**
			TOTAL WATER SURPLUS			**306.5**	

NOTES:
1) Water budget adjusted for latitude and daylight.
2) (^{0}C) - Represents calculated mean of daily temperatures for thr month.
3) Precipitation and Temperature data from Lindsay Frost.
4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.

WATER BALANCE - PRE-DEVELOPMENT- RESIDENTIAL SITE
WATER BALANCE/WATER BUDGET ASSESSMENT, February, 2024

Catchment Designation	Open	Pervious		Totals
Area (m^2)	85370	0		85370
Pervious Area (m^2)	85270			85270
Impervious Area (m^2)	0	0		0
Infiltration Factors				
Topography Infiltration Factor	0.2	0.0		
Soil Infiltration Factor	0.4	0.0		
Land Cover Infiltration Factor	0.1	0.0		
MOE Infiltration Factor	0.7	0.0		
Actual Infiltration Factor	0.7	0.0		
Run-off Coefficient	0.3	0.9		
Run-off from Impervious Surfaces	0.3	0.9		
Inputs (per unit area)				
Precipitation (mm/yr)	897	897		
Run-on (mm/yr)	0	0		
Other Inputs (mm/yr)	0	0		
Total Inputs (mm/yr)	**897**	**897**		
Outputs (per unit area)				
Precipitation Surplus (mm/yr)	307	718		307
Net Surplus (mm/yr)	307	718		307
Evapotranspiration (mm/yr)	591	179		591
Infiltration (mm/yr)	153	0		153
Rooftop Infiltration (mm/yr)	0	0		0
Total Infiltration (mm/yr)	153	0		153
Run-off Pervious Areas	153	0		153
Run-off Impervious Areas	0	718		0
Total Run-off (mm/yr)	153	718		153
Total Outputs (mm/yr)	**897**	**897**		
Difference (Inputs-Outputs)	0	0		
Inputs (Volumes)				
Precipitation (m^3/yr)	76577	0		76577
Run-on (m^3/yr)	0	0		0
Other Inputs (m^3/yr)	0	0		0
Total Inputs (m^3/yr)	**76577**	**0**		76577
Outputs (Volumes)				
Precipitation (m^3/yr)	26209	0		26209
Net Surplus (m^3/yr)	26209	0		26209
Evapotranspiration (m^3/yr)	50454	0		50454
Infiltration (m^3/yr)	13062	0		13062
Rooftop Infiltration (m^3/yr)	0	0		0
Total Infiltration (m^3/yr)	13062	0		13062
Run-off Pervious Areas (m^3/yr)	13046	0		13046
Run-off Impervious Areas (m^3/yr)	0	0		0
Total Run-off (m^3/yr)	13062	0		13062
Total Outputs ($m^{3/}$yr)	76577	0		76577
Difference (Inputs-Outputs)	0	0		0

WATER BALANCE - POST-DEVELOPMENT
WATER BALANCE/WATER BUDGET ASSESSMENT

Catchment Designation	Open	Pervious		Totals
Area (m^2)	75573	9797		85370
Pervious Area (m^2)	75573	0		75573
Impervious Area (m^2)	0	9797		9797
Infiltration Factors				
Topography Infiltration Factor	0.2	0.1		
Soil Infiltration Factor	0.4	0.4		
Land Cover Infiltration Factor	0.1	0.2		
MOE Infiltration Factor	0.7	0.0		
Actual Infiltration Factor	0.7	0.0		
Run-off Coefficient	0.3	0.9		
Run-off from Impervious Surfaces	0.3	0.9		
Inputs (per unit area)				
Precipitation (mm/yr)	897	897		
Run-on (mm/yr)	0	0		
Other Inputs (mm/yr)	0	0		
Total Inputs (mm/yr)	**897**	**897**		
Outputs (per unit area)				
Precipitation Surplus (mm/yr)	307	718		354
Net Surplus (mm/yr)	307	718		354
Evapotranspiration (mm/yr)	591	179		544
Infiltration (mm/yr)	153	0		135
Rooftop Infiltration (mm/yr)	0	0		0
Total Infiltration (mm/yr)	153	0		135
Run-off Pervious Areas	153	0		135
Run-off Impervious Areas	0	718		82
Total Run-off (mm/yr)	153	718		218
Total Outputs (mm/yr)	**897**	**897**		
Difference (Inputs-Outputs)				
Inputs (Volumes)				
Precipitation (m^3/yr)	67789	8788		76577
Run-on (m^3/yr)	0	0		0
Other Inputs (m^3/yr)	0	0		0
Total Inputs (m^3/yr)	**67789**	**8788**		76577
Outputs (Volumes)				
Precipitation (m^3/yr)	23201	7034		30235
Net Surplus (m^3/yr)	23201	7034		30235
Evapotranspiration (m^3/yr)	44664	1754		46417
Infiltration (m^3/yr)	11563	0		11563
Rooftop Infiltration (m^3/yr)	0	0		0
Total Infiltration (m^3/yr)	11563	0		11563
Run-off Pervious Areas (m^3/yr)	11563	0		11563
Run-off Impervious Areas (m^3/yr)	0	7034		7034
Total Run-off (m^3/yr)	11563	7034		18597
Total Outputs ($m^{3/}$yr)	67789	8788		76577
Difference (Inputs-Outputs)	0	0		0

APPPENDIX 5

PHOSPHOROUS LOADING

PHOSPHOROUS LOADING CALCULATIONS

The following details have been input into the tool:
Pre-development area = 8.5370ha
Type of development – hay/pasture

Post-development drainage areas:

Paving (Industrial)	– 0.9797ha
Hay/pasture	– 7.5573ha.

Drainage of all areas will pass through the following facilities:

Infiltration area at 70% removal rate.
An enhanced grass swale to the detention pond with a 55% removal rate.

The attached chart shows the phosphorous removal for both lots based on the assumed impermeable areas. There is close to a net zero removal for the proposed development. The final design can be adjusted to achieve a net zero removal.

COUNTY ROAD 49 - RESIDENTIAL SITE

Pre-dev	Area (ha)	Imp. (ha)	P coef (kg/ha/yr)	P load (kg/yr)
Hay/Pasture	8.5370	2.5611	0.08	0.6830
Total	**8.5370**			**0.6830**

Post-dev	Area (ha)	Imp. (ha)	Tp	P load (kg/yr)
A1-Paving	0.9797	0.8818	0.41	3.2517
A2-Hay/pasture	7.5573	2.2672	0.08	0.4881
Total	**8.5370**			**3.7398**

	A1	A2
TPi	0.4100	0.0800
Precip	897.0000	897.0000
Pj fraction of precip that produce runoff	0.9500	0.3000
Rv runoff coefficient	0.9500	0.3000
10^-2	0.0100	0.0100
Cal P Load	3.2517	0.4881

Phosphorus Export (kg/ha/yr) = TPi x Precip x Pj x RV x 10-2

residential = 0.41 mg/L — assume no fertilizing

commercial = 0.20 mg/L

transportation = 0.50 mg/L

industrial = 0.41 mg/L

Target	P load (kg/yr)
Total Pre-dev	0.6830
Total Post-dev	3.7398
Target	3.0569

Treatment # 1 - Pav. & Roof	Area (ha)	Treated Fraction	Removal Fraction	P Load In (kg/yr)	P reduce (kg/yr)	P Load Left (kg/yr)
Enhanced Swale	0.980	0.55	1.00	3.2517	1.7885	1.4633
Infiltration		0.70	1.00	1.4633	1.0243	0.4390
Total	0.980			4.7150	2.8128	1.9023

Treatment # 2 - Landscape	Area (ha)	Treated Fraction	Removal Fraction	P Load In (kg/yr)	P reduce(kg/yr)	P Load Left (kg/yr)
Enhanced Swale	7.5573	0.55	1.00	0.4881	0.2684	0.2196
Infiltration		0.70	1.00	0.2196	0.1537	0.0659
Total	7.5573			0.7077	0.4222	0.2855

Train	Area (ha)	P In	P reduce kg	%
Treatment # 1	0.980	3.252	2.813	86.5000
Treatment # 2	7.557	0.488	0.422	86.5000
Total	**8.5370**	**3.7398**	**3.2350**	

Phosphorus Load Calculation	Area (ha)	P load (kg)
Pre-dev	8.5370	0.6830
Post-dev	8.5370	3.7398
Target for net-zero		3.0569
BMPs/LIDs	8.5370	3.2350
% Reached		105.8
Total Outstanding		**-0.17808**