



Soil Engineers Ltd.

CONSULTING ENGINEERS

GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

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March 2, 2023

Reference No. 2206-W054

Page 1 of 8

Beachcroft Investments Inc.
20 Cachet Woods Court, Suite 6
Markham, Ontario
L6C 3G1

Attention: Ms. Uzo Rossouw

**Re: Pre- and Post-Development Water Balance Assessment
Proposed Residential Development
63 and 63A Trafalgar Road
Town of Erin**

Dear Madam:

We have completed a pre- and post-development water balance assessment for a proposed residential development, at the captioned site in the Town of Erin, and our findings are presented in this Letter Report.

- **Introduction**

The proposed development site is located at 63 and 63A Trafalgar Road in the Town of Erin. Drawing No. 1, enclosed, shows the location of the subject site for which this water balance applies. The proposed development will involve construction of residential development consisting detached dwellings, townhouses, having basement structures, along with mixed-used senior housing, parks and stormwater management pond blocks. The proposed development footprint encompasses an area of approximately 523,350 square meters.

- **Background**

Soil Engineers Ltd. (SEL) previously completed a preliminary geotechnical soil assessment, for the subject site, dated February 3, 2023 (SEL Reference No. 2206-S054). The study revealed that beneath a veneer of topsoil and ploughed soil, the site is underlain by strata of sand and gravelly sand deposits. Sandy silt till and silt deposits were generally contacted within the lower stratigraphy in some boreholes.



Soil Engineers Ltd. (SEL) also completed a hydrogeological assessment for the site in February 2023 (SEL Reference No. 2206-W054). This study reveals that the measured groundwater level elevations ranged from 440.74 to <421.51 masl, or from the depths, ranging from 2.75 to <6.2 mbgs as recorded during the monitoring period encompassing the period from December 1, 2022 to February 8, 2023. From the recorded groundwater level measurements, the shallow groundwater flow pattern was interpreted to flow in southwesterly direction, towards the tributary of Credit River.

The results of the completed hydrogeological assessment, indicates that the estimated permeability for the gravelly sand is 5.2×10^{-7} , the K estimate for the sandy gravel is 5.7×10^{-7} m/sec, the K estimate for the silt and sand till is 3.6×10^{-6} m/sec and the K estimate for the silty sand is 2.10×10^{-6} m/sec. This confirms the presence of low to moderate permeability for the shallow native subsoil that would be considered for the proposed infiltration infrastructure to redirect the precipitation and runoff to the subsurface.

The subject site is located within the Credit River Watershed. The Credit River Watershed covers an area of approximately 1,000 km², extending from the Town of Orangeville in the north to the City of Mississauga and Lake Ontario in south. A review of the local topography and the ground surface elevations at the borehole and monitoring wells shows that the subject site descends towards Trafalgar Road, towards the southeast.

Runoff from the site is expected to drain in southerly and easterly directions. Based on review of the topographic map for the area, and from review of the ground surface elevations at the borehole and monitoring well locations, the elevation relief across the subject site is about 15.0 m.

- **Water Balance Assessment**

The water balance for this proposed infill development site is based on the following equation:

$$P = ET + R + I + \Delta S$$

Where:

- P -- Average Annual Precipitation
- ET -- Evapotranspiration
- R -- Surface Water Runoff
- I -- Infiltration
- ΔS -- Change in Groundwater Storage, taken as 0



- **Precipitation**

The long-term records (30-year average from 1981 to 2010) for monthly and annual precipitation depths received at the site were adopted from the Environment Canada's Orangeville Station (Climate ID. 6155790), located about 15 km north of the subject site. The 30-year, mean annual precipitation record of 901.50 mm/year was adopted from this station. The 30-year records for average annual, and monthly temperatures were also adopted from this station. The water balance calculations for the pre- and post-developed assessments for the subject site are summarized in the Appendix.

- **Interception**

Based on the review of the SWM Planning and Design Manual (MOECC, 2003), evapotranspiration includes the evaporation from all sources; including; precipitation, water, snow, vegetation and from water droplets on plant surfaces plus the transpiration from plants, not involving water droplets retained on leaves. As such, interception was not included for the current pre- and post-development water balance assessments as it is included in the estimate for evapotranspiration.

- **Groundwater Storage**

Although groundwater storage experiences gains and losses on a short-term basis, the net change in groundwater storage (Δs) over the long-term is generally zero. For this reason, the change in groundwater storage is shown as zero (0) which has not been included in the water balance calculations.

- **Evapotranspiration**

In general, evapotranspiration (ET) refers to the transfer of water from vegetation and from the soil surface to the atmosphere in the form of water vapour. The term considers evaporation from the soil surface, man-made infrastructure surfaces (asphaltic and concrete roads, and from building roofs), and from the transpiration from plants and trees together because of the difficulties in separating these processes. Potential evapotranspiration (PET) refers to the transfer/loss of water from vegetated surfaces to the atmosphere, under the condition of unlimited water supply.

The actual rate of evapotranspiration (AET) is generally less than PET, under dry conditions (i.e., during the summer season when there is a soil moisture deficit). Variation in water holding capacity, which affects ET, depends on the soil type and rooted vegetation. The



gravelly sand, sandy gravel, silt and sand till, and silty sand surface soil at the site, as revealed from the subsurface drilling program, has been assigned a water holding capacity of -150 mm (Soil and Water Conservation Table 18.2 PP 392 G. Schwab et. al.).

Chart 40 from the Climate of the Great Lakes Basin (Environment Canada 1972) suggests that the PET for the Orangeville EC Weather Station should range from about 558.8 to 609.6 mm/year (22 to 24 in/year). Simulations using Thornthwaite and Mather model developed by US Geological Survey (USGS) indicates that the amount of ET (PET) for the subject site ranges from about 526.60 to 530.20 mm/year, which agrees well with the mapped ET values for the general area; therefore, the average AET value of 528.4 mm/year has been applied to the pre- and post-water balance assessments for the subject site.

- **Infiltration and Runoff**

According to the Ministry of the Environment, Conservation and Parks (MECP) Guidance Manual (MECP 1995), a series of infiltration components can be applied to the subject site based on its slope, soil and vegetation coverage. The cumulative value of these sub-components is referred to as the infiltration factor, with the values ranging from 0 to 1. The difference between the value 1 and the infiltration factor is referred to as the runoff factor.

Slope has an influence on both infiltration and runoff. The topography for the subject site is considered flat to gently rolling land, based on its elevation relief, and from a review of available topographic mapping for the area. The elevation relief across the subject site is about 15.0 m.

Surficial soil and vegetation coverage and/or cropping practices also contribute to the infiltration and runoff factors. The subject site is primarily farm field, and is partially wooded and the surficial soil consists mainly of gravelly sand, sandy gravel, silt and sand till, and silty sand. The selected, cumulative infiltration and corresponding runoff factors for the subject site, based on its topography, predominant surface soil and vegetation coverage are provided in Table 1.

The difference between the average annual precipitation and actual evapo-transpiration is termed the water surplus. As mentioned, above, the long-term annual precipitation value of 878.78 mm/year has been adopted for the site. Subtracting the averaged, Thornthwaite and Mather derived AET estimate of 528.4 mm/year from the annual precipitation gives a water surplus estimate of 350.38 mm/year. The site's average annual infiltration depth estimate was calculated by multiplying the cumulative infiltration factor by the water surplus estimate, and the site's runoff was calculated by applying its difference from 1, or 1 minus the cumulative



infiltration factor multiplied by the water surplus estimate. Based on the MECP infiltration factors, a cumulative infiltration factor of 0.70 was considered for the water balance assessment. The average annual depth estimates for infiltration and runoff at the undeveloped site are given in Table 1.

Table 1 - Summary of Infiltration and Runoff Depth Estimates

Land Characteristics	MECP Infiltration Factors	Water Surplus Estimate (mm/yr.)	Infiltration Estimate (mm/yr.)	Runoff Estimate (mm/yr.)
Cover: (Grass, pavement)	0.15	350.38	$I = 0.70 \times 350.38$	$R = (1 - 0.70) \times 350.38$
Slope: (Rolling land)	0.25			
Soil: (gravelly sand, sandy gravel, silt and sand till, and silty sand)	0.3			
Cumulative Infiltration Factor	0.7		245.27	105.11

Runoff from impervious surfaces is calculated differently than for pervious soil/ vegetated covered surfaces. As a general rule, the ET for impervious surfaces on an average annualized basis is calculated by taking 10% of the average annual precipitation, while runoff is calculated by taking 90% of the average annual precipitation. There are existing impervious surfaces on the site, prior to site development, consisting of an existing car dealership and its associated paved, asphalt parking area. Based on this approach, the ET and runoff estimates for the site's impervious surfaces, on an average annualized depth basis are 87.88 mm/year and 790.90 mm/year, respectively.

- **Pre-Development Water Balance**

The pre-development water balance for the site is calculated by multiplying the existing site areas by the various, averaged annualized depth estimates for Precipitation, ET, Infiltration and Runoff. The average volumetric water balance estimates for each water balance component are given in Table 2.



Table 2 - Summary of Pre-Development Volumetric Water Balance Components

Pre-Development Site Areas	Approximate Area Coverage (m²)	Precipitation (m³/year)	AET (m³/year)	Infiltration (m³/year)	Runoff (Pervious) (m³/year)
Existing Pervious Areas (Grass)	523,240.00	459,812.85	276,480.02	128,332.98	54,999.85
Existing Impervious Areas (Asphalt)	110.00	96.67	9.67	0.00	87.00
Total Area/Volume	523,350.00	459,909.51	276,489.68	128,332.98	55,086.85

The pre-development water balance for the subject site is calculated on an annualized depth basis by dividing the volumetric estimates for each water balance component from above by the total site area. Furthermore, there are existing impervious areas on site, including a commercial building, an associated parking lot and paved areas. The anticipated AET and runoff for the existing impervious areas were estimated by taking 10% of the average annual precipitation after correction for interception, while runoff is calculated by taking 90% of the average annual precipitation. Based on this approach, the depth-based water balance components for the pre-developed site are presented as follows:

$$P (878.78) = ET (528.31) + I (245.21) + R (105.26)$$

- **Post-Development Water Balance**

Based on the data provided by Urbanworks Engineering Corporation indicates that the subject site comprised a total area of 523,350 m². Of this, the developed impervious areas will include the building footprints and paved areas, covering about 47.49% of the developed site area, or an area of about 248,514 m². Pervious developed areas, including landscaped areas, will comprise the remaining 52.51% of the site, or an area of 274,835 m².

The post-development water balance was calculated using the same water balance depth estimate components that were used for the pre-development water balance calculations, i.e., average annual precipitation and average annual ET. After development, with no infiltration through the impervious areas, the depth estimates for runoff and become 90% and 10% of the corrected average annual precipitation, respectively. The estimated post-development water balance volumes are provided in Table 3:



Table 3 - Summary of Post-Development Volumetric Water Balance Components

Post-Development Site Areas	Area Coverage (m ²)	Precipitation (m ³ /year)	AET (Pervious) (m ³ /year)	AET (Impervious) (m ³ /year)	Infiltration (m ³ /year)	Runoff (Pervious) (m ³ /year)	Runoff (Impervious) (m ³ /year)
Pervious Area (505-Mixed Block)	1,705.0	1,498.32	900.92	0.00	418.18	179.22	0.00
Pervious Areas (Front Yard)	31,708.0	27,864.36	16,754.51	0.00	7,776.89	3,332.95	0.00
Pervious Areas (Rear Yards)	95,124.0	83,593.07	50,263.52	0.00	23,330.68	9,998.86	0.00
Pervious Areas (ROW)	24,600.0	21,617.99	12,998.64	0.00	6,033.54	2,585.80	0.00
Pervious Areas (Parks)	121,697.0	106,944.89	64,304.69	0.00	29,848.14	12,792.06	0.00
Impervious Area (Buildings)	110,889.2	97,447.21	0.00	9,744.72	0.00	0.00	87,702.49
Impervious Areas (Patios)	2,543.70	2,235.35	0.00	223.54	0.00	0.00	2,011.82
Impervious Areas (Driveways)	14,025.8	12,325.59	0.00	1,232.56	0.00	0.00	11,093.03
Impervious Areas (BROW Sidewalks)	18,450.0	16,213.49	0.00	1,621.35	0.00	0.00	14,592.14
Impervious Areas (Roads)	79,950.0	70,258.46	0.00	7,025.85	0.00	0.00	63,232.61
Impervious Area (Block 505-Mixed)	22,657.3	19,910.78	0.00	1,991.08	0.00	0.00	17,919.70
Total Area/Volume	523,350.0	459,909.51	145,222.29	21,839.09	67,407.44	28,888.90	196,551.80

Based on the volumetric water balance estimates shown in Table 3, the depth-based post-development water balance estimates are presented as follows:

$$P (878.78) = ET (319.22) + I (128.80) + R (430.76)$$

The volumetric comparisons for evapotranspiration, infiltration and runoff between the pre-developed and post-developed site are summarized in Table 4. A review of the findings indicates a decrease of 209.09 mm/year, or 39.58 %, in annual evapo-transpiration, a decrease of 116.41 mm/year, or 47.47 %, in annual infiltration, and a gain in runoff of 325.51 mm/year or 309.24 %.



Table 4 - Comparison Summary of Pre- and Post-Development Water Balance/ Budget Volumetric Components

	Precipitation (m ³ /year)	ET (m ³ /year)	Infiltration (m ³ /year)	Runoff (m ³ /year)
Pre-Development	459,909.51	276,489.68	128,332.98	55,086.85
Post- Development	459,909.51	167,061.37	67,407.44	225,440.70
Volumetric Change in Pre- and Post- Development Water Balance Parameters	0.0	-109,428.31	-60,925.54	+ 170,353.85

Notes: -- loss -- gain

The volumetric comparisons in evapotranspiration, infiltration and runoff between the pre-developed and post-developed site are summarized in Table 4. A review of the findings indicates that decreases of 109,428.31 m³/year and 60,925.54 m³/year are anticipated for ET and infiltration, respectively. An increase of 170,353.85 m³/year is expected for runoff at the post-developed site compared with the pre-developed site.

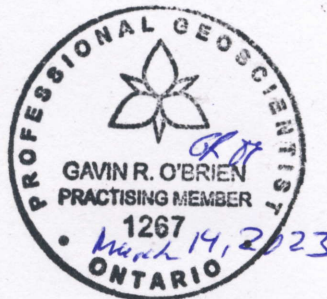
The pre- and post-development water balance calculations for the site are summarized in the attached Appendix.

We trust the above satisfies your present requirements. Should you have any further queries, please feel free to contact this office.

Yours truly,
SOIL ENGINEERS LTD.

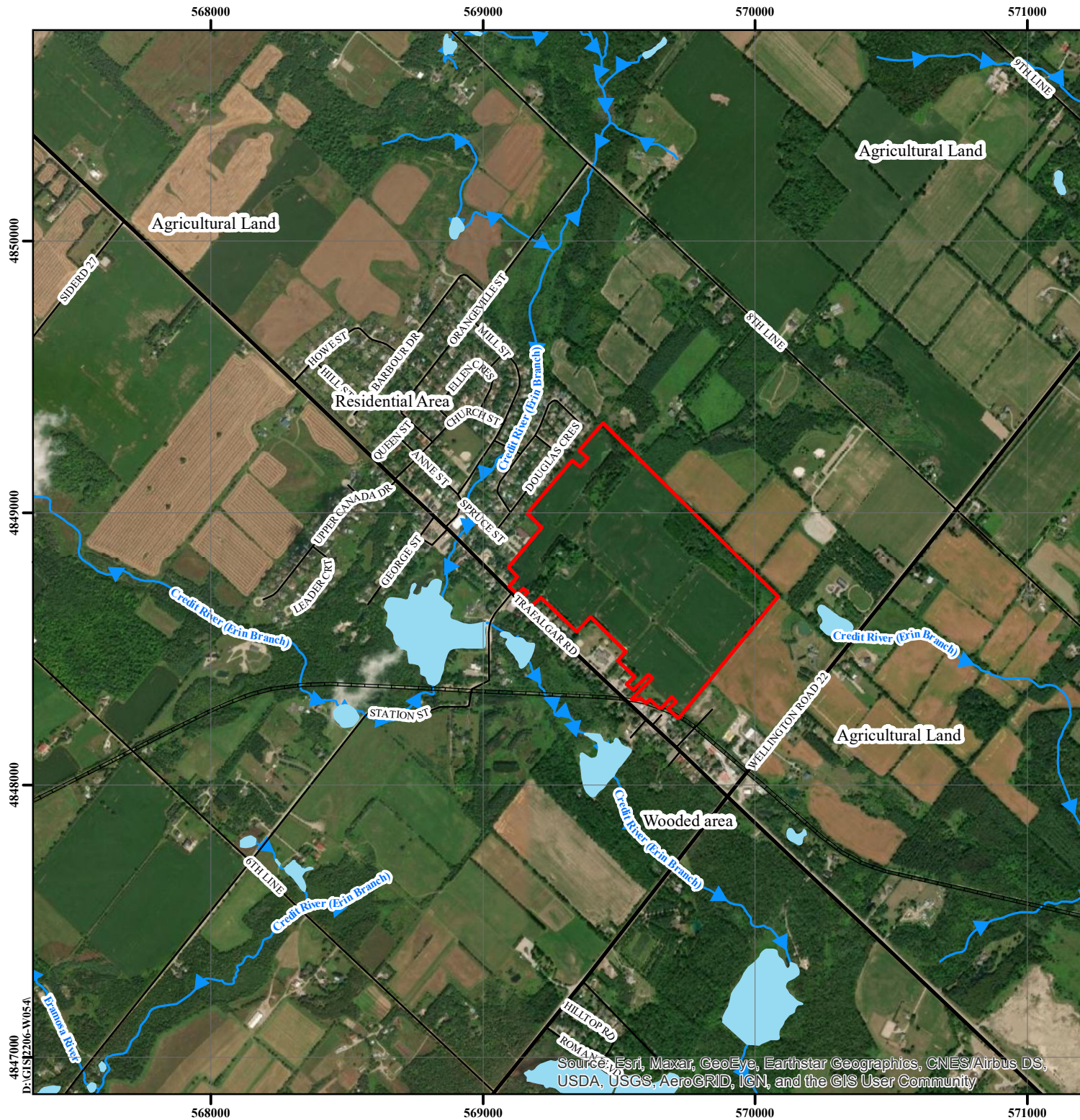
Bhawandeep Singh Brar
Bhawandeep Singh Brar, B.Sc.









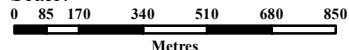
Gavin O'Brien
Gavin O'Brien, M.Sc., P.Geo.
BB/GO



ENCLOSURES

- | | |
|--|---------------|
| Site Location Plan..... | Drawing No. 1 |
| Pre- and Post-Development Water Balance Assessment | Appendix |



	
Legend	
	Approximate Boundary of Subject Site
	waterbody
	Watercourse
	Major Road
	Local Road
	Railway
	
Title: Site Location Plan	
Project:	
Pre-and-Post-Development Water Balance Assessment	
Proposed Residential Development	
Address: 63 and 63A Trafalgar Road, Town of Erin, ON	
Reference No. 2206-W054	
Date: March 2, 2023	
Scale:	
	
Drawing No. 1	
<small>Source: Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022</small>	

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Pre-Development Water Balance/Budget

ET Estimates		Avg Annual Precipitation		MOE factors	
Average for 150 mm gravelly sand, sandy gravel, silt and sand till, and silty sand 43 and 44 deg N. lat from USGS model: 528.4 mm/yr		878.78 mm/yr after removing 4% for interception		Grass covered and wood Lot	
		901.60 mm/yr prior to removal of 4% for interception		cover 0.15 grassland, woodlot	
gravelly sand and silty sand 150 mm 44 lat	ET	ET	impervious surfaces 0.1 10%	slope 0.25	Flat to Rolling land
530.20 mm/yr		R	impervious surfaces 0.9 90%	soil texture 0.3	gravelly sand and silty sand
gravelly sand and silty sand 150 mm 43 lat		MOECC Inf. F		0.70	
526.60 mm/yr					
Site Area	523,350.00 m²				

Site Areas	Areas m ²	Impervious factor	Cum. Infiltration	Assigned ET mm/yr	Water Surplus mm/yr	Infiltration mm/yr	Runoff mm/yr	precipitation m ³ /yr	Infiltration Vol m ³ /yr	RO Vol m ³ /yr	ET Vol m ³ /yr	check
Grass covered Area (Pervious)	523,240.00	0	0.70	528.4	350.38	245.27	105.11	459,812.85	128,332.98	54,999.85	276,480.02	
Road, Buildings (impervious)	110.00	1	0.00	87.88	790.90	0.00	790.90	96.67	0.00	87.00	9.67	
Total Area	523,350.00							459,909.51	128,332.98	55,086.85	276,489.68	
							percentages	459,909.51	0.28	0.12	0.60	1.00

Parcel A: Pre Development Water Balance/Budget (mm/year)									
P	=	ET	+	I	+	R	+	ΔS	Check
878.78	=	528.31	+	245.21	+	105.26	+	0.00	878.78

Total Area	523350.00 m²
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Post-Development Water Balance/Budget																					
Average for 150 mm gravelly sand, sandy gravel, silt and sand till, and silty sand 43 an from USGS model: 528.4 mm/yr			Avg Annual Precipitation		878.78 mm/yr after removing 4% for interception		901.60 mm/yr prior to removal of 4% for interception														
gravelly sand and silty sand 150 mm 44 lat 530.20 mm/yr ET					ET impervious surfaces 0.1 10%		R impervious surfaces 0.9 90%														
gravelly sand and silty sand 150 mm 43 lat 526.60 mm/yr																					
Site Area 523,350.00 m²																					
										Type		MOE factors									
										cover		0.15		grassland, woodlot							
										slope		0.25		Flat to Rolling Land							
										soil texture		0.3		gravelly sand and silty sand							
										MOECC Inf. F		0.70									
Future Developed Site Areas	Areas	Impervious factor	Cum. Infiltration	Assigned ET	Water Surplus	Infiltration - Pervious Portion	ET - Impervious Portion	Runoff - Impervious Areas	Runoff Pervious Portion	precipitation	Pervious Area			Impervious Area		Total Et and Ro.					
	m ²			mm/yr							Infil Vol. Pervious Areas	RO Vol. Pervious Areas	ET Vol Pervious Areas	RO Vol. Impervious Areas	ET Vol Imperv Areas	Total ET	Total RO				
											m ³ /yr	m ³ /yr	m ³ /yr	m ³ /yr	m ³ /yr	m ³ /yr	m ³ /yr				
Pervious Areas (Block 505- Mixed Use)	1,705.00	0	0.70	528.40	350.38	245.27	0.00	0.00	105.11	1,498.32	418.18	179.22	900.92	0.00	0.00	900.92	179.22				
Pervious Areas (Front yards)	31,708.00	0	0.70	528.40	350.38	245.27	0.00	0.00	105.11	27,864.36	7,776.89	3,332.95	16,754.51	0.00	0.00	16,754.51	3,332.95				
Pervious Areas (Rear yards)	95,124.00	0	0.70	528.40	350.38	245.27	0.00	0.00	105.11	83,593.07	23,330.68	9,998.86	50,263.52	0.00	0.00	50,263.52	9,998.86				
Pervious Areas (ROW)	24,600.00	0	0.70	528.40	350.38	245.27	0.00	0.00	105.11	21,617.99	6,033.54	2,585.80	12,998.64	0.00	0.00	12,998.64	2,585.80				
Pervious Areas (Parks)	121,697.00	0	0.70	528.40	350.38	245.27	0.00	0.00	105.11	106,944.89	29,848.14	12,792.06	64,304.69	0.00	0.00	64,304.69	12,792.06				
Impervious Areas (Buildings)	110,889.20	1	0.00	0.00	790.90	0.00	87.88	790.90	0.00	97,447.21	0.00	0.00	0.00	87,702.49	9,744.72	9,744.72	87,702.49				
Impervious Areas (Patios)	2,543.70	1	0.00	1.00	790.90	0.00	87.88	790.90	0.00	2,235.35	0.00	0.00	0.00	2,011.82	223.54	223.54	2,011.82				
Impervious Areas (Driveways)	14,025.80	1	0.00	1.00	790.90	0.00	87.88	790.90	0.00	12,325.59	0.00	0.00	0.00	11,093.03	1,232.56	1,232.56	11,093.03				
Impervious Areas (BROW Sidewalks)	18,450.00	1	0.00	1.00	790.90	0.00	87.88	790.90	0.00	16,213.49	0.00	0.00	0.00	14,592.14	1,621.35	1,621.35	14,592.14				
Impervious Areas (roads)	79,950.00	1	0.00	1.00	790.90	0.00	87.88	790.90	0.00	70,258.46	0.00	0.00	0.00	63,232.61	7,025.85	7,025.85	63,232.61				
Impervious Areas (Block 505-Mixed)	22,657.30	1	0.00	1.00	790.90	0.00	87.88	790.90	0.00	19,910.78	0.00	0.00	0.00	17,919.70	1,991.08	1,991.08	17,919.70				
Total Area	523,350.00								Total	459,909.51	67,407.44	28,888.90	145,222.29	196,551.80	21,839.09	167,061.37	225,440.70				
										Totals				Total RO		225,440.70		Total ET		167,061.37	
Post Development Water Balance/Budget (mm/year)																					
P		=	ET	+	I	+	R	+	ΔS									Check			
878.78		=	319.22	+	128.80	+	430.76	+	0									878.78			
Pre Development Water Balance/Budget (mm/year)																					
P		=	ET	+	I	+	R	+	ΔS									Check			
878.78		=	528.31	+	245.21	+	105.26	+	0									878.78			
Loss/Gain in Post																					
		ET		I		R		DS													
		loss: 209.09		loss: 116.41		gain: 325.51		0													
		% loss: 39.58		% loss: 47.47		% gain: 309.246															