King EPCM
3780 14th Avenue, Unit 211
Markham, ON L3R 9Y5
T: 647-459-5647
General@KingEPCM.com
www.KingEPCM.com

STORMWATER MANAGEMENT

AT

MAPLEVIEW SUBDIVISION PROJECT (PART OF LOTS 31, 32 & 33, CONCESSION 1, TOWNSHIP OF HUMBERSTONE, CITY OF PORT COLBORNE, KILLALY STREET WEST, ONTARIO)

PREPARED FOR:

1000046816 ONTARIO LIMITED.
1 VALLEYBROOK DR SUITE 303, NORTH YORK, ON M3B 2S7

February 15th, 2024

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1. Site Background

King EPCM (the Engineer) was retained by 1000046816 Ontario Limited (the Client) to carry out civil engineering designs for a proposed residential sub-division, including the creation of a Stormwater Management Plan (SWM). The property was located at Mapleview Port Colborne, Part of Lots 31, 32 & 33, Concession 1, East of Quarry Ponds, Township of Humberstone, Killaly Street West, City of Port Colborne, Ontario (the Site). It is understood that the SWM is for the sole purpose of the application and extension to the settlement area boundary through the construction of several new dwellings plus driveways, sidewalks, and parking lots. This report is to be submitted to the City of Port Colborne, Niagara Peninsula Conservation Authority (NPCA), and the Regional Municipality of Niagara (Niagara Region).

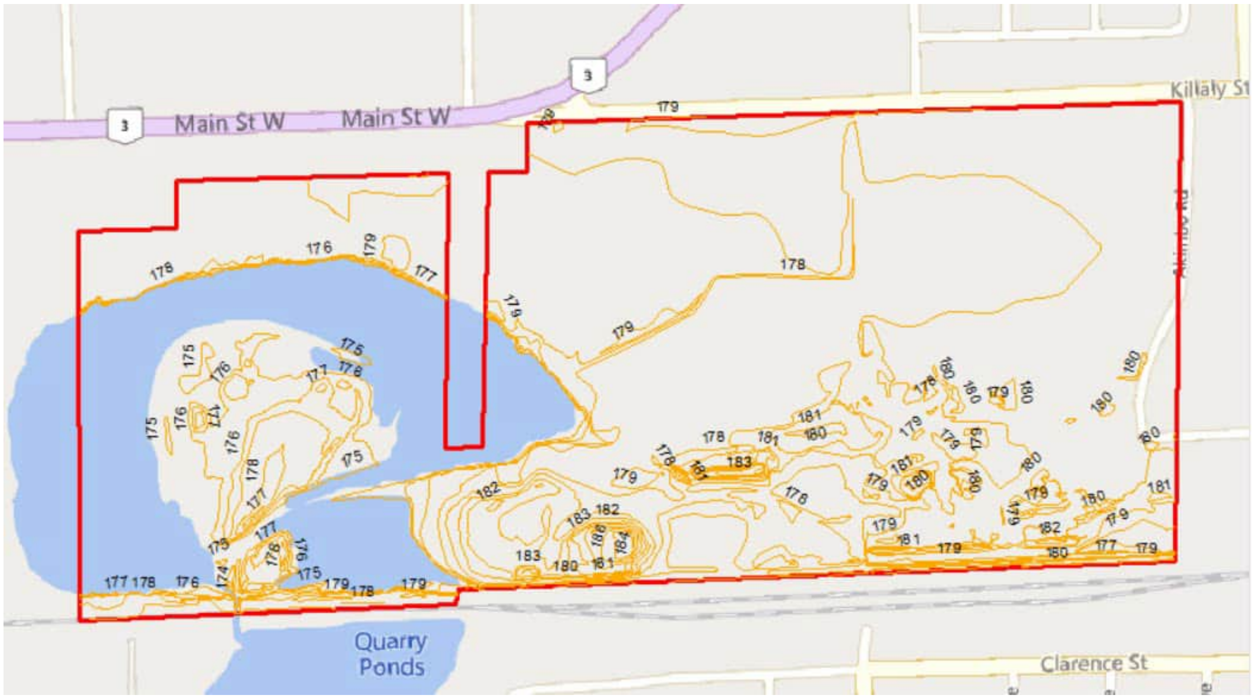

Figure 1 – Topographic map of Subject Area at Mapleview, Port Colborne, ON

The Site was considered as the industrial land use historically throughout the years until the factory was demolished. The Site is currently vacant. The site property is considered rectangular in shape, measures approximately 139 acres (including woodlot = 571,520 m^2, excluding woodlot = 549.473 m^2), and is situated south of Highway 3 and Killaly Street west, east of Cement Road, west of Akimbo Rd., north of Gord Harry Conservation Trail, Port Colborne, Ontario. The Site was on industrial land use, with residential properties to the north, east, and south, and a quarry pond to the west followed by the agricultural area. The previous concrete factory area was located southeast of the Site.

This Site was originally used to mine the limestone bedrock, which was converted into cement, and shipped by rail along the southern property boundary to construct the Welland Canal. The north portion of the property is currently a flat agricultural hayfield, with a small stand of trees at the northwest corner. The east property boundary was along Akimbo Rd. and abutted Elgin Street, and there were currently two parks with manicured grass lawns and a pedestrian trail entering the property. The south property boundary included a drainage channel running from southeast to southwest and discharged into the Quarry Ponds. A railway line for parking & temporary storage purposes was on the south side of the drainage channel. The west property boundary was surrounded by Quarry Pond as well as the island within the pond.

The Site property is considered an abandoned brownfield, with the majority of the western portion of the site as an abandoned / vacant quarry pit, while the central area is a scrubby-vegetation vacant property, with exposed high-bedrock and remnants of abandoned demolished concrete structures. The northeast corner of the property is vacant with agricultural hayfields.

The Site is bound by the north boundary by Killaly Street West, the east boundary by a proposed future extension of West Side Road (but currently vacant), and the south is bound by a commercial railway track owned by the City of Port Colborne.

This property is located in a relatively flat area with a general elevation of approximately 180 m (amsl), with a quarry pond elevation of 176 m (amsl). The general surface drainage is towards the west and southwest direction in the region.

Based on the Bedrock Geology Report, the rock type included limestone, dolostone, and shale, and the primary strata contained the Onondaga Formation for the Detroit River Group. The ERIS's Soils Report along with recent borehole drill logs indicated that this Hydrological Soil Group near the Site belonged to the soils with moderate to high infiltration rates when completely wetted.

Based on OBM and MNRF Topographic Maps and the Site Survey by the Surveyor, the water body onsite was the existing Quarry Pond on the property, which was categorized as a “provincially significant wetland” (PSW).

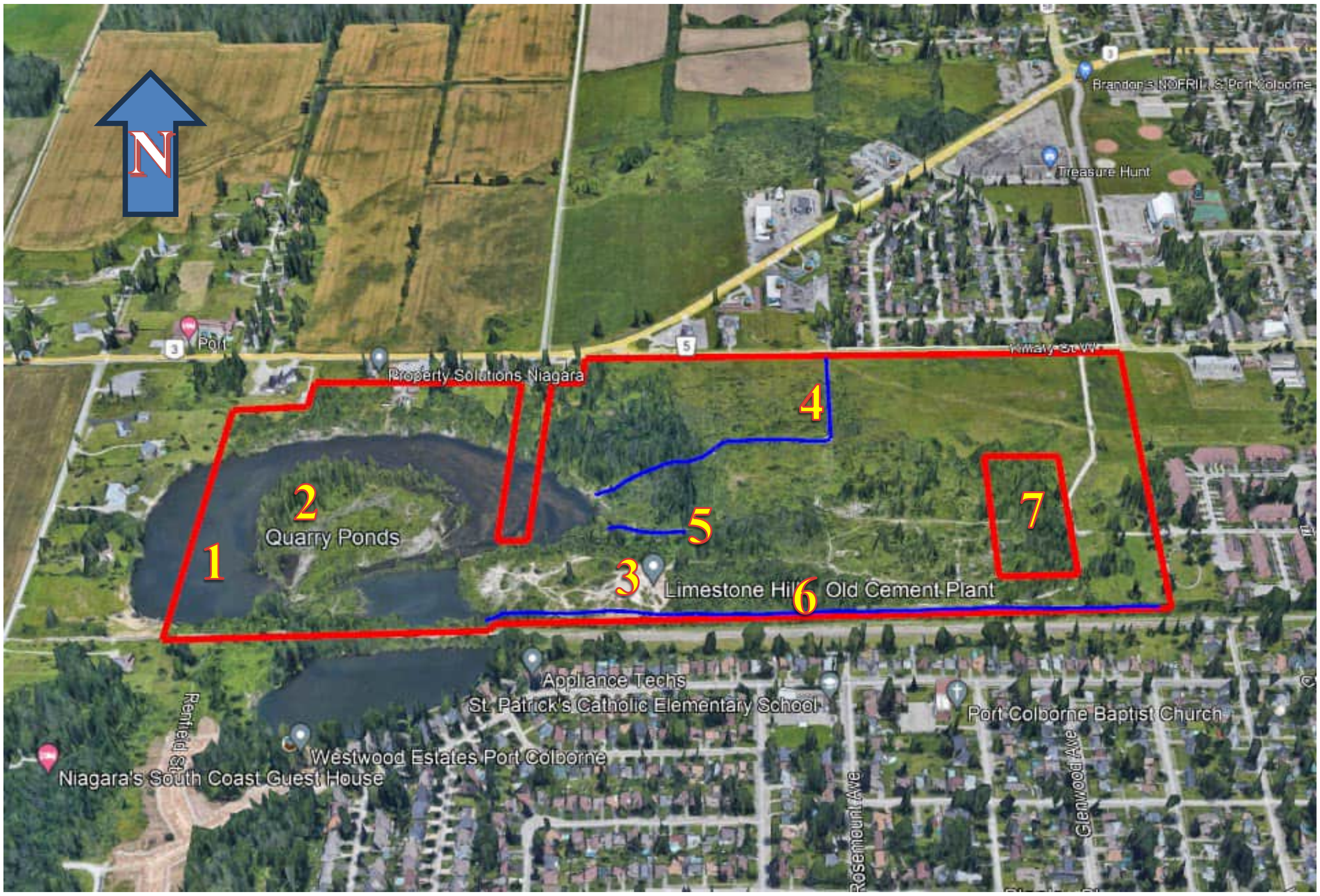

Figure 2 – Existing Site Location

In the above figure, the existing property is displayed which is:
#1: Quarry Pond (Area = 76,060 m^2)
#2: Wetland (Area = 31,237 m^2)
#3: Limestone Stockpile (Area or TIMP = 11,805 m^2)
#4-6: Waterways (streams)

and the existing landscaped pervious areas which are located within the site boundary:
Parkland (Area= 359,917 m^2)
Grass (Area= 70,453 m^2)

and there is a Significant Woodland/Woodlot within the site boundary, in the eastern portion.

#7: Woodlot (Area= 22,047 m^2)

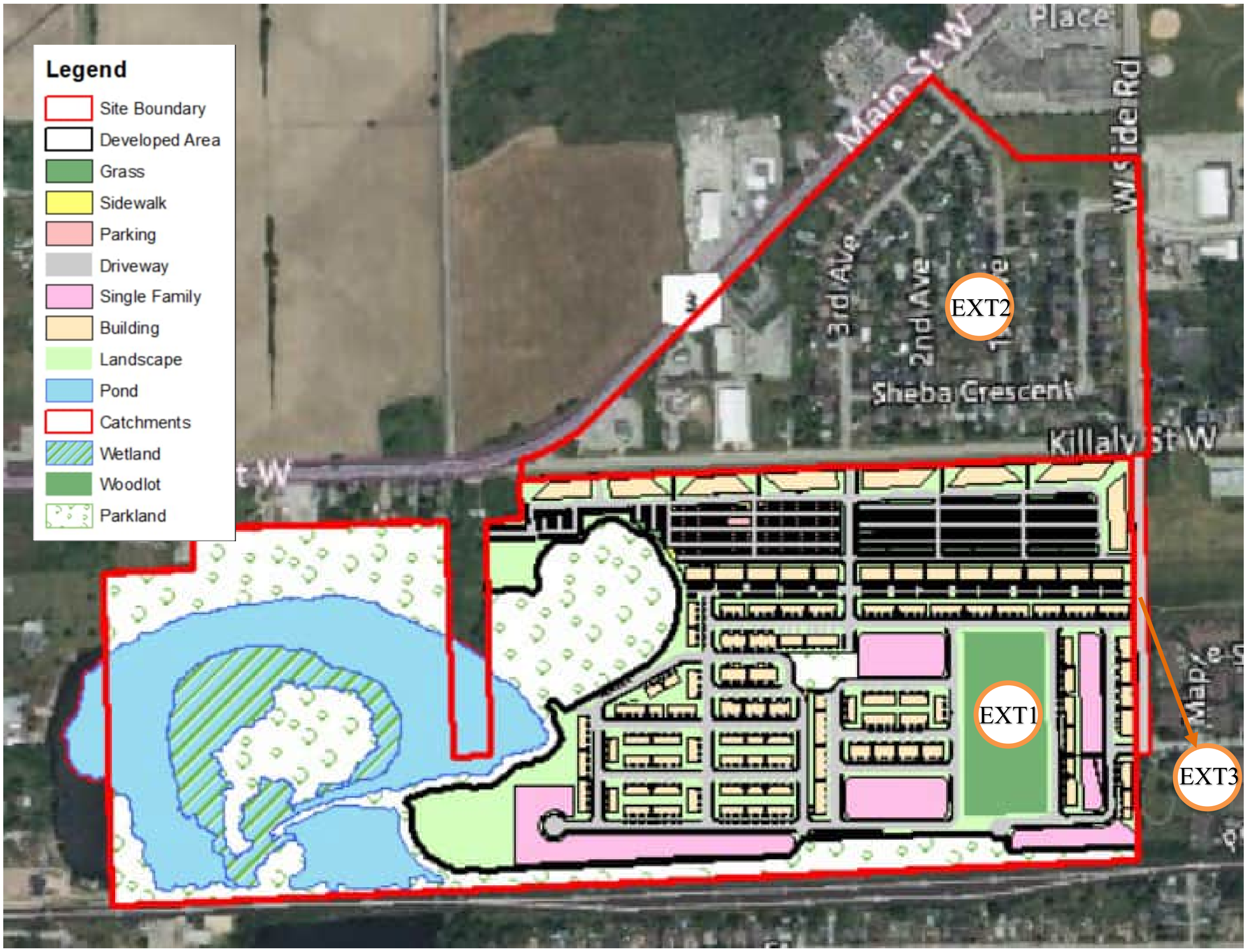

Figure 3 – Proposed Site Location Plan

In the above figure, the proposed developments within the site boundary developed area (black line) are displayed which are (Total developed area = 302,307.5 m^2):

#1: Building (TIMP= 51,762.1 m^2)
#2: Driveway (TIMP= 82,471.2 m^2)
#3: Parking Lot (TIMP= 22,358.3 m^2)
#4: Sidewalk (TIMP= 18,353.9 m^2)
#5: Single Family (TIMP= 33,555 m^2)
#6: Parkland (TIMP= 3098.7 m^2)
#7: Grass/Landscape (TIMP= 90,708.3 m^2)

There is a large sub-division external drainage area to be accommodated through any development of the subject property, north of Killaly St W. (EXT2), plus an existing woodlot within the site boundary

(EXT1). On the east side, a new street is proposed to connect the west Side Rd to the existing cul-de-sac (EXT3).

#EXT1: Woodland (TIMP= 0.0 m^2 & Total area = 22,047 m^2)
#EXT2: Northern Sub-division (TIMP= 106,219.3 m^2 & Total area = 212,438.6 m^2)
#EXT3: Eastern Street (TIMP = 5160.5 m^2)

Since 24.7 ha of the site area is located outside of the proposed development and are natural heritage features such as Wetland, Quarry Pond, Parkland, and Woodland, no SWM facilities will be proposed for those portions and the effective study area for the subject property would be 302,307.5 m^2.

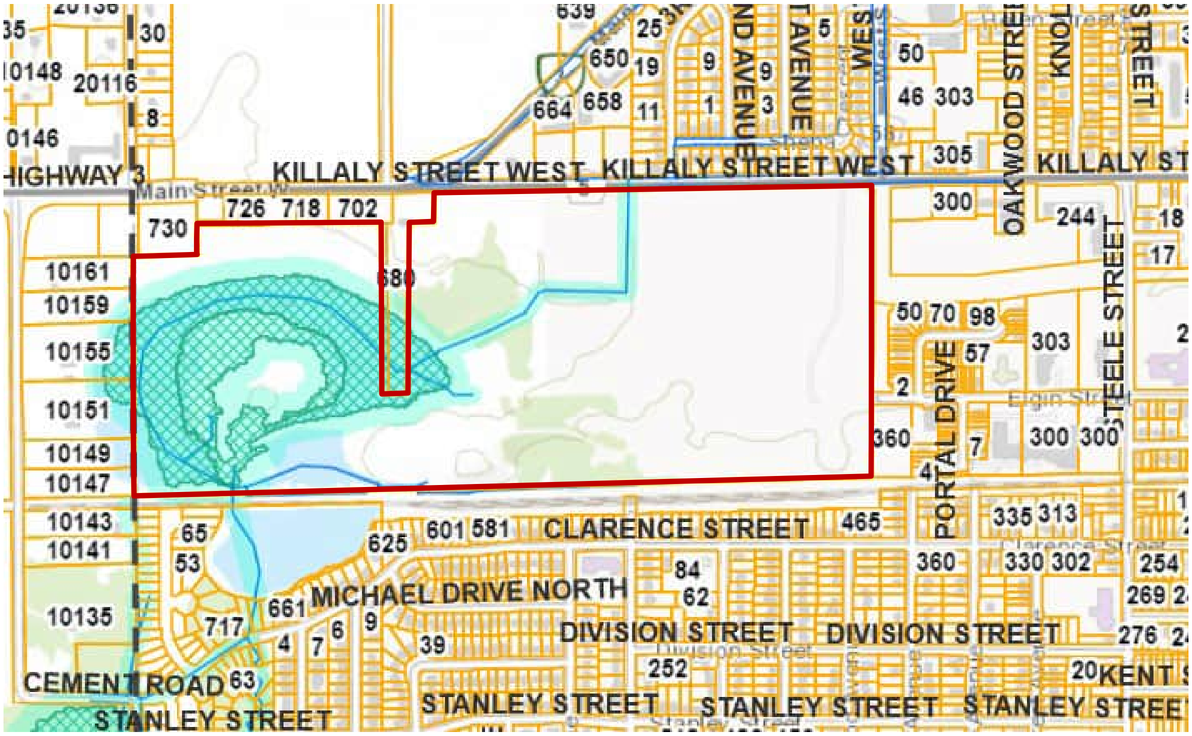

Figure 4–NPCA Regulated Area map, Subject Area at Mapleview, Port Colborne, ON

2. Site Investigation- Monitoring Wells & In-Situ Permeameter Testing

2.1. Monitoring Wells

Three (3) deep boreholes (BH101-BH103) were drilled at the site property by a sub-contractor and overseen by King EPCM on February 28 and March 2, 2022, in the previous factory area, at the stockpile area west of the previous factory, and at the abandoned small pond area northwest of the previous factory, respectively, and then developed into monitoring wells (Under the O. Reg. 903 criteria). Groundwater has also been observed in 0.8-11.5 meters below ground in all boreholes during drilling (Table 2).

Additionally, a total of nine shallow boreholes (BH201 – BH209) were drilled within the site property by King EPCM (O.Reg 903 License C-7691) on May 9-12, 2022, and then developed into monitoring wells. No groundwater has been observed in these boreholes since drilling, except in BH205, near the Quarry pond, where a shallow water level was recorded after rainy days last summer (~0.36-0.51m).

Detailed borehole drill logs are in Appendix III, while Table 1 below shows the summary. The soil stratigraphy confirmed the presence of a thin clay layer mixed with sand and pebbles or stone chips (SC, OH) below the ground surface down to depths 0.5-1.4m.

Table 1 - Borehole & Monitoring Well Summary

Borehole #	Drilled Date	Northing (UTM)	Easting (UTM)	Surface Elev. (amsl)	Hole Depth (m)	Screen Elevations (m)	Surface Soil type	Groundwater
101	02-Mar-22	4,749,772.78	641,413.98	179.69	15.12	164.6-167.7	Bedrock (gravel/stone with sandy clay)	yes
102	28-Feb-22	4,749,890.98	641,263.50	178.54	10.61	167.9-170.9	Bedrock (gravel/stone with sandy clay)	yes
103	02-Mar-22	4,749,799.28	641,016.77	179.3	11.13	168.2-171.2	Bedrock (gravel/stone with sandy clay)	yes
201	10-May-22	4,750,079.70	641,324.17	179.2	0.58	178.54-179.2	Clay with sand	no
202	11-May-22	4,750,147.77	641,166.72	179.1	0.58	178.52-179.1	Clay with sand and pebbles	no
203	11-May-22	4,750,044.10	641,218.90	180.84	1.0	179.84-180.84	Clay with sand	no
204	11-May-22	4,750,018.14	641,080.47	179.19	0.4	178.79-179.19	Clay with sand	no
205	12-May-22	4,749,907.61	640,988.00	178.59	0.58	178.03-178.59	Clay with sand	no
206	12-May-22	4,749,978.35	640,944.37	178.7	0.57	178.13-178.7	Clay with sand	no
207	09-May-22	4,749,920.37	641,424.74	179.96	0.53	179.43-179.96	Sandy clay	no
208	09-May-22	4,749,840.42	641,482.90	178.35	0.43	177.92-178.35	Clay with sand	no
209	09-May-22	4,749,829.82	641,205.52	178.35	1.4	176.95-178.35	Clay with stone chips/backfill	no

Table 2 –Water-level measurements(m) in monitoring wells, Lake Erie, and Quarry pond, May to September 2022

Date		BH 201	BH 202	BH 203	BH 204	BH 205	BH 206	BH 207	BH 208	BH 209	Lake Erie (amsl)	Quarry pond (amsl)	Points
March 11, 2022	GW depth (mbgl)	11.45	2.87	1.88	–	–	–	–	–	–	NA	NA	A
	GW Level (amsl)	168.237	175.667	177.43	–	–	–	–	–	–	NA	NA	B
May 10, 2022	GW depth (mbgl)	–	–	–	–	–	–	–	–	–	174.48	174.93	A
	GW Level (amsl)	–	–	–	–	–	–	–	–	–	174.46	174.88	B
June 8, 2022	GW depth (mbgl)	–	–	–	–	–	–	–	–	–	174.59	*	A
	GW Level (amsl)	–	–	–	–	–	–	–	–	–	174.57	*	B
July 6, 2022	GW depth (mbgl)	–	–	–	–	0.36	–	–	–	–	174.34	174.67	A
	GW Level (amsl)	–	–	–	–	178.23	–	–	–	–	174.33	174.63	B
August 10, 2022	GW depth (mbgl)	–	–	–	–	0.51	–	–	–	–	174.503	174.426	A
	GW Level (amsl)	–	–	–	–	178.08	–	–	–	–	174.492	174.471	B
September 22, 2022	GW depth (mbgl)	–	–	–	–	–	–	–	–	–	176.097	174.422	A
	GW Level (amsl)	–	–	–	–	–	–	–	–	–	174.531	174.464	B

** Unable to get Quarry Pond elevation due to technical issues*

– Dry well.

NA: not available

Table 3 – Precipitation (mm) observed at the stations closest to the Site, before water level measurements

Event	**Date**	**Port Colborne 6136606**	**Welland-Pelham 6139449**
1	May 10, 2022 (During drilling)	*No rainfall recorded*	*No rainfall recorded*
2	June 8, 2022	*18.2mm @ June 6* *Missing data @ June 7- 8*	*10.4mm @ June 6* *15.2mm @ June 7* *2.4mm @ June 8*
3	July 6, 2022	*2mm @ July 5* *0mm @ July 6*	*1.9mm @ July 5* *0mm @ July 6*
4	August 10, 2022	*Missing data @ Aug. 8-10*	*1.8mm @ August 8* *0mm @ August 9- 10*
5	September 22, 2022	*Missing data @ Sep.21 -22*	*0.6mm @ Sep. 21* *1.5mm @ Sep. 22*

In Table 2, the results of water level measurements in two points of both water bodies (i.e., Lake Erie & Quarry Pond) showed that the water level in the pond inside the site was about 0.5 meters higher than Lake Erie in the south, in the middle of spring and after the end of snow melting season. This difference gradually decreased to about 30 cm in early summer. According to the results, the water level of the pond in the middle of summer (August 10) was almost equal to or lower (~ 7 cm) than the water level of the lake and this situation continued until the end of summer, after each rainfall event in this region.

In none of the periodic visits to the monitoring wells inside the Site, no groundwater was observed after rainy days, except in BH205 near the pond, where the depth of the water was recorded to be 36 to 51 cm. These amounts were observed only after two rainfalls (July 6 & August 10) last summer and in other events, all wells were dry.

After those rainfalls, there was no sign of water in the north culvert that directs water from the northern exterior basin (EXT2: northern sub-division), upstream of the Killaly St. W., through this site to the southwest pond, except a very little water stayed in the waterway during last visit on September 22, when it was raining during the visit.

To measure the relationship between precipitation and groundwater level within this Site, the rainfall data of the nearest stations (Port Colborne @ 1.4 km southeast and Welland-Pelham @ 9.7 km northwest) were collected on the rainy days before each monitoring day (Table 3). The results indicated that there is no significant relationship between the precipitation and the groundwater level inside the Site. For example, no water was observed in boreholes on 8th June after heavy rains on June 6-8, after rainfall termination, while the groundwater rose to a depth of 36-51 cm below ground, only in BH205, near the eastern shore of the Quarry Pond, in the third and fourth events with total rainfall of less than 2 mm before measurement. In other words, heavy rainfalls in several consecutive days in June did not have any effect on the groundwater level inside the Site, and minor changes in the only mentioned borehole in July and August are only related to recharging from the pond.

2.2.In-Situ Permeameter Testing

Based on a field visit dated August 10, 2022, "field-saturated" hydraulic conductivity, K_{fs}, was achieved using the "Constant Head Well Permeameter" (CHWP) method. K_{fs} was conducted in the southwest, near BH103 using the ETC Standard Pask Permeameter Apparatus, while for the second test located at the northeast, near the entrance, the ETC Slow Soils Pask Permeameter Apparatus was used. The "Constant Head Well Permeameter" (CHWP) method was described in Appendix IV in detail.

It is understood that the in-situ infiltration test was not tested at the actual LID bottom but based on sieve size analysis and borehole soil samples, it is in the Engineer's opinion as a geotechnical engineer that the soils perform similarly in hydrological infiltration potential.

The ETC Pask Permeameter is a convenient and easy-to-use apparatus for ponding a constant head of water in a well, and simultaneously measuring the flow into the soil. The K_{fs} was calculated as:

K_{fs1} = 2.3E-7 m/sec = 2.3E-5 cm/sec
K_{fs2} = 3.4E-5 m/sec = 3.4E-3 cm/sec

It should be noted that the first test has a low permeability in clay soils which confirms the upper thin soil layer (clay mixed with sand, d ~ 0.4 to 1.0m) has a low infiltration rate within this property while the second test shows a high infiltration rate in the lower bedrock layer (i.e., sandy clay). The second value would be used for infiltration calculations in the future development plan.

K_{fs} were then corrected for temperature (for soil temperature=28-29$^{\circ c}$):

K_{a1}=1.3E-7 m/sec = 1.3E-5 cm/sec
K_{a2}=1.9E-5 m/sec = 1.9E-3 cm/sec

Correlations between Perc Time (PT) and field-saturated hydraulic conductivity (K_{fs}) are often used in the development of on-site water recycling and treatment facilities that operate by infiltration into unsaturated soil. Based on OMMAH (1997) interpolation, the measured infiltration rate may be interpolated as:

PT = 5.9 min / cm (Infiltration Rate = 102 mm/hour)

The engineer's opinion is to trust the values obtained from the OMMAH (1997), with an unfactored surface infiltration rate of 102mm/hour.

For a conservative approach to infiltration speeds, the Wisconsin Department of Natural Resources (2004) method shall be used for the calculation of a factored design infiltration rate and the Engineer's opinion is that the factored engineering design infiltration rate is 41 mm/hour, with a safety factor of 2.5.

See Appendix IV for more details, the calculations, and the graphs provided.

3. Pre-development site conditions

Prior to development, the property is considered nearly vacant with a Total Impervious Surface Area of less than 3.4% (~1 ha) near the southern boundary (old cement plant footprint) and in the west portion of the site (Quarry Pond), with grasses & trees for the remaining 84%. The ground surface is relatively flat and level (grading between 1 – 2% west and southwest) with minor undulations, with sand-primary soil allowing for relatively high infiltration rates. However, there is a local limestone hill in the southern portion, near the Quarry Pond with slopes less than 20%. The site conditions prior to development can be broken down into several groups of information:

3.1. Topographic Elevation & Base Precipitation

- The site topography, ground cover, land use, and drainage patterns of the subject property were established through site visitation, interpretation of topographic maps, historical aerial photographs, and a topographic survey.
- The Site is situated in the physiographical region known as Haldimand clay plain along the shoreline of Lake Erie, where an intermixture of lacustrine clay and glacial clay till occurs above a shallow limestone bedrock of Bois Blanc formation.
- Site survey & topographic information in Appendix I.
- The site is within the LENS Eagle Marsh Drain Subwatershed, part of Lake Erie's north shore watershed with Sand/Clay Hydrologic Soil Group B/C.
- The Site was used as a concrete factory back in 1934, until between 1968 and 1973 when the factory was demolished.
- There is a waterway in the middle part of the site property which crosses the northern boundary to convey runoffs towards the Quarry Pond while another drainage channel is observed along the southern property boundary which flows west and drains into the Quarry Pond.
- Base yearly precipitation is 1000.9mm/year (EC Welland-Pelham monitoring station-1977 to 2006, Climate ID: 6139445, Appendix V)
- The general surface drainage is towards the west & and southwest of the site.

3.2.Vegetation & Evapotranspiration

- The site property is considered rectangular in shape, measures approximately 139 acres (571,520 m^2 with the interior woodlot), and is located on the east side of Quarry Pond, southwest quadrant of Killaly Street West and west side road, City of Port Colborne.
- The subject land is mostly grassing field (>50%) with several tree cover in the south half portion of the site property, especially around the pond (>30%).
- The Site has several dense tree belts along the southern half portion and especially on the western side, near the pond, total estimation of 22.2 ha of parkland within the developed area.
- 7.05 ha / 23% of the Site (developed area) is grassy lawn, especially in the northeast, along the site boundary with Killay St W.
- <u>Estimated site actual evapotranspiration is 583.3mm/year (Appendix V)</u>

3.3.Precipitation Surplus (Recharge + Runoff)

- Net surplus (precipitation surplus) = 1000.9 – 583.3 = 417.6 mm/year for pervious area
- Recharge for pervious area based on MOEE Hydrogeological Tech Info, 1995, Table 2: Infiltration factors:
  - Topography (Flat land) = 0.3
  - Soil (Medium combinations of clay and loam) = 0.2
  - Cover = 0.1 (Grass) & 0.15 (Parkland)
  - MOE infiltration factor = 0.6 (Grass) and 0.65 (Parkland)
  - Recharge rate for pervious area would be 0.6*417.6 = 250.6 mm/year (Grass)*
  - Recharge rate for pervious area would be 0.65*417.6 = 271.4 mm/year (Parkland)*

  * **<u>It is the engineer's opinion that all site runoffs will be directed to the existing Quarry Pond and infiltrated into the ground while the Quarry Pond has no outlet.</u>**
- Storm runoff from the Grass area = 417.6 – 417.6 = 0.0 mm/year
- Storm runoff from the Parkland area = 417.6 – 417.6 = 0.0 mm/year
- Total area-weighted average storm runoff = 0.0mm/year
- Total area-weighted average recharge = 436mm/year
- Total area-weighted average precipitation surplus (recharge + runoff) = 436mm/year.

3.4.Stormwater Run-off

- There are no city-maintained stormwater sewers, with stormwater generally infiltrated by sandy clay soils or collected by the interior ditches and discharged to Quarry Pond.
- All stormwater in interior waterways which also collected runoffs from the northern side of Killaly St. West, generally infiltrated or moved downstream towards the pond, with no visual presence of any semi-aquatic vegetation or any standing water in the ditches during inspections. The historical wells records and new monitoring boreholes drilled by the engineer within the Site, near the main stream crossing the site from the north boundary, confirm that the seasonal groundwater level in this property is very low, except near the pond due to pond recharge.

- All minor & major storm site drainage is to be collected on site and outlet towards the Quarry Pond. This pond has no visible outlet, and it is discharged mainly by evaporation or infiltration. If there is any overflow, it might be discharged towards the south to a tributary of Eagle Marsh Drain finally and flows to the east to Lake Erie.
- Based on an in-situ infiltration test using ETC Pask Permeameter Apparatus, the infiltration rate of the thin upper clay layer with stone/sand was 22.4 min/cm = 0.45 mm/min = 27mm/hour while the bottom thick layer of sandy clay has a high infiltration rate of 5.9 min/cm = 102 mm/hour.
- Native permeable infiltration rate should use a non-factored infiltration rate of 102 mm/hour because the predominant soil material of this site is composed of sandy clay to a depth of more than 10 meters and a factored engineering design infiltration rate of 41 mm/hour with a safety factor of 2.5 for infiltration purposes.
- Based on the NPCA requirements, the Regional Storm is the Hurricane Hazel event, with data from Port Colborne Weather Station 6136606, cited in the NPCA SWM Manual-Appendices, “Appendix H: IDF Curves, 1964-2000”, with A, B, C values of 3-parameter Chicago distribution design storm as: i = a / (t+b)^c.
- See Table 4: Chicago Distribution Design Storm Parameters and Rainfall Amounts cited in the “NPCA SWM Manual- Appendices (Appendix H)”, showing the IDF values (Appendix VI).

Table 4 - City of Port Colborne Chicago Distribution Storm Parameters

Return Period	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
a	755	830	860	900	960	1020
b	8	7.3	6.5	5.2	5.1	4.7
c	0.789	0.777	0.763	0.745	0.736	0.731

- Furthermore, the precipitation intensities from the historical IDF curve from Environment Canada cited as Table 8 in the Stormwater and Wastewater Infrastructure, Final Report, Development of Projected Intensity-Duration-Frequency Curves for Welland, Ontario, Canada, “Historical IDF Table, Port Colborne, 6136606”, showing the IDF values as below table.

Table 5 –Historical IDF Table, Port Colborne, 6136606

	Return Interval (years)					
Duration	2	5	10	25	50	100
5 min	92.80	116.30	131.80	151.50	166.00	180.50
10 min	64.50	83.60	96.20	112.20	124.10	135.80
15 min	52.10	69.10	80.30	94.50	105.10	115.50
30 min	35.70	48.90	57.60	68.70	76.90	85.00
1 hr	22.90	31.60	37.40	44.70	50.20	55.50
2 hr	13.80	18.60	21.70	25.70	28.60	31.60
4 hr	8.33	11.35	13.26	15.77	17.60	19.47
6 hr	5.80	8.10	9.50	11.40	12.80	14.20
12 hr	3.50	4.90	5.90	7.10	7.90	8.80
24 hr	2.00	2.80	3.30	3.90	4.40	4.80

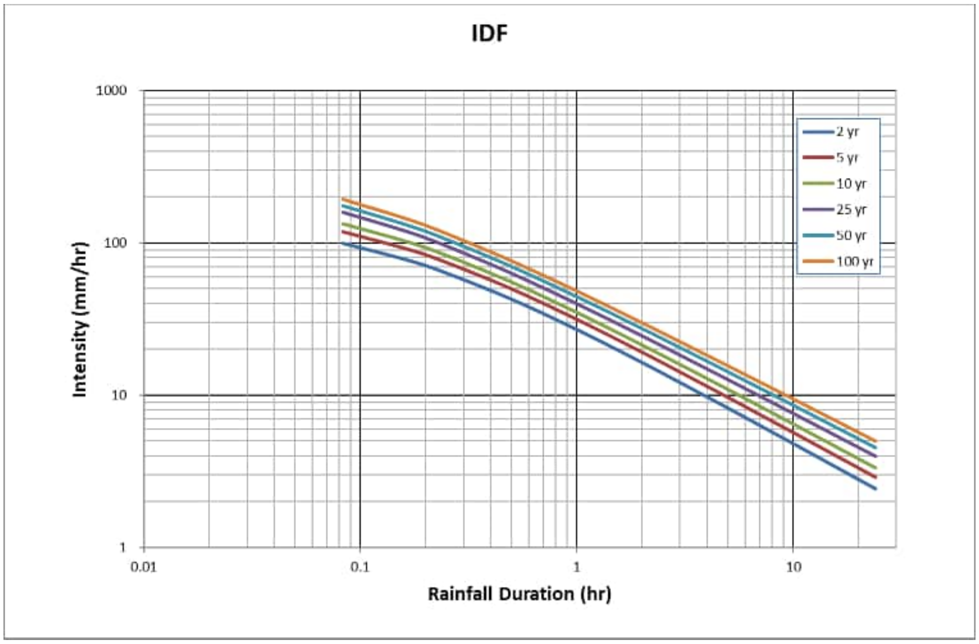

Figure 5- Intensity-Frequency-Duration (IDF) Curves, Port Colborne, 6136606

According to the NPCA Technical Guidelines for Stormwater Management (Section 7.2), four methods are generally used for Hydrologic/Hydraulic Analysis. This modeling approach can be as simple as estimating peak flows with the Rational Method to sophisticated hydrologic and hydraulic computer models. The rational method is generally proposed to derive synthetic design storms. In spite of the availability of advanced computational techniques, it remains a valid approach to peak flow estimation for small drainage areas. <u>The application of this method should be limited to watersheds less than 100 ha in size and should not be used for the design of SWM ponds</u>.

The Modified Rational Method also has been developed to improve the accuracy of the standard rational method to take account of the variable runoff coefficients in the catchment and the losses in rainfall and storage in the system. In assessing the pre- and post-development flows, the design storm that yields the lowest pre-development flows and the highest uncontrolled post-development flows should be used, considering multiple storm durations (i.e., 3-hour, 12-hour, 24-hour) and design storm types/distributions (i.e., Chicago, SCS Type II).

So, it can be noted that NPCA recommended manual calculations such as the Rational or Modified Rational Method when watersheds are less than 100 hectares, and the Engineer has used the Modified Rational Method for this site. These methods are based on a simple empirical formula used to determine flow that results from a rainfall of specific intensity applied to an area based on an average catchment land use condition.

- Pre-development 1 in 2 years, 1 in 5 years, 1 in 10 years, 1 in 25 years, 1 in 50 years, and the 1 in 100-year design storm events, peak flow conditions are calculated as follows:
- Peak flow rate Modified Rational Formula: Qp = (0.001/3600) * A * C * Ca * i
    - A = Developed area in m^2 = 302,307.5 m^2**
    - C = runoff coefficient = 0.35 (Clay, parkland & grass, 3.4% TIMP, flat, MTO 1997 design chart 1.07 for rural & urban and Table 4.1, Niagara Region SWM Guidelines)

  ** Note: The Engineer unselected conservatively the effect of Key Natural Heritage and/or Hydrologic Features (KNHHF) in runoff coefficient estimation. This portion is located outside the development area plan and has the same effect on the runoff captured in pre- and post-development scenarios. In other words, the difference in runoff captured by this portion will be zero in both cases.

    - Ca = Antecedent Precipitation Factor = 1.0 for 2, 5, and 10 years, 1.10 for 25 years, 1.20 for 50 years, and 1.25 for 100 years.
    - i = average rainfall intensity in mm/hour (4, 12 & 24 hour IDF for Port Colborne Table 5 above)
    - Detailed calculations are contained within the attached Excel Spreadsheet.

- Time of Concentration:
    - Airport Method if $C < 0.4$, $\boldsymbol{T_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}}$

      Where:
      T_c= time of concentration (min)
      L = catchment length, (m)
      S_w = catchment slope (%)
      C = runoff coefficient (-)

For Developed area: C = 0.35, L = 782m, $S_w = 0.67\%$, $\boldsymbol{T_c = 78.2}$ ***min***

For EXT1: **minimum T_c = 10min**

For EXT3: C = 0.25, L = 355m, $S_w = 0.5\%$, $\boldsymbol{T_c = 65.6}$ ***min***

- Bransby Williams Method if $C > 0.4$, $T_c = \frac{0.057 * L}{S_w^{0.2} * A^{0.1}}$

  Where:
  T_c= time of concentration (min)
  L = catchment length, (m)
  S_w = catchment slope (%)
  A = catchment area (ha)

For EXT2: C = 0.60, L = 770m, A = 21.2 ha, $S_w = 0.5\%$, $T_c = 37.1$ ***min***

- When the time of concentration is calculated as less than 10 minutes, an assumed time of concentration for those catchments is 10 minutes.

- It should be noted that exterior catchments (Pond, Wetland, Parkland, and Woodland) will remain the same in pre- and post-development conditions, and they do not contribute drainage to the proposed storm sewer system, except the Woodland which will be directed into the surrounding streets and conveyed to the southern ditch/swale through storm sewer pipes.

Table 6– Flow Rate Calculations using Modified Rational Method

(Pre-Development Scenario)

Parameter	**Catchment**	**Area (ha)**	**Runoff Coefficient (-)**	**Time of Concentration (min)**	**Design Storm**					
					2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**
Total Runoff (Qp) in cms **(Intensity in mm/hr)**	Developed area	30.2	0.35	78.2	0.66 (22.4)	0.77 (26.2)	0.85 (29.1)	1.07 (33.3)	1.30 (37.1)	1.48 (40.4)
	EXT1	2.2	0.20	10	0.09 (77.2)	0.11 (90.6)	0.12 (101.3)	0.16 (118.5)	0.19 (130.2)	0.22 (143.0)
	EXT2	21.2	0.60	37.1	1.32 (37.4)	1.54 (43.5)	1.71 (48.2)	2.15 (55.3)	2.59 (61.1)	2.95 (66.6)
	EXT3	0.52	0.25	65.6	0.01 (25.4)	0.01 (29.6)	0.01 (32.9)	0.01 (37.7)	0.02 (41.8)	0.02 (45.5)

4. Stormwater Management Plan

The SWM plan has been prepared in accordance with the MOE Stormwater Management Planning and Design Manual, NPCA Stormwater Technical Guidelines, and Niagara Region Stormwater Management Guidelines as detailed in Section 11. The SWM plan is subject to review and approval by the City, Region, and NPCA, and is presented in the following sections.

4.1.Design Criteria

The following design criteria are to be satisfied in the proposed SWM plan:

- The stormwater management plan must maintain existing stormwater runoff rates at the site outlet by restricting post-development peak flow rates to pre-development levels for the 1:2-year through 1:100-year design storms;
- The stormwater management plan must provide quantity control storage for storm events up to and including a 1:100-year design storm in addition to the 25mm storm runoff volume;
- Safe conveyance of the 2-year to 100-year peak flows through the site to the downstream drainage system must be provided for surface runoff generated within the development;
- Stormwater runoff from the development shall be collected and treated to an Enhanced (80% TSS removal) standard prior to discharge to the receiving watercourse (Quarry Pond); and,
- Protect life and property from flooding and erosion.

4.2.Stormwater Management Strategy

Based on the above and a review of the site-specific considerations, the following stormwater management strategies have been established for this site:

- Stormwater **quality** controls are to be provided to provide Enhanced Protection (80% TSS removal) in accordance with MECP guidelines prior to outletting to the Quarry Pond;
- Stormwater **quantity** controls are not required for stormwater flows discharging from the subject lands; and,
- A permanent water elevation is present in the Quarry Pond, which is maintained by the water elevation in Lake Erie while there is no visible outlet along the pond boundary. Therefore, downstream erosion effects are not anticipated in the Quarry Pond due to uncontrolled stormwater flows discharging from the subject lands in frequent storm events.
- Lot grading is to be kept as flat as practical in order to slow down stormwater and encourage infiltration.
- Roof leaders are to be discharged to the ground surface in order to slow down stormwater and encourage infiltration.
- Grassed swales along with a conveyance structure (box culvert) and outlet structures are to be used to collect interior and exterior lot drainages and direct towards the pond. Grassed swales tend to filter sediments and slow down the rate of stormwater.
- use of an oil/grit separator for each outfall;

5. Proposed SWM Plan

The Client has proposed to construct a variety of types of townhouses, mid-rise mixed-use buildings, and single detached dwellings, along with parking lots, sidewalks, and driveways on the property while retaining the existing natural heritage (woodlands, parklands, wetlands, and pond) outside of the developed area. Based on the low groundwater level observed during borehole drilling, monitoring wells in the last year, and high infiltration sandy clay layer existed in the site to a considerable depth, below a thin layer of upper clay layer mixed with sand and pebbles or stone chips, the Engineer proposes that rooftop downspouts along with parking lots and roads runoffs to be captured into storm sewers through catchbasins and then directed to the existing Quarry pond through box culvert (Catchment # 100 & EXT2) or swale (Catchment # 200, 400, 500, 600, EXT1, EXT3) or directly (Catchment # 300). Storm sewers shall be designed to drain all lands based on the Rational Method 5-year storm events. It is evident that precipitation influences the groundwater level but there was no significant relationship between the precipitation and the groundwater level inside the Site.

The results indicated that there is no significant relationship between the precipitation and the groundwater level inside the Site. For example, no water was observed in boreholes on 8th June after heavy rains on June 6-8, after rainfall termination, while the groundwater rose to a depth of 36-51 cm below ground, only in BH205, near the eastern shore of the Quarry Pond, in the third and fourth events with total rainfall of less than 2 mm before measurement. In other words, heavy rainfalls in several consecutive days in June did not have any effect on the groundwater level inside the Site, and minor changes in the only mentioned borehole in July and August are only related to recharging from the pond.

It is recommended that separate Oil/Grit Separators (OGS) units be installed in each outfall to treat the pollutant-generating areas, such as the roadways, driveways, parking spaces, etc.

Below is a summary of the proposed site conditions:

- Total site surface area (developed area) = 302,307.5 m^2
- Total pervious surface area (Parkland, Grass, and landscapes) = 110,584.4m^2 (36.6%)
- Total impervious surface area (TIMP) = 191,723.1 m^2 (63.4%)
  - 51,762.1 m^2– new buildings
  - 82,471.2 m^2– new driveways (municipal roadway)
  - 22,358.3 m^2– new parking lots
  - 18,353.9 m^2– new sidewalks
  - 33,555.0 m^2– new single-family
- Rooftop downspouts, parking lot, driveway, and interior road runoffs are captured by catchbasins.
- A box culvert in the northern portion of the site to collect the runoff from EXT2 and Catchment 100.
- Grass Swales along both sides of the property boundaries in the north and south.
- Post-development peak flow conditions are calculated as follows:
- Peak flow rate Modified Rational Formula: Qp = (1/360) * A * C * Ca * i
  - A = area in m^2 = 30.3 ha
- C = runoff coefficient = 0.69 for the developed area (Sandy clay or Clay & 63.4% TIMP,

MTO 1997 design chart and Table 4.1, Niagara Region SWM Guidelines 1.07 for rural & urban), See Appendix IX for details runoff coefficient calculations for each catchment.

  - Ca = Antecedent Precipitation Factor = 1.0 for 2, 5 and 10 years, 1.10 for 25 years, 1.20 for 50 years, and 1.25 for 100 years.
  - i = average rainfall intensity in mm/hour (IDF for Port Colborne, Table 4 above)
  - See the post-development catchment area in Appendix VIII.

- Time of Concentration:
  - Airport Method if $C < 0.4$, $\boldsymbol{T_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}}$:

For INT1: $C = 0.25$, $L = 65.5$m, $S_w = 0.5\%$, $\boldsymbol{T_c = 28.2}$ ***min***
For INT2: $C = 0.25$, $L = 137.6$m, $S_w = 0.5\%$, $\boldsymbol{T_c = 40.9}$ ***min***
For EXT1: **minimum T_c = 10min**

  - Bransby Williams Method if $C > 0.4$, $\boldsymbol{T_c = \frac{0.057 * L}{S_w^{0.2} * A^{0.1}}}$

For EXT2: $C = 0.60$, $L = 770$m, $A = 21.2$ ha, $S_w = 0.5\%$, $\boldsymbol{T_c = 37.1}$ ***min***

  - The minimum time of concentration per city standards is 10 minutes.

- See Table 7: Post-development peak flows for the 1:2-year through 1:100-year design storms based on the Rational Method. The Modified Rational Method calculations are included in Appendix X for reference.

- See Table 8: To compare the Pre-development versus the Post-development peak flows for the 1:2-year through 1:100-year design storms based on the City's Rational for each catchment.

Table 7– Flow Rate Calculations using Modified Rational Method

(Post-Development Scenario)

Parameter	**Catchment**	**Area (ha)**	**Runoff Coefficient (-)**	**Time of Concentration (min)**	**Design Storm**					
					2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**
Total Runoff (Qp) in cms **(Intensity in mm/hr)**	100	8.62	0.81	14.9	1.25 (64.5)	1.46 (75.5)	1.62 (84.0)	2.07 (97.4)	2.49 (107.1)	2.83 (117.2)
	200	5.67	0.69	13.9	0.72 (67.1)	0.84 (78.6)	0.94 (87.5)	1.2 (101.6)	1.44 (111.7)	1.64 (124.4)
	300	1.79	0.67	15.0	0.23 (65.9)	0.27 (77.0)	0.30 (85.8)	0.38 (99.5)	0.46 (109.5)	0.53 (119.9)
	400	5.22	0.67	13.6	0.67 (67.5)	0.78 (79.1)	0.87 (88.1)	1.12 (102.3)	1.34 (112.5)	1.53 (123.2)
	500	3.92	0.74	14.3	0.52 (64.5)	0.61 (75.4)	0.68 (83.9)	0.86 (97.2)	1.04 (107.0)	1.18 (117.1)
	600	2.91	0.66	14.9	0.34 (63.4)	0.39 (74.1)	0.44 (83.4)	0.56 (95.5)	0.67 (105.0)	0.76 (114.9)
	INT1	0.58	0.25	28.2	0.02 (44.5)	0.02 (51.8)	0.02 (57.5)	0.03 (65.9)	0.03 (72.8)	0.04 (79.4)
	INT2	1.52	0.25	40.9	0.04 (35.1)	0.04 (40.9)	0.05 (45.3)	0.06 (51.9)	0.07 (57.4)	0.08 (62.5)
	EXT1	2.2	0.20	10	0.09 (77.2)	0.11 (90.6)	0.12 (101.3)	0.16 (118.5)	0.19 (130.2)	0.22 (143.0)
	EXT2	21.2	0.60	37.1	1.32 (37.4)	1.54 (43.5)	1.71 (48.2)	2.15 (55.3)	2.59 (61.1)	2.95 (66.6)
	EXT3	0.52	0.95	13.8	0.09 (65.6)	0.10 (76.7)	0.12 (85.4)	0.15 (99.1)	0.18 (108.9)	0.20 (119.3)

Table 8 –Comparison of peak flows for pre- and post-development based on the modified Rational method.

Parameters	**Catchment**	**Design Storm**					
		2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**
Post-Development Peak Flows (cms) **(*Allowable Peak Flows = Pre-Development Peak Flows in cms*)***	100	1.25 (*0.19*)	1.46 (*0.22*)	1.62 (*0.24*)	2.07 (*0.31*)	2.49 (*0.37*)	2.83 (*0.42*)
	200	0.72 (*0.12*)	0.84 (*0.14*)	0.94 (*0.16*)	1.2 (*0.20*)	1.44 (*0.24*)	1.64 (*0.28*)
	300	0.23 (*0.04*)	0.27 (*0.05*)	0.30 (*0.05*)	0.38 (*0.06)*	0.46 (*0.08*)	0.53 (*0.09*)
	400	0.67 (*0.11*)	0.78 (*0.13*)	0.87 (*0.15*)	1.12 (*0.19*)	1.34 (*0.23*)	1.53 (*0.26*)
	500	0.52 (*0.09*)	0.61 (*0.10*)	0.68 (*0.11*)	0.86 (*0.14*)	1.04 (*0.17*)	1.18 (*0.19*)
	600	0.34 (*0.06*)	0.39 (*0.07*)	0.44 (*0.08*)	0.56 (*0.10*)	0.67 (*0.13*)	0.76 (*0.14*)
	INT1	0.02 (*0.01*)	0.02 (*0.01*)	0.02 (*0.02*)	0.03 (*0.02*)	0.03 (*0.02*)	0.04 (*0.03*)
	INT2	0.04 (*0.03*)	0.04 (*0.04*)	0.05 (*0.04*)	0.06 (*0.05*)	0.07 (*0.07*)	0.08 (*0.07*)
	EXT1	0.09 (0.09)	0.11 (*0.11*)	0.12 (*0.12*)	0.16 (*0.16*)	0.19 (*0.19*)	0.22 (*0.22*)
	EXT2	1.32 (*1.32*)	1.54 (*1.54*)	1.71 (*1.71*)	2.15 (*2.15*)	2.59 (*2.59*)	2.95 (*2.95*)
	EXT3	0.09 (*0.01*)	0.10 (*0.01*)	0.12 (*0.01*)	0.15 (*0.01*)	0.18 (*0.02*)	0.20 (*0.02*)

Note: (*1.32*) denotes pre-development peak flow.

* Allowable Peak Flow = Pre-dev. Peak Flow – Uncontrolled Post-dev. Peak Flow (The allowable release rate will be set to the pre-development flow as there is no Uncontrolled Post-dev. Peak Flow in this project)

The existing property is currently vacant (brownfield) and is not serviced by any storm sewer or stormwater management facilities, except a Quarry Pond located within the site boundary in the southwest with a total area of 7.6ha. Since the total post-development peak flows from the site exceed the pre-development levels due to TIMP increases, quantity controls are required (Table 8).

Based on the detailed Modified Rational Method calculations in Appendix X, it is concluded that the proposed development will result in an increase in surface runoff to the Quarry Pond of 3538 m^3 from the proposed development during the worst-case scenario, i.e., a 100-year storm event. When compared to the storage capacity of the pond with a total surface of 7.6 ha, this will result in an increase in water level of 4.7 mm over existing conditions. This represents a limited impact on the pond.

Due to the high infiltration rate along with the low groundwater table in this site, the proposed stormwater facility consists of a buried storm sewer system along with separate outlet structures for each catchment outfall. Outlets will be discharged into the Quarry Pond finally, through a box culvert or swale which will be established towards the existing pond on the site property to the west/south.

See Appendix II & X for detailed stormwater management calculations and the SWM flowchart (Fig. 6 below).

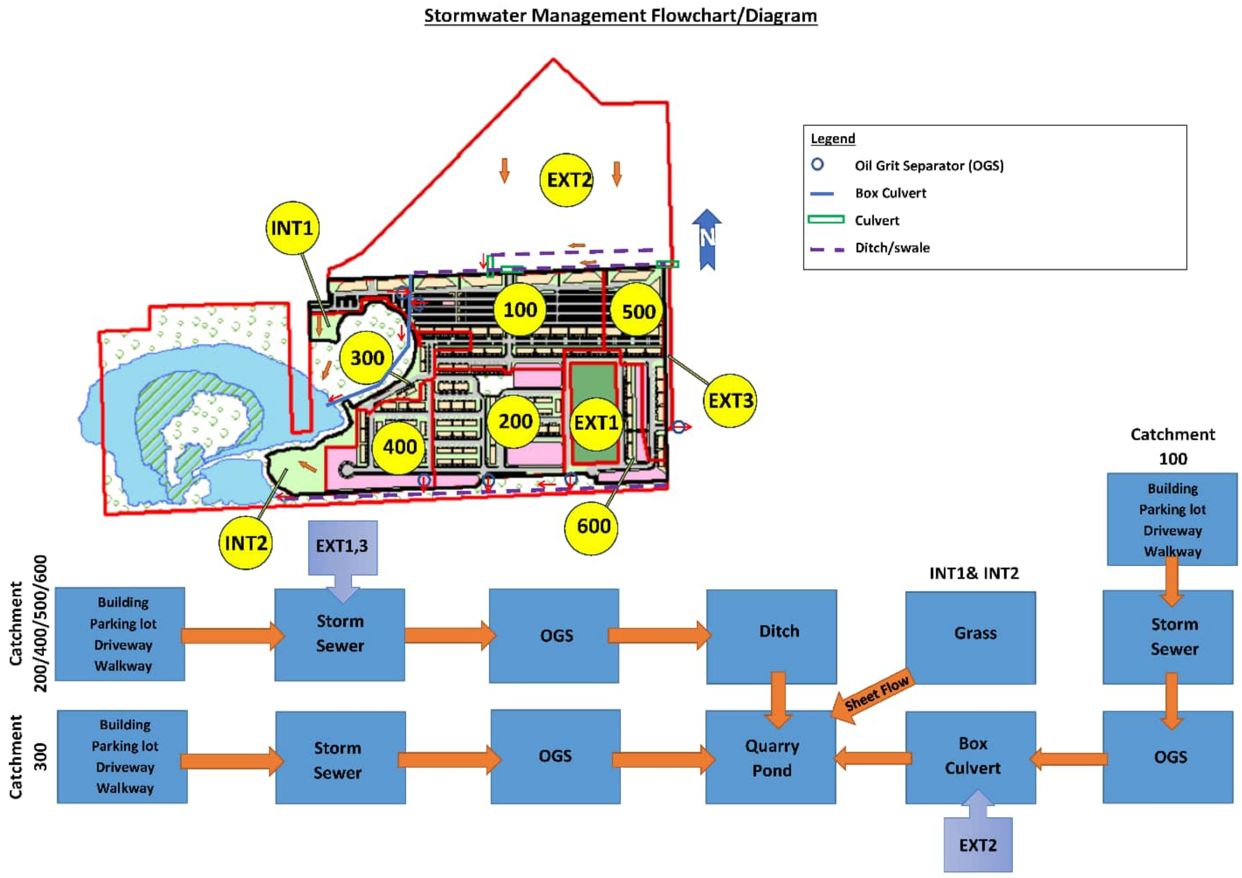

Figure 6- Stormwater Management Flowchart/Diagram

6. Water Quantity

6.1. Peak flow control

Prior to development, the site property is considered vacant with a Total Impervious Surface Area of 3.4% within the site as an existing limestone stockpile, with trees and grasses for the remaining 96.6%. The property has an average grade of 0.5 - 1% towards the Quarry Pond, with sand-primary soil having high infiltration rates.

Stormwater runoff peak flow discharges must be controlled to the pre-development levels for the 2-to-100-year design storms for the Subdivision Plan area in accordance with the NPCA's criteria for peak flow control and the guidelines of the Ministry of Environment Stormwater Management Planning and Design Manual, March 2003.

Post-development has a TIMP = 63.4% and combined with the existing Quarry Pond along with storm sewer systems and conveyance ditches along the north and south boundaries, there are not any expected changes in peak runoff flow rates or total volumes. All stormwater is to be collected on-site and outlet towards the Quarry Pond. The pond has no surface water outlet, and all flows are released via infiltration and evaporation.

For a 1:100-year storm, there is an excess of 3538 m^3 of peak flow capacity when comparing pre-development and post-development without any mitigations for the whole site (302,283 m^2). This volume is equal to 4.7 mm of water rising on the surface of the pond with an area of 7.6 hectares and has a limited impact on the pond.

Post-development peak flows for each catchment are calculated above using the Modified Rational Method (Tables 7-8). The calculations are included in Appendix X.

6.2. Volume control

Based on NPCA SWM guidelines, quantity control to detain and release the 25mm, 4-hour Chicago design storm over a 24-hour period shall be provided for all receiving systems that are demonstrated to be stable watercourses or for proposed development that comprise less than 10% of the total area that drains to the receiving system.

In Table 9 the total runoff volume control target for the post-development scenario (25 mm storm event) and volume capacity of the proposed SWM are shown. The total volume of stormwater runoff produced due to a 25 mm rainfall event from the total impervious area of the study site is 4793 m^3, which is equal to a 6.3 mm increase in the water level of the Quarry Pond and it is really negligible, as discussed above in Section 5.

Table 9 shows that runoff volume reduction is met and that the post-construction runoff volume shall be fully captured and retained on the site from a 25 mm rainfall event from the total impervious area.

Table 9 – Runoff volume control target (25 mm) and values provided by post-development design (m^3)

Parameter	Building	Driveway	Parking	Sidewalk	Single-Family	Total
TIMP Area (m^2)	51,762	82,471	22,358	18,354	16,777	191,722
25 mm runoff volume control (m^3)	1294	2062	559	459	419	4793

6.3.Major-minor system conveyance

This site is classified as a high infiltration area due to the presence of a thick sandy clay layer below the ground surface, after a thin clay sub-layer, down to significant depths (>10m), in most parts of the developed area, 102mm/hr unfactored infiltration rate vs 1:100 year 4-hour event of 19.5mm/hr precipitation.

The proposed development shall control both minor (i.e., 11.4mm/hr precipitation in 5yr storm event) and major (i.e., 19.5mm/hr precipitation in 100yr storm event) flows to the downstream storm sewer capacity and existing Quarry Pond. In other words, the existing Quarry Pond will collect both major and minor stormwater flows from their respective drainage areas.

The right-of-way (ROW) will provide the drainage route within the subject property to the overland flow discharge location adjacent to the Quarry Pond. A piped stormwater system (minor system) has been designed to convey storm events up to and including the 5-year storm to the stormwater management pond.

Due to the high permeability of the natural sandy clay layer on-site, 4-hour precipitation on permeable surfaces will be fully infiltrated, while the probable runoff due to lower rainfall duration and more intensity would be drained to the on-site wetland or Quarry Pond through site grading. Similarly, all precipitation on impermeable surfaces of developed areas will be drained to the Quarry Pond for evaporation and infiltration, with no chance of discharging the overflow to the downstream watercourse.

The proposed catchbasins shall have sufficient inlet capacity to collect the entire minor flow from the developed area into the storm sewers which are also designed to collect and convey runoff from 5-year storm events. The sewers will be discharged to the Quarry Pond through separate outfalls, e.g., the catchments 100 and EXT2 through the box culvert, the catchments 200, 400, 500, 600, EXT1, EXT3 through the southern drainage ditch, and the catchment 300 through sheet flow.

The major system conveyance is for flows between 5- and 100-year storm events, and is the same for pre-development and post-development, generally flowing from northeast to southwest. The major storm events from the development's contributing drainage area will be conveyed along the internal roadways to the Quarry Pond. The paved surface will provide sufficient erosion protection.

Overland routes on the western section of the site (between Quarry Pond and the developed area) which are undisturbed are expected to follow the pre-grading, with the southwest portion being a locally elevated region, and flowing northwest towards Quarry Pond.

There is no relation between the rainfall and the groundwater of the topsoil layer (upper 0.5 meters) inside the site, and the precipitation immediately infiltrates into the lower layers or gradually infiltrates after discharging into the Quarry Pond.

6.4.Regulatory storm conveyance

The site property is serviced by different ditches along the north and south side boundaries with Killaly St. W. and the railroad. The north ditch is the main drainage outlet for the northern residential subdivision through the site property towards the pond while the south ditch is connected to the eastern residential area and directs to the pond. The northern ditch along the Killay St. W. is responsible for the safe transfer of the regulatory storm from the northern part of the Killay St. W. to the Quarry Pond, which is located completely outside the developed area and will be restored with a new shape and pipe culverts at the site entrance crossings. This ditch leads to the proposed box culvert which will be sized to collect both the catchments 100 and EXT2 to discharge to the pond. The eastern portion of the site (Catchment 500) along with the neighbors to the east of the site drains to the existing southern ditch that flows west to the Quarry Pond.

7. Water Quality

7.1.Total Suspended solids

Stormwater quality controls will be implemented in accordance with requirements of the City of Port Colborne, Niagara Region, and Niagara Peninsula Conservation Authority (NPCA) with a targeted Total Suspended Solids (TSS) removal of 80% in accordance with provincial policy.

The proposed post-development has all impervious areas draining the entirety of the minor and major storm event volumes into the storm sewer system and then directs to the seven (7) independent OGS units and their outlets will be discharged into the Quarry Pond. Based on MOE 2003 SWM PDM Table 3.2, Enhanced 80% S.S. Removal by infiltration requires 30 m^3/ha for 55% imperviousness. For the subject site, TIMP is 63.4%, and required storage volumes are obtained through interpolation of Table 3.2, about 32.8 m^3/ha. Using 32.8m^3/ha to meet the required 80% TSS removal and the area of the site 30.2 ha, a minimum of 990.6m^3 of storage must be provided. The proposed site has a Quarry Pond of 7.6 ha with an average depth of 1.5m (typical depth of 0.0 to 3.0 m depth, based on the bathymetry by the Engineer last summer), which confirms that the pond volume should be greater than 100,000 m^3. Therefore 80% TSS removal has already been achieved through stormwater quantity control measures while there are separate OGS units proposed at the outfalls of each catchment to provide 80% TSS removal, before entering the Pond.

An OGS treatment unit (Stormceptor EFO8 and EFO12 or equivalent) treats the stormwater released from this site to the MOE's Enhanced Level Protection standard. This separator will be required to be sized to capture and treat at least 90% of the runoff volume that occurs for this site on a long-term average basis for water quality objectives of enhanced protection (See Appendix XIV for details). Thus, the efficiency would be:

Initial TSS Load Upstream of the storm sewer outlet = 1.0
TSS Load Removed by OGS units = 1.0 X 80% Removal Rate = 0.8
Remaining TSS Load Downstream of OGS which drained to Vegetative filter = 1.0 – 0.8 = 0.2
TSS Load Removed by Vegetative filter = 0.2 X 60% Removal Rate = 0.12
Final TSS Load Downstream of Vegetative filter which drained to Wetland/Pond = 0.2 – 0.12= 0.08
Final TSS Removal Rate = 1.0 – 0.08 = 0.92 or 92%

Proposed OGS units (Stormceptor EFO8 and EFO12) combined with vegetative filter (grass swale or grassy lawn area) will treat the post-development flows to the required MOE quality standard, with a TSS removal rate of approximately 92%, and the NPCA 80% TSS reduction on "developed areas / impervious areas" is also met.

7.2.Winter salt

Post-development winter salt use is anticipated to be higher than pre-development. This is primarily a concern for the driveways, parking lots, and roads with a total asphalt area equal to 12.3ha (40.7% of total area). Design practices that help reduce winter salt use include:

- Minimal trees or use of deciduous plants are considered for landscaping near driveways/roads, to reduce winter shading.
- Effective parking lot grading can minimize the freezing of wet pavement surfaces as well as prevent melt water from ponding and refreezing, reducing the need for re-application of salts.
- Effective drainage management can reduce salt use over the life of the facility. Proposed drainage systems will lead to reduced ice accumulation, and as such, reduce salt usage.
- Parking lots are designed with catch basins located near the perimeter so melt water from snow storage areas does not have to flow a long way across paved surfaces where it could freeze and require excessive salting.
- Effective drift control can reduce snow and ice control efforts including salt use. Drifting can be controlled through the erection of drift control devices such as snow fences (structural and living) and snow ridges and the strategic placement of buildings.
- By designing sidewalks that are wide enough for mechanical clearing and anticipating pedestrian flow, the number of walkways and salt required on them is minimized.
- All driveways are graded up towards block entrances, preventing ice build-up at entrances.
- Recommend the client use sand & gravel for traction instead of salt.

7.3.Other Contaminates

The existing site property is not serviced by the city storm sewer system. Post-development contaminates generated in the residential sub-division would be captured by the proposed storm sewer systems and conveyed towards the existing Quarry Pond. Stormwater runoff from rooftops, sidewalks, roads, and parking areas will require water quality treatment to an 80% TSS removal standard, as per the NPCA & MECP criteria. This will be accomplished mainly through the installation of oil-grit separator (OGS) units at each discharge point for 6 catchments, i.e., 100 to 600. Each OGS will be sized based on its contributing catchment area and the overall imperviousness of the catchment. Furthermore, Oil-grit separators (OGS) are designed to be installed in outflow directions as part of a treatment train to remove heavy particulates, floating debris, and hydrocarbons from stormwater. See the SWM plan in Appendix II to find the marked location of the proposed OGS (EGR 1.3). See Appendix XIV for more details of the proposed OGS.

8. Water Balance

Based on Welland-Pelham Climate Station Data, precipitation is 1000.9mm/year, and the averaged evapotranspiration rate is mostly grass and trees in hydrologic soil group B/C, 583.3mm/year (Appendix V).

Pre-development site conditions have high groundwater infiltration/recharge, as the site is primarily sandy clay soil with slopes <2% grade and a little part of the runoff flows into the existing Quarry Pond within the site boundary through the existing waterways or sheet flow. On a 30.2 ha with 3.4% TIMP, there is an estimated 131,726m^3 of groundwater recharge per year. Runoff is 0 mm/year because there is no visible outlet along the existing Quarry Pond shorelines.

Pre-development condition parameters are shown in Table 10, below, as well as detailed in Section 3 of this report. The site is within the LENS Eagle Marsh Drain Subwatershed, part of Lake Erie's north shore watershed with Sand/Clay Hydrologic Soil Group B/C, 3.4% TIMP, containing 22.2 ha (73.3%) parkland, 1.0 ha (3.4%) of limestone stockpiles and 7.0 ha (23.3%) of grass/landscape.

The proposed post-development TIMP is 19.2 ha / 63.4% and, without any LID treatments, the site recharge is estimated at an equivalent of 97mm/year, or 29,309 m^3 (-77.8% as compared to pre-development).

The proposed development includes 19.2 ha total impervious surface area (TIMP), 63.4% of the total drainage area, within the total site area = 54.9 ha. Parklands and grassy lawns are reduced through the development of the property, which causes a reduction in evapotranspiration of 56.6% from pre-development levels, while 73.5% or 228,482 m^3 of the precipitation surplus within the TIMP area is managed for recharge and infiltration. Since there is no visible outlet along the Quarry Pond shorelines and considering the capacity of the pond (Area = 7.6 ha), the amount of external outflow has no change compared to the pre-development state (0mm or $\Delta V = 0m^3$). In other words, the proposed mitigation measure is the same as the existing condition through Quarry Pond, by infiltration and evaporation.

Post-development with mitigation, the total rate of infiltration has increased from 436 mm/year to 756 mm/year or 131,726 m^3 to 228,482 m^3 (+73.5%). The proposed SWM plan shall capture and retain runoff from all impervious surfaces and the focus is on controlling runoff volume and peak flow through infiltration or evaporation, without any outlet. Detailed calculations of water balance for each scenario are presented in Appendix XIII.

Table 10 –Water Balance Summary

Characterstic	Site				
	Pre-Development	Post-Development	Change (Pre- to Post-)	Post-Development with Mitigation	Change (Pre- to Post- with Mitigation)
Inputs (Volumes)					
Precipitaiton (m^3/yr)	302,580	302,580	0.0%	302,580	0.0%
Run-On (m^3/yr)	0	0	0.0%	0	0.0%
Other Inputs (m^3/yr)	0	0	0.0%	0	0.0%
Total Inputs (m^3/yr)	**302,580**	302,580	0.0%	302,580	0.0%
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	131,726	228,482	73.5%	228,482	73.5%
Net Surplus (m^3/yr)	131,726	228,482	73.5%	228,482	73.5%
Evapotranspiratin (m^3/yr)	170,854	74,098	-56.6%	74,098	-56.6%
Infiltration (m^3/yr)	131,726	29,309	-77.8%	167,783	27.4%
Rooftop Infiltration (m^3/yr)	0	0	0.0%	60,698	0.0%
Total Infiltration (m^3/yr)	131,726	29,309	-77.8%	228,482	73.5%
Runoff Pervious Area (m^3/yr)	0	18,475	0.0%	0	0.0%
Runoff Impervious Area (m^3/yr)	0	172,088	0.0%	0	0.0%
Total Runoff (m^3/yr)	0	190,563	0.0%	0	0.0%
Total Outputs (m^3/yr)	302,580	302,580	0.0%	203,606	-32.7%

9. Erosion and Sediment Control During Construction

In general, the guiding principles of the ESC Plan are according to the NPCA

1. Minimizing soil erosion at the source;
2. Containing sediment on site;
3. Treating sediment-laden runoff; and
4. Being proactive, not reactive.

1.1. Minimizing soil erosion at the source

Based on the proposed developments, the site needs to fill the materials to construct storm/sanitary sewers. Since earthworks generally cause significant erosion, the main area of concern for ESC is the construction of the proposed buildings along with the new proposed servicing structures including watermain, sanitary, and storm sewers. This area will be used as a catchment infiltration basin due to its large footprint area and high permeability below the ground. All temporary grading will have slopes directed into the excavated area. This type of basin can store water as it runs off or is generated from upstream land. While this water is being held or ponded or infiltrated, either managing surface water and solids and some contaminants can be settled out of the water column. Water with less sediment in it is less erosive.

1.2. Containing sediment on site

Where sediments are not directed into the excavation area, it is a requirement to install silt fences as per NPCA or Niagara Region design charts along with pinned silt socks at the site boundary with surrounding wetlands, ponds, and woodlands.

1.3. Treating sediment-laden runoff
The proposed cut-and-fill plan is significant and requires careful management to prevent sediment-laden storm runoff from being conveyed off-site and into nearby wetlands, ponds, and streams. Based on the high infiltration rate of the site (sandy clay soil & infiltration rate = 5.9 min/cm), it is estimated that a very small part of the runoff will leave the site. Assuming that silt fences/socks are adequately installed and maintained, any temporary ponding of sediment-laden runoff will be infiltrated into the natural soils and runoff outflow from ditches will be captured by a series of straw bale check dams to slow sediment-laden water and allow sediment to settle before flowing downstream.

1.4. Being proactive, not reactive (Best Management Engineering Practice)
The project proposes cut & fill operations. Topsoil stripping of the fill location must be prepared prior to cut operations. This allows the fill portion to occur as soon as feasible, with minimal stockpiling. Backfilled areas are required to be seeded as soon as possible.

This project can be separated into four (4) separate phases as follows:

Phase 1 – Site Preparations: Driveway construction and the preparation for future cut & fill operations requiring topsoil stripping. Silt fences along with silt socks are installed in this phase. All topsoil shall be stockpiled at the south or east side of the property, behind the silt fences, to act as a loose permeable filtration mound. To reduce tracking of sediment to municipal roads, temporary tracking pads like mud mats are required at the site entrances. Local on-site CB/MH also needs to have filter fabric/sediment catchers that remove sediment.

Phase 2 – Cut & Fill Operations: Once site preparation is completed, the actual cut & fill operation within each phase of construction can begin. At the edges of the excavation void/cut area, all surface grading must slope into the excavation void, such that all stormwater and drainage are captured by the excavation itself. Stripped topsoil needs to be transported and stockpiled at the south/east property area, while excess soils can be locally used as backfill or as a base layer for driveway construction. Emergency spill kits are required to be available at the site at all times.

Phase 3 –Main construction: The proposed buildings will be constructed in this phase. All buried cables, pipelines, or other utilities such as manholes, catchbasins, watermain, sanitary, and storm sewers will be installed and buried in this phase, along with other site services, such as propane tanks. All excavated soils must be fully backfilled, graded, covered with topsoil, and reseeded as soon as possible.

Phase 4 – Final Grading & Auxiliary Structures: After the overall backfill is completed, the physical construction may be completed, as well as keeping a small amount of soil for final grading. Auxiliary structures will be constructed at this stage; paving parking lots, sidewalks, interior roads and roadways, planting, and landscaping. Previously stockpiled topsoil would be mechanically processed and then used to cover all exposed soils.

10. Reliance & Signature

This report is the intellectual property of King EPCM, and has been prepared for the sole use of 1000046816 Ontario Limited (the Client). King EPCM accepts no liability for claims arising from the use of this report, or from actions taken or decisions made as a result of this report, by parties other than the Client. The Client may submit this report to the City of Port Colborne, Niagara Peninsula Conservation Authority (NPCA), and Regional Municipality of Niagara (Niagara Region) in regards to the Client's urban development project at Mapleview Port Colborne, Part of Lots 31, 32 & 33, Concession 1, East of Quarry Ponds, Township of Humberstone, Killaly Street West, Port Colborne, ON.

Respectfully,

A. Samadi

Amir Samadi, PhD, EIT
Senior Engineer – Water Resources
King EPCM

Supervised and reviewed by:

Yu Tao (Tony) Wang, P. Eng
Principal Engineer
King EPCM

LICENSED PROFESSIONAL ENGINEER
Y. T. WANG
100228476
02/20/2024
PROVINCE OF ONTARIO

11. References

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APPENDIX I – SITE SURVEY PLAN

GENERAL NOTES:

1. THIS IS A COMBINED LEGAL SURVEY AND SITE TOPOGRAPHIC SURVEY:
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   - SPOT ELEVATIONS ABUTTING PROPERTY BOUNDARY AND ROADS ARE BASED ON "BARICH GRENKIE SURVEYING LTD." ON DEC. 20, 2022
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2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

■	DENOTES	SURVEY MONUMENT FOUND
☐	DENOTES	SURVEY MONUMENT PLANTED
IB	DENOTES	IRON BAR
SIB	DENOTES	STANDARD IRON BAR
SSIB	DENOTES	SHORT STANDARD IRON BAR
RIB	DENOTES	ROUND IRON BAR
WIT	DENOTES	WITNESS
OU	DENOTES	ORIGIN UNKNOWN
P1	DENOTES	PLAN 59R-8019
P2	DENOTES	PLAN 59R-14852
P3	DENOTES	PLAN 59R-16319
P4	DENOTES	PLAN 59R-10319
P5	DENOTES	PLAN 59R-8960
P6	DENOTES	PLAN 59R-11025
P7	DENOTES	PLAN RD-213
P8	DENOTES	PLAN 59R-16944
P9	DENOTES	PLAN 59R-14799
P10	DENOTES	PLAN 59M-282
P11	DENOTES	PLAN 59R-4880
759	DENOTES	C. J. CLARKE, O.L.S.
799	DENOTES	R. H. FUNK, O.L.S.
895	DENOTES	D. A. LANE, O.L.S.
1337	DENOTES	D. G. MARR, O.L.S.
1654	DENOTES	D. G. CHAMBERS, O.L.S.
MTO	DENOTES	MINISTRY OF TRANSPORTATION - ONTARIO
JEL	DENOTES	LANTHIER & GILMORE SURVEYING LTD.
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CLF	DENOTES	CHAIN LINK FENCE
BF	DENOTES	BOARD FENCE
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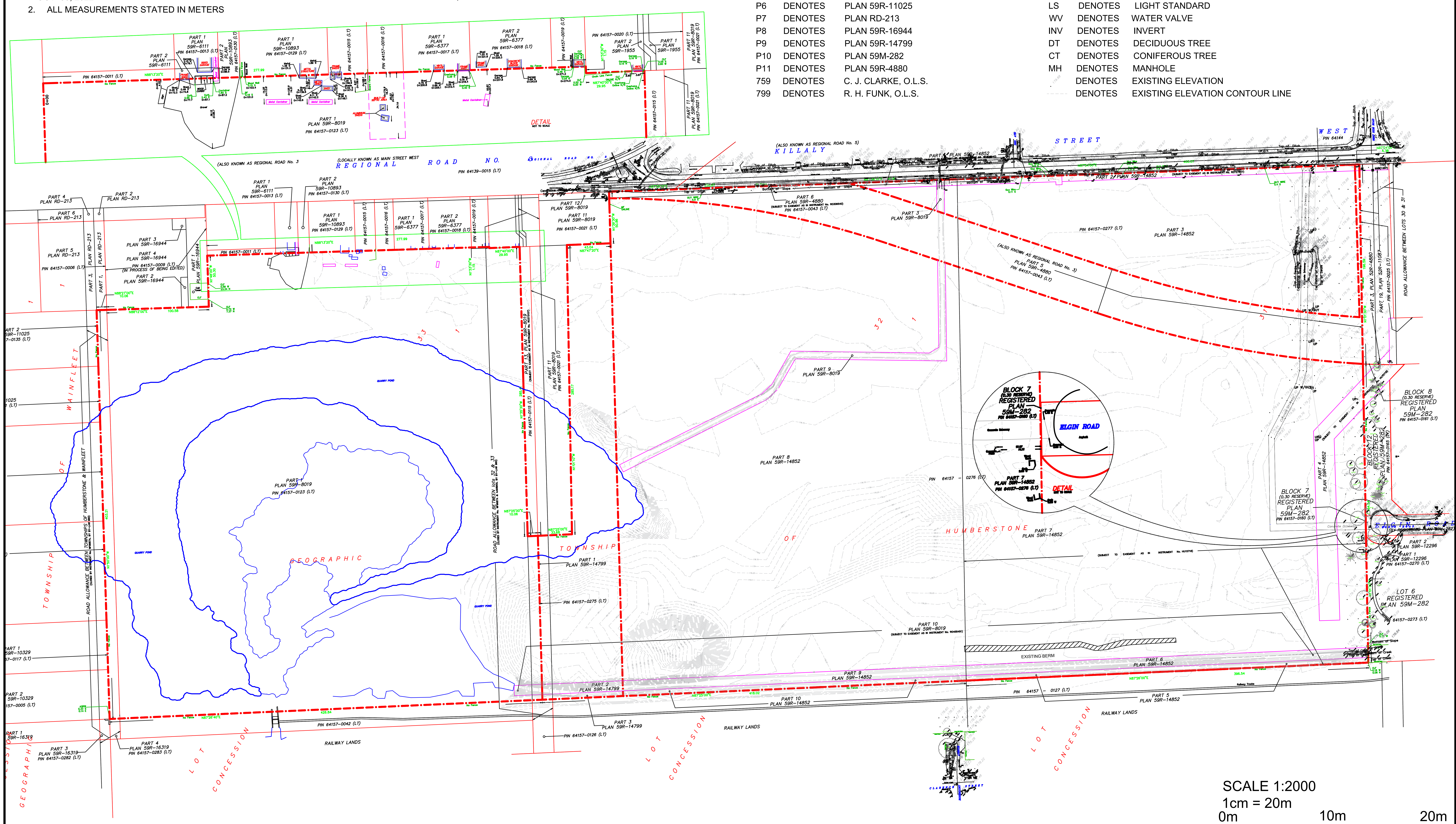
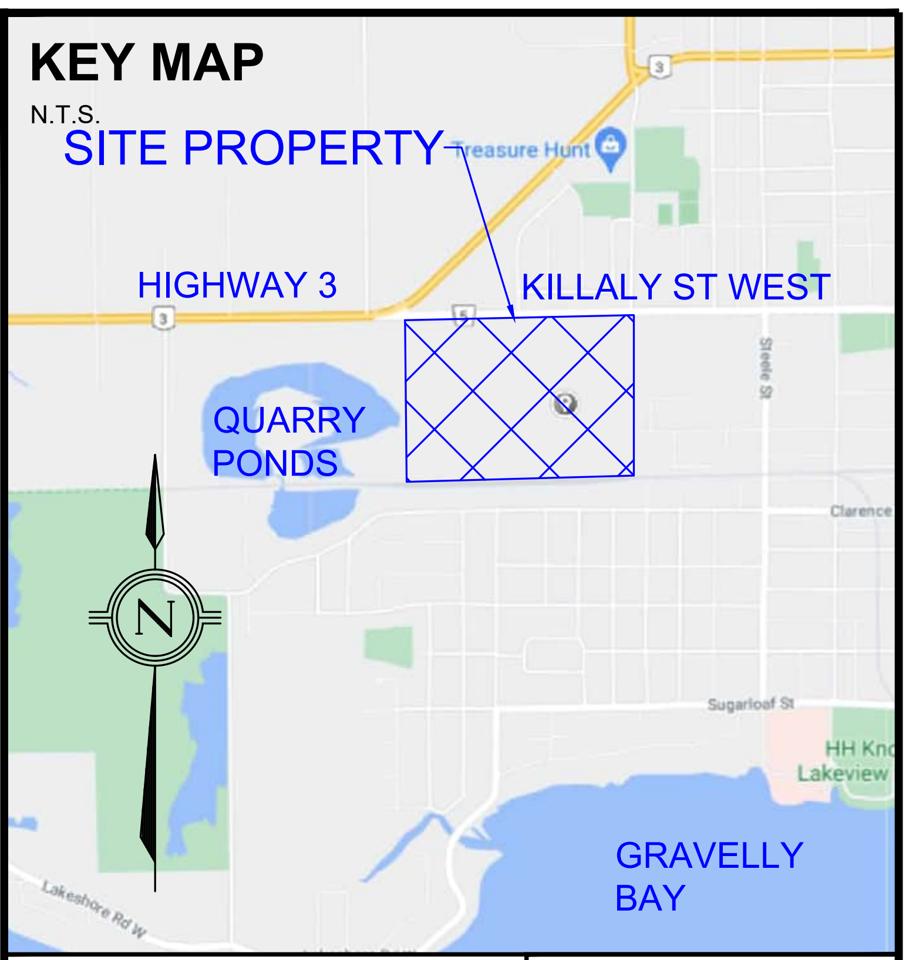
WV	DENOTES	WATER VALVE
INV	DENOTES	INVERT
DT	DENOTES	DECIDUOUS TREE
CT	DENOTES	CONIFEROUS TREE
MH	DENOTES	MANHOLE
	DENOTES	EXISTING ELEVATION
	DENOTES	EXISTING ELEVATION CONTOUR LINE



SCALE 1:2000
1cm = 20m
0m 10m 20m

KEY MAP

N.T.S.



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DATE
JAN. 11, 2023

KING EPCM

King EPCM
570 Hood Rd, Unit 26
Markham, ON, L3R 4G7
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT
1000046816 Ontario Limited

PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
PARTS OF LOT 31 & 32, CONCESSION 1, TOWNSHIP OF HUMBERSTONE, CITY OF PORT COLBORNE, KILLALY STREET WEST

PRINT TITLE
LEGAL SURVEY & TOPOGRAPHIC SURVEY DATA

FILE No.
ENG-1.1

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V1	INTERNAL REVIEW	JAN. 11, 2023	ZW	

GENERAL NOTES:

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2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

■	DENOTES	SURVEY MONUMENT FOUND
□	DENOTES	SURVEY MONUMENT PLANTED
IB	DENOTES	IRON BAR
SIB	DENOTES	STANDARD IRON BAR
SSIB	DENOTES	SHORT STANDARD IRON BAR
RIB	DENOTES	ROUND IRON BAR
WIT	DENOTES	WITNESS
OU	DENOTES	ORIGIN UNKNOWN
P1	DENOTES	PLAN 59R-8019
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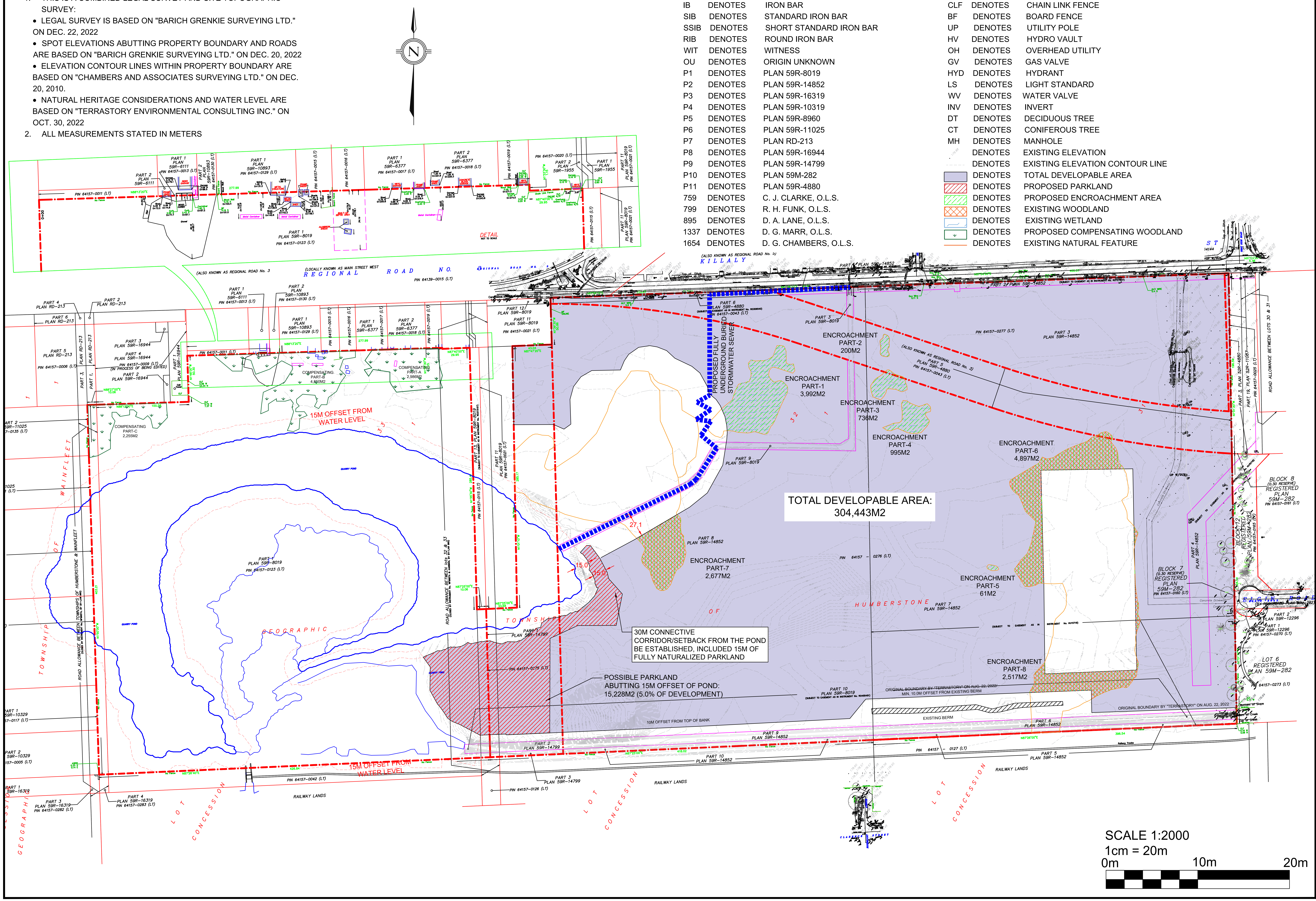
INV	DENOTES	INVERT
DT	DENOTES	DECIDUOUS TREE
CT	DENOTES	CONIFEROUS TREE
MH	DENOTES	MANHOLE
179.88	DENOTES	EXISTING ELEVATION
- - - -	DENOTES	EXISTING ELEVATION CONTOUR LINE
■	DENOTES	TOTAL DEVELOPABLE AREA
▨	DENOTES	PROPOSED PARKLAND
▨	DENOTES	PROPOSED ENCROACHMENT AREA
▩	DENOTES	EXISTING WOODLAND
□	DENOTES	EXISTING WETLAND
□	DENOTES	PROPOSED COMPENSATING WOODLAND
—	DENOTES	EXISTING NATURAL FEATURE



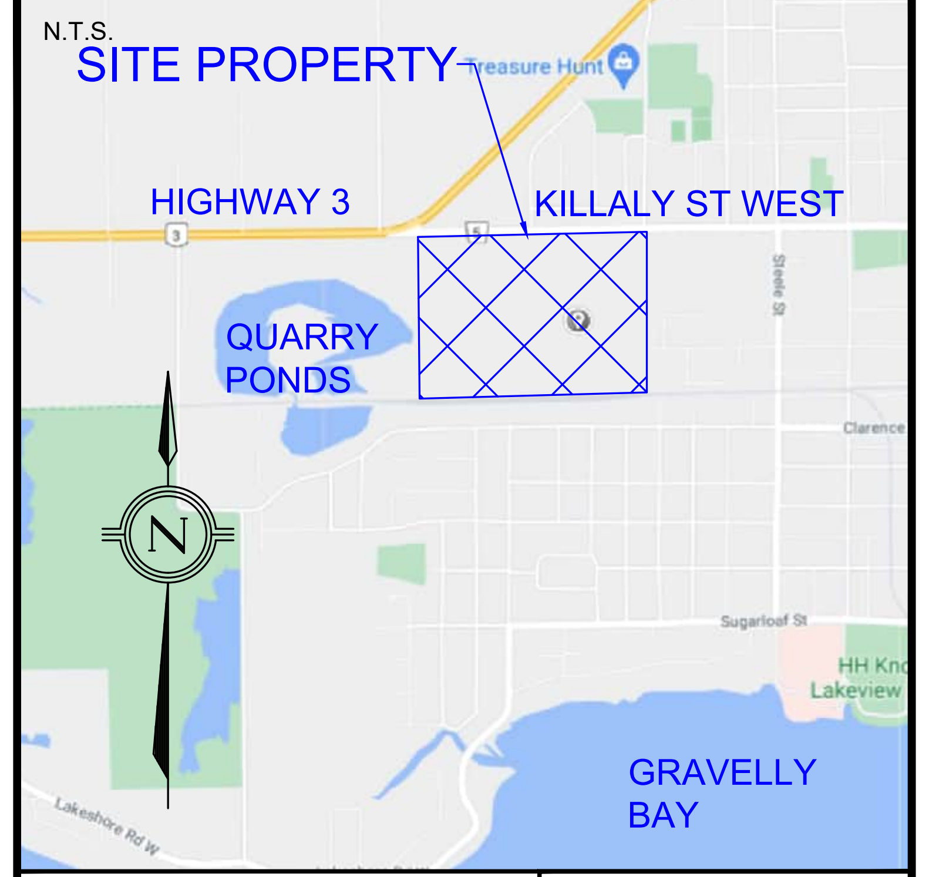
TOTAL DEVELOPABLE AREA: 304,443M2

30M CONNECTIVE CORRIDOR/SETBACK FROM THE POND BE ESTABLISHED, INCLUDED 15M OF FULLY NATURALIZED PARKLAND

POSSIBLE PARKLAND ABUTTING 15M OFFSET OF POND: 15,228M2 (5.0% OF DEVELOPMENT)

SCALE 1:2000
1cm = 20m
0m 10m 20m

KEY MAP



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King EPCM
570 Hood Rd, Unit 26
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PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
**PARTS OF LOT 31 & 32,
CONCESSION 1,
TOWNSHIP OF HUMBERSTONE,
CITY OF PORT COLBORNE,
KILLALY STREET WEST**

PRINT TITLE
DEVELOPABLE AREA (15M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
ENG-1.2

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V1	INTERNAL REVIEW	JAN. 11, 2023	ZW	

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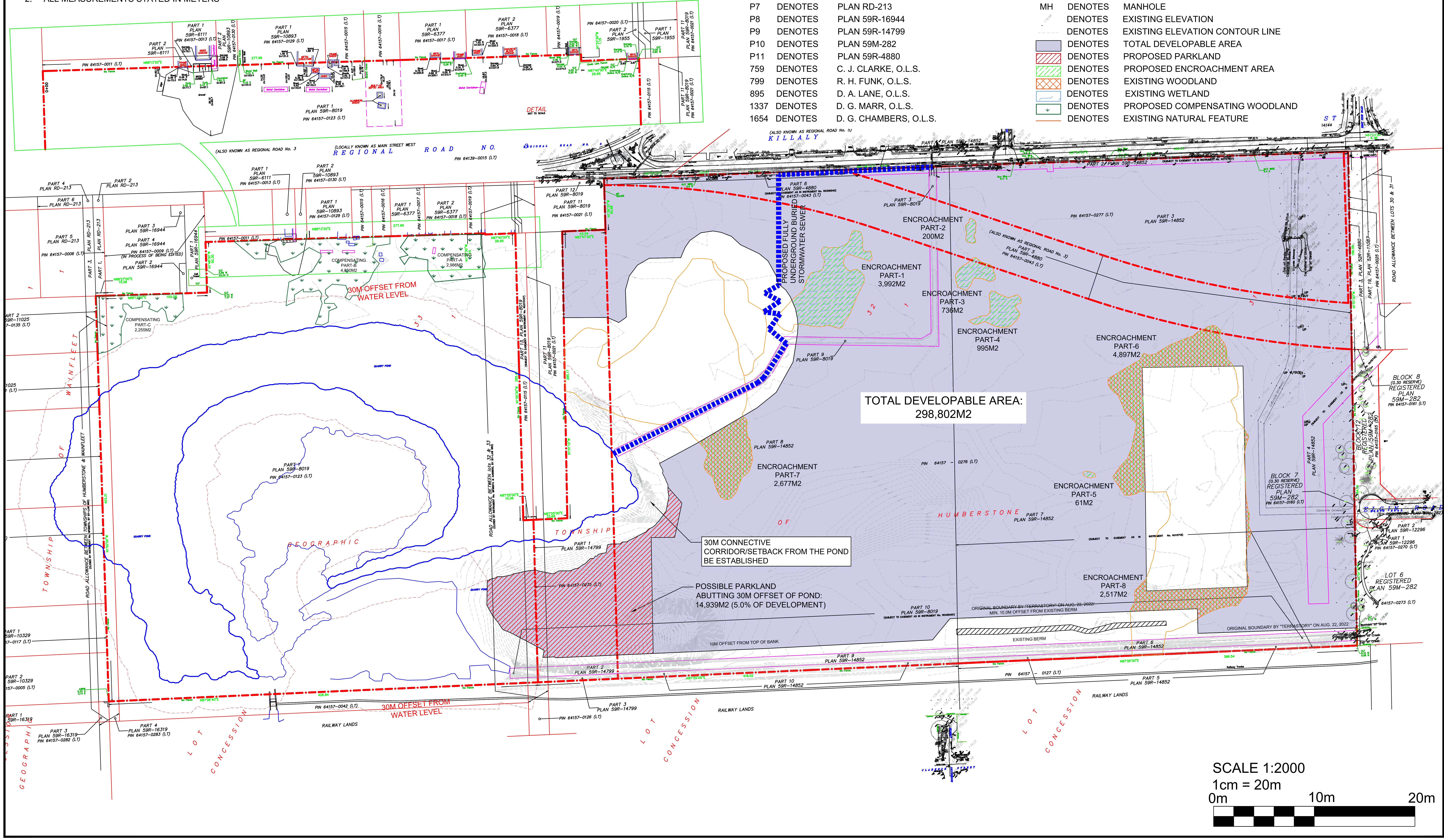
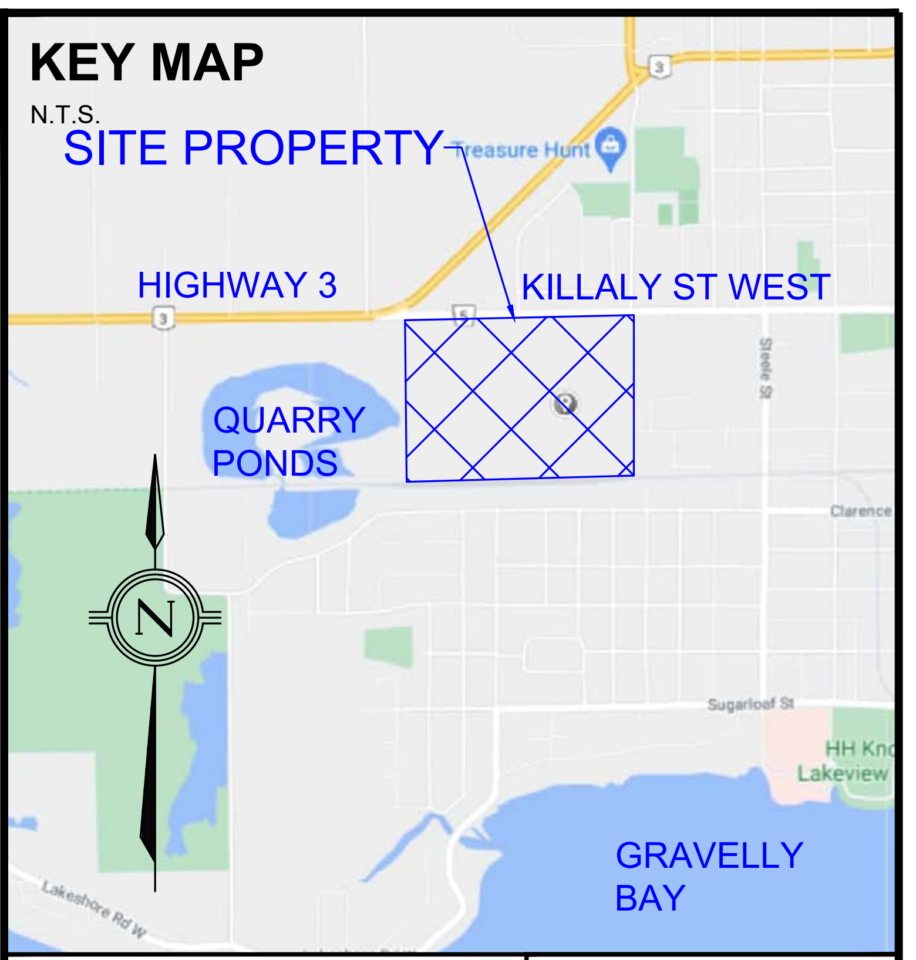


KEY MAP



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KILLALY STREET WEST

PRINT TITLE
DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
ENG-1.2

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
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PLAN OF SURVEY OF

PART OF LOTS 31, 32 & 33 CONCESSION 1 & PART OF ROAD ALLOWANCE BETWEEN TOWNSHIPS OF WAINFLEET & HUMBERSTONE

(CLOSED BY INSTRUMENT WF9687A, BY-LAW 960)

PART OF ROAD ALLOWANCE BETWEEN LOTS 32 & 33

(CLOSED BY INSTRUMENTS WF9687A & AA68900, BY-LAW 960)
IN

CITY OF PORT COLBORNE

REGIONAL MUNICIPALITY OF NIAGARA

SCALE & NOTES
Scale 1:1000
20 0 20 40 60 METRES

BARICH GRENKIE SURVEYING LTD.
A DIVISION OF GEOMAPLE

METRIC

DISTANCES AND CO-ORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

BEARING NOTE

BEARINGS ARE UTM GRID, DERIVED FROM GPS OBSERVED REFERENCE POINTS 1 AND 2, BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17 (81° 00' WEST LONGITUDE) NAD83 (CSRS) (2010.0).

BEARING COMPARISONS SHOWN ARE WITH ASTRONOMIC BEARINGS ON UNDERLYING PLANS

FOR BEARING COMPARISONS, A ROTATION OF 1°10'00" COUNTER-CLOCKWISE WAS APPLIED TO BEARINGS ON P1,P4,P5,P6,P7,P10,P11,P12

HORIZONTAL DATUM NOTE

PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
(UTM, ZONE 17, CM 81°00'W)

DATUM: NAD83 (CSRS)(2010.0)

GRID SCALE CONVERSION

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID DISTANCES BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999817.

OBSERVED REFERENCE POINTS (ORPs) DERIVED FROM GPS OBSERVATIONS USING REAL TIME NETWORK (RTN) OBSERVATIONS UTM ZONE 17, NAD83 (CSRS)(2010.0).
COORDINATES TO URBAN ACCURACY PER SEC 14(2) OF O.REG. 216/10

OBSERVED REFERENCE POINTS		
MONUMENT ID	NORTHING	EASTING
Ⓐ IB	4750197.175	640837.352
Ⓑ IB	4750211.780	641241.762

COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THIS PLAN.

LEGEND

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759	DENOTES	C. J. CLARKE, O.L.S.
799	DENOTES	R. H. FUNK, O.L.S.
895	DENOTES	D. A. LANE, O.L.S.
1337	DENOTES	D. G. MARR, O.L.S.
1654	DENOTES	D. G. CHAMBERS, O.L.S.
MTO	DENOTES	MINISTRY OF TRANSPORTATION – ONTARIO
JEL	DENOTES	LANTHIER & GILMORE SURVEYING LTD.
MF	DENOTES	METAL FENCE
CLF	DENOTES	CHAIN LINK FENCE
BF	DENOTES	BOARD FENCE
ASRW	DENOTES	ARMOUR STONE RETAINING WALL
HV	DENOTES	HYDRO VAULT
OH	DENOTES	OVERHEAD UTILITY
GV	DENOTES	GAS VALVE
UP	DENOTES	UTILITY POLE

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
V-29341
THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR
In accordance with Regulation 1026, Section 29(3)

SURVEYOR'S CERTIFICATE

I CERTIFY THAT
1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.

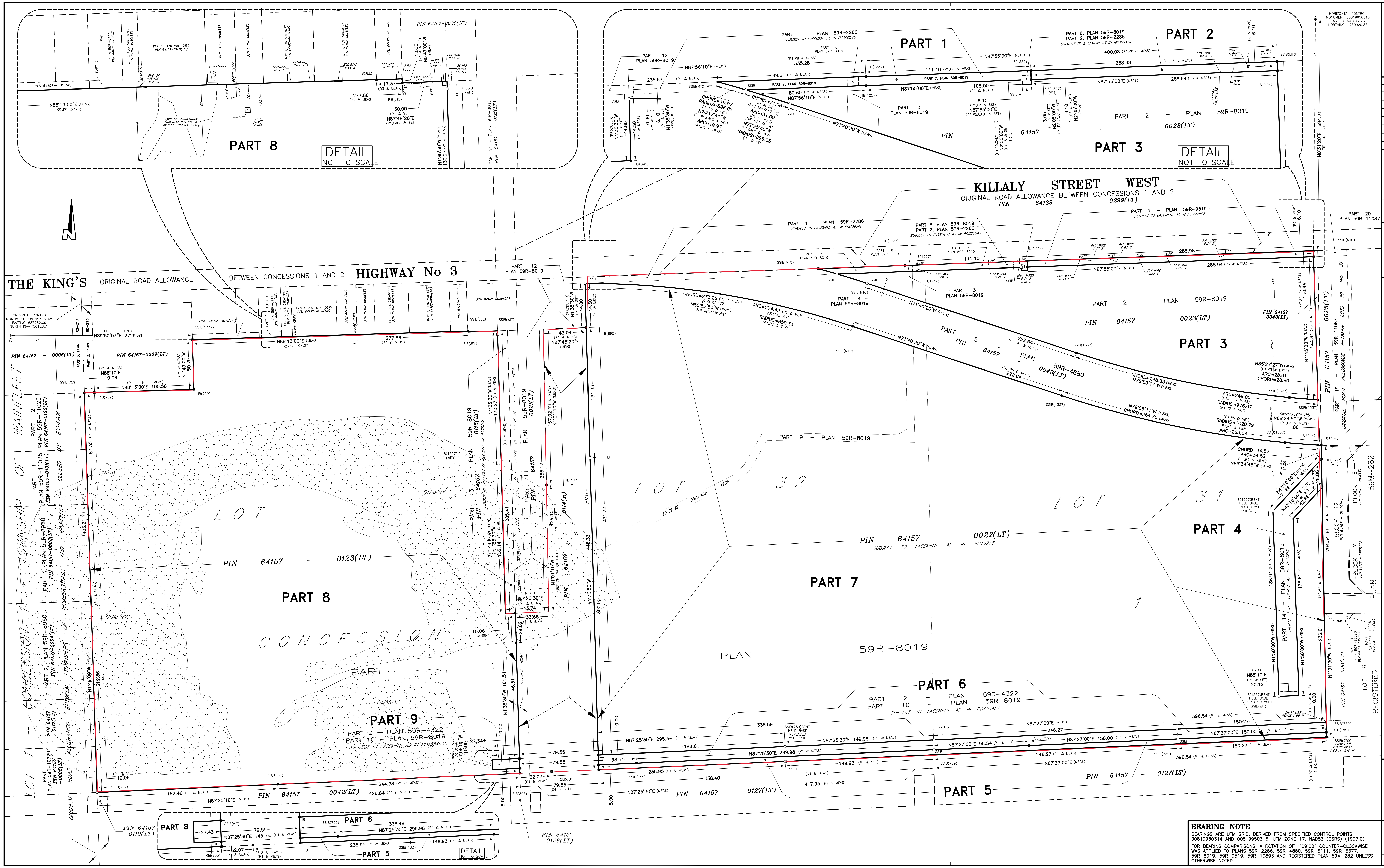
2. THE SURVEY WAS COMPLETED ON DECEMBER 20, 2022.

DECEMBER 22, 2022

ERIC G. SALZER
O.L.S., O.L.I.P.

Barich Grenkie Surveying Ltd.
301 HWY No. 8 (2ND FLOOR) - STONEY CREEK, ON
L8G 1E5 (905) 662-6767
A DIVISION OF GEOMAPLE

DWN BY: EWA
CHK BY: EGS
JOB No. 22-3058



BEARING NOTE

BEARINGS ARE UTM GRID, DERIVED FROM SPECIFIED CONTROL POINTS 00819950314 AND 00819950316, UTM ZONE 17, NAD83 (CSRS) (1997.0)

FOR BEARING COMPARISONS, A ROTATION OF 1°09'00" COUNTER-CLOCKWISE WAS APPLIED TO PLANS 59R-2286, 59R-4880, 59R-6111, 59R-6377, 59R-8019, 59R-9519, 59R-10893 AND REGISTERED PLAN 59M-282 UNLESS OTHERWISE NOTED.

I REQUIRE THIS PLAN TO BE DEPOSITED UNDER THE LAND TITLES ACT.

DATE ____________________

____
DONALD G. CHAMBERS, B. Sc., O.L.S.

PLAN 59R-________

RECEIVED AND DEPOSITED

DATE ____________________

____
ASSISTANT DEPUTY LAND REGISTRAR FOR THE LAND TITLES DIVISION OF NIAGARA SOUTH(59)

SCHEDULE

PART	LOT	CONCESSION	PIN
1	PART OF LOTS 31 AND 32	CONCESSION 1	64157-0023(LT)
2	PART OF LOT 31		
3	PART OF LOTS 31 AND 32		
4	PART OF LOT 31		64157-0022(LT)
5	PART OF LOTS 31 AND 32		
6			
7			
8	PART OF LOT 33, PART OF THE ROAD ALLOWANCE BETWEEN LOTS 32 AND 33 (CLOSED BY BY-LAW No 205, INST. No RO64733) AND PART OF THE ROAD ALLOWANCE BETWEEN TOWNSHIPS OF WAINFLEET AND HUMBERSTONE CLOSED BY BY-LAW 546(1915) FOR THE TOWNSHIP OF HUMBERSTONE (UNREGISTERED)		64157-0123(LT)
9	PART OF LOT 33 AND PART OF THE ROAD ALLOWANCE BETWEEN LOTS 32 AND 33 (CLOSED BY BY-LAW No 205, INST. No RO64733)	CONCESSION 1	

PARTS 1, 2 AND 3: ALL OF PIN 64157-0023(LT)
PART 1 SUBJECT TO EASEMENT AS IN RO306540
PART 2 SUBJECT TO EASEMENT AS IN RO727807

PARTS 4, 5, 6 AND 7: ALL OF PIN 64157-0022(LT)
PARTS 4, 5, 6 AND 7 SUBJECT TO EASEMENT AS IN HU15718
PART 5 SUBJECT TO EASEMENT AS IN RO455451

PARTS 8 AND 9: ALL OF PIN 64157-0123(LT)
PART 9 SUBJECT TO EASEMENT AS IN RO455451

PLAN OF SURVEY OF

PART OF LOTS 31, 32 AND 33, CONCESSION 1
PART OF THE ROAD ALLOWANCE BETWEEN LOTS 32 AND 33, CONCESSION 1

CLOSED BY BY-LAW No 205, INSTRUMENT No RO64733

GEOGRAPHIC TOWNSHIP OF HUMBERSTONE

AND PART OF THE ROAD ALLOWANCE BETWEEN TOWNSHIPS OF WAINFLEET AND HUMBERSTONE

CLOSED BY BY-LAW 546(1915) FOR THE TOWNSHIP OF HUMBERSTONE (UNREGISTERED)

IN THE

CITY OF PORT COLBORNE

REGIONAL MUNICIPALITY OF NIAGARA

SCALE 1 : 1500

METRIC NOTE

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

DISTANCE NOTE

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.99982.

SPECIFIED CONTROL POINTS (SCPs): UTM ZONE 17, NAD 83 (CSRS) (1997.0).
CO-ORDINATES TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10

POINT ID	NORTHING	EASTING
SCP 00819950314	4750128.71	637782.09
SCP 00819950316	4750920.37	641647.76

CO-ORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THIS PLAN.

LEGEND

■	DENOTES	SURVEY MONUMENT FOUND
□	"	SURVEY MONUMENT SET
SIB	"	STANDARD IRON BAR
SSIB	"	SHORT STANDARD IRON BAR
IB	"	IRON BAR
CC	"	CUT CROSS
RIB	"	ROUND IRON BAR
IP	"	IRON PIPE
MEAS	"	MEASURED
WIT	"	WITNESS
OU	"	ORIGIN UNKNOWN
N/S/E/W	"	NORTH/SOUTH/EAST/WEST
HP	"	HYDRO POLE
PIN	"	PROPERTY IDENTIFICATION NUMBER
P1	"	DEPOSITED PLAN 59R-8019
P2	"	DEPOSITED PLAN 59R-6111
P3	"	DEPOSITED PLAN 59R-10893
P4	"	DEPOSITED PLAN 59R-6377
P5	"	DEPOSITED PLAN 59R-4880
P6	"	DEPOSITED PLAN 59R-9519
P7	"	REGISTERED PLAN 59M-282
P8	"	DEPOSITED PLAN 59R-2286
D1	"	INSTRUMENT No RO247122 – PIN 64157-0015(LT)
D2	"	INSTRUMENT No RO473497 – PIN 64157-0016(LT)
D3	"	INSTRUMENT No RO756862 – PIN 64157-0019(LT)
D4	"	INSTRUMENT No BB51278 – PIN 64157-0114(R)
759	"	C. J. CLARKE, O.L.S.
895	"	D. A. LANE, O.L.S.
1257	"	R. LAROCQUE, O.L.S.
1337/MARR	"	D. G. MARR, O.L.S.
1654	"	D. G. CHAMBERS, O.L.S.
JEL	"	J. E. LANTHIER, O.L.S.

BARS FOUND BEAR THE NUMBER 1654 UNLESS OTHERWISE NOTED.

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:

1) THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM;
2) THE SURVEY WAS COMPLETED ON THE 17th DAY OF JANUARY, 2011.

____________ ____________________
DATE DONALD G. CHAMBERS, B. Sc., O.L.S.

CHAMBERS AND ASSOCIATES SURVEYING LTD

12 THOROLD ROAD EAST
WELLAND ONTARIO
L3C 3T2

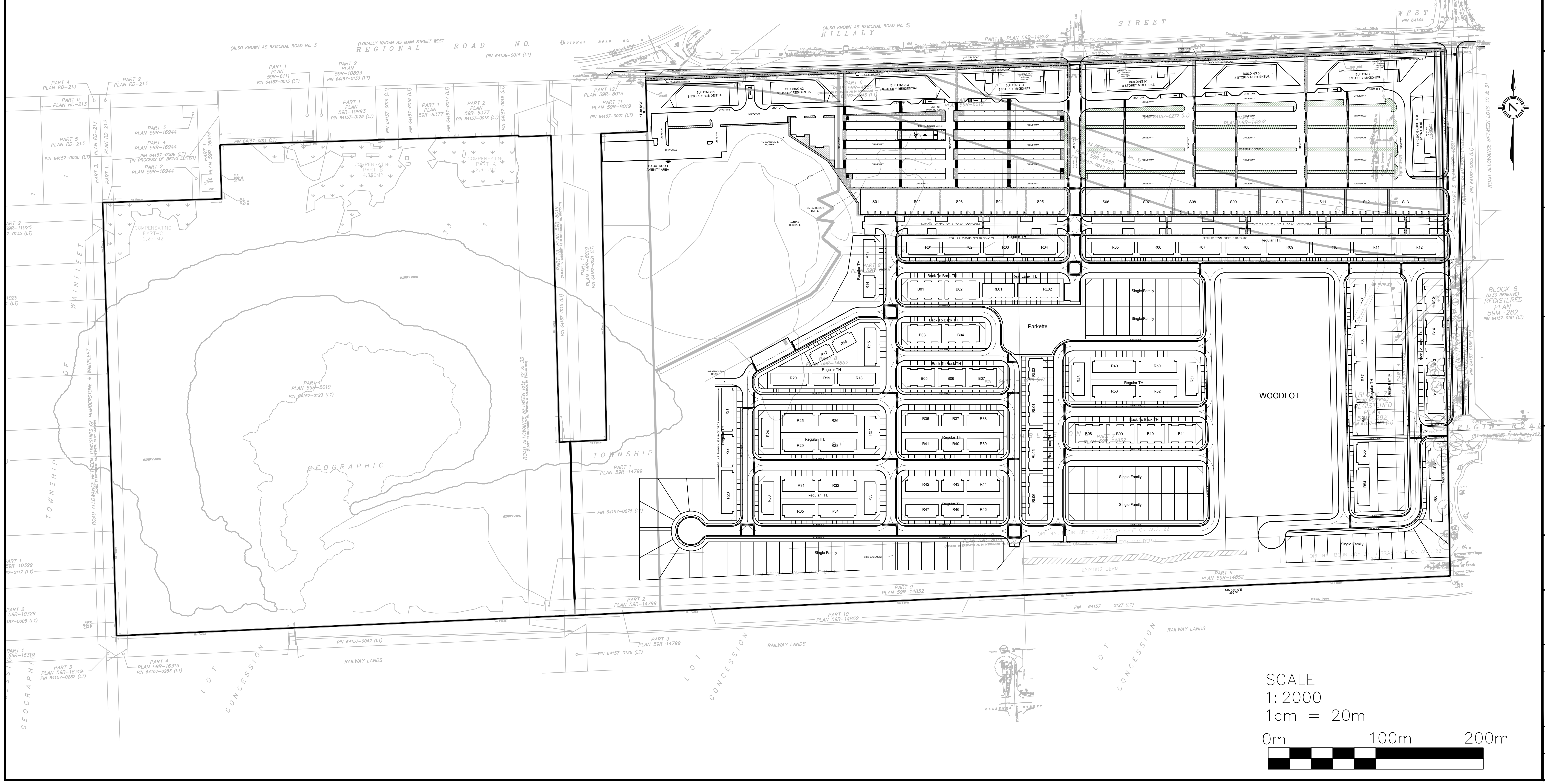
(905) 735-7841 / 735-7844
FAX (905) 735-7333
don@casl-surveying.com

DRAWN BY:	DISK:	DWG:	FILE No:
D. H. T.	CIVIL 2010	06084-1_LT	06-84-1

APPENDIX II – SITE GRADING & SWM PLAN

GENERAL NOTES:

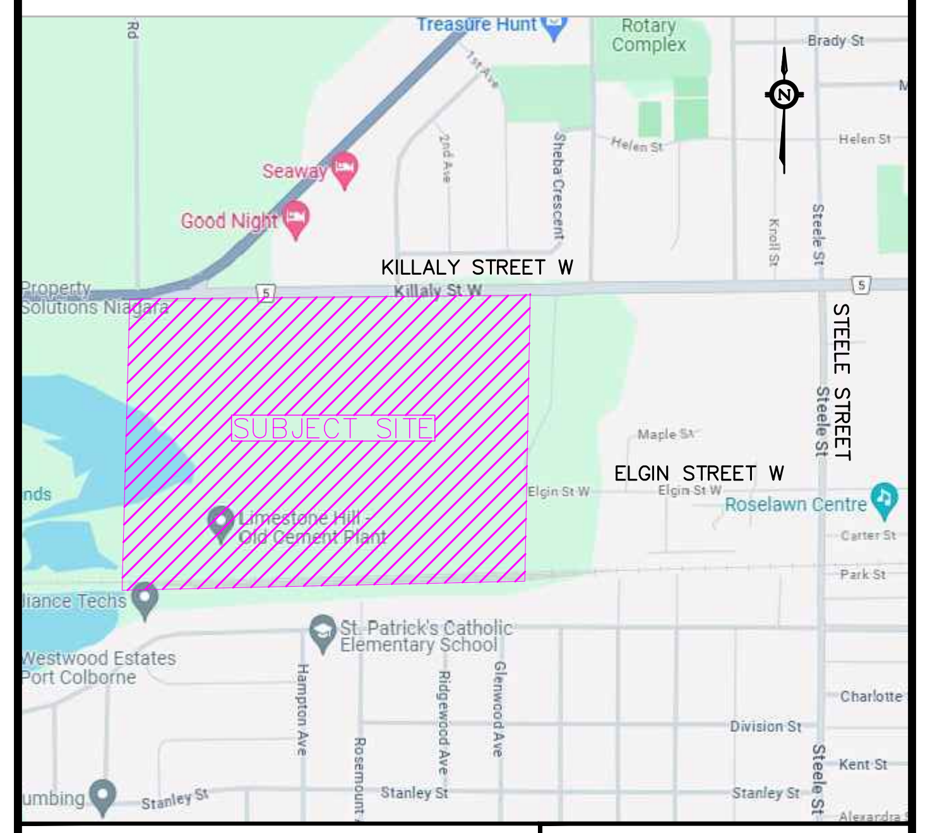
1. THIS IS A COMBINED LEGAL SURVEY AND **SITE** TOPOGRAPHIC SURVEY:
   - LEGAL SURVEY IS BASED ON "BARICH GRENKIE SURVEYING LTD." ON DEC. 22, 2022
   - SPOT ELEVATIONS ABUTTING PROPERTY BOUNDARY AND ROADS ARE **BASED ON** "BARICH GRENKIE SURVEYING LTD." ON DEC. 20, 2022
   - ELEVATION CONTOUR LINES WITHIN PROPERTY BOUNDARY ARE BASED ON "CHAMBERS AND ASSOCIATES SURVEYING LTD." ON DEC. 20, 2010.
   - NATURAL HERITAGE CONSIDERATIONS AND WATER LEVEL ARE BASED ON "TERRASTORY ENVIRONMENTAL CONSULTING INC." ON OCT. 30, 2022
2. ALL MEASUREMENTS STATED IN METERS



SCALE
1: 2000
1cm = 20m
0m 100m 200m

KEY MAP

N.T.S.



DRAWN

K.L.

STAMP

DATE

FEB. 17, 2024

KING EPCM

King EPCM
3780 14thAve., Unit 221
Markham ON L3R 9Y5
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT

1000046816 Ontario Limited

PROJECT NAME

MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION

**PARTS OF LOT 31 & 32,
CONCESSION 1,
TOWNSHIP OF HUMBERSTONE,
CITY OF PORT COLBORNE,
KILLALY STREET WEST**

PRINT TITLE

DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.

SITE PLAN

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V2	ISSUED TO CLIENT	JAN 19, 2024	K.L.	
V9	FIRST SUBMISSION	FEB 17, 2024	K.L.	

GENERAL NOTES:

1. THIS IS A COMBINED LEGAL SURVEY AND SITE TOPOGRAPHIC SURVEY:
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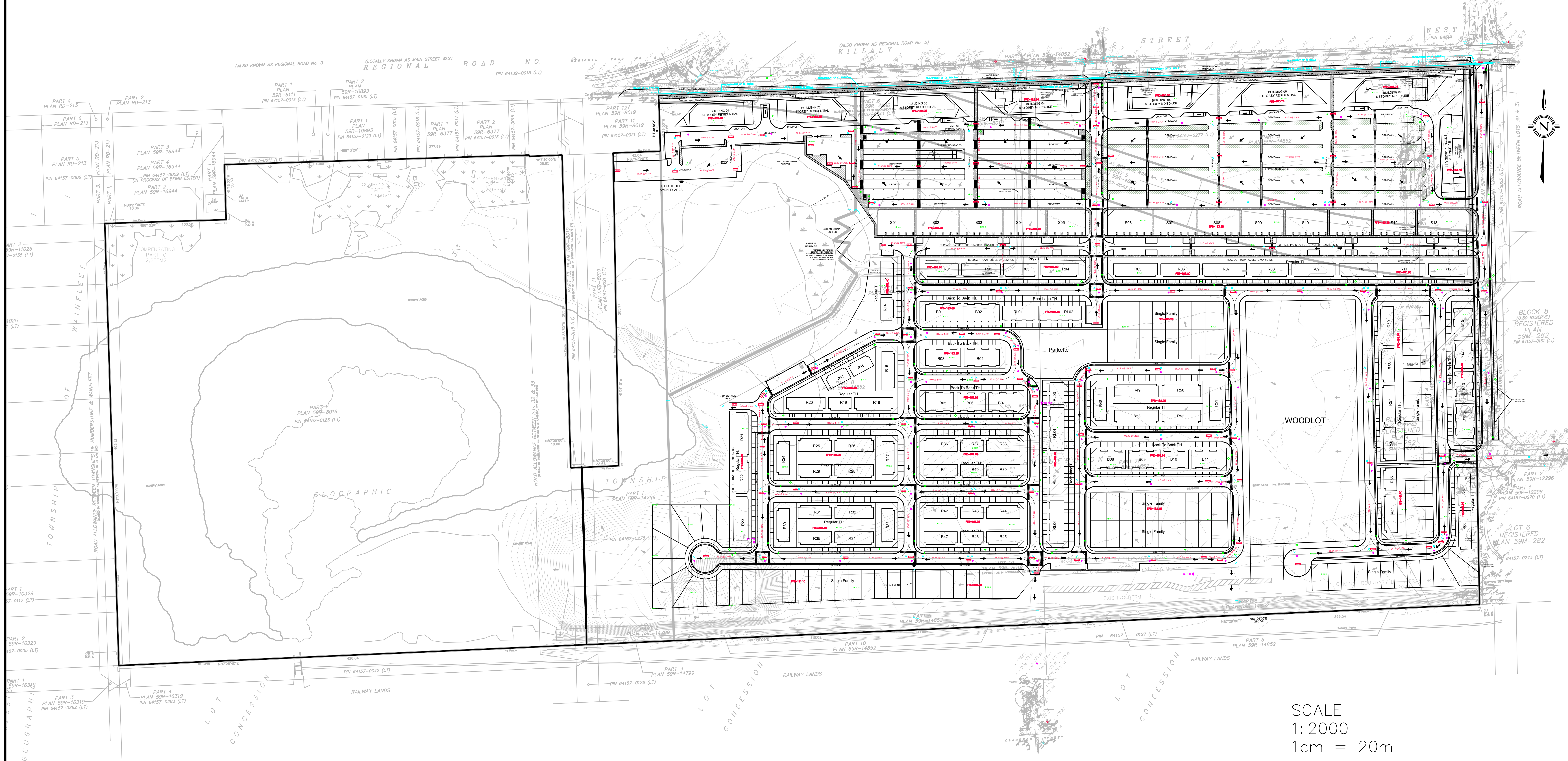
2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

×315.58	EXISTING ELEVATION
×182.70	BEDROCK ELEVATION
× 182.70	PROPOSED ELEVATION
➡	EXISTING SURFACE FLOW ROUTE
➡	PROPOSED SURFACE FLOW ROUTE
●	PROPOSED SANITARY MANHOLE
○	PROPOSED STORM MANHOLE
▨	EXISTING MANHOLE
⌖	PROPOSED HYDRANT AND VALVE
⊗	PROPOSED GATE VALVE
⌖	EXISTING HYDRANT
⊗	EXISTING GATE VALVE
● BH 101	BOREHOLE
◄	PROPOSED CENTERLINE SWALE



SCALE
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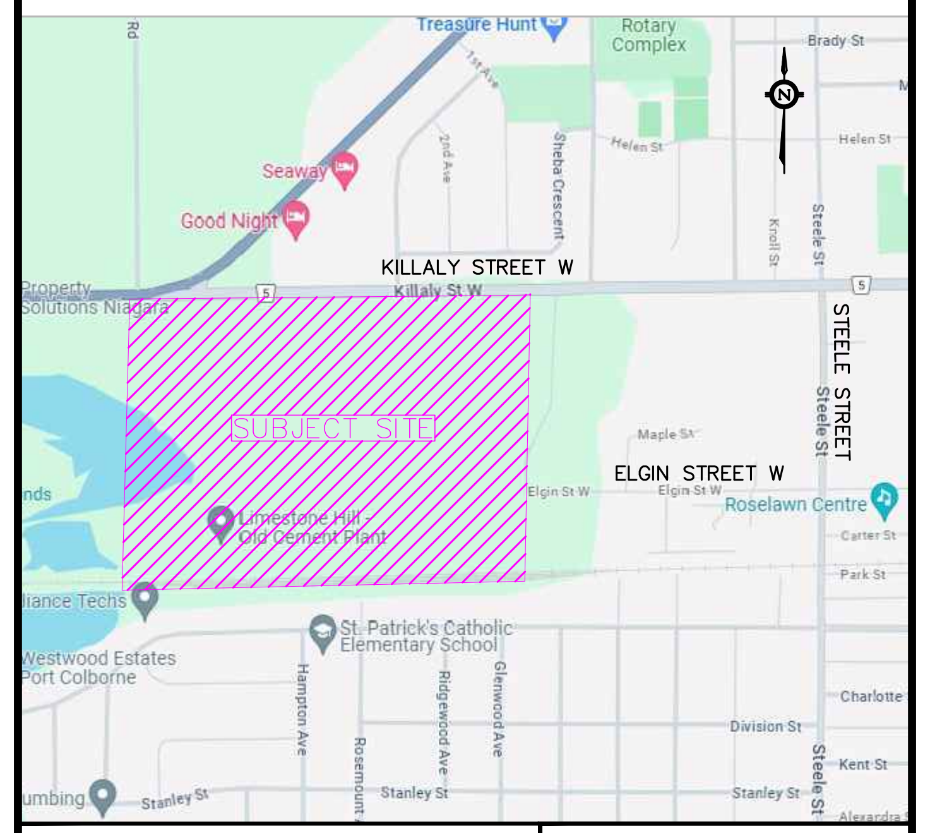
0m 100m 200m

KEY MAP

N.T.S.



DRAWN
K.L.

DATE
FEB. 17, 2024

STAMP

KING EPCM

King EPCM
3780 14thAve., Unit 221
Markham ON L3R 9Y5
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT
1000046816 Ontario Limited

PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
PARTS OF LOT 31 & 32,
CONCESSION 1,
TOWNSHIP OF HUMBERSTONE,
CITY OF PORT COLBORNE,
KILLALY STREET WEST

PRINT TITLE
DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
GRADING PLAN

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V2	ISSUED TO CLIENT	JAN 19, 2024	K.L.	
V9	FIRST SUBMISSION	FEB 17, 2024	K.L.	

GENERAL NOTES:

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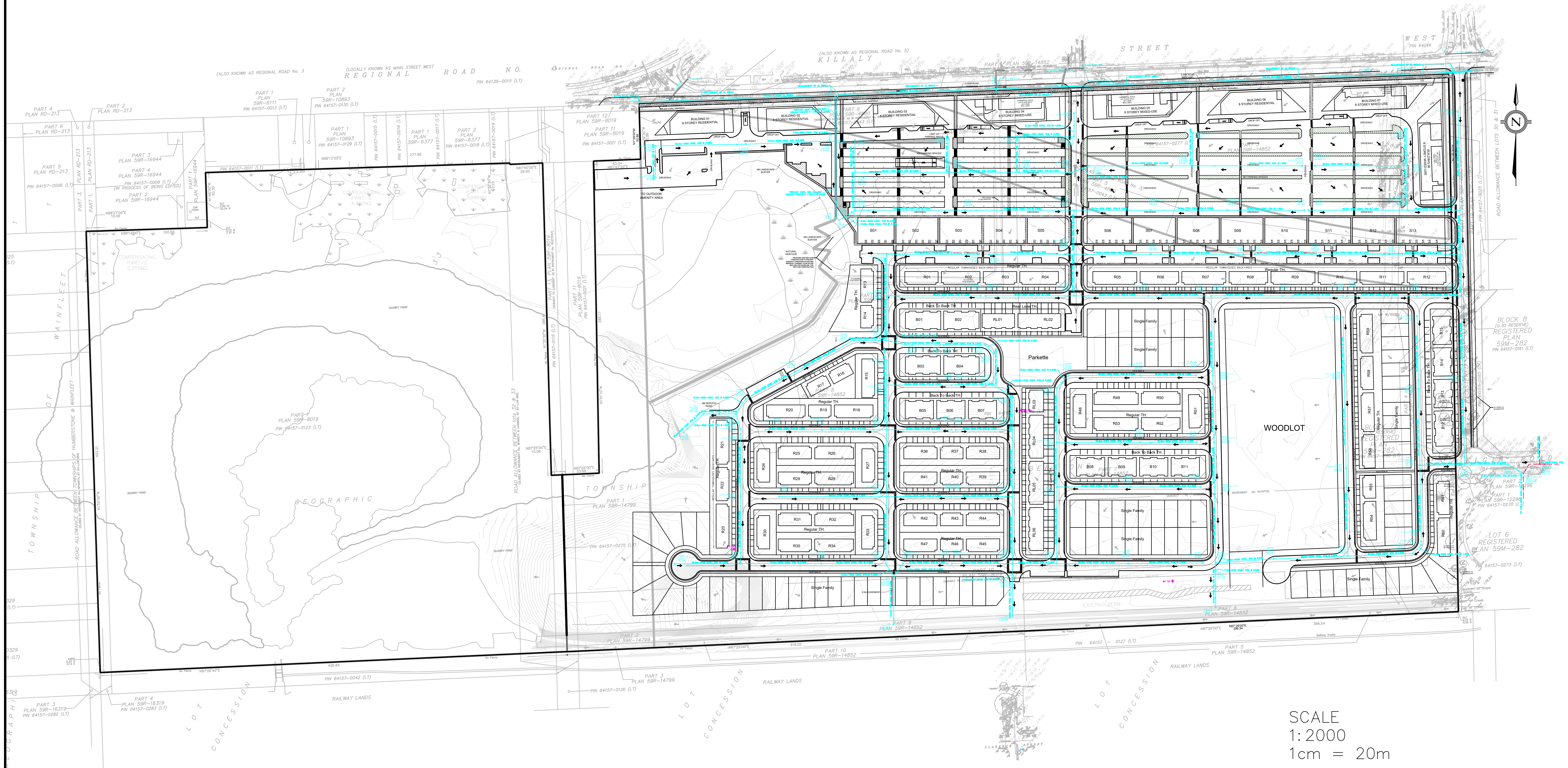
   - NATURAL HERITAGE CONSIDERATIONS AND WATER LEVEL ARE BASED ON "TERRASTORY ENVIRONMENTAL CONSULTING INC." ON OCT. 30, 2022
2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

×315.58	EXISTING ELEVATION
➔	EXISTING SURFACE FLOW ROUTE
➔	PROPOSED SURFACE FLOW ROUTE
○	PROPOSED STORM MANHOLE
▨	EXISTING STORM MANHOLE
—▶—	PROPOSED STORM SEWER
– ▶ –	FUTURE STORM SEWER
—◀—◀—	PROPOSED CENTERLINE SWALE
– ▶ –	EXISTING STORM SEWER
● BH 101	BOREHOLE



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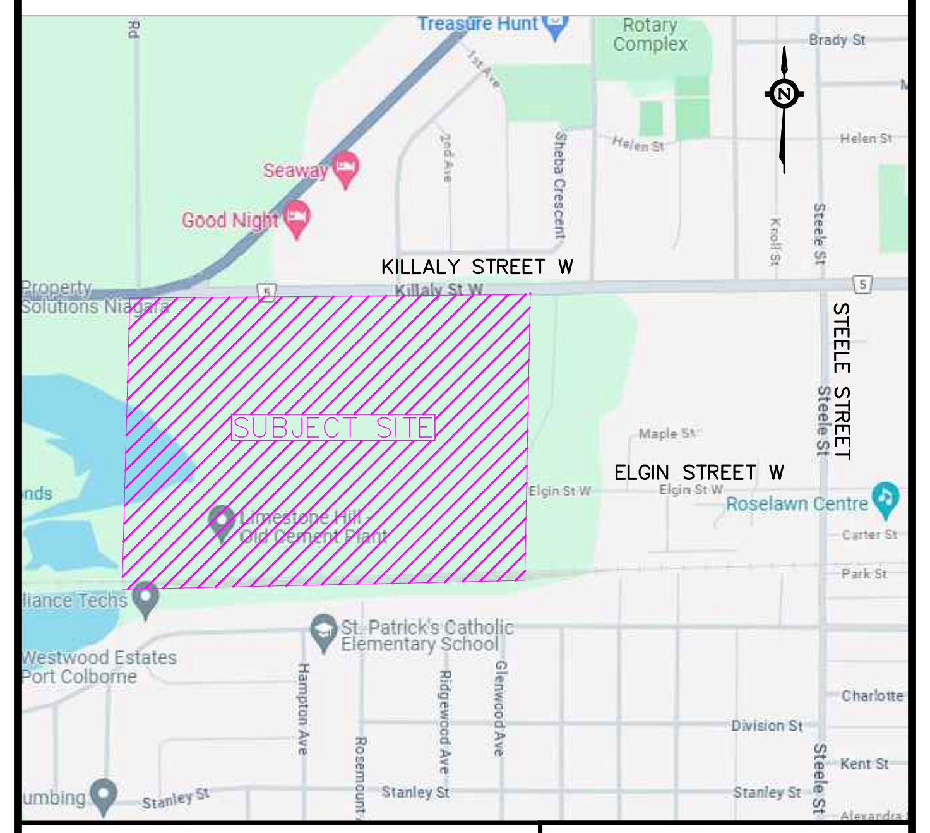
KEY MAP
N.T.S.



DRAWN
K.L.

STAMP

DATE
FEB. 17, 2024

KING EPCM

King EPCM
3780 14thAve., Unit 221
Markham ON L3R 9Y5
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT
1000046816 Ontario Limited

PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
PARTS OF LOT 31 & 32,
CONCESSION 1,
TOWNSHIP OF HUMBERSTONE,
CITY OF PORT COLBORNE,
KILLALY STREET WEST

PRINT TITLE
DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
STORM SERVICING PLAN

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V2	ISSUED TO CLIENT	JAN 19, 2024	K.L.	
V9	FIRST SUBMISSION	FEB 17, 2024	K.L.	

GENERAL NOTES:

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   - NATURAL HERITAGE CONSIDERATIONS AND WATER LEVEL ARE BASED ON "TERRASTORY ENVIRONMENTAL CONSULTING INC." ON OCT. 30, 2022
2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

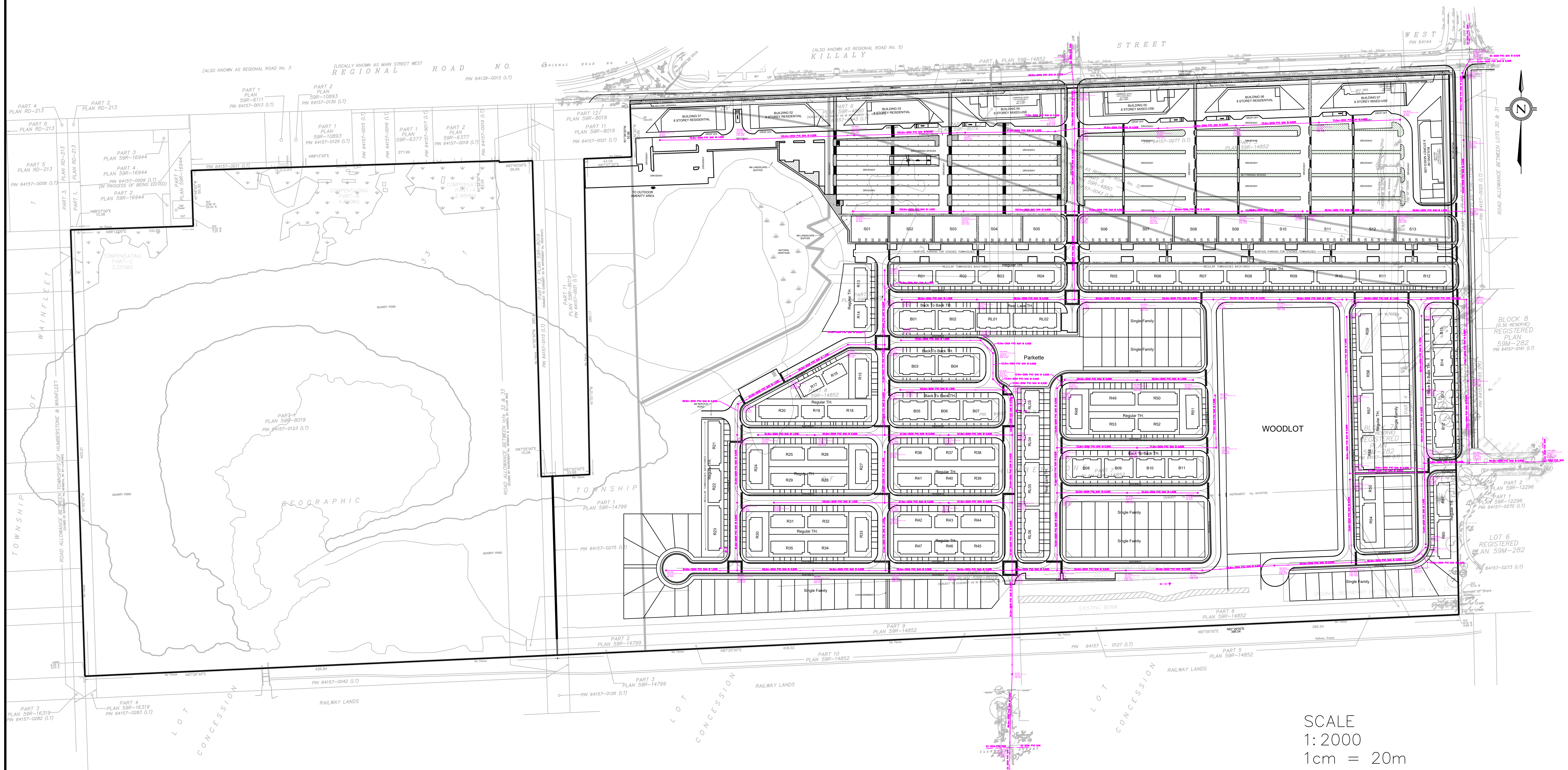
● PROPOSED SANITARY MANHOLE

▨ EXISTING SANITARY MANHOLE

▶ PROPOSED SANITARY SEWER

▶ EXISTING SANITARY SEWER

● BOREHOLE (BH 101)



SCALE
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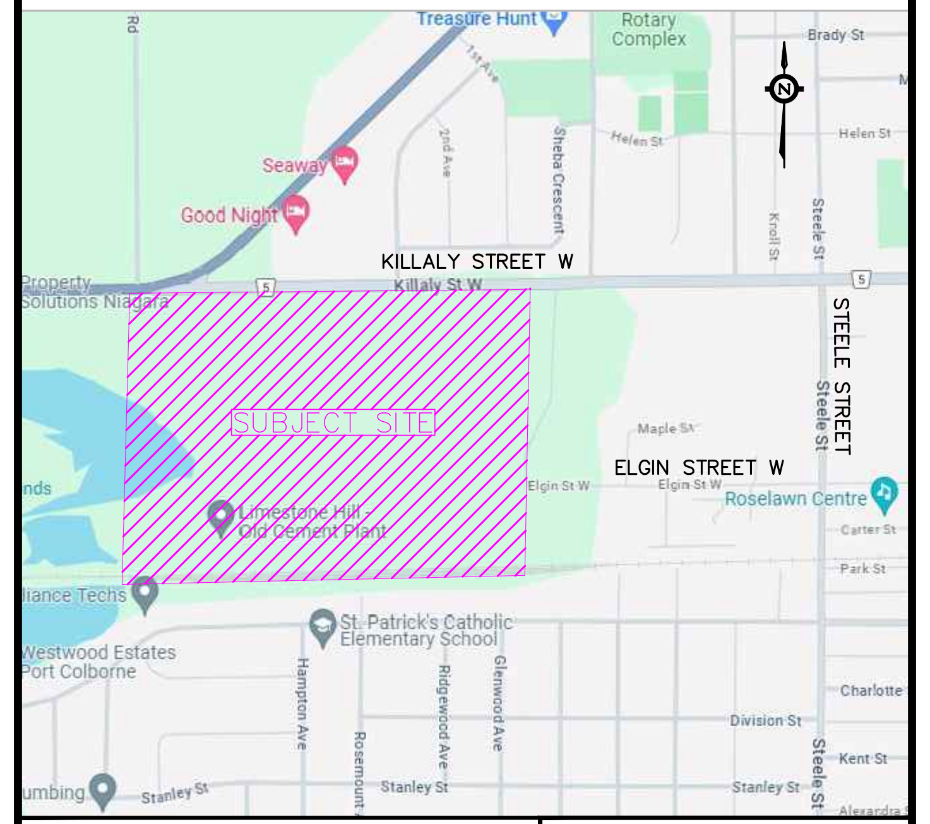
KEY MAP

N.T.S.



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K.L.

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DATE
FEB. 17, 2024

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3780 14thAve., Unit 221
Markham ON L3R 9Y5
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT
1000046816 Ontario Limited

PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
PARTS OF LOT 31 & 32, CONCESSION 1, TOWNSHIP OF HUMBERSTONE, CITY OF PORT COLBORNE, KILLALY STREET WEST

PRINT TITLE
DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
SANITARY SERVICING PLAN

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V2	ISSUED TO CLIENT	JAN 19, 2024	K.L.	
V9	FIRST SUBMISSION	FEB 17, 2024	K.L.	

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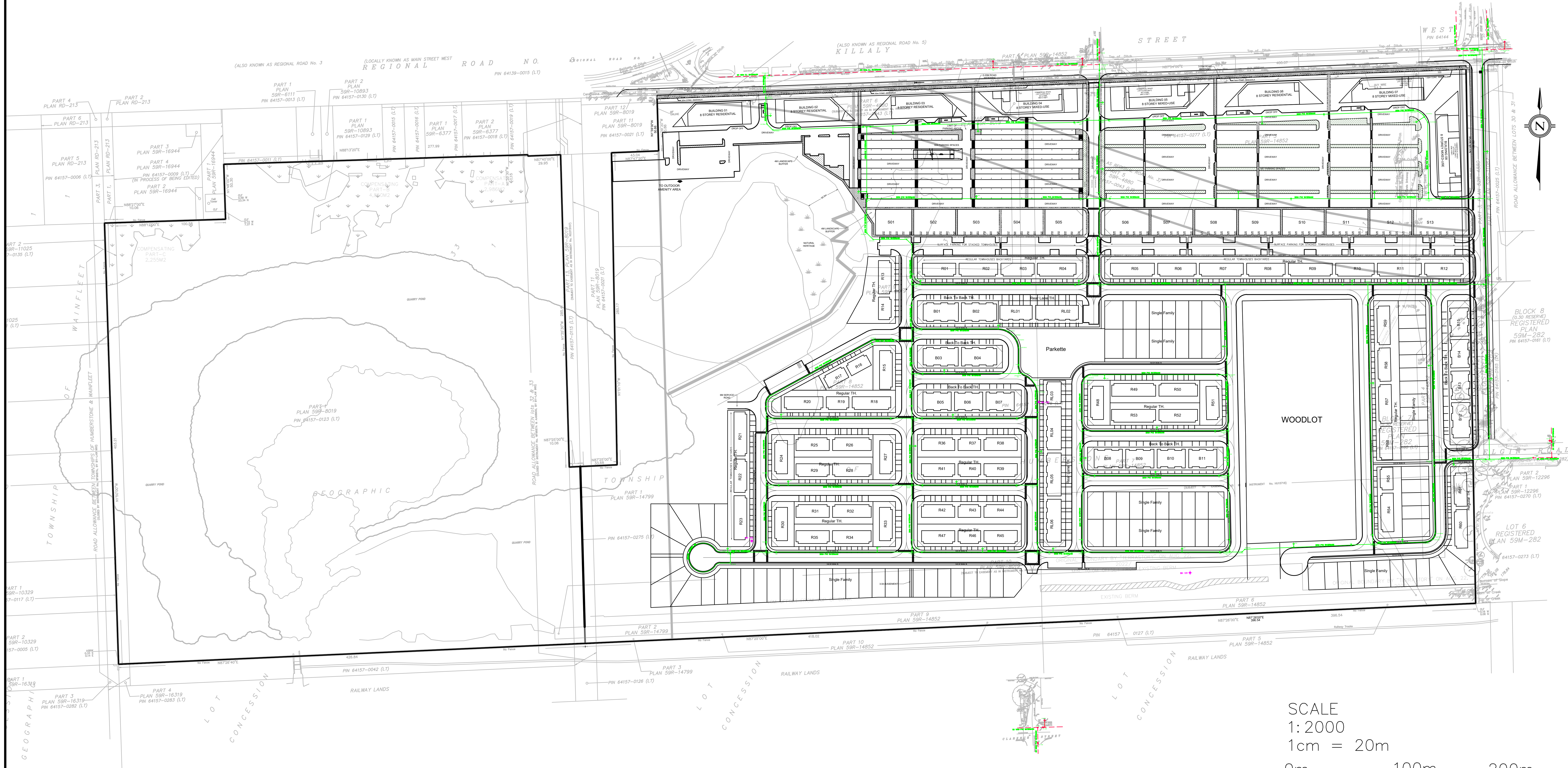
   - NATURAL HERITAGE CONSIDERATIONS AND WATER LEVEL ARE BASED ON "TERRASTORY ENVIRONMENTAL CONSULTING INC." ON OCT. 30, 2022
2. ALL MEASUREMENTS STATED IN METERS

LEGEND:

⊕	PROPOSED HYDRANT AND VALVE
⊗	PROPOSED GATE VALVE
⊕	EXISTING HYDRANT
⊗	EXISTING GATE VALVE
—	PROPOSED WATERMAIN
- - -	EXISTING WATERMAIN
● BH 101	BOREHOLE



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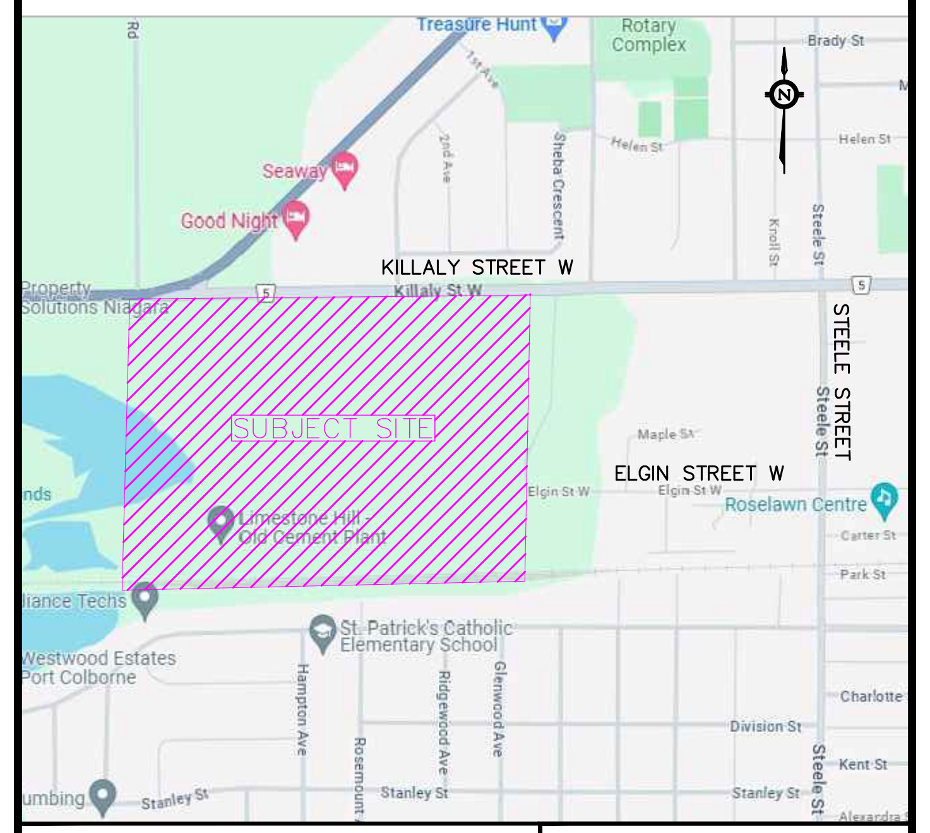
KEY MAP

N.T.S.



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K.L.

STAMP

DATE
FEB. 17, 2024

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CLIENT
1000046816 Ontario Limited

PROJECT NAME
MAPLEVIEW PORT COLBORNE HOMES DEVELOPMENT AREA

PROJECT LOCATION
PARTS OF LOT 31 & 32,
CONCESSION 1,
TOWNSHIP OF HUMBERSTONE,
CITY OF PORT COLBORNE,
KILLALY STREET WEST

PRINT TITLE
DEVELOPABLE AREA (30M OFFSET FROM WATER LEVER) & NATURAL HERITAGE CONSIDERATIONS

FILE No.
WATERMAIN PLAN

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V2	ISSUED TO CLIENT	JAN 19, 2024	K.L.	
V9	FIRST SUBMISSION	FEB 17, 2024	K.L.	

APPENDIX III – BOREHOLE DRILL LOG

KEY MAP
N.T.S.

DRAWN
CC

STAMP

DATE
MAY 16, 2022

KING EPCM

King EPCM
204-304 Toronto Street South
Uxbridge, ON, L9P 1Z7
www.KingEPCM.com
647-459-5647
General@KingEPCM.com

CLIENT
MAPLEVIEW

PROJECT NAME
GEOTECHNICAL, GROUNDWATER, AND BEDROCK REVIEW

PROJECT LOCATION
0TH KILLALY STREET WEST
PORT COLBORNE, ON

PRINT TITLE
DRAFT SITE PLAN

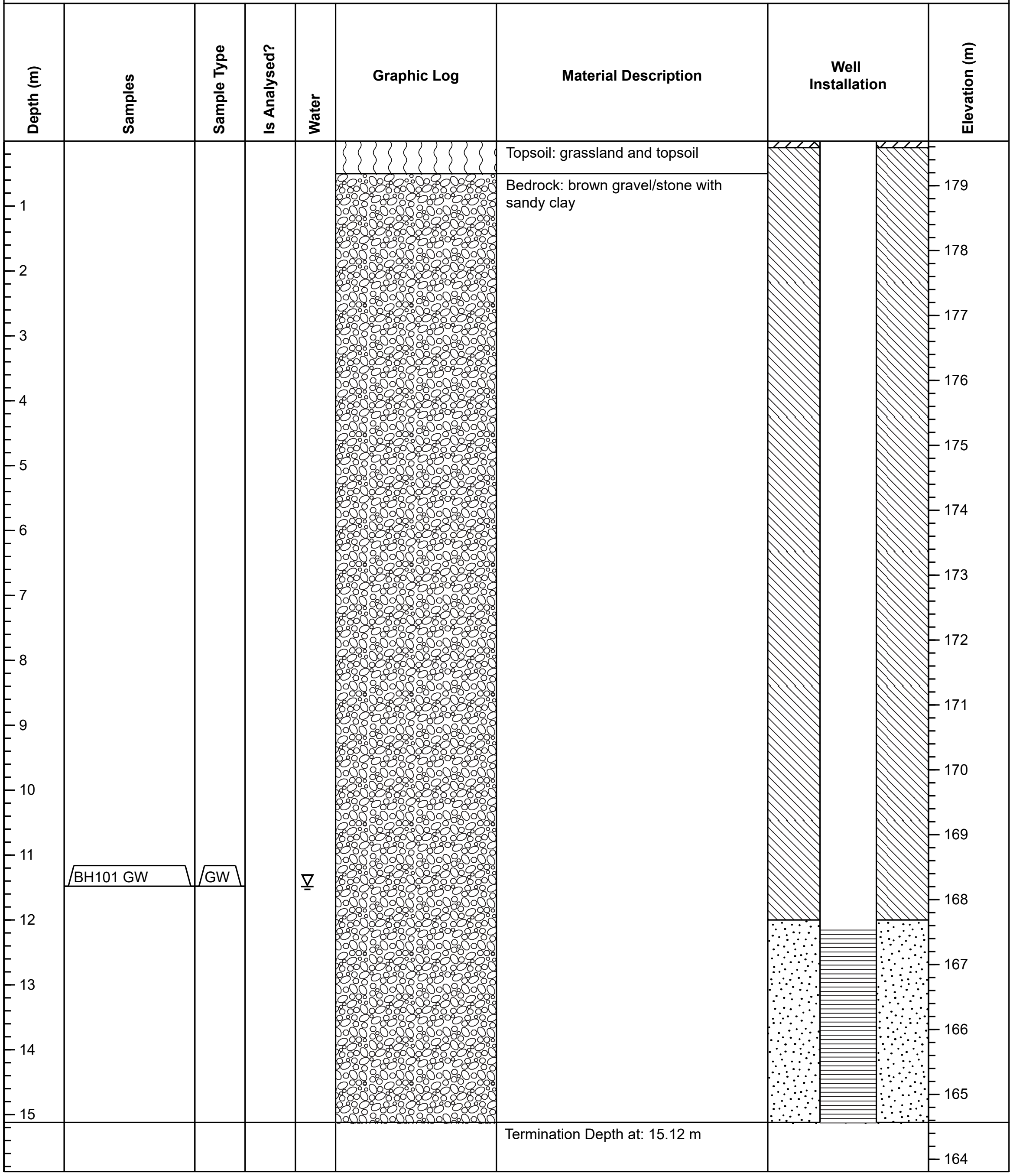
FILE No.
EGR - 2.1

No.	ISSUED FOR:	DATE	DRAW BY	CHECK
V1	INTERNAL REVIEW	MAY 16, 2022	CC	TW

BOREHOLE AND GROUNDWATER WELL LOG BH101 MW

PROJECT NUMBER	**DRILLING COMPANY** Terra Firma Environmental	**COORDINATES** N:4749890.98m E:641263.50m
PROJECT NAME Phase II ESA	**DRILLER**	**COORD SYS** UTM17
CLIENT 1000046816 Ontario Limited	**DRILL RIG** D-50 Drilling Rig	**SURFACE ELEVATION** 179.687m
ADDRESS Mapleview Port Colborne	**DRILLING METHOD** Continuous Flight Auger	**WELL TOC**
DRILLING DATE March 2, 2022	**TOTAL DEPTH** 15.12 m	**LOGGED BY** CC
LICENCE NO.	**DIAMETER** 2 Inch Well	**CHECKED BY** TW
COMPLETION	**CASING** Casing up type	**SCREEN** 3 m from the bottom of Well

COMMENTS GW sampled on March 11, 2022



Topsoil: grassland and topsoil

Bedrock: brown gravel/stone with sandy clay

Termination Depth at: 15.12 m

produced by ESlog.ESdat.net on 28 Mar 2022

KING EPCM
Flexible. Dependable. On-site Engineering.

BOREHOLE AND GROUNDWATER WELL LOG BH102 MW

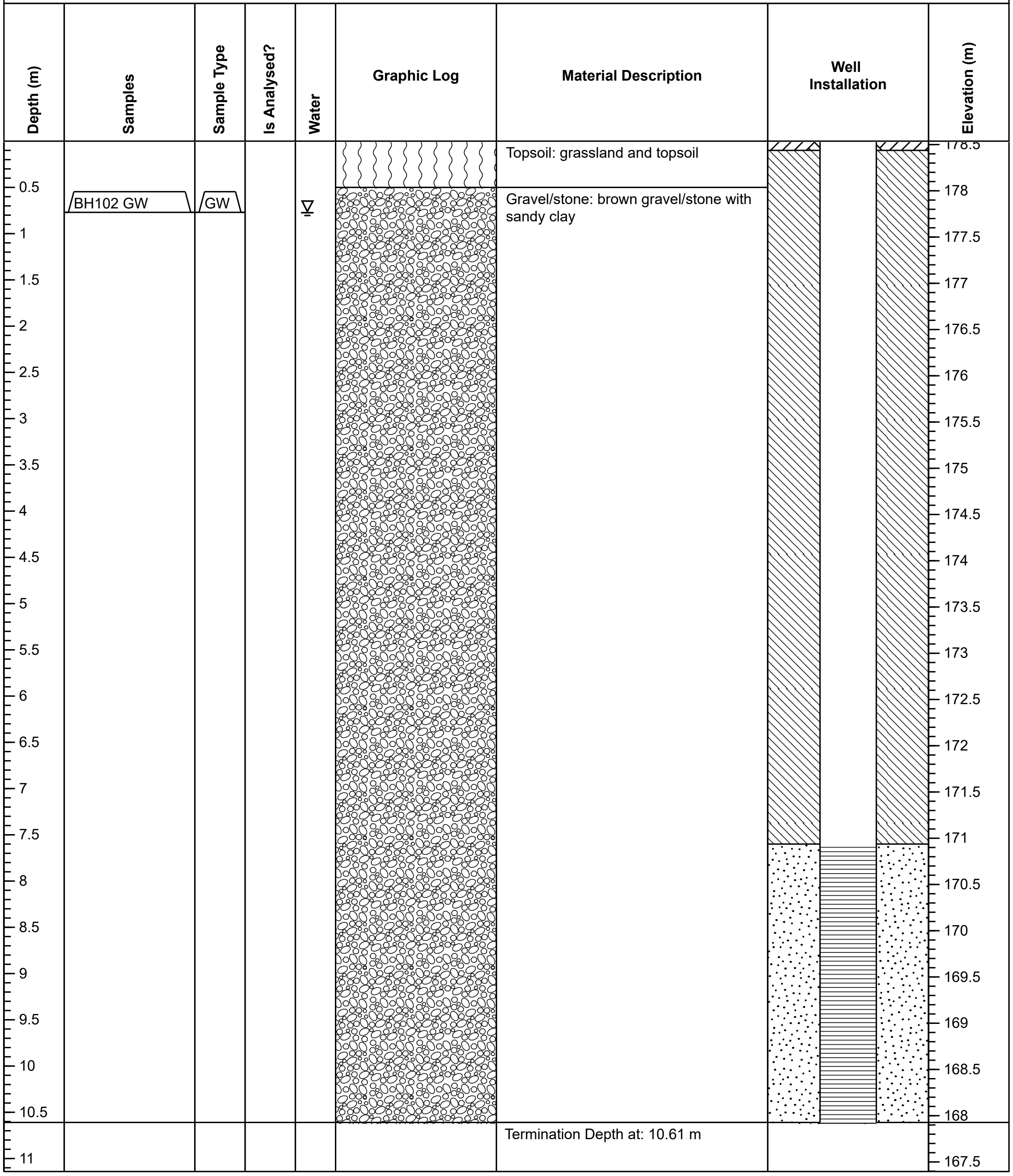
PROJECT NUMBER
PROJECT NAME Phase II ESA
CLIENT 1000046816 Ontario Limited
ADDRESS Mapleview Port Colborne
DRILLING DATE Febuary 28, 2022
LICENCE NO.

DRILLING COMPANY Terra Firma Environmental
DRILLER
DRILL RIG D-50 Drilling Rig
DRILLING METHOD Continuous Flight Auger
TOTAL DEPTH 10.61 m
DIAMETER 2 Inch Well

COORDINATES N:4749890.98m E:641263.50m
COORD SYS UTM17
SURFACE ELEVATION 178.537m
WELL TOC
LOGGED BY SX
CHECKED BY TW

COMPLETION
CASING Casing up type
SCREEN 3 m from the bottom of Well

COMMENTS GW sampled on March 11, 2022



Topsoil: grassland and topsoil

Gravel/stone: brown gravel/stone with sandy clay

Termination Depth at: 10.61 m

produced by ESlog.ESdat.net on 28 Mar 2022

BOREHOLE AND GROUNDWATER WELL LOG BH103 MW

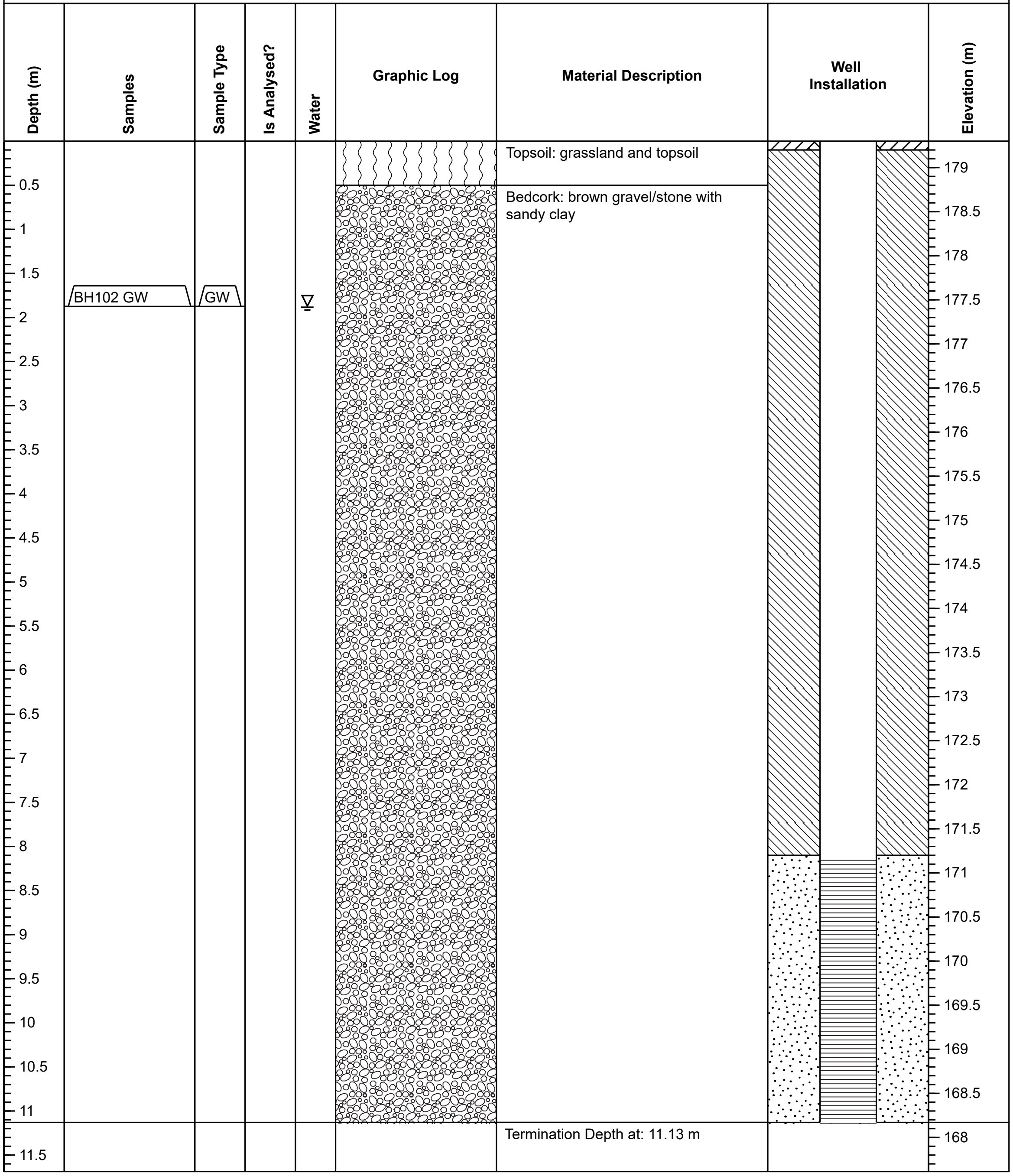
PROJECT NUMBER
PROJECT NAME Phase II ESA
CLIENT 1000046816 Ontario Limited
ADDRESS Mapleview Port Colborne
DRILLING DATE March 2, 2022
LICENCE NO.

DRILLING COMPANY Terra Firma Environmental
DRILLER
DRILL RIG D-50 Drilling Rig
DRILLING METHOD Continuous Flight Auger
TOTAL DEPTH 11.13 m
DIAMETER 2 Inch Well

COORDINATES N:4749799.28m E:641016.77m
COORD SYS UTM17
SURFACE ELEVATION 179.3m
WELL TOC
LOGGED BY CC
CHECKED BY TW

COMPLETION
CASING Casing up type
SCREEN 3 m from the bottom of Well

COMMENTS GW sampled on March 11, 2022



Topsoil: grassland and topsoil

Bedcork: brown gravel/stone with sandy clay

Termination Depth at: 11.13 m

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GROUNDWATER MONITORING Well BH201

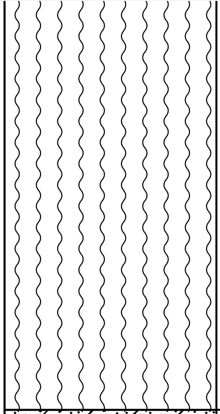
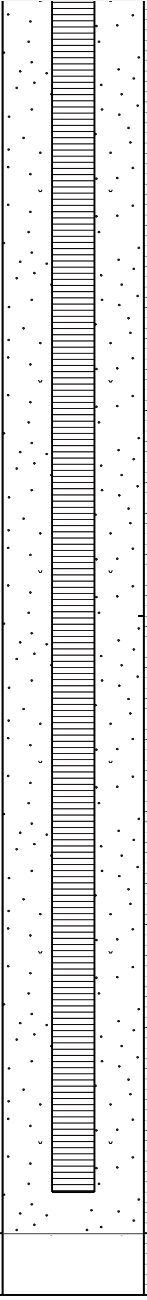
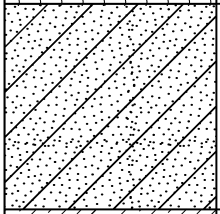
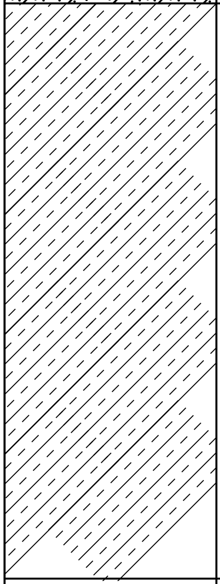
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/10/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.58
DIAMETER 1.5 inch

COORDINATES 641324.17E, 4750079.70N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS

Depth (m)	Graphic Log	USCS SAMPLES	Material Description	Additional Observations	Well Installation	Elevation (m)
0 – 0.2			Topsoil, Black wet			
0.2 – 0.3		USCS: SC	Brown, moist clay mixed with sand, very plastic			
0.3 – 0.58		USCS: OH	Dark yellow, moist clay, very plastic			
			Termination Depth at: 0.58 m hit bedrock			

Depth (m)	Elevation (m)
0.05	179.1
0.1	179.0
0.15	179
0.2	178.9
0.25	178.9
0.3	178.8
0.35	178.8
0.4	178.7
0.45	178.7
0.5	178.6
0.55	178.6
0.6	178.5

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GROUNDWATER MONITORING Well BH202

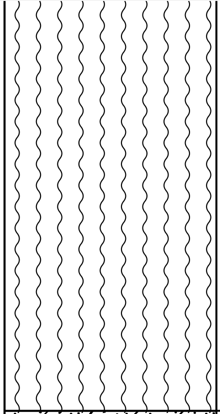
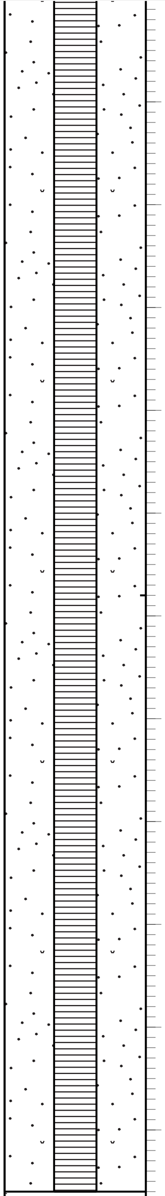
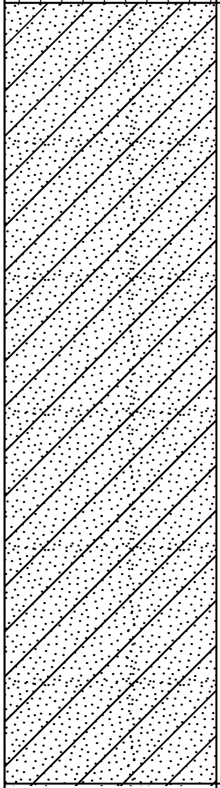
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/11/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.58 m
DIAMETER 1.5 inch

COORDINATES 641166.72E, 4750147.77N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS

Depth (m)	Graphic Log	USCS SAMPLES	Material Description	Additional Observations	Well Installation	Elevation (m)
0.05 0.1 0.15			Topsoil, Black, moist			179.0 179 178.9
0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55		USCS: SC	Brown, moist clay mixed with sand and pebbles, very plastic			178.9 178.8 178.8 178.7 178.7 178.6 178.6 178.5
0.6			Termination Depth at: 0.58 m hit bedrock			178.5

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KING EPCM

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GROUNDWATER MONITORING Well BH203

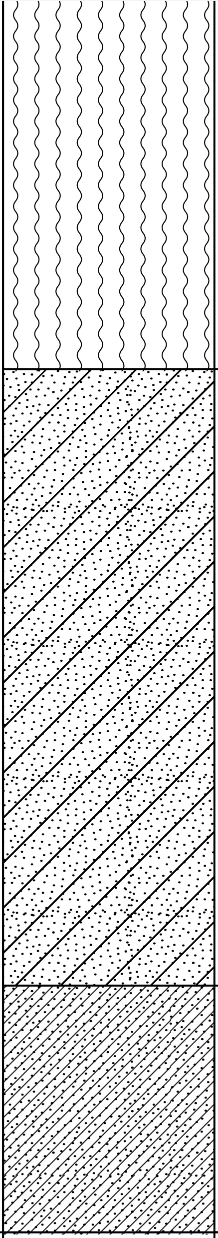
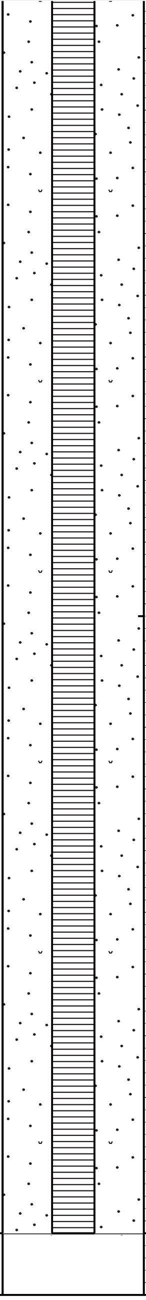
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/11/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 1 m
DIAMETER 1.5 inch

COORDINATES 641218.90E, 4750044.10N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS

Depth (m)	Graphic Log	USCS SAMPLES	Material Description	Additional Observations	Well Installation
0 – 0.3			Topsoil, Black, moist		
0.3 – 0.8		USCS: SC	Brown, moist clay mixed with sand, very plastic		
0.8 – 1		USCS: CLS	Yellow and hint of pinky very plastic clay, moist		
1			Termination Depth at: 1 m hit bedrock		

Depth (m)	Elevation (m)
0.05	180.8
0.1	180.7
0.15	180.7
0.2	180.6
0.25	180.6
0.3	180.5
0.35	180.5
0.4	180.4
0.45	180.4
0.5	180.3
0.55	180.3
0.6	180.2
0.65	180.2
0.7	180.1
0.75	180.1
0.8	180.0
0.85	180
0.9	179.9
0.95	179.9
1	179.8
	179.8

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GROUNDWATER MONITORING Well BH204

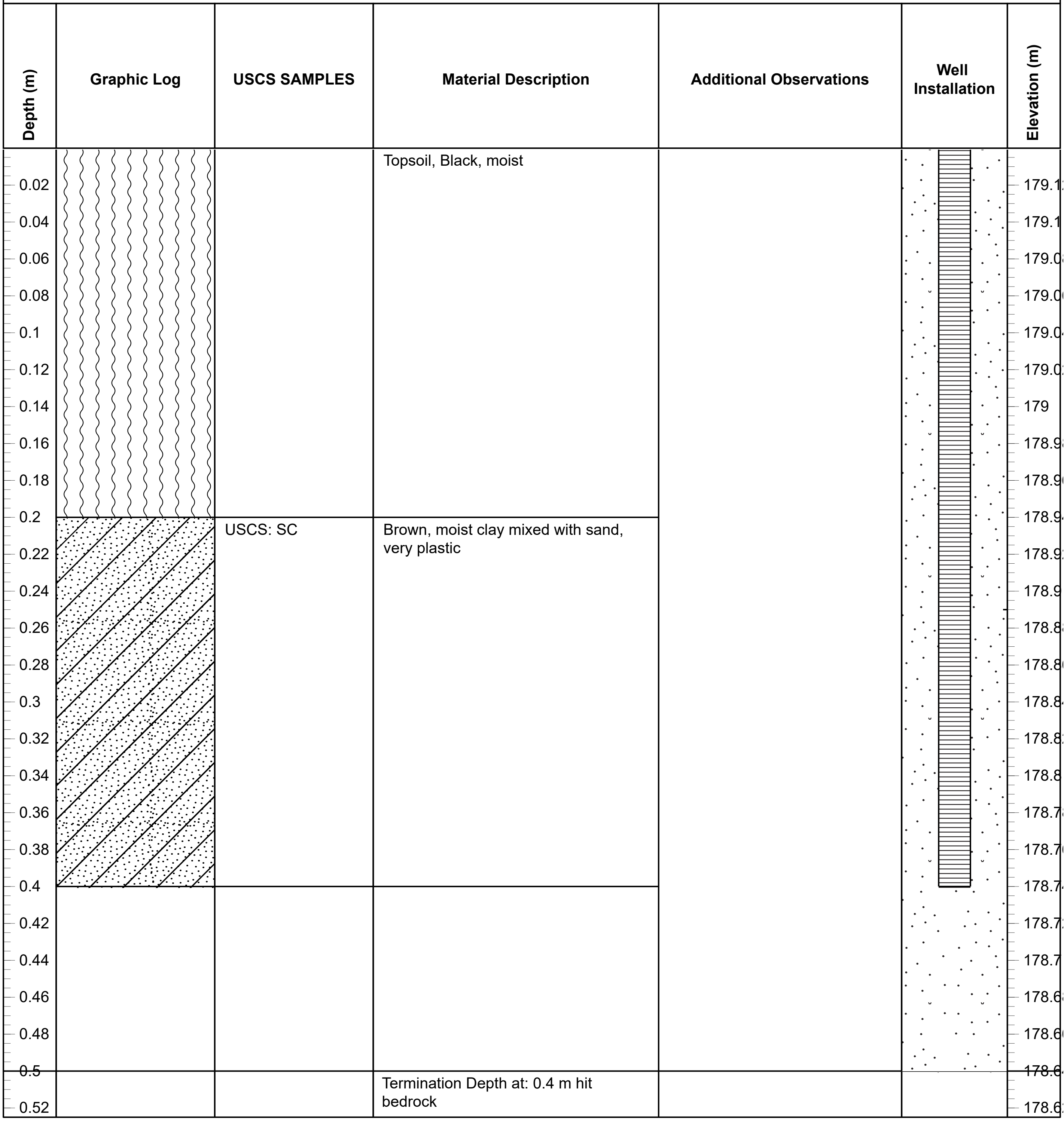
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/11/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.4 m
DIAMETER 1.5 inch

COORDINATES 641080.47E, 4750018.14N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS



Topsoil, Black, moist

USCS: SC

Brown, moist clay mixed with sand, very plastic

Termination Depth at: 0.4 m hit bedrock

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GROUNDWATER MONITORING Well BH205

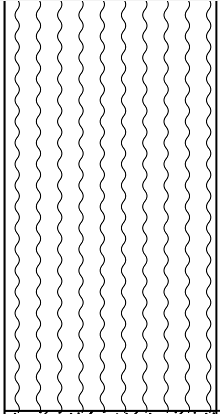
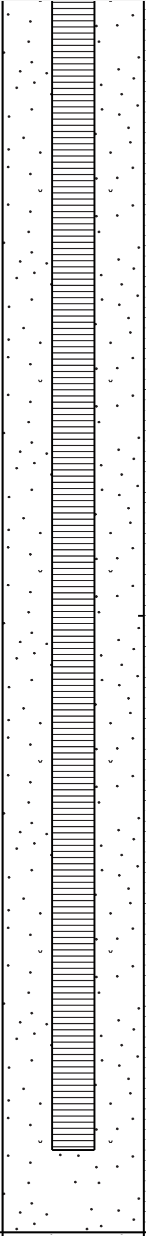
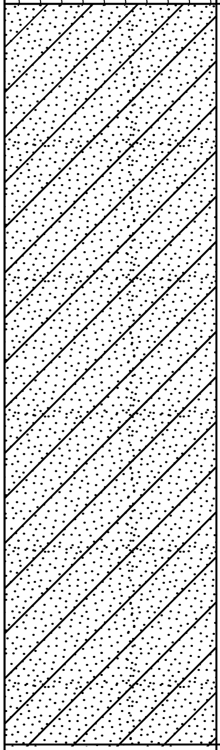
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/12/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.56 m
DIAMETER 1.5 inch

COORDINATES 640988.00E, 4749907.61N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS

Depth (m)	Graphic Log	USCS SAMPLES	Material Description	Additional Observations	Well Installation	Elevation (m)
0.05 0.1 0.15			Topsoil, Black, very wet			178.5 178.5 178.4
0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55		USCS: SC	Brown, moist clay mixed with sand, very plastic			178.4 178.3 178.3 178.2 178.2 178.1 178.1 178.0
0.6						178
			Termination Depth at: 0.56 m hit bedrock			

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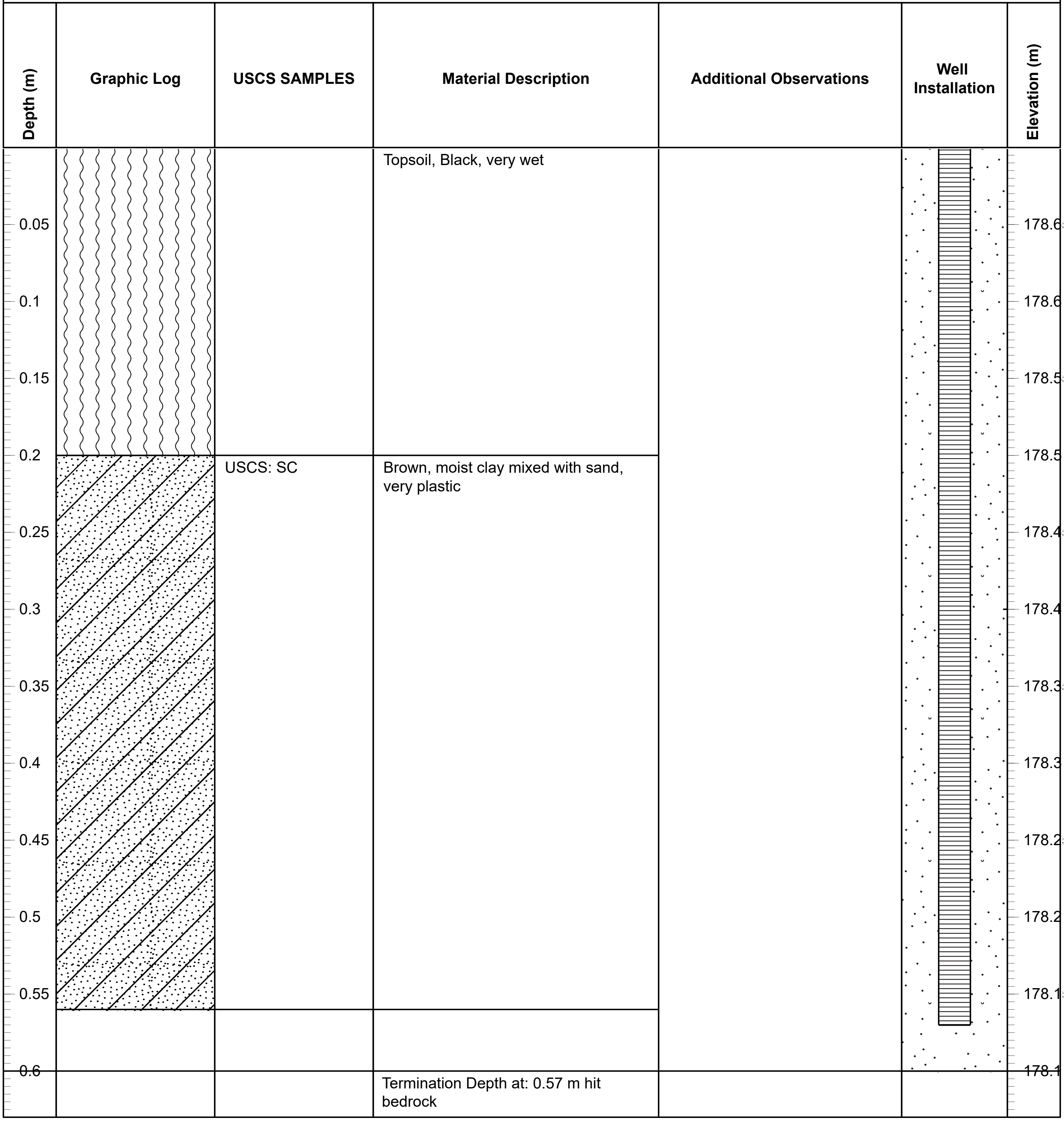
GROUNDWATER MONITORING Well BH206

PROJECT NUMBER	**DRILLING COMPANY** King EPCM	**COORDINATES** 640944.37E, 4749978.35N
PROJECT NAME	**DRILLER** Chris Chen	**COORD SYS** UTM-17
CLIENT	**DRILL RIG**	**SURFACE ELEVATION** 90 AMSL
ADDRESS Mapleview, PORT COLBORNE	**DRILLING METHOD** Hand Auger	**WELL TOC** None
DRILLING DATE 05/12/2022	**TOTAL DEPTH** 0.57 m	**LOGGED BY** Chris Chen
LICENCE NO. C-7691	**DIAMETER** 1.5 inch	**CHECKED BY** Tony Wang, P Eng, Principal Engineer
COMPLETION	**CASING** 1.25 inch	**SCREEN** 1.25 inch

COMMENTS



USCS SAMPLES	Material Description	Additional Observations
	Topsoil, Black, very wet	
USCS: SC	Brown, moist clay mixed with sand, very plastic	
	Termination Depth at: 0.57 m hit bedrock	

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GROUNDWATER MONITORING Well BH207

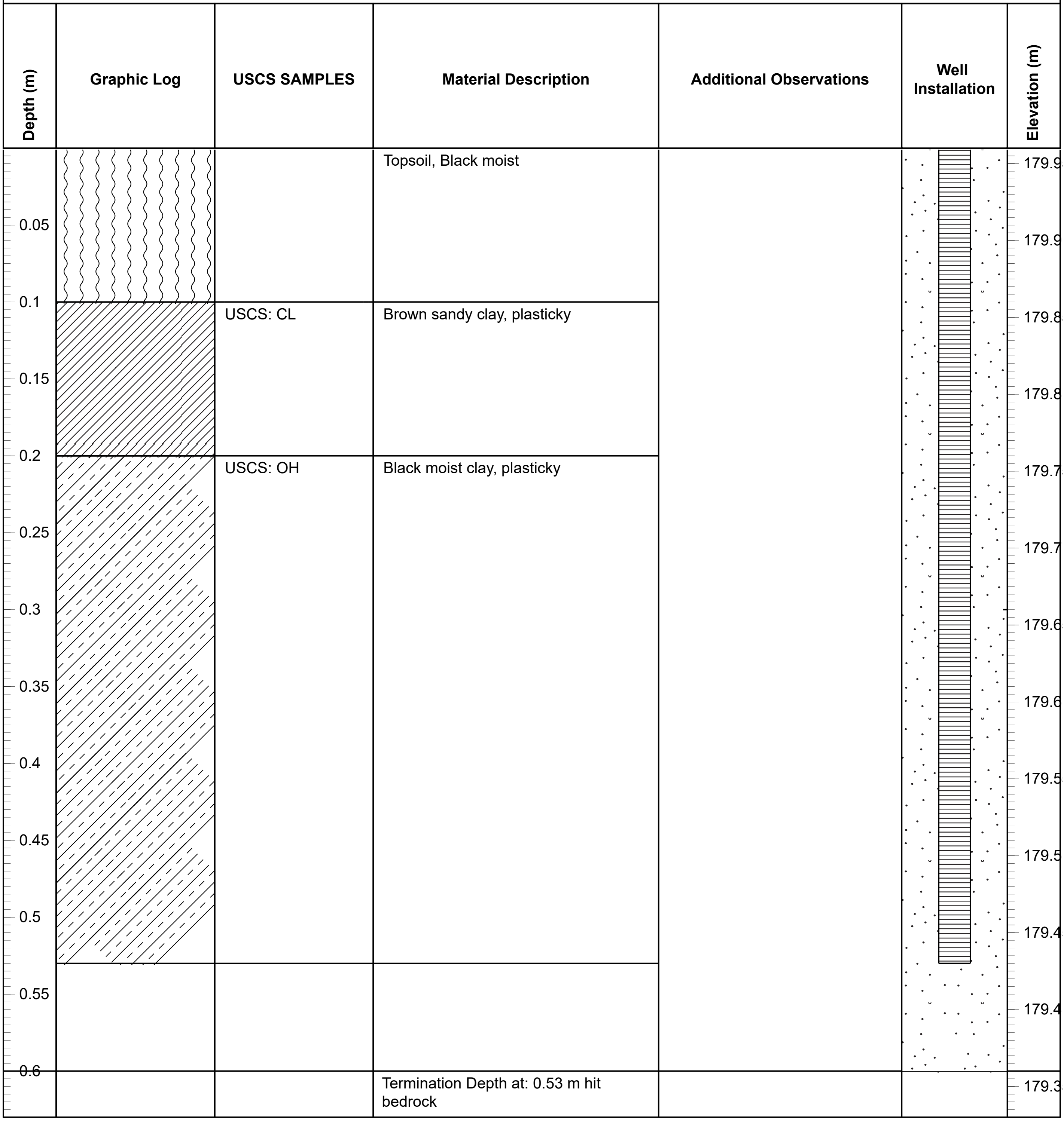
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/09/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Pincheng Zhao, Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.53
DIAMETER 1.5 inch

COORDINATES 641424.74E, 4749920.37N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS



USCS SAMPLES	Material Description	Additional Observations
	Topsoil, Black moist	
USCS: CL	Brown sandy clay, plasticky	
USCS: OH	Black moist clay, plasticky	
	Termination Depth at: 0.53 m hit bedrock	

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GROUNDWATER MONITORING Well BH208

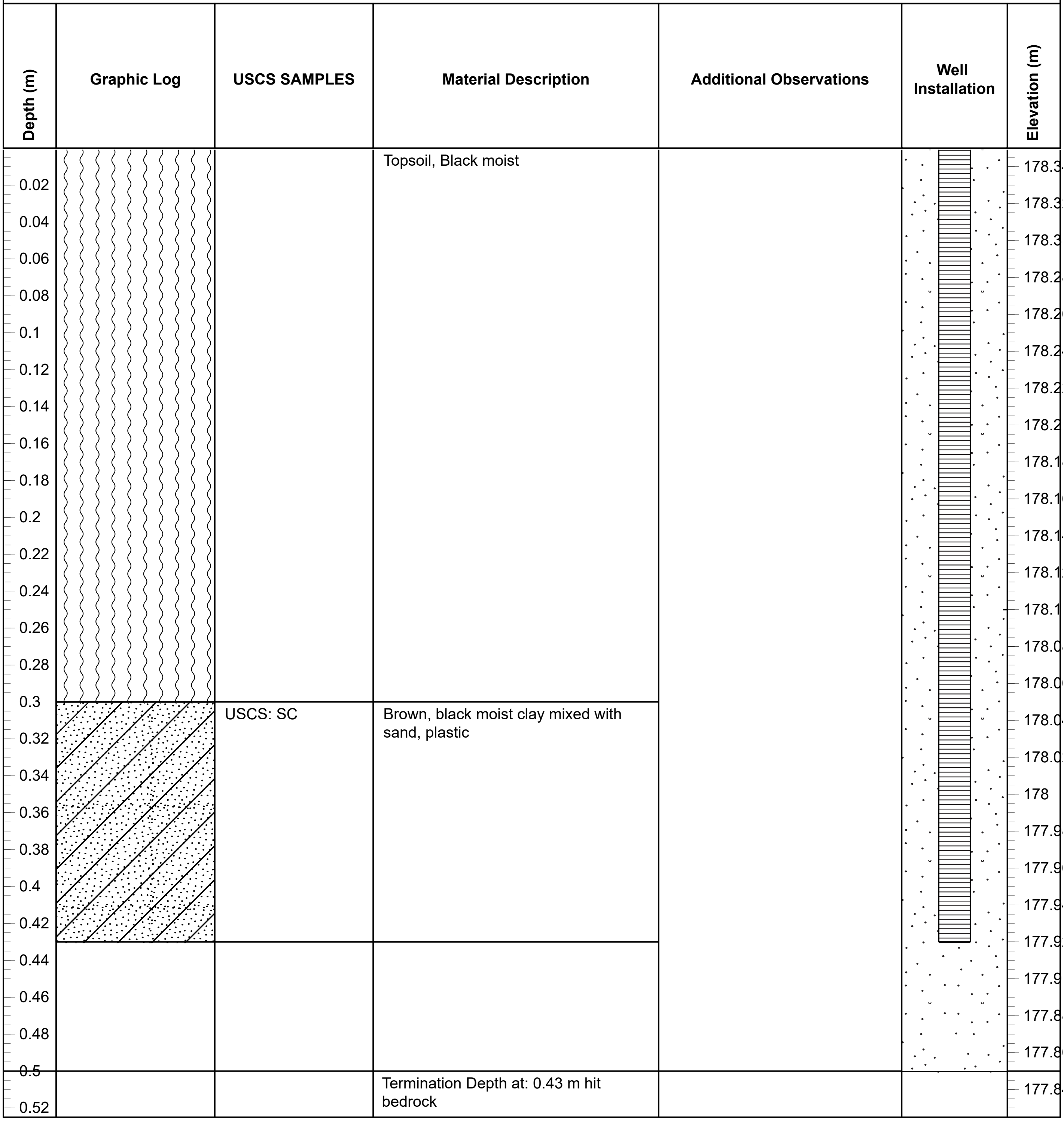
PROJECT NUMBER
PROJECT NAME
CLIENT
ADDRESS Mapleview, PORT COLBORNE
DRILLING DATE 05/09/2022
LICENCE NO. C-7691

DRILLING COMPANY King EPCM
DRILLER Pincheng Zhao, Chris Chen
DRILL RIG
DRILLING METHOD Hand Auger
TOTAL DEPTH 0.43
DIAMETER 1.5 inch

COORDINATES 641482.90E, 4749840.42N
COORD SYS UTM-17
SURFACE ELEVATION 90 AMSL
WELL TOC None
LOGGED BY Chris Chen
CHECKED BY Tony Wang, P Eng, Principal Engineer

COMPLETION
CASING 1.25 inch
SCREEN 1.25 inch

COMMENTS



USCS SAMPLES	Material Description	Additional Observations
	Topsoil, Black moist	
USCS: SC	Brown, black moist clay mixed with sand, plastic	
	Termination Depth at: 0.43 m hit bedrock	

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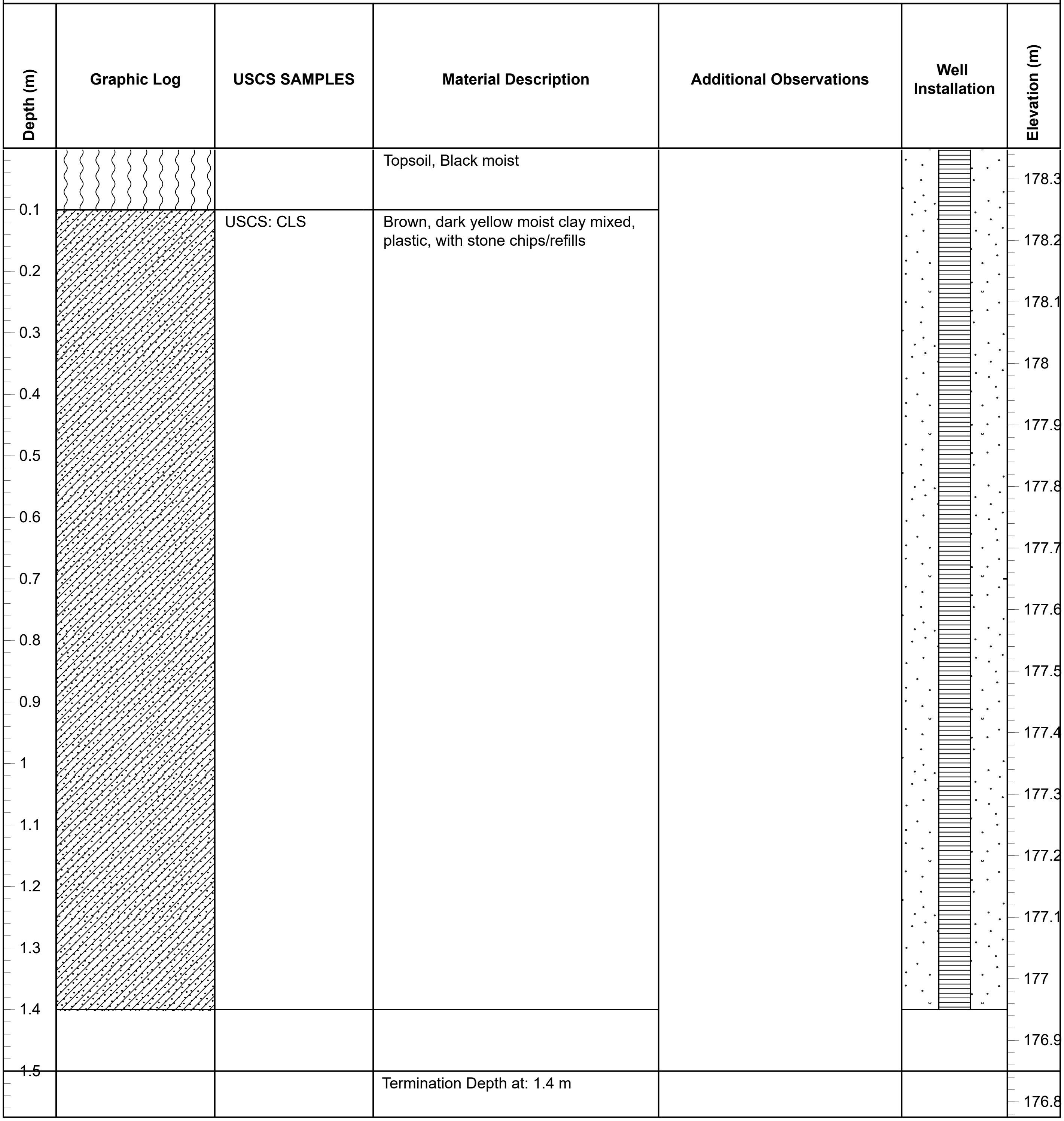
GROUNDWATER MONITORING Well BH209

PROJECT NUMBER	**DRILLING COMPANY** King EPCM	**COORDINATES** 641205.52E, 4749829.82N
PROJECT NAME	**DRILLER** Pincheng Zhao, Chris Chen	**COORD SYS** UTM-17
CLIENT	**DRILL RIG**	**SURFACE ELEVATION** 90 AMSL
ADDRESS Mapleview, PORT COLBORNE	**DRILLING METHOD** Continuous Flight Auger	**WELL TOC** None
DRILLING DATE 05/09/2022	**TOTAL DEPTH** 1.4	**LOGGED BY** Chris Chen
LICENCE NO. C-7691	**DIAMETER** 1.5 inch	**CHECKED BY** Tony Wang, P Eng, Principal Engineer
COMPLETION	**CASING** 1.25 inch	**SCREEN** 1.25 inch

COMMENTS



Depth (m)	Graphic Log	USCS SAMPLES	Material Description	Additional Observations	Well Installation	Elevation (m)
			Topsoil, Black moist			
0.1		USCS: CLS	Brown, dark yellow moist clay mixed, plastic, with stone chips/refills			
1.4						
1.5			Termination Depth at: 1.4 m			

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APPENDIX IV – FIELD PERMEABILITY TEST

In-situ Measurement of Field Saturated Hydraulic Conductivity

1. Field Permeability Test

The "Constant Head Well Permeameter" (CHWP) method (Reynolds, 1993; Elrick and Reynolds, 1986) is based on the observation that when a constant height or "head" of water is ponded in a borehole or "well" augured into unsaturated soil, a "bulb" of field-saturated soil is gradually established around the base of the well. The K_{fs} value achieved through this method can be less than or equal to half of K_s (Saturated hydraulic conductivity) due to partial blocking of soil pores by air bubbles and it is preferred over Ks in the design of on-site stormwater LID infiltration design, because drainage through the soil should be designed to occur at less than complete soil saturation.

The in-situ measurements were done by the ETC Soils Pask Permeameter, is an extended single-head analysis method and calculations procedure used here are based on the work of W.D. Reynolds and D.E. Elrick formerly of the University of Guelph, Ontario, Canada.

The ETC Pask Permeameter is a convenient and easy to use apparatus for ponding a constant head of water in a well, and simultaneously measuring the flow into the soil. The rate of fall (R) of the water level in the permeameter reservoir and reservoir cross-sectional area (X) allows determination of quasi steady water flow Irate (Q) into the soil (i.e Q = XR). K_{fs} is then calculated using Equation 1 (Reynolds, 1993):

$$K_{fs} = CQ / [2\pi H^2 + C\pi a^2 + (2\pi H/\alpha^*)] \qquad \text{(Eq. 1)}$$

In which:
K_{fs} = the calculated permeability from the field test

Table 1. Parameters used

Parameter	**Description**	**1**	**2**
		NE	**SW**
Soil Texture Factor (**α^***) in cm^{-1}	* Porous materials that are both fine textured and massive; including unstructured clayey and silty soils, as well as very fine to fine structureless sandy materials. ** Coarse and gravelly sands; may also include some highly structured soils with large cracks and /or macropores.	0.04	0.36
R in cm/min	Quasi steady state (constant) rate of fall of water in permeameter reservoir (Measured in the site)	0.3	4.9
μ_k/μ_a	Temperature Correction Factor (t= 28-29$^{\circ c}$)	0.567	
C	Shape factor	1.35	1.36
X in cm^2	Cross-sectional area of permeameter reservoir	53.46	12.80
H	Height of air inlet hole from bottom of the test hole	15	

in cm		
a in cm	Well hole radius	4.15

Based on data described in the above table and using Pask Permeameter ETC Quick Field Reference Tables for both Standard (BH2) and Slow Soils (BH1), the K_{fs} was calculated as:

K_{fs1} = 2.3E-7 m/sec = 2.3E-5 cm/sec
K_{fs2} = 3.4E-5 m/sec = 3.4E-3 cm/sec

And then the temperature corrected permeability would be calculated using equation 2 as follows:

$K_a = K_{fs} \times \mu_k/\mu_a$ (Eq. 2)

In which:
K_a = corrected permeability adjusted for design temperature conditions

Then using the temperature correction factor (for t=28-29$^{\circ c}$) from the manual:
K_{a1}=1.3E-7 m/sec = 1.3E-5 cm/sec
K_{a2}=1.9E-5 m/sec = 1.9E-3 cm/sec

The field permeability data sheet is in the following.

2. Percolation time/infiltration rate for design (Reynolds et al., 2015)

Correlations between Perc Time (PT) and field-saturated hydraulic conductivity (K_{fs}) are often used in development of on-site water recycling and treatment facilities that operate by infiltration into unsaturated soil. The physically based PT versus K_{fs} expression in Reynolds et al. (2015) for cylindrical test holes in unsaturated soil can be simplified to Eq. 3.

$$PT = \frac{\Delta t}{\Delta H} = m\mathrm{K}_{fs}^{-1} \qquad \text{(Eq. 3)}$$

Where:

$$m = \frac{\bar{C}a^2}{\left[2\bar{H}^2+\bar{C}a^2+\frac{2\bar{H}[1-\exp(\alpha\,\psi_{\alpha})]}{\alpha}\right]}; 0 < m < 1 \qquad \text{(Eq. 4)}$$

And a is test hole radius, $\bar{H}$ is average water level (ponding depth) in the test hole over time interval, Δt, ψα is the antecedent or background pore water pressure head in the soil surrounding the test hole, α may be viewed as the "integrally correct" slope of the soil's unsaturated hydraulic conductivity versus pore water pressure head relationship, K(ψ) and $\bar{C}$ is a "shape function" (Reynolds et al., 2015).

Conversion of CHWP K_{fs}/k_a to equivalent Perc Time, PT for this site using m= 1.05E-06 (Very Strong capillarity category):

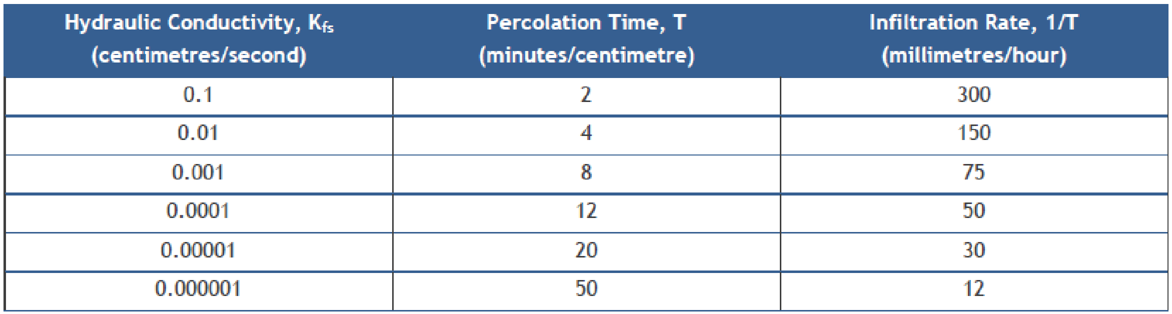
$$PT_1 = \mathrm{mK}_{a1}^{-1} = \frac{(3.18\mathrm{E}-6)}{(1.3\mathrm{E}-7)} = 24.5\ \mathrm{min/cm}\quad \text{(Infiltration Rate =24.5 mm/hour)}$$

$$PT_2 = \mathrm{mK}_{a2}^{-1} = \frac{(7.0\mathrm{E}-6)}{(1.9\mathrm{E}-5)} = 0.37\ \mathrm{min/cm}\quad \text{(Infiltration Rate =1629 mm/hour)}$$

3. Percolation time/infiltration rate for design (OMMAH, 1997)

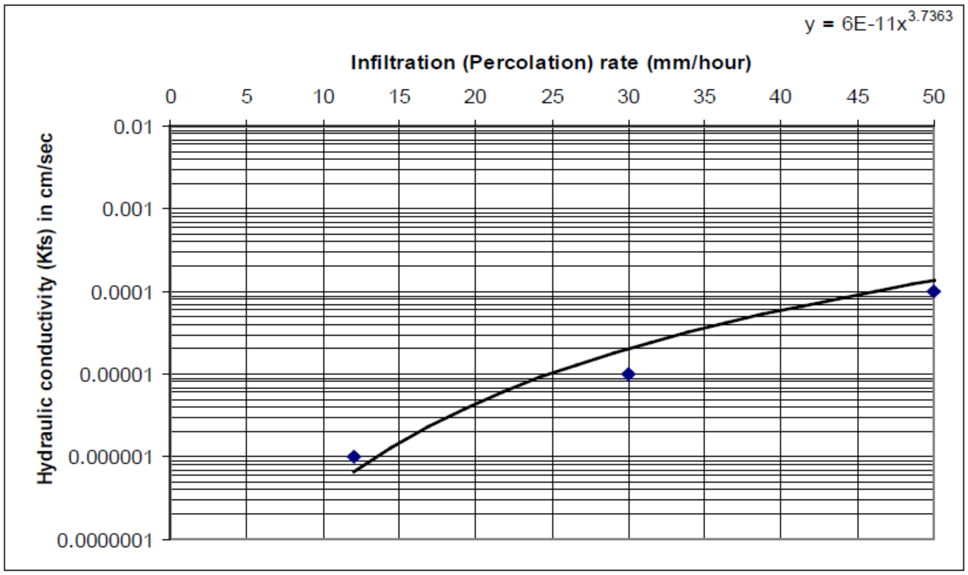
Despite the newer academic papers published by Reynolds et al. (2015), TRCA and other Conservation Authorities often still review design of infiltration basins based on historic trends. Below are two TRCA (2012) design criteria that describe the relationship between K_{fs}, PT, and infiltration rates, based on the 1997 (OMMAH) supplementary guidelines to OBC (1997).

Table 2. Approximate relationships between hydraulic conductivity, percolation time and infiltration rate



Hydraulic Conductivity, K_{fs} (centimetres/second)	Percolation Time, T (minutes/centimetre)	Infiltration Rate, 1/T (millimetres/hour)
0.1	2	300
0.01	4	150
0.001	8	75
0.0001	12	50
0.00001	20	30
0.000001	50	12

***Source**: Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.*



***Source**: Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.*

Figure 1. Approximate relationship between infiltration rate and hydraulic conductivity

Based on OMMAH interpolation from Table 2 and Figure 1 above, the measured K_{fs} may be interpolated as:

PT_1 = 22.4 min / cm (Infiltration Rate = 27 mm/hour)

PT_2 = 5.9 min / cm (Infiltration Rate = 102 mm/hour)

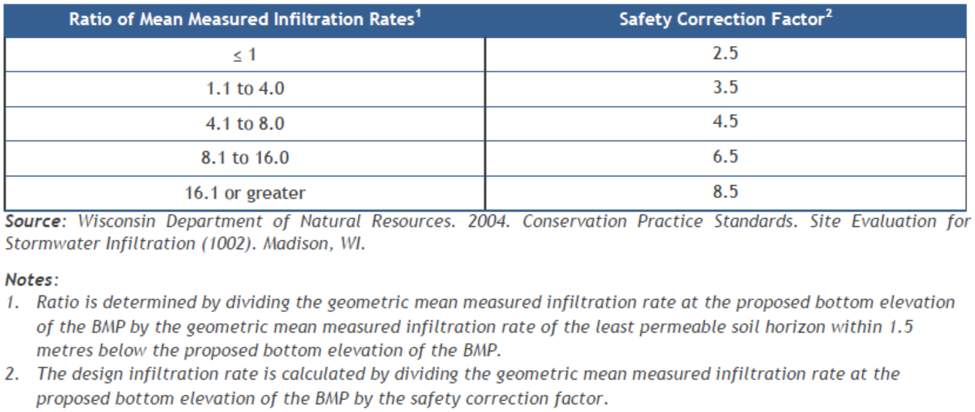
When comparing the OMMAH result with that obtained by Reynolds et al. (2015) formula (PT= 0.37-24.5 min/cm), the two methods of conversion are completely different results, especially for standard soils and it seems that the values of the first method have overestimated the infiltration rate and Perc Time. As per the TRCA Stormwater Management Criteria guideline, the engineer's opinion is to trust to the value obtained from the second method (OMMAH, 1997) which was proposed by TRCA to convert measured hydraulic conductivity to percolation time and/or infiltration rate. Therefore, the engineer's opinion is to trust the values obtained from the second method (OMMAH, 1997), with an unfactored infiltration rate = 27 mm/hour to 102 mm/hour which confirms the upper thin soil layer (clay mixed with sand, d ~ 0.4 to 1.0m) has a low permeability within this property while the lower weathered bedrock layer has high infiltration rate due to some cracks and fissures, in addition to its coarse textured.

4. Factored Engineering Design Infiltration Rate (Wisconsin Department of Natural Resources, 2004)

For a conservative approach to infiltration speeds, the Wisconsin Department of Natural Resources (2004) method shall be used for the calculation of a factored design infiltration rate. The overall upper thin soil formation is clay soils mixed with sand or stone, with an unfactored infiltration rate =27 mm/hour, while the bottom bedrock layer is gravel/stone with sandy clay, with an unfactored infiltration rate =102 mm/hour. Since the infiltration rate used to design an infiltration BMP must incorporate a safety correction factor that compensates for potential reductions in soil permeability due to compaction or smearing during construction, gradual accumulation of fine sediments over the lifespan of the BMP and uncertainty in measured values when less permeable soil horizons exist within 1.5 meters below the proposed bottom elevation of the BMP. As discussed above, the predominant soil material of this site is composed of clay soils to a depth of less than 1 meter and follows with a deep sandy clay layer to a depth of more than 3 meters, which has high permeability rate.

Based on borehole data, the soil layer remains consistent of sandy clay types (similar to BH2), including the soil layers 1.5 meters below the proposed bottom of the BMP. This means that based on the below Table 3, the measured infiltration rate should be divided by a safety correction factor to calculate the design infiltration rate. Thus the mean infiltration rate measured at the proposed bottom elevation of the BMP is 102 mm/hour, and the mean infiltration rate measured in the slowest underlying soil horizon is 41 mm/hour, and the ratio of infiltration rates is 2.5.

Table 3. Safety correction factors for calculating design infiltration rates



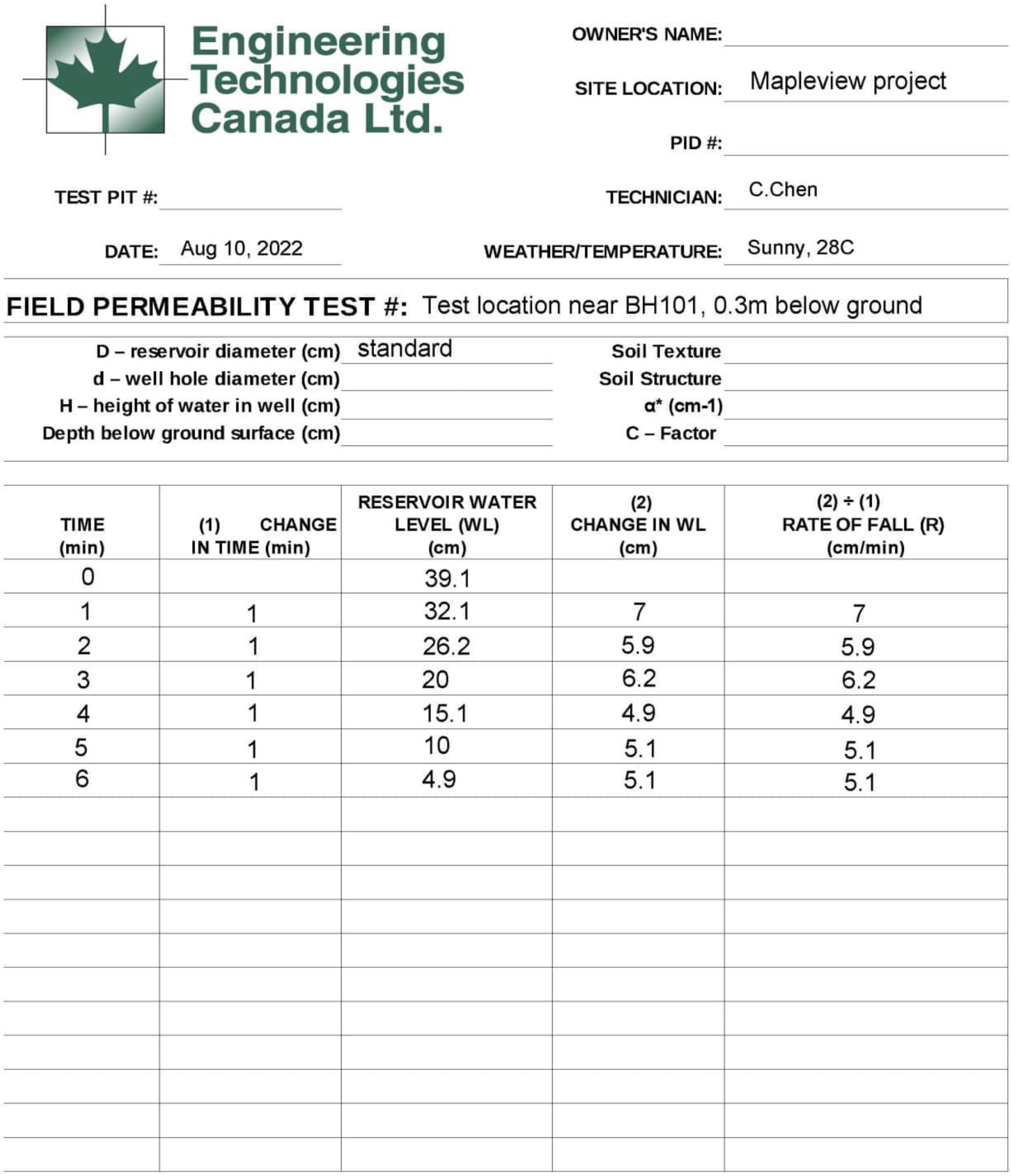
Ratio of Mean Measured Infiltration Rates[1]	Safety Correction Factor[2]
≤ 1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

Source: *Wisconsin Department of Natural Resources. 2004. Conservation Practice Standards. Site Evaluation for Stormwater Infiltration (1002). Madison, WI.*

Notes:

1. *Ratio is determined by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the BMP by the geometric mean measured infiltration rate of the least permeable soil horizon within 1.5 metres below the proposed bottom elevation of the BMP.*
2. *The design infiltration rate is calculated by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the BMP by the safety correction factor.*

Field Permeability Test Sheet



Engineering Technologies Canada Ltd.

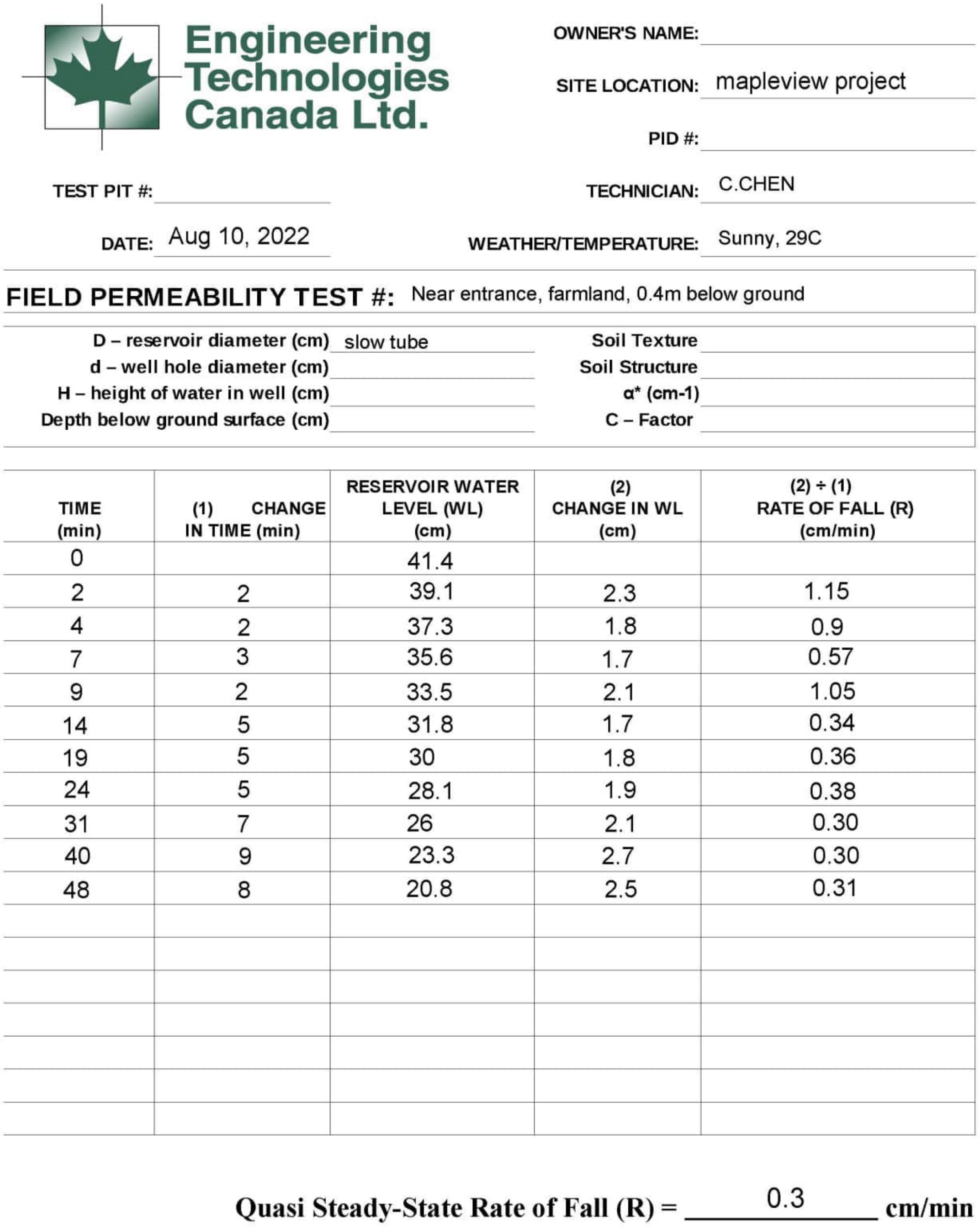
OWNER'S NAME:
SITE LOCATION: Mapleview project
PID #:
TEST PIT #:
TECHNICIAN: C.Chen
DATE: Aug 10, 2022
WEATHER/TEMPERATURE: Sunny, 28C

FIELD PERMEABILITY TEST #: Test location near BH101, 0.3m below ground

D – reservoir diameter (cm)	standard	Soil Texture	
d – well hole diameter (cm)		Soil Structure	
H – height of water in well (cm)		α* (cm-1)	
Depth below ground surface (cm)		C – Factor	

TIME (min)	(1) CHANGE IN TIME (min)	RESERVOIR WATER LEVEL (WL) (cm)	(2) CHANGE IN WL (cm)	(2) ÷ (1) RATE OF FALL (R) (cm/min)
0		39.1		
1	1	32.1	7	7
2	1	26.2	5.9	5.9
3	1	20	6.2	6.2
4	1	15.1	4.9	4.9
5	1	10	5.1	5.1
6	1	4.9	5.1	5.1

Quasi Steady-State Rate of Fall (R) = 4.9 cm/min



Engineering Technologies Canada Ltd.

OWNER'S NAME:

SITE LOCATION: mapleview project

PID #:

TEST PIT #:

TECHNICIAN: C.CHEN

DATE: Aug 10, 2022

WEATHER/TEMPERATURE: Sunny, 29C

FIELD PERMEABILITY TEST #: Near entrance, farmland, 0.4m below ground

D – reservoir diameter (cm) slow tube

d – well hole diameter (cm)

H – height of water in well (cm)

Depth below ground surface (cm)

Soil Texture

Soil Structure

α* (cm-1)

C – Factor

TIME (min)	(1) CHANGE IN TIME (min)	RESERVOIR WATER LEVEL (WL) (cm)	(2) CHANGE IN WL (cm)	(2) ÷ (1) RATE OF FALL (R) (cm/min)
0		41.4		
2	2	39.1	2.3	1.15
4	2	37.3	1.8	0.9
7	3	35.6	1.7	0.57
9	2	33.5	2.1	1.05
14	5	31.8	1.7	0.34
19	5	30	1.8	0.36
24	5	28.1	1.9	0.38
31	7	26	2.1	0.30
40	9	23.3	2.7	0.30
48	8	20.8	2.5	0.31

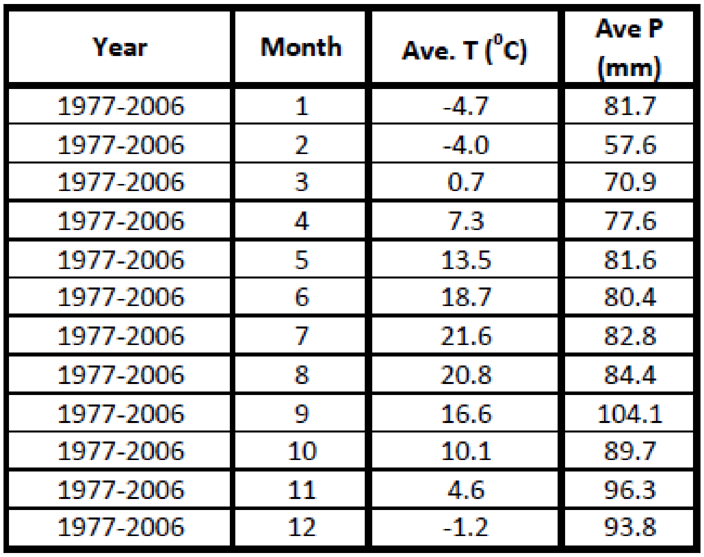
Quasi Steady-State Rate of Fall (R) = 0.3 cm/min

APPENDIX V –CLIMATE DATA TABLE

Climate Data

Welland

Climate Station ID: 6139445



Year	Month	Ave. T (°C)	Ave P (mm)
1977-2006	1	-4.7	81.7
1977-2006	2	-4.0	57.6
1977-2006	3	0.7	70.9
1977-2006	4	7.3	77.6
1977-2006	5	13.5	81.6
1977-2006	6	18.7	80.4
1977-2006	7	21.6	82.8
1977-2006	8	20.8	84.4
1977-2006	9	16.6	104.1
1977-2006	10	10.1	89.7
1977-2006	11	4.6	96.3
1977-2006	12	-1.2	93.8

Climate Data

Welland

Climate Station ID: 6139445

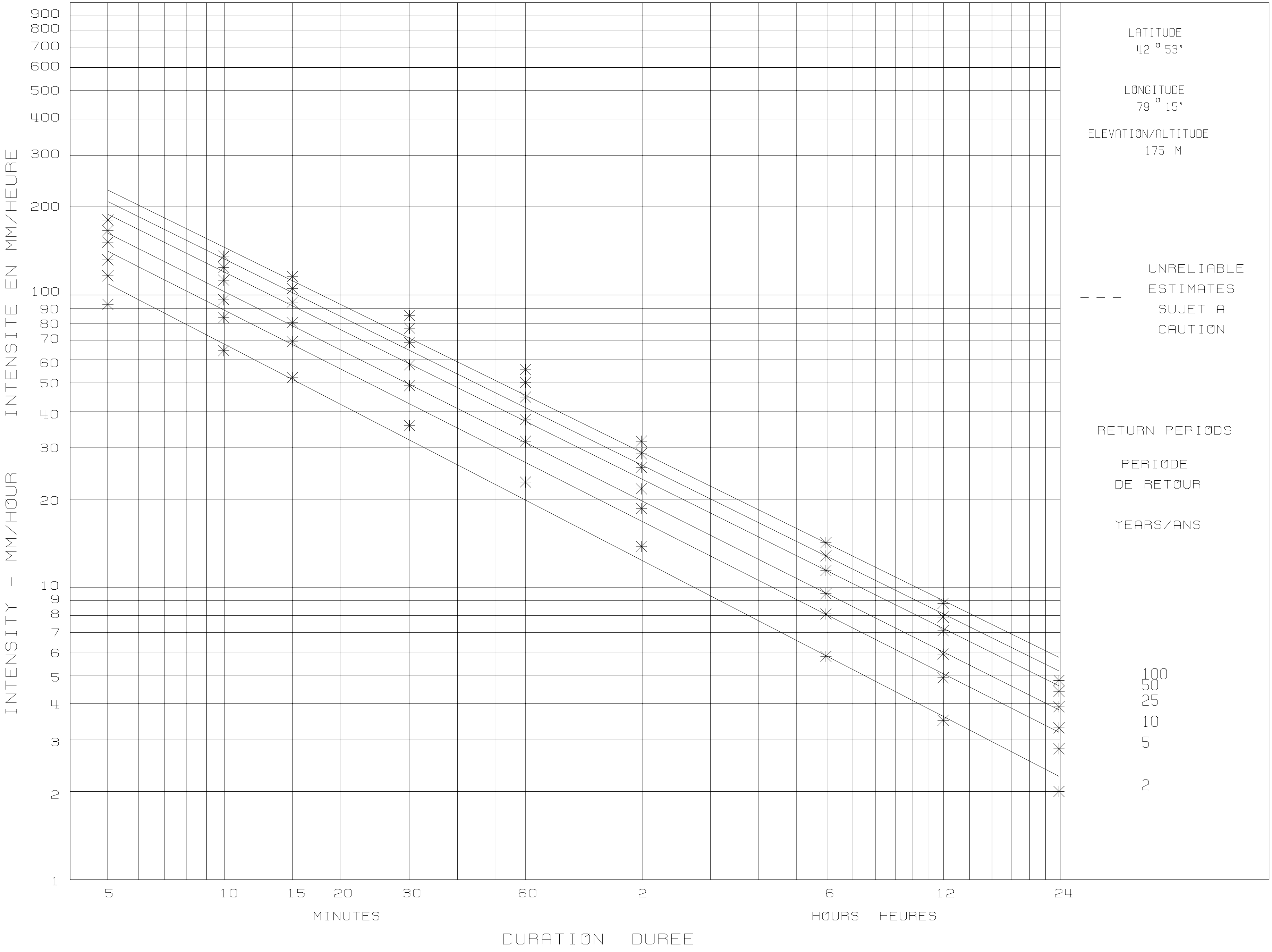
Month	PET	P	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus
January	9.6	81.7	45.3	198.1	9.6	0.1	40.8	42.3
February	11.3	57.6	44.6	199.6	11.3	0.0	42.4	43.1
March	21.5	70.9	79.6	200.0	21.5	0.0	12.3	79.2
April	39.7	77.6	50.2	199.8	39.7	0.0	0.0	50.4
May	72.4	81.6	9.1	189.6	72.4	0.0	0.0	19.3
June	105.3	80.4	-24.9	160.7	103.1	2.2	0.0	6.2
July	125.2	82.8	-42.4	125.3	115.7	9.5	0.0	2.5
August	101.6	84.4	-17.3	115.7	91.3	10.3	0.0	2.6
September	60.5	104.1	43.6	144.9	58.2	2.3	0.0	16.8
October	32.2	89.7	57.4	175.6	32.2	0.0	0.0	26.8
November	17.3	96.3	78.9	191.9	17.3	0.0	0.1	62.5
December	11.0	93.8	69.0	196.7	11.0	0.0	14.0	64.2
Annual Rate (mm/yr)	607.7	1000.9	393.2	2097.9	583.3	24.3	109.6	415.9

APPENDIX VI –IDF DATA

SHORT DURATION RAINFALL INTENSITY-DURATION FREQUENCY DATA FOR-
DONNEES SUR L'INTENSITE,LA DUREE ET LA FREQUENCE DES CHUTES DE PLUIE DE COURTE DUREE A PORT COLBORNE ONT

GUMBEL-METHOD OF MOMENTS
METHODE DES MOMENTS

BASED ON RECORDING RAIN GAUGE DATA FOR THE PERIOD-
BASEES SUR LES DONNEES DU PLUVIOGRAPHES POUR LA PERIOD 1964 - 2000 35 YEARS/AN



PREPARED BY - PREPARE PAR LE

ATMOSPHERIC ENVIRONMENT SERVICE - ENVIRONMENT CANADA
SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - ENVIRONNEMENT CANADA

The rainfall intensity is generally taken from Intensity Duration Frequency (IDF) curves derived for the study area from historical rainfall data (see Section 8.3) at a nearby rain gauge. **Table 8.2** gives some sample standard IDF coefficients (a, b, c) for three locations in the Niagara Region where the intensity can be calculated using:

$$i = \frac{a}{(t_c + b)^c}$$

Table 8.1.2
Sample IDF coefficients in the Niagara Region

Location	**Storm Frequency (years)**	**a**	**b**	**c**
St. Catherines	2	567	5.2	0.746
	5	664	4.7	0.744
	10	724	4.3	0.739
	25	821	4.0	0.735
	50	900	3.8	0.734
	100	980	3.7	0.732
Welland	2	755	8	0.789
	5	830	7.3	0.777
	10	860	6.5	0.763
	25	900	5.2	0.745
	50	960	5.1	0.736
	100	1020	4.7	0.731
Niagara Falls	2	521.97	5.28	0.7588
	5	719.50	6.34	0.7687
	10	577.93	2.483	0.669
	25	1020.69	7.29	0.779
	100	1264.57	7.72	0.7814
Grimsby	2	603.25	6.00	0.79
	5	785.59	6.00	0.79
	10	953.64	7.00	0.79
	25	1119.02	7.00	0.79
	50	1301.80	8.00	0.80
	100	1426.13	8.00	0.80

Additional IDF curves generated by Environment Canada can be found on the following pages.

APPENDIX VII –SUBWATERSHEDS WHITHIN THE SITE

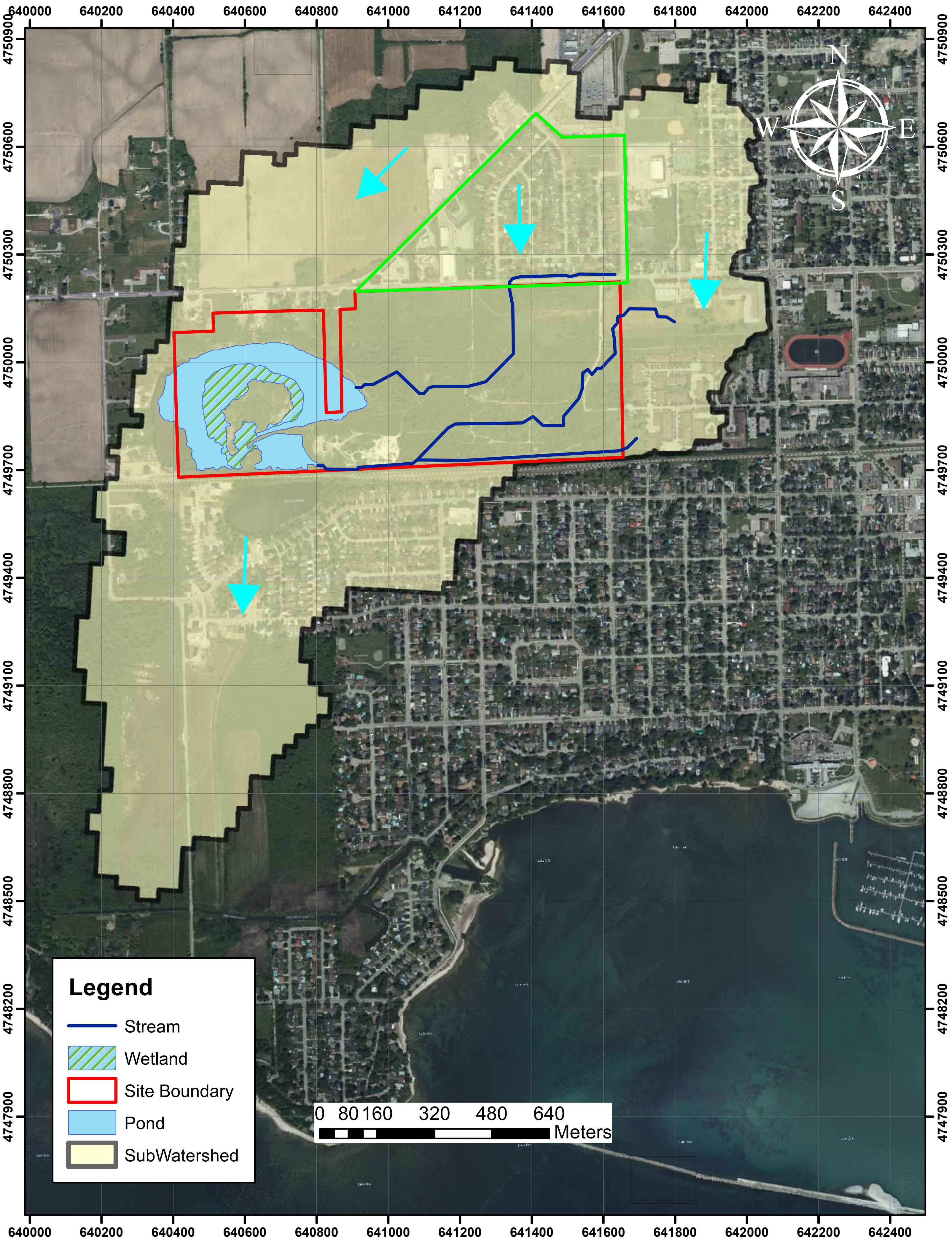

640000
640200
640400
640600
640800
641000
641200
641400
641600
641800
642000
642200
642400
4750900
4750600
4750300
4750000
4749700
4749400
4749100
4748800
4748500
4748200
4747900
N
W
E
S
Legend
Stream
Wetland
Site Boundary
Pond
SubWatershed
0
80
160
320
480
640
Meters

Figure 2-3. Niagara Region Subwatershed Areas

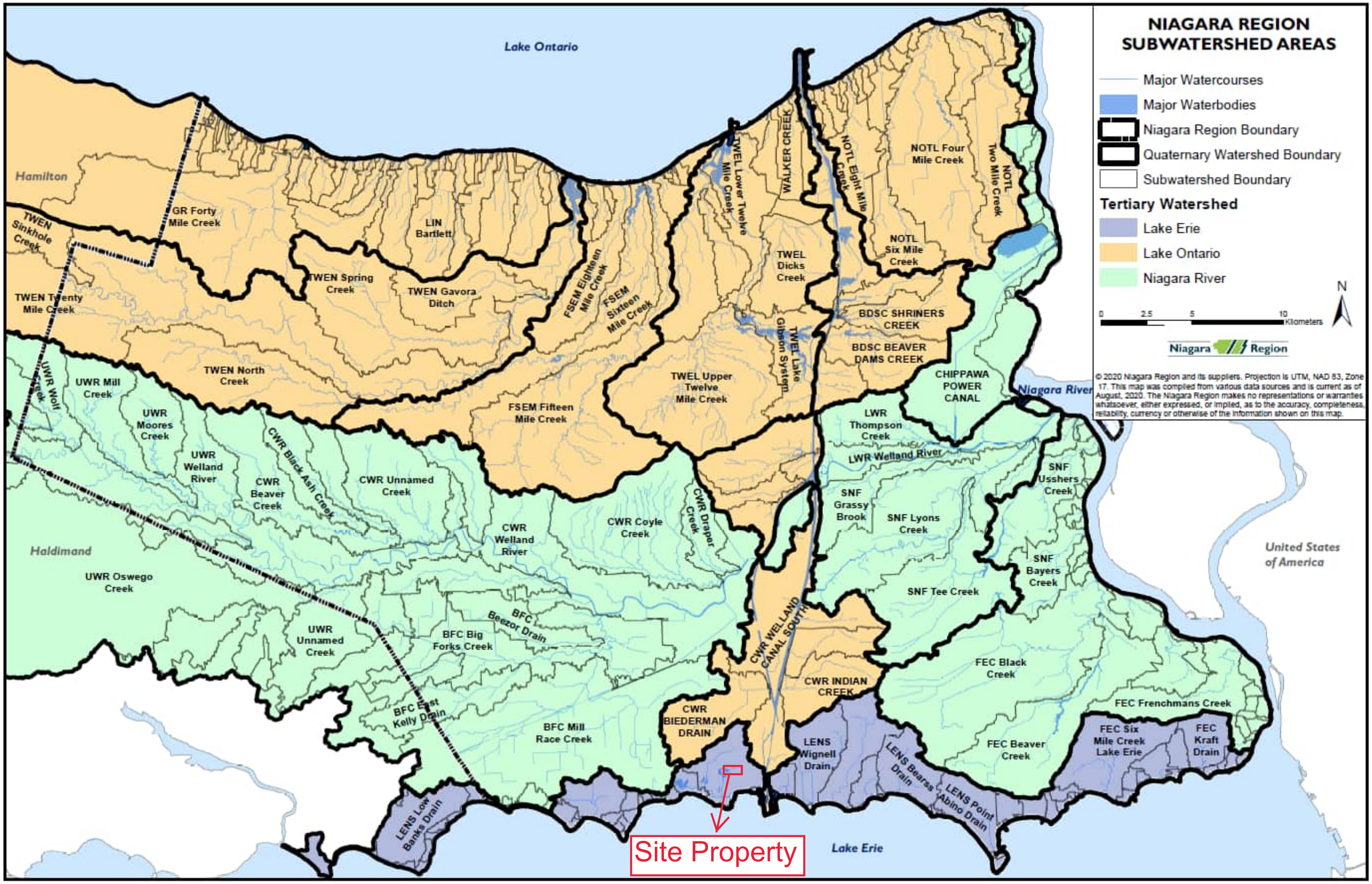


Figure 2-1. Niagara Region – Tertiary Watershed Areas

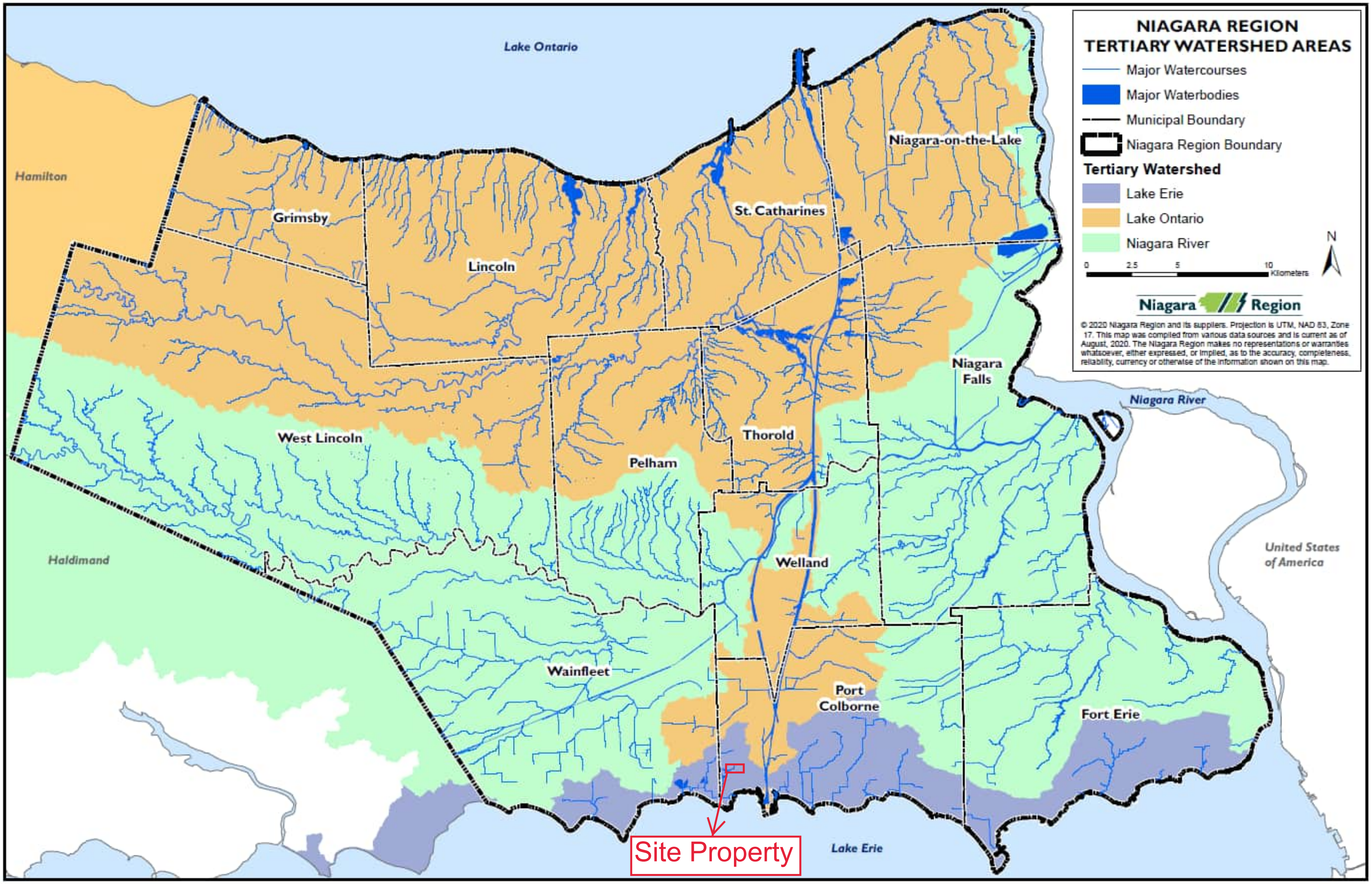
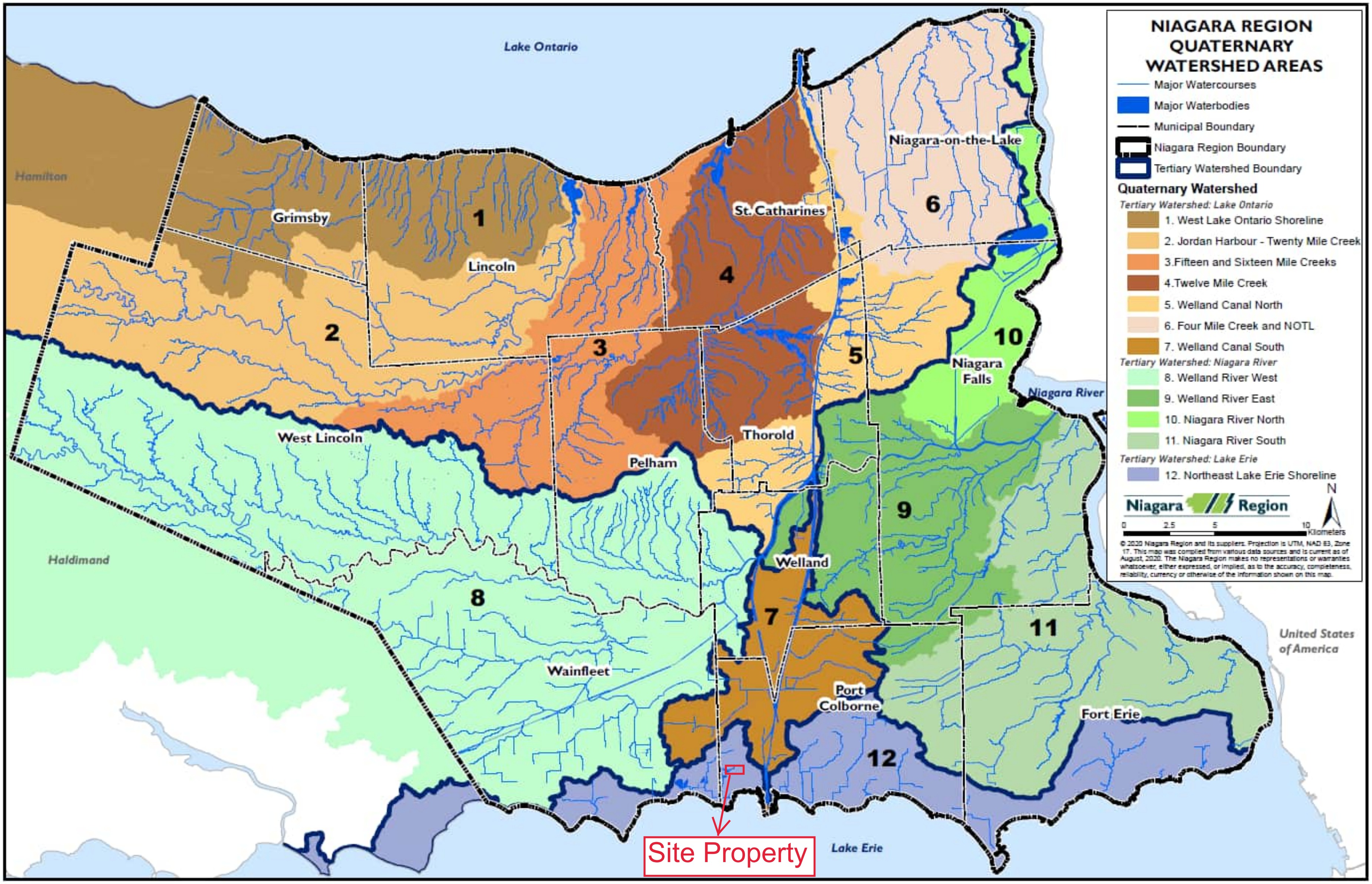
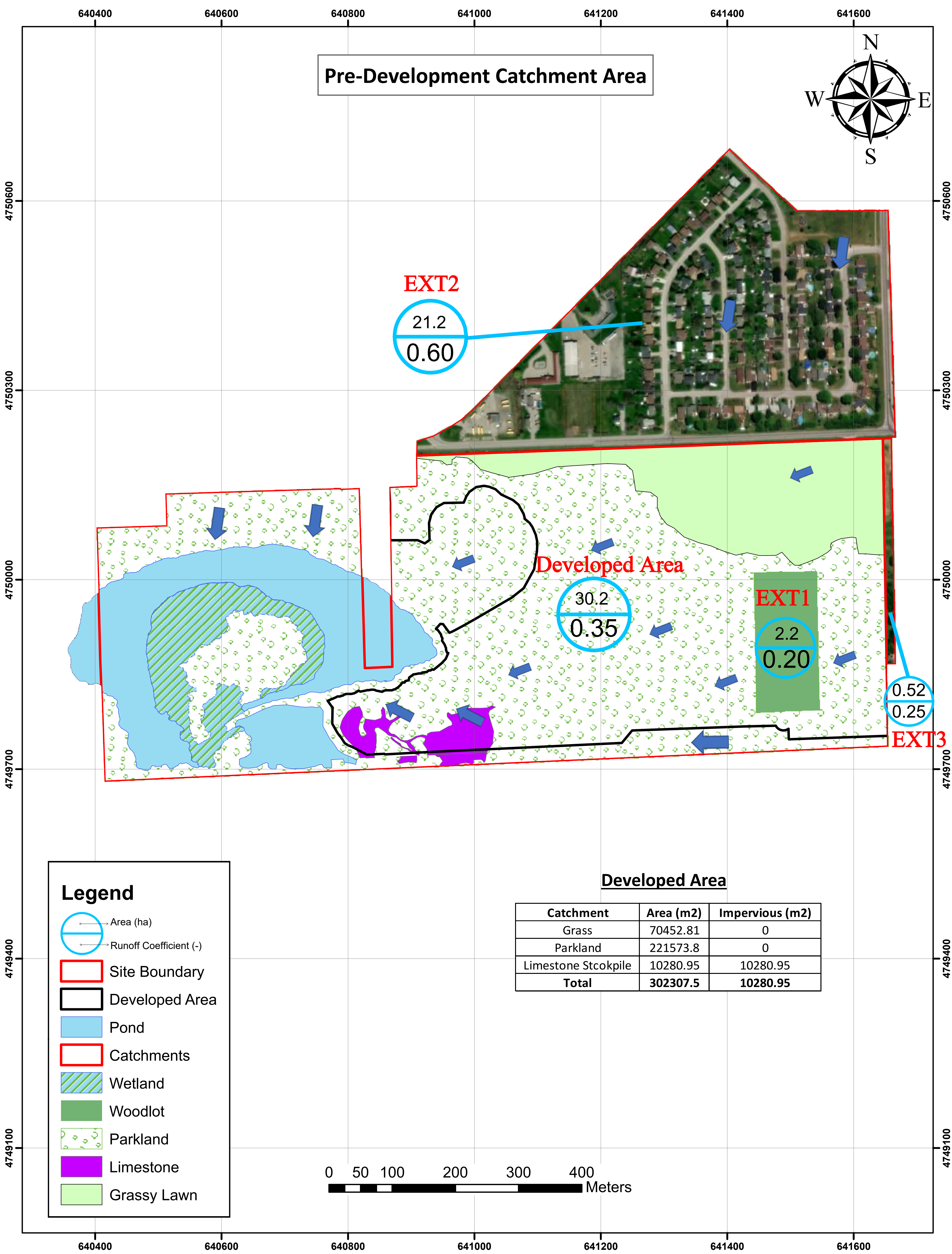


Figure 2-2. Niagara Region – Quaternary Watershed Areas



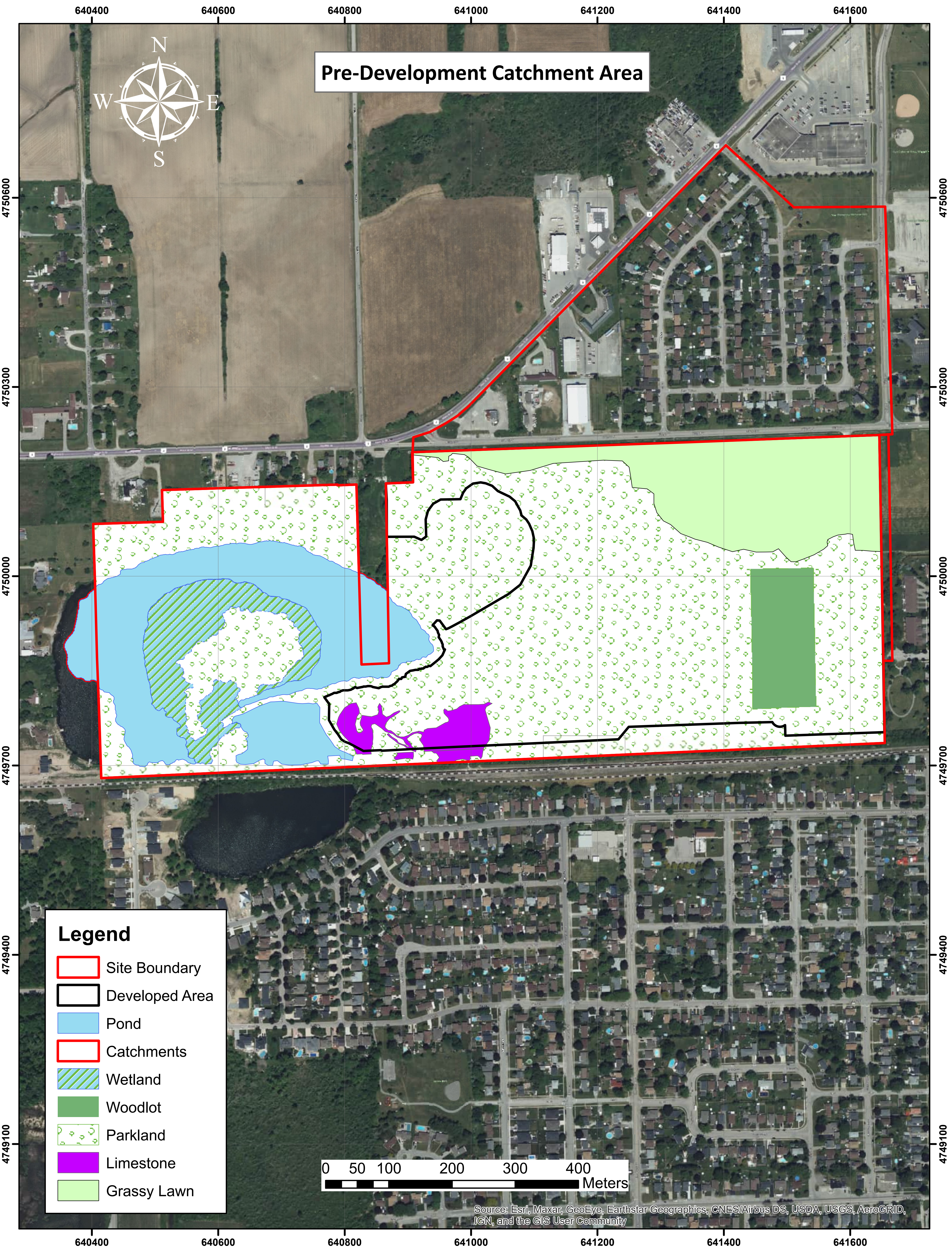
APPENDIX VIII –PRE- AND POST-DEVELOPMENT CATCHEMENT AREA

Pre-Development Catchment Area



Developed Area

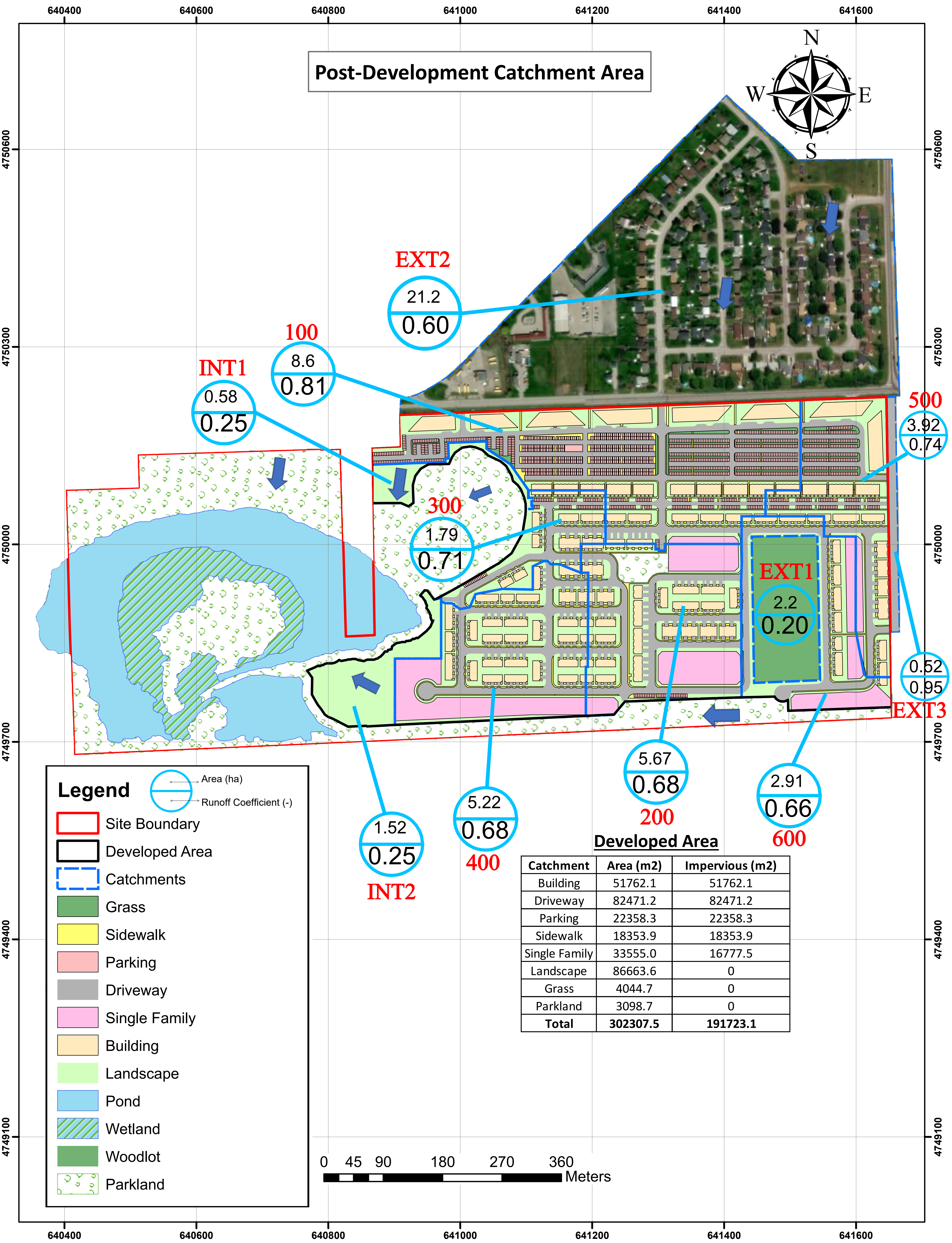
Catchment	Area (m2)	Impervious (m2)
Grass	70452.81	0
Parkland	221573.8	0
Limestone Stcokpile	10280.95	10280.95
Total	**302307.5**	**10280.95**



Pre-Development Catchment Area

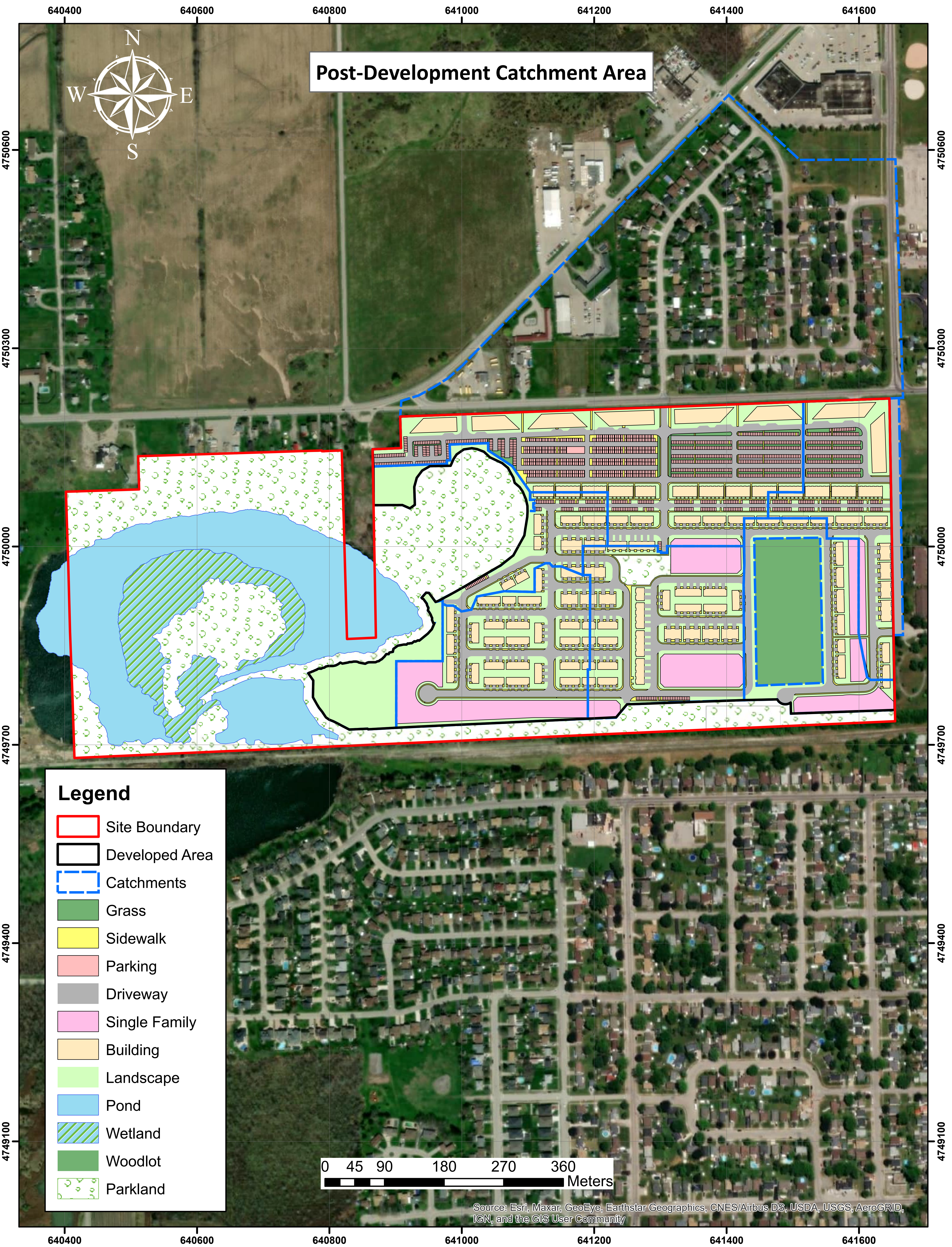
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Post-Development Catchment Area



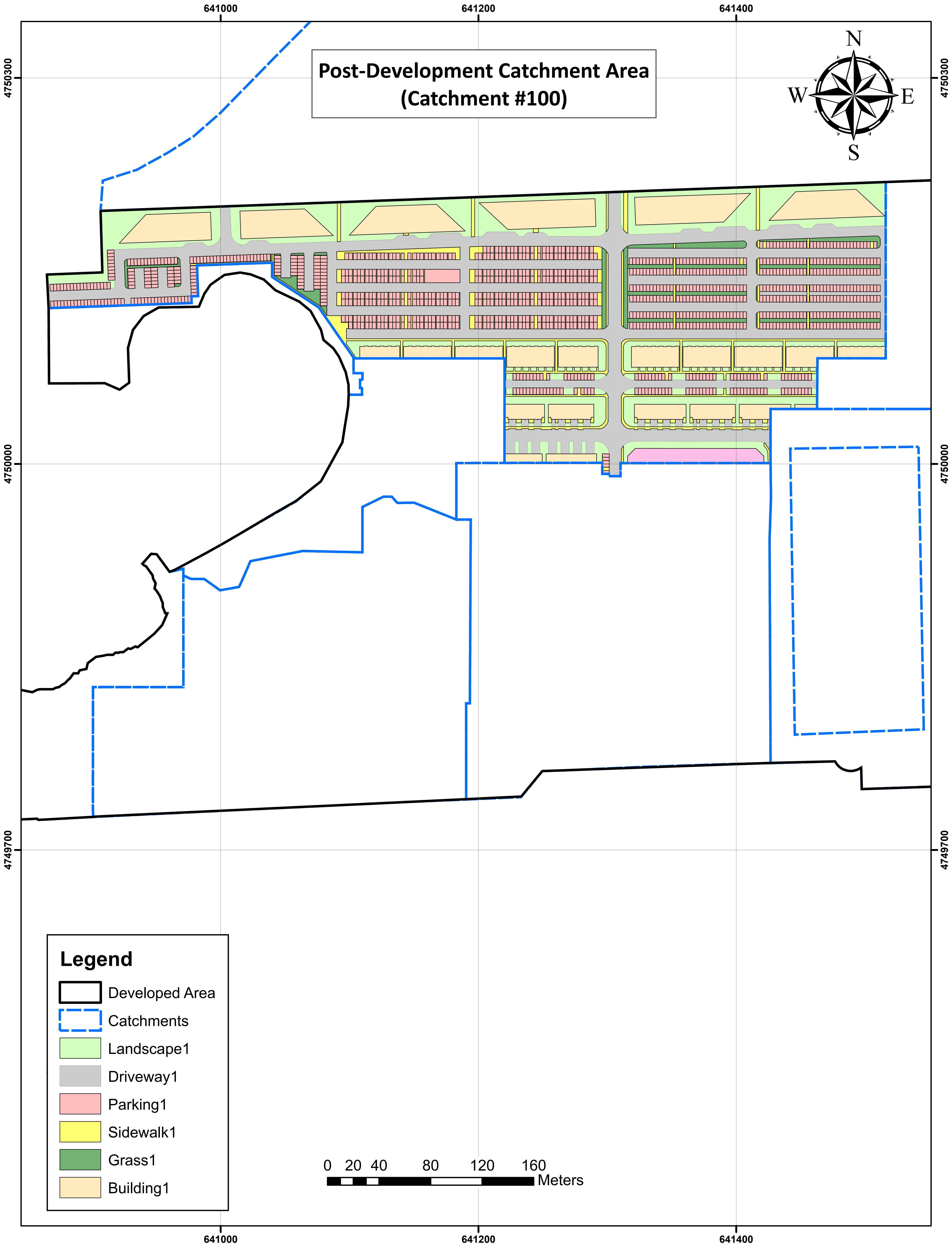
Developed Area

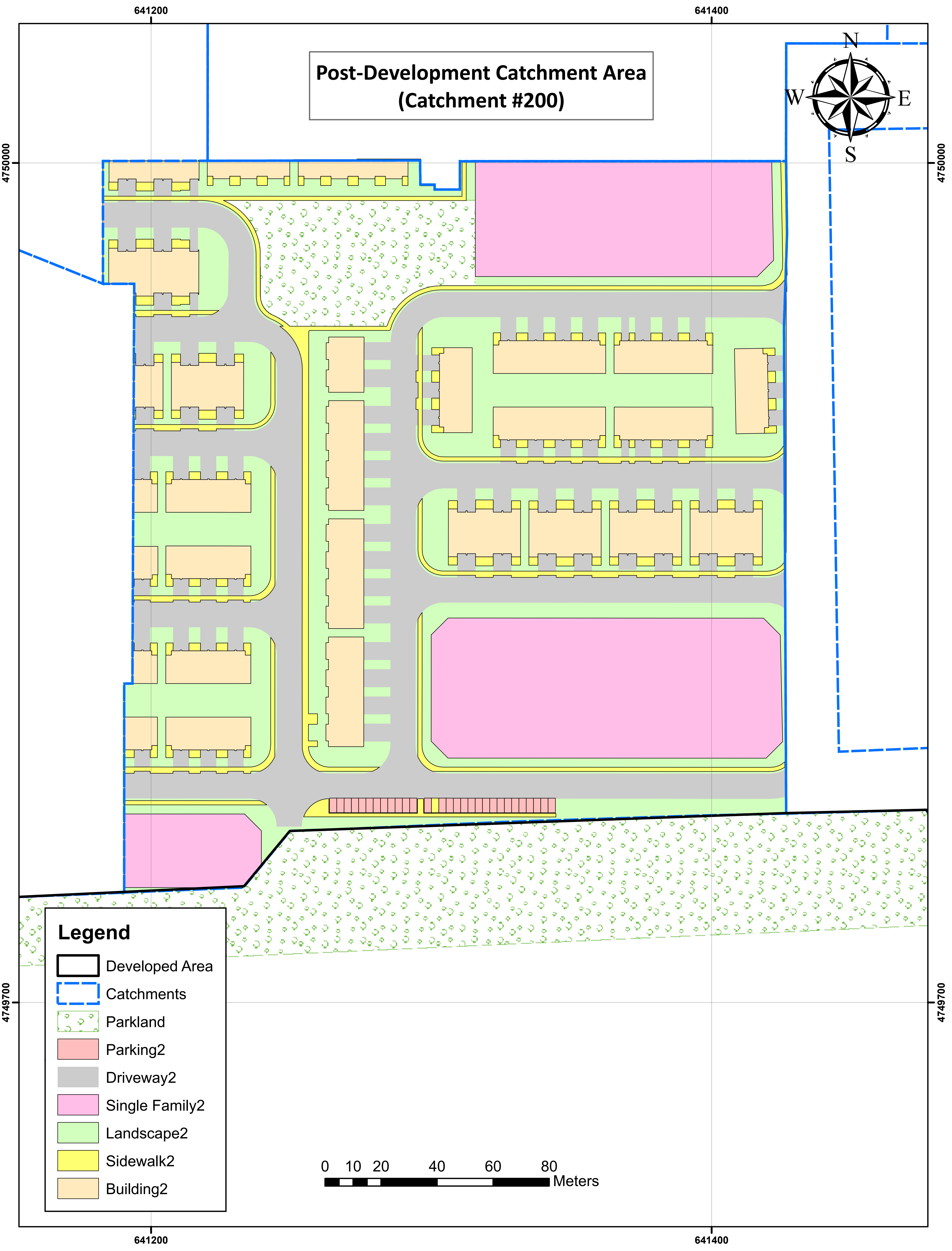
Catchment	Area (m2)	Impervious (m2)
Building	51762.1	51762.1
Driveway	82471.2	82471.2
Parking	22358.3	22358.3
Sidewalk	18353.9	18353.9
Single Family	33555.0	16777.5
Landscape	86663.6	0
Grass	4044.7	0
Parkland	3098.7	0
Total	**302307.5**	**191723.1**



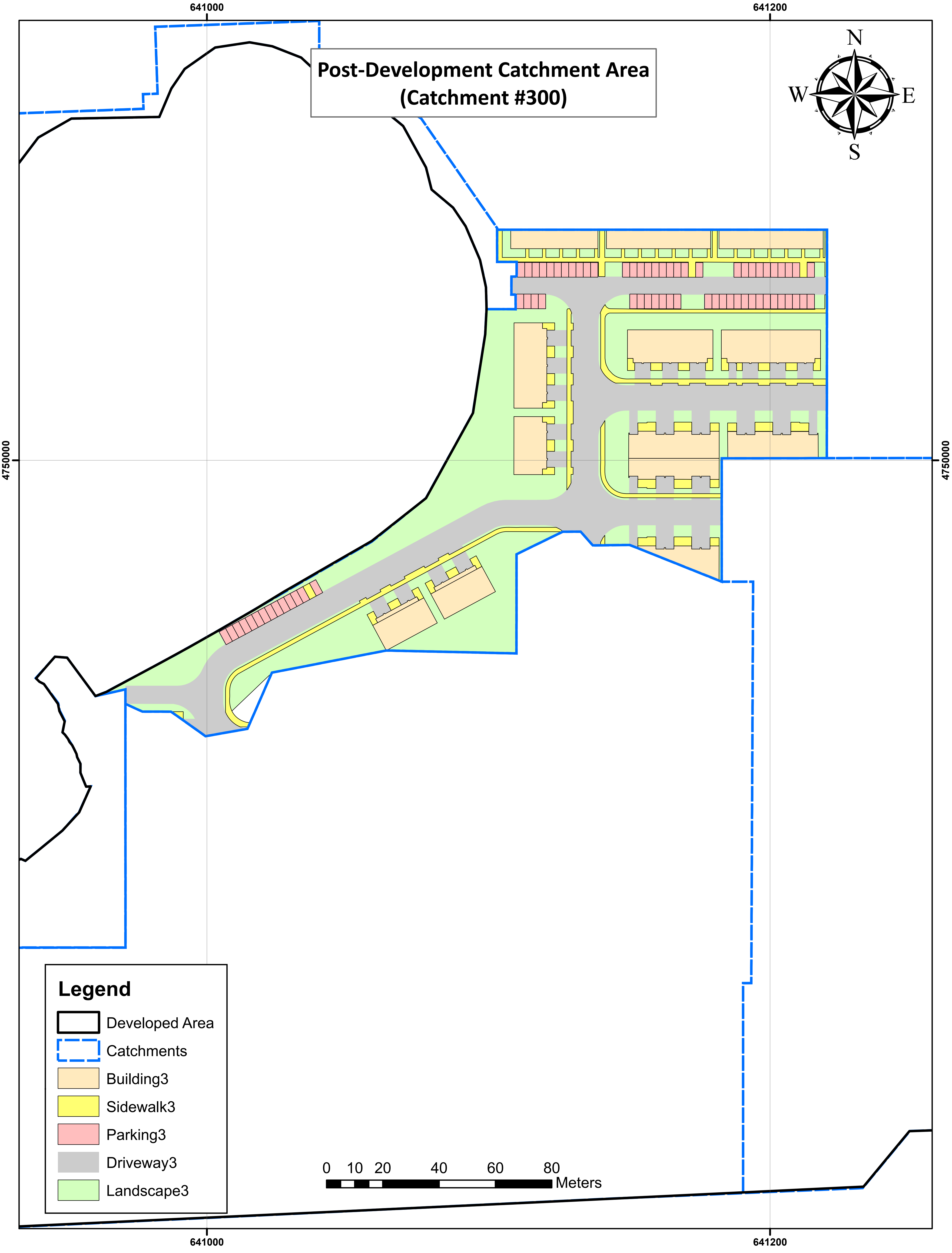
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Post-Development Catchment Area (Catchment #100)

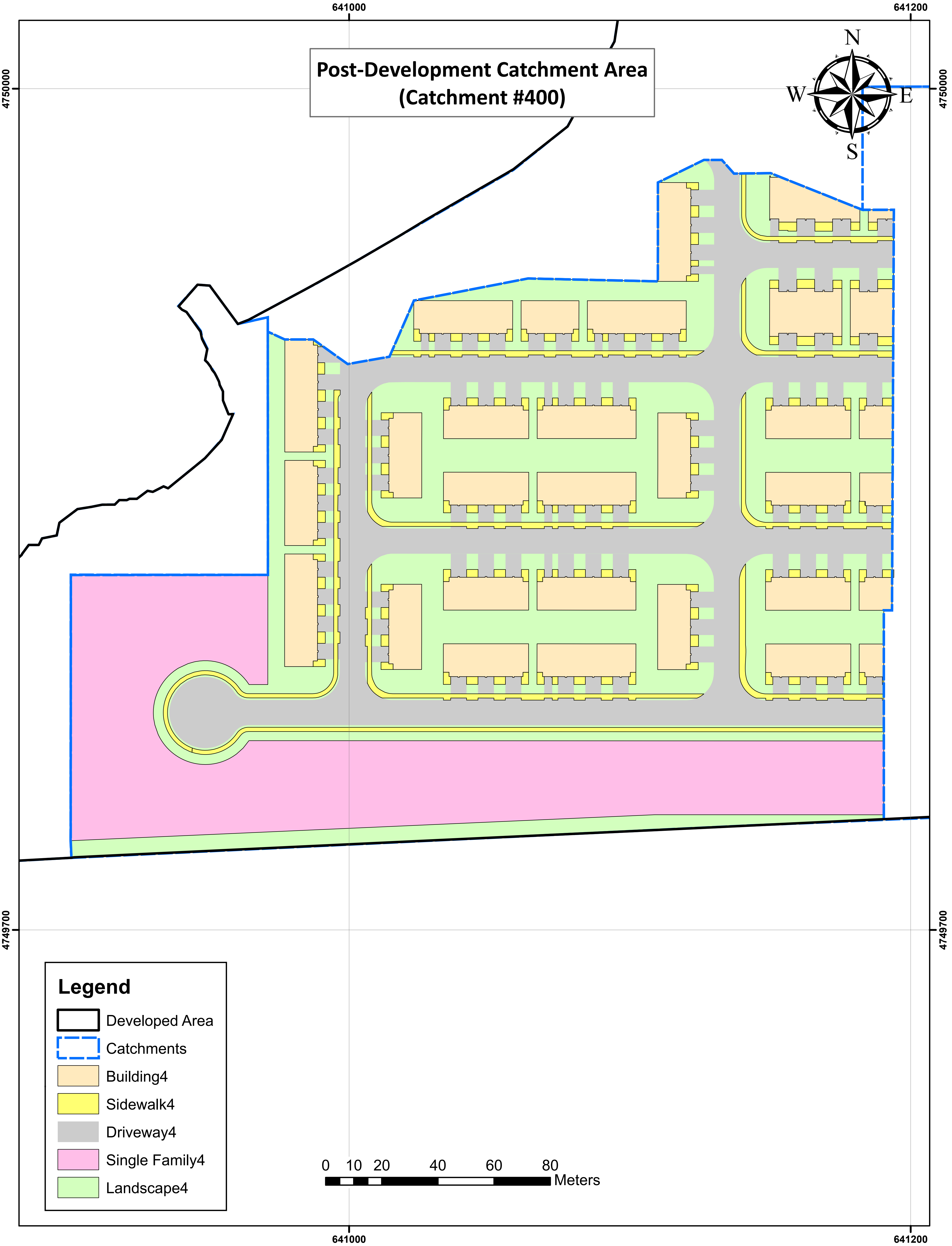


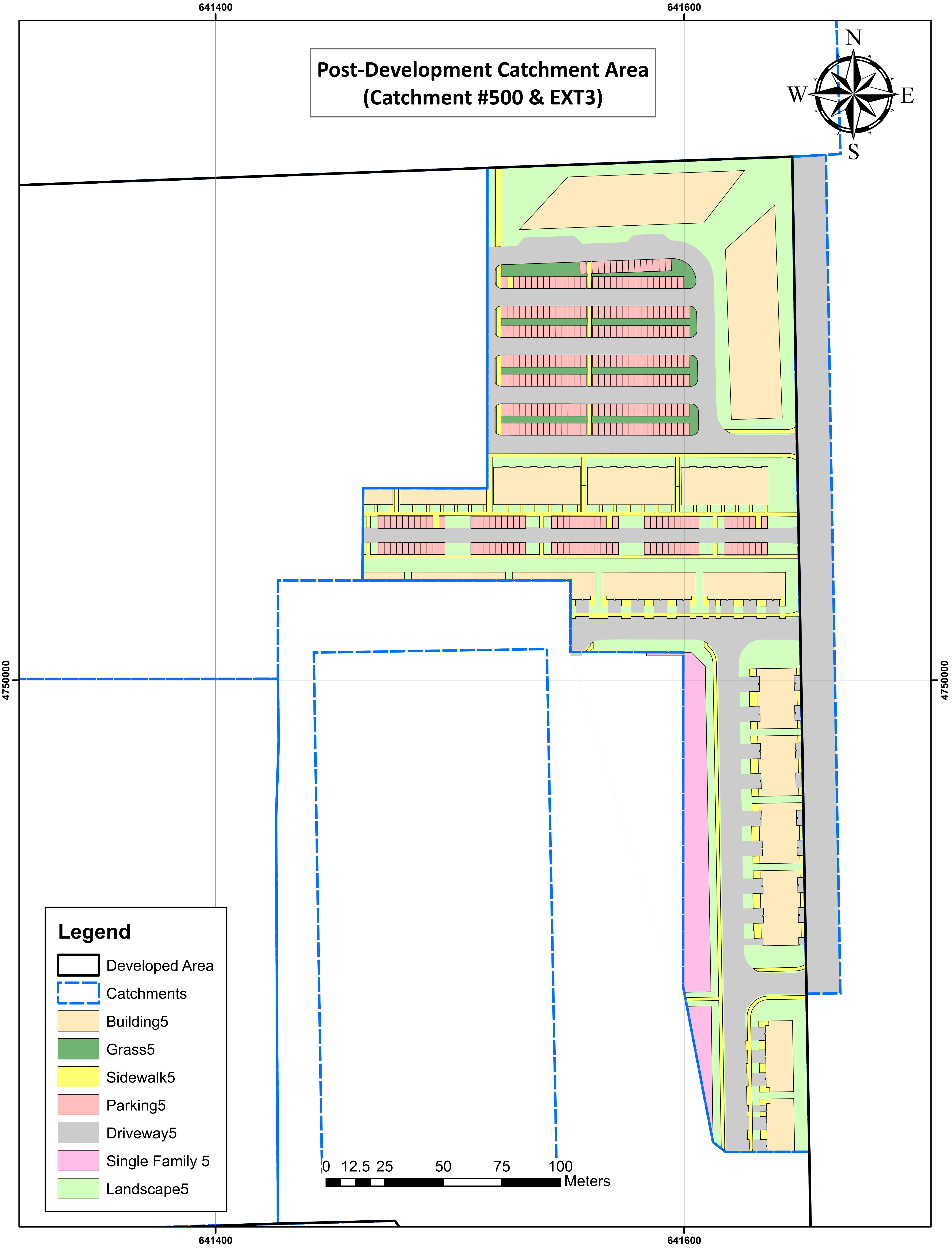


Post-Development Catchment Area (Catchment #200)


Post-Development Catchment Area
(Catchment #300)
641000
641200
4750000
4750000
641000
641200
N
W
E
S
Legend
Developed Area
Catchments
Building3
Sidewalk3
Parking3
Driveway3
Landscape3
0
10
20
40
60
80
Meters

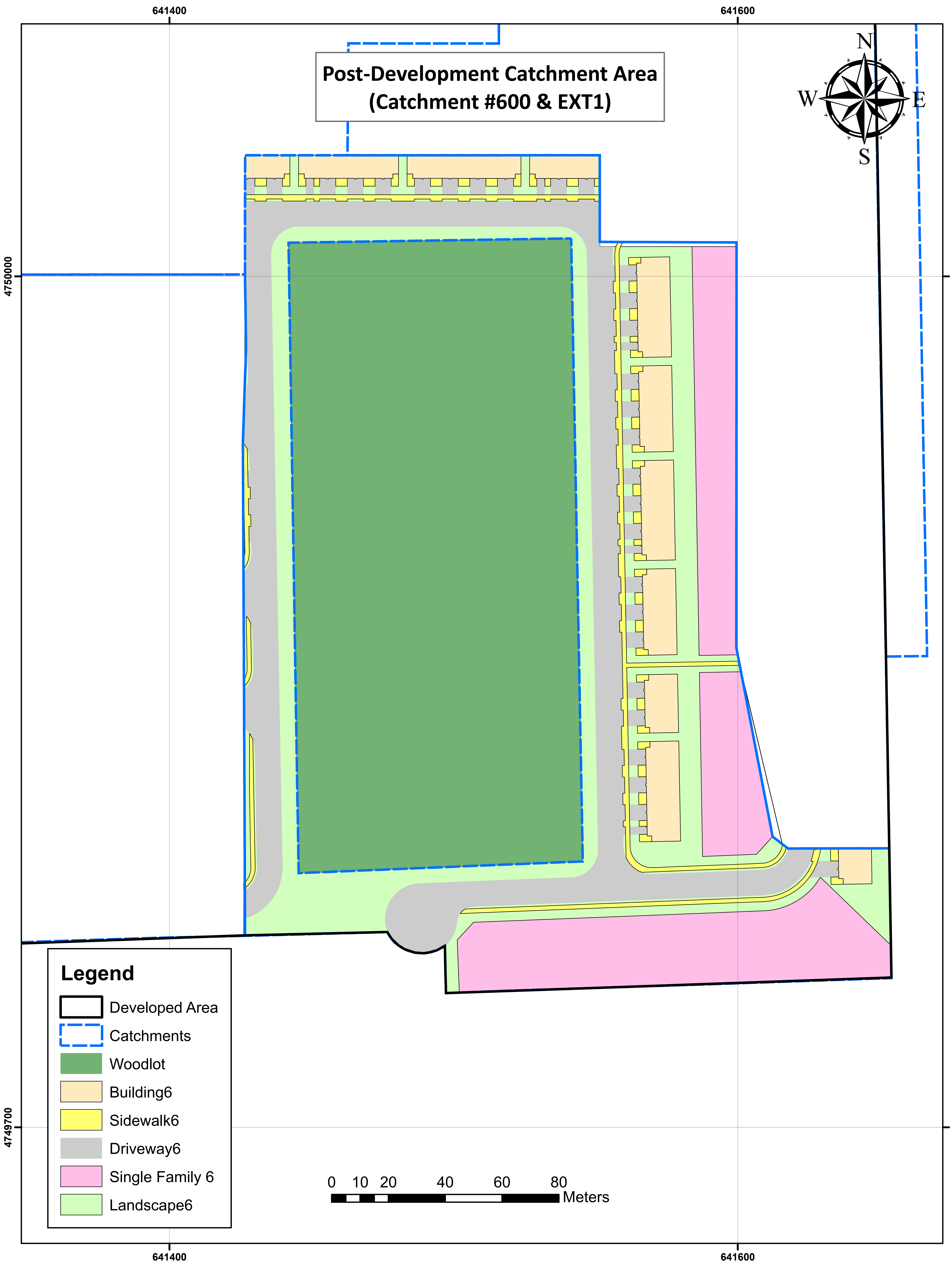
Post-Development Catchment Area
(Catchment #400)





Post-Development Catchment Area (Catchment #500 & EXT3)

Post-Development Catchment Area
(Catchment #600 & EXT1)



APPENDIX IX – RUNOFF COEFFICIENT CALCULATIONS

PRE-DEVELOPMENT (Runoff coefficient)

Ref.: Runoff Coefficients, Section 22, Appendix C, MTO Drainage Management Manual 1997 design chart 1.07 for rural & urban and Table 4.1, Stormwater Management Guidelines, Niagara Region, 2022.

Entire Site Boundary

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m²)	A × C	A × % Imp.
Grass	0.25	0.0	70452.81	17613.2	0.0
Parkland	0.35	0.0	359917.0	125970.93	0.0
Limestone Stockpile	1.0	100	11805.32	11805.3	11805.32
Wetland	0.05	0.0	31236.77	1561.8	0.0
Quarry Pond	0.05	0.0	76060.77	3803.0	0.0
Weighted Average			**549472.6**	**0.29**	**2.1%**

Developed Area

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m²)	A × C	A × % Imp.
Grass	0.25	0.0	70452.81	17613.2	0.0
Parkland	0.35	0.0	221573.76	77550.8	0.0
Limestone Stockpile	1.0	100	10280.95	10281	10280.95
Weighted Average			**302307.5**	**0.35**	**3.4%**

External Area

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m²)	A × % Imp.
EXT1 (Woodland)	0.20	0.0	22047.2	0.0
EXT2 (Northern Subdivision)	0.60	50	212438.6	106219.3
EXT3 (Eastern Street)	0.95	100	5160.5	5160.5

POST-DEVELOPMENT (Runoff coefficient)

Ref.: Runoff Coefficients, Section 22, Appendix C, MTO Drainage Management Manual 1997 design chart 1.07 for rural & urban and Table 4.1, Stormwater Management Guidelines, Niagara Region, 2022.

Entire Site Boundary

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m^2)	A × C	A × % Imp.
Building	0.95	100	51762.13	49174.0	51761.24
Driveway	0.95	100	82471.2	78347.6	82471.2
Parking	0.95	100	22358.3	21240.4	22358.3
Sidewalk	0.95	100	18353.9	17436.2	18353.9
Single Family	0.60	50	33555.0	20133.0	16777.5
Grass/Landscape	0.20	0.0	91082.09	22770.5	0.0
Parkland	0.35	0.0	142592.43	49907.4	0.0
Wetland	0.05	0.0	31236.77	1561.8	0.0
Quarry Pond	0.05	0.0	76060.77	3803.0	0.0
Weighted Average			**549472.6**	**0.48**	**34.9%**

Developed Area

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m^2)	A × C	A × % Imp.
Building	0.95	100	51762.13	49174.0	51762.13
Driveway	0.95	100	82471.2	78347.6	82471.2
Parking	0.95	100	22358.3	21240.4	22358.3
Sidewalk	0.95	100	18353.9	17436.2	18353.9
Single Family	0.60	50	33555.0	20133.0	16777.5
Grass/Landscape	0.20	0.0	90708.3	22677.1	0.0
Parkland	0.35	0.0	3098.70	1084.5	0.0
Weighted Average			**302307.5**	**0.69**	**63.4%**

Catchment # 100

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m^2)	A × C	A × % Imp.
Building	0.95	100	16300.7	15485.7	16300.7
Driveway	0.95	100	29683.8	28199.6	29683.8
Parking	0.95	100	16769.5	15931.0	16769.5
Sidewalk	0.95	100	5354.1	5086.4	5354.1
Single Family	0.60	50	1173.01	703.81	586.5
Grass/Landscape	0.20	0.0	16932.4	4233.1	0.0
Weighted Average			**86213.5**	**0.81**	**79.7%**

Catchment # 200

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m^2)	A × C	A × % Imp.
Building	0.95	100	9413.5	12104.46	9413.5
Driveway	0.95	100	15002.5	18395.22	15002.5
Parking	0.95	100	392.42	372.80	392.42
Sidewalk	0.95	100	3841.7	4882.16	3841.7
Single Family	0.60	50	11789.5	7823.03	5894.8
Grass/Landscape	0.20	0.0	13139.2	4200.7	0.0
Parkland	0.35	0.0	3098.7	1084.5	0.0
Weighted Average			**56677.4**	**0.68**	**61.0%**

Catchment # 300

Land Use	Runoff Coefficient "C"	% Imperviousness	Total Area (m^2)	A × C	A × % Imp.
Building	0.95	100	3498.9	3323.9	3498.9
Driveway	0.95	100	5647.2	5364.8	5647.2
Parking	0.95	100	960.75	912.7	960.75
Sidewalk	0.95	100	1568.9	1490.5	1568.9
Grass/Landscape	0.20	0.0	6252.95	1563.2	0.0
Weighted Average			**17928.6**	**0.67**	**59.5%**

Catchment # 400

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × C**	**A × % Imp.**
Building	0.95	100	10079.3	6790.1	10079.3
Driveway	0.95	100	13166.5	5402.6	13166.5
Sidewalk	0.95	100	3372.3	2146.7	3372.3
Single Family	0.60	50	11581.2	6199.2	5790.6
Grass/Landscape	0.20	0.0	13993.6	2663.70	0.0
Weighted Average			**52192.9**	**0.68**	**62.1%**

Catchment # 500

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × C**	**A × % Imp.**
Building	0.95	100	9249.1	8284.6	9249.1
Driveway	0.95	100	10522.3	9663.6	10522.3
Parking	0.95	100	4235.6	3676.8	4235.6
Sidewalk	0.95	100	2606.5	2251.7	2606.5
Single Family	0.60	50	1849.36	1109.6	924.7
Grass/Landscape	0.20	0.0	10773.7	2559.2	0.0
Weighted Average			**39236.6**	**0.74**	**70.2%**

Catchment # 600

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × C**	**A × % Imp.**
Building	0.95	100	3220.72	3059.7	3220.72
Driveway	0.95	100	8448.84	8026.4	8448.84
Sidewalk	0.95	100	1610.4	1529.9	1610.4
Single Family	0.60	50	7162.02	4297.2	3581.0
Grass/Landscape	0.20	0.0	8654.9	2163.7	0.0
Weighted Average			**29007.0**	**0.66**	**58.0%**

Catchment # INT1

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × C**	**A × % Imp.**
Grass/Landscape	0.20	0.0	5751.2	1437.8	0.0
Weighted Average			**5751.2**	**0.20**	**0.0%**

Catchment # INT2

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × C**	**A × % Imp.**
Grass/Landscape	0.20	0.0	15210.4	3802.6	0.0
Weighted Average			**15210.4**	**0.20**	**0.0%**

External Area

Land Use	**Runoff Coefficient "C"**	**% Imperviousness**	**Total Area (m^2)**	**A × % Imp.**
EXT1 (Woodland)	0.20	0.0	22047.2	0.0
EXT2 (Northern Subdivision)	0.60	50	212438.6	106219.3
EXT3 (Eastern Street)	0.95	100	5160.5	5160.5

APPENDIX X –STORMWATER MANAGEMENT CALCULATIONS

STORMWATER MANAGEMENT CALCULATIONS

Pre-Development Peak Flows

Storm (yrs)	City of Port Colborne Coeff A	Coeff B	Coeff C
2	755	0.789	8.0
5	830	0.777	7.3
10	860	0.763	6.5
25	900	0.745	5.2
50	960	0.736	5.1
100	1020	0.731	4.7

Modified Rational Method
Q= CaCIA/360

Where:
Q- Flow Rate (m3/s)
Ca- Peaking Coefficient
C- Rational Method Runoff Coefficient
I- Storm Intensity (mm/hr)
A- Area (ha)

Area #	Developed Area	
Area	30.23	ha
Runoff Coefficient	0.35	
Time of Concentration	78.2	min
Return Rate	2	year
Peaking Coefficient	1.0	
Rainfall Intensity	22.44	mm/hr
Pre-Development Peak Flow	0.66	cms
Return Rate	5	year
Peaking Coefficient	1.0	
Rainfall Intensity	26.19	mm/hr
Pre-Development Peak Flow	0.77	cms
Return Rate	10	year
Peaking Coefficient	1.0	
Rainfall Intensity	29.09	mm/hr
Pre-Development Peak Flow	0.85	cms
Return Rate	25	year
Peaking Coefficient	1.1	
Rainfall Intensity	33.35	mm/hr
Pre-Development Peak Flow	1.07	cms
Return Rate	50	year
Peaking Coefficient	1.2	
Rainfall Intensity	37.05	mm/hr
Pre-Development Peak Flow	1.30	cms
Return Rate	100	year
Peaking Coefficient	1.25	
Rainfall Intensity	40.39	mm/hr
Pre-Development Peak Flow	1.48	cms

Post-Development Peak Flows

	City of Port Colborne		
Storm (yrs)	Coeff A	Coeff B	
2	755	0.789	8.0
5	830	0.777	7.3
10	860	0.763	6.5
25	900	0.745	5.2
50	960	0.736	5.1
100	1020	0.731	4.7

Modified Rational Method
Q= CaCIA/360

Where:
Q- Flow Rate (m3/s)
Ca- Peaking Coefficient
C- Rational Method Runoff Coefficient
I- Storm Intensity (mm/hr)
A- Area (ha)

Area #	Developed Area
Area	30.23 ha
Runoff Coefficient	0.69
Time of Concentration	15.1 min
Return Rate	2 year
Peaking Coefficient	1.0
Rainfall Intensity	63.35 mm/hr
Post-Development Peak Flow	3.70 cms
Return Rate	5 year
Peaking Coefficient	1.0
Rainfall Intensity	74.07 mm/hr
Post-Development Peak Flow	4.32 cms
Return Rate	10 year
Peaking Coefficient	1.0
Rainfall Intensity	82.42 mm/hr
Post-Development Peak Flow	4.81 cms
Return Rate	25 year
Peaking Coefficient	1.1
Rainfall Intensity	95.47 mm/hr
Post-Development Peak Flow	6.13 cms
Return Rate	50 year
Peaking Coefficient	1.2
Rainfall Intensity	105.01 mm/hr
Post-Development Peak Flow	7.35 cms
Return Rate	100 year
Peaking Coefficient	1.25
Rainfall Intensity	114.93 mm/hr
Post-Development Peak Flow	8.38 cms

Pre-Development Peak Flows – Catchments

	City of Port Colborne		
Storm (yrs)	Coeff A	Coeff B	Coeff C
2	755	0.789	8.0
5	830	0.777	7.3
10	860	0.763	6.5
25	900	0.745	5.2
50	960	0.736	5.1
100	1020	0.731	4.7

Modified Rational Method
Q= CaCIA/360

Where:
Q- Flow Rate (m3/s)
Ca- Peaking Coefficient
C- Rational Method Runoff Coefficient
I- Storm Intensity (mm/hr)
A- Area (ha)

		Woodlot	North subdivision	Eastern Street
Area #	Developed area	EXT1	EXT2	EXT3
Area	30.23 ha	2.20 ha	21.24 ha	0.52 ha
Runoff Coefficient	0.35	0.20	0.60	0.25
Time of Concentration	78.2 min	10 min	37.1 min	65.6 min
Return Rate	2 year	2 year	2 year	2 year
Peaking Coefficient	1.0	1.0	1.0	1.0
Rainfall Intensity	22.44 mm/hr	77.19 mm/hr	37.37 mm/hr	25.40 mm/hr
Pre-Development Peak Flow	0.66 cms	0.09 cms	1.32 cms	0.01 cms
Return Rate	5 year	5 year	5 year	5 year
Peaking Coefficient	1.0	1.0	1.0	1.0
Rainfall Intensity	26.19 mm/hr	90.60 mm/hr	43.53 mm/hr	29.62 mm/hr
Pre-Development Peak Flow	0.77 cms	0.11 cms	1.54 cms	0.01 cms
Return Rate	10 year	10 year	10 year	10 year
Peaking Coefficient	1.0	1.0	1.0	1.0
Rainfall Intensity	29.09 mm/hr	101.29 mm/hr	48.23 mm/hr	32.87 mm/hr
Pre-Development Peak Flow	0.85 cms	0.12 cms	1.71 cms	0.01 cms
Return Rate	25 year	25 year	25 year	25 year
Peaking Coefficient	1.1	1.1	1.1	1.1
Rainfall Intensity	33.35 mm/hr	118.51 mm/hr	55.26 mm/hr	37.66 mm/hr
Pre-Development Peak Flow	1.07 cms	0.16 cms	2.15 cms	0.01 cms
Return Rate	50 year	50 year	50 year	50 year
Peaking Coefficient	1.2	1.2	1.2	1.2
Rainfall Intensity	37.05 mm/hr	130.18 mm/hr	61.07 mm/hr	41.78 mm/hr
Pre-Development Peak Flow	1.30 cms	0.19 cms	2.59 cms	0.02 cms
Return Rate	100 year	100 year	100 year	100 year
Peaking Coefficient	1.25	1.25	1.25	1.25
Rainfall Intensity	40.39 mm/hr	142.99 mm/hr	66.57 mm/hr	45.54 mm/hr
Pre-Development Peak Flow	1.48 cms	0.22 cms	2.95 cms	0.02 cms

Post-Development Peak Flows – Catchments

Storm (yrs)	City of Port Colborne Coeff A	Coeff B	
2	755	0.789	8.0
5	830	0.777	7.3
10	860	0.763	6.5
25	900	0.745	5.2
50	960	0.736	5.1
100	1020	0.731	4.7

Modified Rational Method
Q= CaCIA/360

Where:

Q-	Flow Rate (m3/s)
Ca-	Peaking Coefficient
C-	Rational Method Runoff Coefficient
I-	Storm Intensity (mm/hr)
A-	Area (ha)

3.7

Area #	100	200	300	400	500
Area	8.62 ha	5.67 ha	1.79 ha	5.22 ha	3.92 ha
Runoff Coefficient	0.81	0.68	0.71	0.68	0.74
Time of Concentration	14.6 min	13.5 min	14.0 min	13.3 min	14.6 min
Return Rate	2 year	2 year	2 year	2 year	2 year
Peaking Coefficient	1.0	1.0	1.0	1.0	1.0
Rainfall Intensity	64.52 mm/hr	67.13 mm/hr	65.85 mm/hr	67.54 mm/hr	64.45 mm/hr
Post-Development Peak Flow	1.25 cms	0.72 cms	0.23 cms	0.67 cms	0.52 cms
Return Rate	5 year	5 year	5 year	5 year	5 year
Peaking Coefficient	1.0	1.0	1.0	1.0	1.0
Rainfall Intensity	75.46 mm/hr	78.57 mm/hr	77.04 mm/hr	79.05 mm/hr	75.37 mm/hr
Post-Development Peak Flow	1.46 cms	0.84 cms	0.27 cms	0.78 cms	0.61 cms
Return Rate	10 year	10 year	10 year	10 year	10 year
Peaking Coefficient	1.0	1.0	1.0	1.0	1.0
Rainfall Intensity	83.99 mm/hr	87.52 mm/hr	85.79 mm/hr	88.08 mm/hr	83.89 mm/hr
Post-Development Peak Flow	1.62 cms	0.94 cms	0.30 cms	0.87 cms	0.68 cms
Return Rate	25 year	25 year	25 year	25 year	25 year
Peaking Coefficient	1.1	1.1	1.1	1.1	1.1
Rainfall Intensity	97.37 mm/hr	101.63 mm/hr	99.53 mm/hr	102.31 mm/hr	97.24 mm/hr
Post-Development Peak Flow	2.07 cms	1.2 cms	0.38 cms	1.12 cms	0.86 cms
Return Rate	50 year	50 year	50 year	50 year	50 year
Peaking Coefficient	1.2	1.2	1.2	1.2	1.2
Rainfall Intensity	107.08 mm/hr	111.74 mm/hr	109.45 mm/hr	112.48 mm/hr	106.95 mm/hr
Post-Development Peak Flow	2.49 cms	1.44 cms	0.46 cms	1.34 cms	1.04 cms
Return Rate	100 year	100 year	100 year	100 year	100 year
Peaking Coefficient	1.25	1.25	1.25	1.25	1.25
Rainfall Intensity	117.23 mm/hr	122.41 mm/hr	119.86 mm/hr	123.22 mm/hr	117.08 mm/hr
Post-Development Peak Flow	2.83 cms	1.64 cms	0.53 cms	1.53 cms	1.18 cms

	Grass	Grass	Woodlot	North subdivision	Eastern Street
600	INT1	INT2	EXT1	EXT2	EXT3
2.91 ha	0.58 ha	1.52 ha	2.20 ha	21.24 ha	0.52 ha
0.66	0.25	0.25	0.20	0.60	0.95
15.1 min	28.2 min	40.9 min	10 min	37.1 min	14.1 min
2 year	2 year	2 year	2 year	2 year	2 year
1.0	1.0	1.0	1.0	1.0	1.0
63.35 mm/hr	44.49 mm/hr	35.11 mm/hr	77.19 mm/hr	37.37 mm/hr	65.57 mm/hr
0.34 cms	0.02 cms	0.04 cms	0.09 cms	1.32 cms	0.09 cms
5 year	5 year	5 year	5 year	5 year	5 year
1.0	1.0	1.0	1.0	1.0	1.0
74.07 mm/hr	51.84 mm/hr	40.89 mm/hr	90.60 mm/hr	43.53 mm/hr	76.70 mm/hr
0.39 cms	0.02 cms	0.04 cms	0.11 cms	1.54 cms	0.10 cms
10 year	10 year	10 year	10 year	10 year	10 year
1.0	1.0	1.0	1.0	1.0	1.0
82.42 mm/hr	57.45 mm/hr	45.31 mm/hr	101.29 mm/hr	48.23 mm/hr	85.40 mm/hr
0.44 cms	0.02 cms	0.05 cms	0.12 cms	1.71 cms	0.12 cms
25 year	25 year	25 year	25 year	25 year	25 year
1.1	1.1	1.1	1.1	1.1	1.1
95.47 mm/hr	65.94 mm/hr	51.89 mm/hr	118.51 mm/hr	55.26 mm/hr	99.07 mm/hr
0.56 cms	0.03 cms	0.06 cms	0.16 cms	2.15 cms	0.15 cms
50 year	50 year	50 year	50 year	50 year	50 year
1.2	1.2	1.2	1.2	1.2	1.2
105.01 mm/hr	72.75 mm/hr	57.38 mm/hr	130.18 mm/hr	61.07 mm/hr	108.94 mm/hr
0.67 cms	0.03 cms	0.07 cms	0.19 cms	2.59 cms	0.18 cms
100 year	100 year	100 year	100 year	100 year	100 year
1.25	1.25	1.25	1.25	1.25	1.25
114.93 mm/hr	79.36 mm/hr	62.54 mm/hr	142.99 mm/hr	66.57 mm/hr	119.29 mm/hr
0.76 cms	0.04 cms	0.08 cms	0.22 cms	2.95 cms	0.20 cms

Allowable Release Rate

$$Q = P_{pre} - Q_U$$

Where:

Q = Allowable Post-Development Release Rate
Q_{PRE} = Pre-Development Flow
Q_U = Post-Development Uncontrolled Flow

Storm	Pre-Development Flow	Post- Development Uncontrolled Flow	Allowable Outflow	Pond Release
(yrs)	Qpre (cms)	Q_U (cms)	Q (cms)	Q (cms)
2	2.1	0.0	2.08	0.0
5	2.4	0.0	2.43	0.0
10	2.7	0.0	2.70	0.0
25	3.4	0.0	3.40	0.0
50	4.1	0.0	4.11	0.0
100	4.7	0.0	4.66	0.0

Quantity Control Volume Calculations

Drainage Area (ha)	**30.23**
Runoff Coeff. (C)	**0.69**
Time of Concentration	14.9 min
Time Step	2 min
Controlled Release Rate (Q_C) (l/s)	0.0
Max. Storage Required (m3)	**3537.7**

Results

Storm Event	**Storage**	**Time**
(yr)	**(m3)**	**(min)**
2	1507.8	12
5	1774.9	12
10	1990.6	12
25	2586.9	12
50	3081.1	12
100	3537.7	12

Required Storage Volumes (2yr)

T	$I = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V = V_R - V_C$
Time	Rainfall Intensity	Runoff	Runoff Vol.	Controlled Release Vol.	Storage Vol.
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	122.73	7.220	866.4	0.0	866.4
4	106.29	6.252	1500.6	500.2	1000.4
6	94.11	5.536	1993.1	750.3	1242.8
8	84.70	4.983	2391.7	1000.4	1391.3
10	77.19	4.541	2724.3	1250.5	1473.8
12	71.03	4.178	3008.4	1500.6	1507.8
14	65.88	3.876	3255.5	1750.7	1504.8
16	61.51	3.619	3473.8	2000.8	1472.9
18	57.75	3.397	3668.8	2250.9	1417.9
20	54.47	3.204	3844.9	2501.0	1343.9

🟨 :Maximum Storage Volume

Required Storage Volumes (5yr)

T	$I = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V = V_R - V_C$
Time	Rainfall Intensity	Runoff	Runoff Vol.	Controlled Release Vol.	Storage Vol.
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	146.75	8.632	1035.9	291.6	744.3
4	126.14	7.420	1780.8	583.2	1197.6
6	111.13	6.538	2353.5	874.8	1478.7
8	99.67	5.863	2814.4	1166.4	1648.0
10	90.60	5.329	3197.7	1458.0	1739.7
12	83.21	4.895	3524.5	1749.6	1774.9
14	77.08	4.534	3808.7	2041.3	1767.4
16	71.89	4.229	4059.6	2332.9	1726.7
18	67.43	3.967	4284.0	2624.5	1659.5
20	63.56	3.739	4486.7	2916.1	1570.7

🟨 :Maximum Storage Volume

Required Storage Volumes (10yr)

T	$I = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V = V_R - V_C$
Time	Rainfall Intensity	Runoff	Runoff Vol.	Controlled Release Vol.	Storage Vol.
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	168.02	9.884	1186.0	323.5	862.6
4	143.00	8.412	2018.9	646.9	1372.0
6	125.19	7.364	2651.1	970.4	1680.7
8	111.78	6.576	3156.4	1293.9	1862.5
10	101.29	5.958	3575.0	1617.3	1957.7
12	92.82	5.460	3931.4	1940.8	1990.6
14	85.83	5.049	4241.1	2264.3	1976.8
16	79.94	4.703	4514.6	2587.7	1926.9
18	74.91	4.407	4759.5	2911.2	1848.3
20	70.56	4.151	4981.0	3234.7	1746.3

🟨 :Maximum Storage Volume

Required Storage Volumes (25yr)

T	$i = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V= V_R-V_C$
Time	**Rainfall Intensity**	**Runoff**	**Runoff Vol.**	**Controlled Release Vol.**	**Storage Vol.**
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	206.79	13.381	1605.7	408.2	1197.6
4	172.27	11.148	2675.4	816.3	1859.1
6	148.79	9.628	3466.1	1224.5	2241.6
8	131.65	8.519	4089.0	1632.6	2456.4
10	118.51	7.669	4601.3	2040.8	2560.6
12	108.09	6.994	5035.8	2448.9	2586.9
14	99.58	6.444	5412.8	2857.1	2555.8
16	92.50	5.985	5745.9	3265.2	2480.6
18	86.49	5.596	6044.2	3673.4	2370.8
20	81.32	5.262	6314.6	4081.5	2233.0

🟨 :Maximum Storage Volume

Required Storage Volumes (50yr)

T	$i = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V= V_R-V_C$
Time	**Rainfall Intensity**	**Runoff**	**Runoff Vol.**	**Controlled Release Vol.**	**Storage Vol.**
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	226.85	16.014	1921.7	492.8	1428.9
4	188.98	13.340	3201.7	985.5	2216.2
6	163.27	11.526	4149.2	1478.3	2670.9
8	144.53	10.203	4897.2	1971.1	2926.2
10	130.18	9.190	5513.7	2463.8	3049.9
12	118.79	8.386	6037.7	2956.6	3081.1
14	109.50	7.730	6493.2	3449.4	3043.9
16	101.77	7.184	6896.4	3942.1	2954.3
18	95.20	6.721	7258.2	4434.9	2823.3
20	89.56	6.322	7586.5	4927.6	2658.9

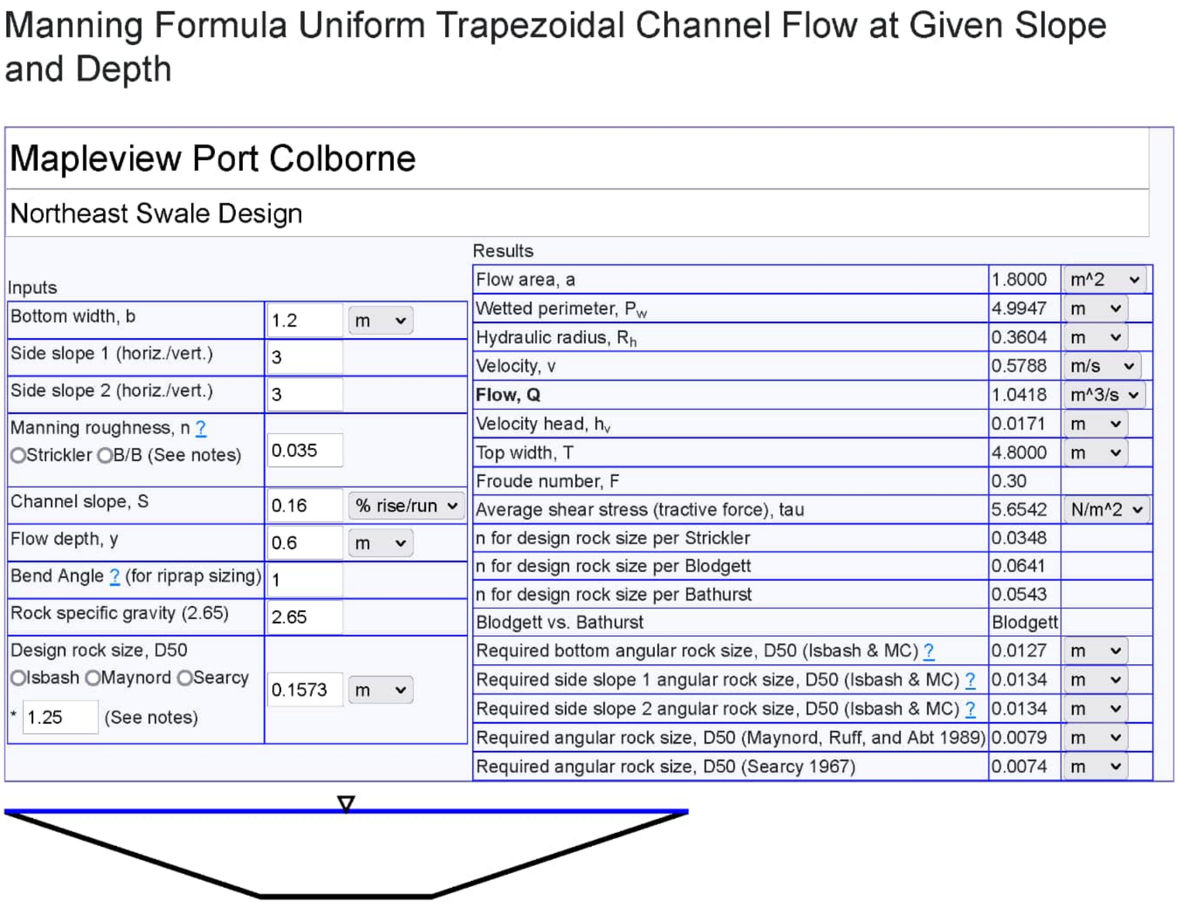
🟨 :Maximum Storage Volume

Required Storage Volumes (100yr)

T	$i = A/(t+B)^C$	$Q_R = 0.0028(C.Ca.I.A)$	$V_R = Q_R.T.60$	$V_C = Q_C.T.60$	$V= V_R-V_C$
Time	**Rainfall Intensity**	**Runoff**	**Runoff Vol.**	**Controlled Release Vol.**	**Storage Vol.**
(min)	(mm/hr)	(cms)	(m3)	(m3)	(m3)
2	253.94	18.673	2240.8	559.7	1681.0
4	209.80	15.427	3702.6	1119.5	2583.1
6	180.35	13.262	4774.2	1679.2	3095.0
8	159.12	11.700	5616.2	2239.0	3377.2
10	142.99	10.514	6308.4	2798.7	3509.7
12	130.26	9.578	6896.1	3358.5	3537.7
14	119.92	8.818	7407.0	3918.2	3488.8
16	111.33	8.187	7859.2	4478.0	3381.2
18	104.07	7.653	8265.1	5037.7	3227.4
20	97.85	7.195	8633.7	5597.5	3036.3

🟨 :Maximum Storage Volume

S = 0.16% (North-East Swale)



Manning Formula Uniform Trapezoidal Channel Flow at Given Slope and Depth

Mapleview Port Colborne

Northeast Swale Design

Inputs

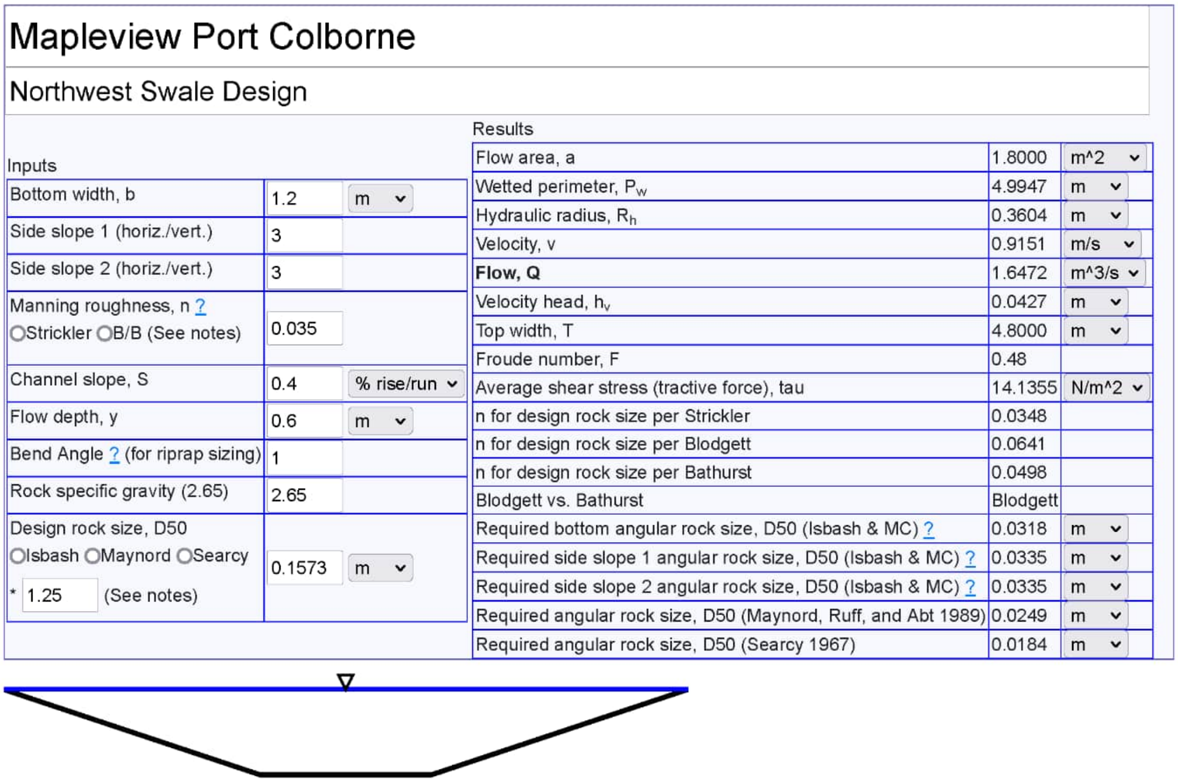
Bottom width, b	1.2	m
Side slope 1 (horiz./vert.)	3	
Side slope 2 (horiz./vert.)	3	
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.035	
Channel slope, S	0.16	% rise/run
Flow depth, y	0.6	m
Bend Angle ? (for riprap sizing)	1	
Rock specific gravity (2.65)	2.65	
Design rock size, D50 ○Isbash ○Maynord ○Searcy * 1.25 (See notes)	0.1573	m

Results

Flow area, a	1.8000	m^2
Wetted perimeter, P_w	4.9947	m
Hydraulic radius, R_h	0.3604	m
Velocity, v	0.5788	m/s
Flow, Q	1.0418	m^3/s
Velocity head, h_v	0.0171	m
Top width, T	4.8000	m
Froude number, F	0.30	
Average shear stress (tractive force), tau	5.6542	N/m^2
n for design rock size per Strickler	0.0348	
n for design rock size per Blodgett	0.0641	
n for design rock size per Bathurst	0.0543	
Blodgett vs. Bathurst	Blodgett	
Required bottom angular rock size, D50 (Isbash & MC) ?	0.0127	m
Required side slope 1 angular rock size, D50 (Isbash & MC) ?	0.0134	m
Required side slope 2 angular rock size, D50 (Isbash & MC) ?	0.0134	m
Required angular rock size, D50 (Maynord, Ruff, and Abt 1989)	0.0079	m
Required angular rock size, D50 (Searcy 1967)	0.0074	m

S = 0.4% (North-West Swale)

Manning Formula Uniform Trapezoidal Channel Flow at Given Slope and Depth



Mapleview Port Colborne

Northwest Swale Design

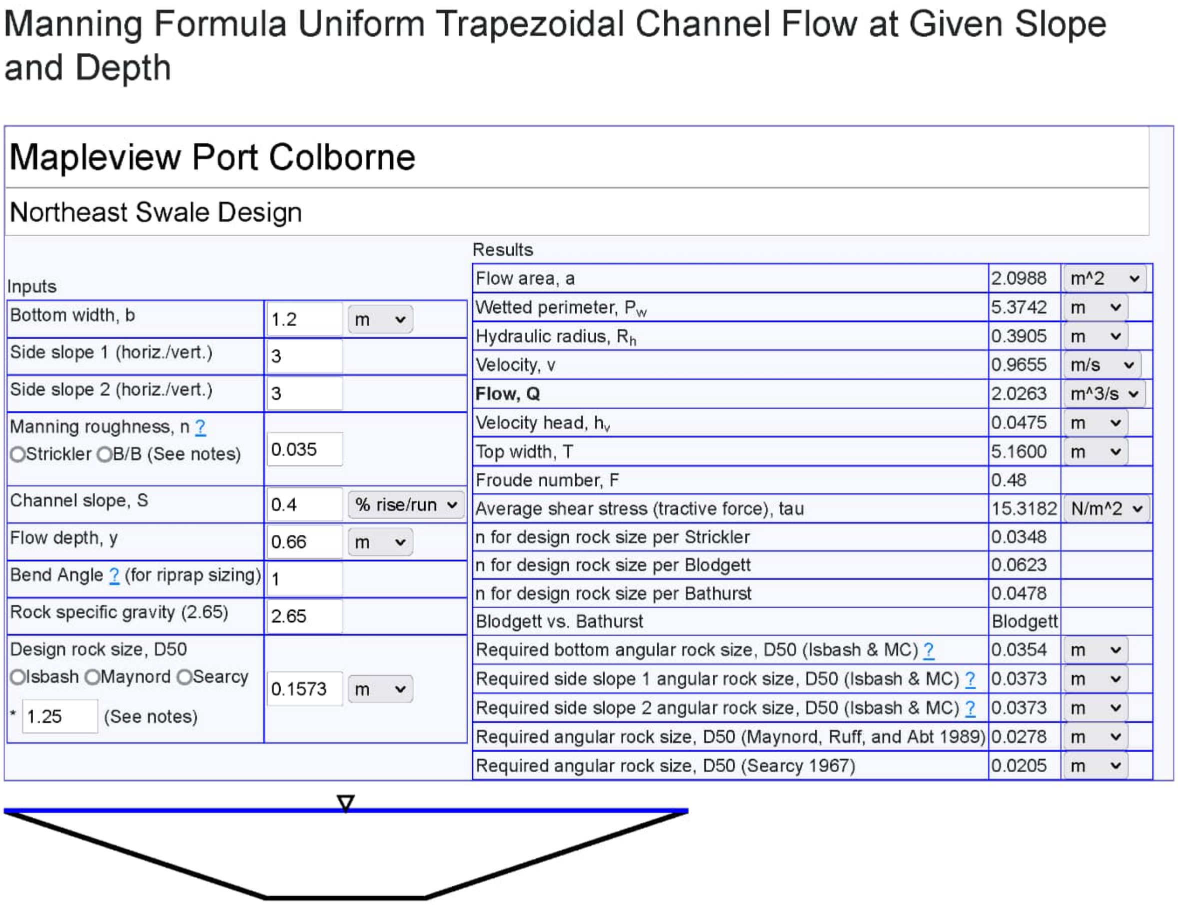
Inputs

Bottom width, b	1.2	m
Side slope 1 (horiz./vert.)	3	
Side slope 2 (horiz./vert.)	3	
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.035	
Channel slope, S	0.4	% rise/run
Flow depth, y	0.6	m
Bend Angle ? (for riprap sizing)	1	
Rock specific gravity (2.65)	2.65	
Design rock size, D50 ○Isbash ○Maynord ○Searcy * 1.25 (See notes)	0.1573	m

Results

Flow area, a	1.8000	m^2
Wetted perimeter, P_w	4.9947	m
Hydraulic radius, R_h	0.3604	m
Velocity, v	0.9151	m/s
Flow, Q	1.6472	m^3/s
Velocity head, h_v	0.0427	m
Top width, T	4.8000	m
Froude number, F	0.48	
Average shear stress (tractive force), tau	14.1355	N/m^2
n for design rock size per Strickler	0.0348	
n for design rock size per Blodgett	0.0641	
n for design rock size per Bathurst	0.0498	
Blodgett vs. Bathurst	Blodgett	
Required bottom angular rock size, D50 (Isbash & MC) ?	0.0318	m
Required side slope 1 angular rock size, D50 (Isbash & MC) ?	0.0335	m
Required side slope 2 angular rock size, D50 (Isbash & MC) ?	0.0335	m
Required angular rock size, D50 (Maynord, Ruff, and Abt 1989)	0.0249	m
Required angular rock size, D50 (Searcy 1967)	0.0184	m

S = 0.4% (South Swale)



Manning Formula Uniform Trapezoidal Channel Flow at Given Slope and Depth

Mapleview Port Colborne

Northeast Swale Design

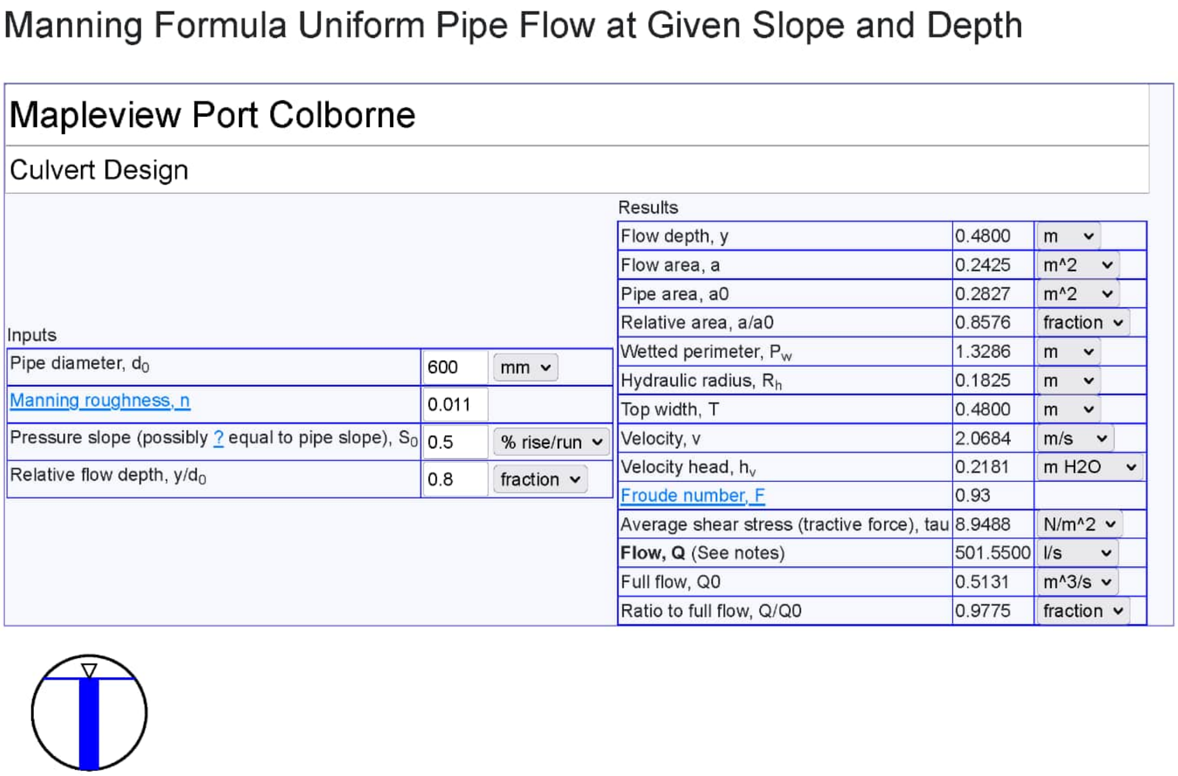
Inputs

Bottom width, b	1.2	m
Side slope 1 (horiz./vert.)	3	
Side slope 2 (horiz./vert.)	3	
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.035	
Channel slope, S	0.4	% rise/run
Flow depth, y	0.66	m
Bend Angle ? (for riprap sizing)	1	
Rock specific gravity (2.65)	2.65	
Design rock size, D50 ○Isbash ○Maynord ○Searcy * 1.25 (See notes)	0.1573	m

Results

Flow area, a	2.0988	m^2
Wetted perimeter, P_w	5.3742	m
Hydraulic radius, R_h	0.3905	m
Velocity, v	0.9655	m/s
Flow, Q	2.0263	m^3/s
Velocity head, h_v	0.0475	m
Top width, T	5.1600	m
Froude number, F	0.48	
Average shear stress (tractive force), tau	15.3182	N/m^2
n for design rock size per Strickler	0.0348	
n for design rock size per Blodgett	0.0623	
n for design rock size per Bathurst	0.0478	
Blodgett vs. Bathurst	Blodgett	
Required bottom angular rock size, D50 (Isbash & MC) ?	0.0354	m
Required side slope 1 angular rock size, D50 (Isbash & MC) ?	0.0373	m
Required side slope 2 angular rock size, D50 (Isbash & MC) ?	0.0373	m
Required angular rock size, D50 (Maynord, Ruff, and Abt 1989)	0.0278	m
Required angular rock size, D50 (Searcy 1967)	0.0205	m

S = 0.5% (Culvert)



Manning Formula Uniform Pipe Flow at Given Slope and Depth

Mapleview Port Colborne

Culvert Design

Inputs

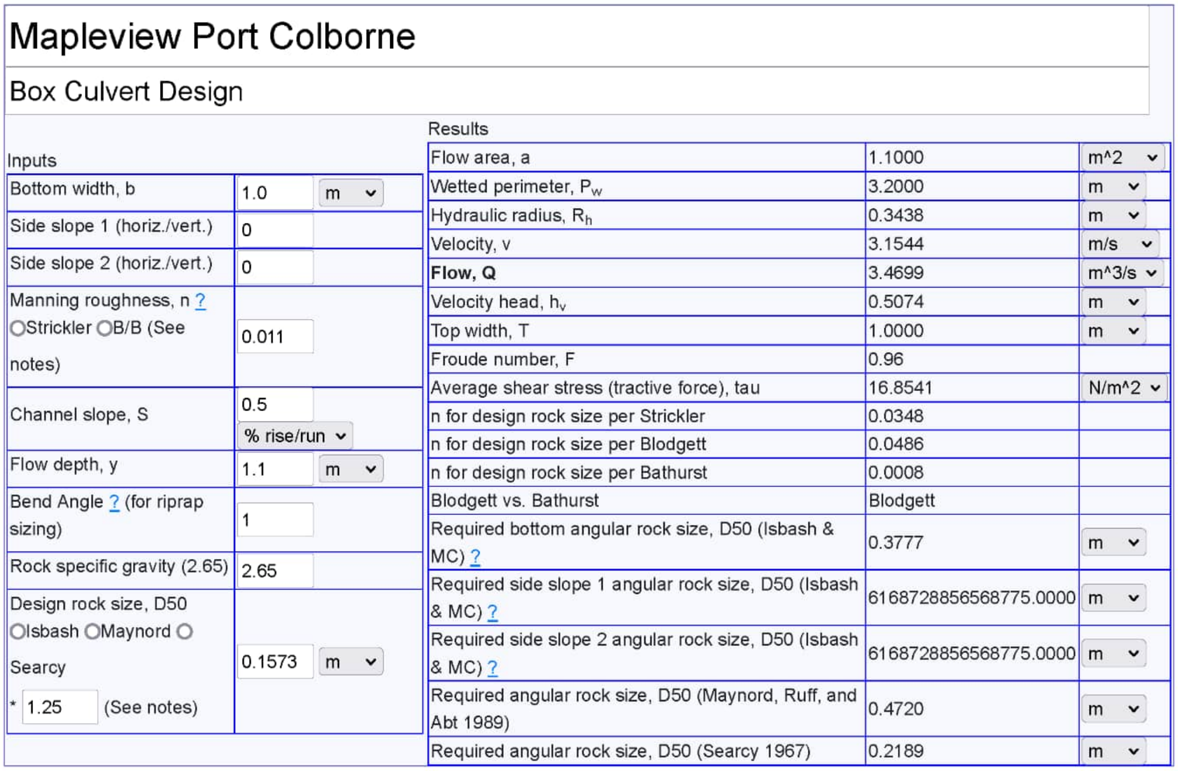
Pipe diameter, d_0	600	mm
Manning roughness, n	0.011	
Pressure slope (possibly ? equal to pipe slope), S_0	0.5	% rise/run
Relative flow depth, y/d_0	0.8	fraction

Results

Flow depth, y	0.4800	m
Flow area, a	0.2425	m^2
Pipe area, a0	0.2827	m^2
Relative area, a/a0	0.8576	fraction
Wetted perimeter, P_w	1.3286	m
Hydraulic radius, R_h	0.1825	m
Top width, T	0.4800	m
Velocity, v	2.0684	m/s
Velocity head, h_v	0.2181	m H2O
Froude number, F	0.93	
Average shear stress (tractive force), tau	8.9488	N/m^2
Flow, Q (See notes)	501.5500	l/s
Full flow, Q0	0.5131	m^3/s
Ratio to full flow, Q/Q0	0.9775	fraction

S = 0.5% (Box Culvert)

Manning Formula Uniform Trapezoidal Channel Flow at Given Slope and Depth



Mapleview Port Colborne

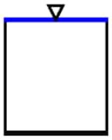
Box Culvert Design

Inputs

Bottom width, b	1.0	m
Side slope 1 (horiz./vert.)	0	
Side slope 2 (horiz./vert.)	0	
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.011	
Channel slope, S	0.5 % rise/run	
Flow depth, y	1.1	m
Bend Angle ? (for riprap sizing)	1	
Rock specific gravity (2.65)	2.65	
Design rock size, D50 ○Isbash ○Maynord ○ Searcy * 1.25 (See notes)	0.1573	m

Results

Flow area, a	1.1000	m^2
Wetted perimeter, P_w	3.2000	m
Hydraulic radius, R_h	0.3438	m
Velocity, v	3.1544	m/s
Flow, Q	3.4699	m^3/s
Velocity head, h_v	0.5074	m
Top width, T	1.0000	m
Froude number, F	0.96	
Average shear stress (tractive force), tau	16.8541	N/m^2
n for design rock size per Strickler	0.0348	
n for design rock size per Blodgett	0.0486	
n for design rock size per Bathurst	0.0008	
Blodgett vs. Bathurst	Blodgett	
Required bottom angular rock size, D50 (Isbash & MC) ?	0.3777	m
Required side slope 1 angular rock size, D50 (Isbash & MC) ?	616872885656875.0000	m
Required side slope 2 angular rock size, D50 (Isbash & MC) ?	616872885656875.0000	m
Required angular rock size, D50 (Maynord, Ruff, and Abt 1989)	0.4720	m
Required angular rock size, D50 (Searcy 1967)	0.2189	m



APPENDIX XI – STORM SEWER HYDRAULIC DESIGN SHEET

Flexible. Dependable. On-site Engineering.

Storm Sewer Hydraulic Design Sheet

King EPCM
Unit # 211, 3780 14th Avenue
Markham, ON, L3R 4B7
T: 647-459-5647
General@KingEPCM.com
www.KingEPCM.com

Site Location: Mapleview Port Colborone, Killay St W
Reference #
Reviewer:

Design Storm Event: 5 Year

n = 0.012 for concrete pipes

Rational Formula: Q=2.78*CIA
Q = peak flow (L/s)
C = runoff coefficient
I = rainfall intensity (mm/h)
A = area (ha)

Concentration time: tc=ti + tf (minute)
Where: ti: inlet time before pipe (minute)
tf: time of flow in pipe (minute)
tf= L/(60V) (minute)

Manning Equation:
Qcap = (D/1000)^2.667*(S/100)^0.5/(3.211*n)*1000 (L/S)
D: pipe diameter size (mm)
S: slope (grade) of pipe (%)
n: roughness coefficient

Catchment #100

Location			Runoff							Pipe						
Street Name	From	To	Area (A)	Runoff Coefficient (C)	Section (AC)	Accum. (AC)	Concentration Time (tc)	Rainfall Intensity (I)	Peak Flow (Q)	Length (L)	Slope (S)	N. D. (D)	Qcap. (full)	V (full)	Time of flow in pipe (tf)	(Q) / Qcap.
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	128	125	0.35	0.81	0.28	0.28	10.91	87.05	67.65	81	1.0	300	104.6	1.48	0.91	0.65
Interior of Lot	127	126	0.23	0.81	0.19	0.19	10.59	88.26	45.74	52.5	1	300	104.6	1.48	0.59	0.44
Interior of Lot	126	125	0.28	0.81	0.22	0.41	11.52	84.84	96.63	68	0.5	375	134.2	1.21	0.93	0.72
Interior of Lot	125	121	0.06	0.81	0.05	0.74	11.99	83.26	170.68	38	0.5	450	218.2	1.37	0.46	0.78
Interior of Lot	122	121	0.30	0.81	0.25	0.25	10.87	87.20	59.39	77.5	1	300	104.6	1.48	0.87	0.57
Interior of Lot	124	123	0.35	0.81	0.28	0.28	10.95	86.91	68.51	84.5	1.0	300	104.6	1.48	0.95	0.65
Interior of Lot	123	121	0.24	0.81	0.20	0.48	11.91	83.51	111.61	70	0.5	375	134.2	1.21	0.96	0.83
Interior of Lot	121	117	0.05	0.81	0.04	1.51	12.32	82.16	343.80	40.5	0.5	600	469.9	1.66	0.41	0.73
Interior of Lot	120	119	0.27	0.81	0.22	0.22	10.79	87.49	52.96	70.5	1	300	104.6	1.48	0.79	0.51
Interior of Lot	119	118	0.26	0.81	0.21	0.43	11.75	84.05	100.27	70	0.5	375	134.2	1.21	0.96	0.75
Interior of Lot	118	117	0.25	0.81	0.20	0.63	12.60	81.24	141.98	70	0.5	450	218.2	1.37	0.85	0.65
Interior of Lot	117	116	0.36	0.81	0.29	2.43	13.53	78.42	529.13	100	0.5	675	643.3	1.80	0.93	0.82
Interior of Lot	116	OGS1B	0.35	0.81	0.29	2.71	14.46	75.81	571.73	100	0.5	675	643.3	1.80	0.93	0.89
Interior of Lot	113	111	0.73	0.81	0.59	0.59	10.97	86.84	141.67	100	1	375	189.7	1.72	0.97	0.75
Interior of Lot	112	111	0.55	0.81	0.44	0.44	10.30	89.41	110.58	30.5	1.0	375	189.7	1.72	0.30	0.58
Interior of Lot	111	110	0.40	0.81	0.32	1.36	11.92	83.49	314.74	94.5	0.5	600	469.9	1.66	0.95	0.67
Interior of Lot	110	109	0.09	0.81	0.08	1.43	12.08	82.94	330.13	16.5	0.5	600	469.9	1.66	0.17	0.70
Interior of Lot	109	104	0.12	0.81	0.10	1.53	12.57	81.35	346.35	48.5	0.5	600	469.9	1.66	0.49	0.74
Interior of Lot	107	106	0.33	0.81	0.27	0.27	10.24	89.65	66.75	21	1.0	300	104.6	1.48	0.24	0.64
Interior of Lot	106	105	0.21	0.81	0.17	0.44	10.92	87.01	105.97	50	0.5	375	134.2	1.21	0.69	0.79
Interior of Lot	105	104	0.22	0.81	0.18	0.62	11.32	85.55	146.63	33	0.5	450	218.2	1.37	0.40	0.67
Interior of Lot	104	102	0.21	0.81	0.17	2.32	13.17	79.50	513.01	64.5	0.5	675	643.3	1.80	0.60	0.80
Interior of Lot	103	102	0.40	0.81	0.33	0.33	10.34	89.22	80.75	30.5	1.0	300	104.6	1.48	0.34	0.77
Interior of Lot	102	100	0.25	0.81	0.20	2.85	13.91	77.33	612.53	86	0.5	750	852.0	1.93	0.74	0.72
Interior of Lot	101	100	0.32	0.81	0.26	0.26	10.33	89.27	63.43	29.5	1.0	300	104.6	1.48	0.33	0.61
Interior of Lot	100	OGS1B	0.14	0.81	0.11	3.22	14.21	76.49	684.15	34.5	0.5	750	852.0	1.93	0.30	0.80
Interior of Lot	OGS1B	OGS1A	0	0.81	0.00	5.93	14.49	75.74	1248.57	3.5	0.5	900	1385.6	2.18	0.03	0.90
Interior of Lot	OGS1A	Box Culvert	0	0.81	0.00	5.93	14.59	75.46	1243.99	13.5	0.5	900	1385.6	2.18	0.10	0.90
Interior of Lot	132	131	0.28	0.81	0.23	0.23	10.32	89.31	56.38	28.5	1	300	104.6	1.48	0.32	0.54
Interior of Lot	131	130	0.48	0.81	0.38	0.61	11.33	85.53	145.49	83	0.5	450	218.2	1.37	1.01	0.67
Interior of Lot	130	OGS2	0.51	0.81	0.41	1.02	12.15	82.71	235.64	75	0.5	525	329.1	1.52	0.82	0.72
Interior of Lot	OGS2	Box Culvert	0	0.81	0.00	1.02	12.23	82.46	234.92	7	0.5	525	329.1	1.52	0.08	0.71

Catchment #200

Location			Runoff							Pipe						
Street Name	From	To	Area (A)	Runoff Coefficient (C)	Section (AC)	Accum. (AC)	Concentration Time (tc)	Rainfall Intensity (I)	Peak Flow (Q)	Length (L)	Slope (S)	N. D. (D)	Qcap. (full)	V (full)	Time of flow in pipe (tf)	(Q) / Qcap.
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	27	26	0.52	0.68	0.36	0.36	10.57	88.33	87.23	51	1.0	300	104.6	1.48	0.57	0.83
Interior of Lot	26	25	0.54	0.68	0.37	0.72	11.37	85.39	171.30	65.5	0.5	450	218.2	1.37	0.80	0.79
Interior of Lot	25	24	0.18	0.68	0.13	0.85	11.56	84.72	199.57	15.5	0.5	450	218.2	1.37	0.19	0.91
Interior of Lot	24	21	0.14	0.68	0.09	0.94	12.11	82.84	216.77	50.5	0.5	525	329.1	1.52	0.55	0.66
Interior of Lot	23	22	0.28	0.68	0.19	0.19	10.58	88.31	47.60	51.5	1.0	300	104.6	1.48	0.58	0.45
Interior of Lot	22	21	0.32	0.68	0.22	0.42	11.63	84.48	97.56	76.5	0.5	375	134.2	1.21	1.05	0.73
Interior of Lot	21	18	0.11	0.68	0.07	1.43	12.52	81.50	323.82	41	0.5	600	469.9	1.66	0.41	0.69
Interior of Lot	20	19	0.40	0.68	0.27	0.27	10.72	87.77	66.29	64	1.0	300	104.6	1.48	0.72	0.63
Interior of Lot	19	18	0.34	0.68	0.24	0.51	11.65	84.42	118.98	67.5	0.5	375	134.2	1.21	0.93	0.89
Interior of Lot	18	15	0.15	0.68	0.10	2.04	13.17	79.49	449.91	70	0.5	675	643.3	1.80	0.65	0.70
Interior of Lot	17	16	0.35	0.68	0.24	0.24	10.77	87.60	58.20	68	1.0	300	104.6	1.48	0.77	0.56
Interior of Lot	16	15	0.31	0.68	0.21	0.45	11.66	84.36	105.28	65.5	0.5	375	134.2	1.21	0.90	0.78
Interior of Lot	15	1	0.14	0.68	0.10	2.58	13.55	78.37	562.49	40.5	0.5	675	643.3	1.80	0.38	0.87
Interior of Lot	12	11	0.17	0.68	0.12	0.12	10.43	88.87	29.48	38.5	1.0	300	104.6	1.48	0.43	0.28
Interior of Lot	11	10	0.13	0.68	0.09	0.21	10.61	88.20	51.56	11	0.5	300	74.0	1.05	0.18	0.70
Interior of Lot	10	8	0.13	0.68	0.09	0.30	11.01	86.70	71.45	29	0.5	375	134.2	1.21	0.40	0.53
Interior of Lot	9	8	0.14	0.68	0.10	0.10	10.39	89.03	23.73	35	1.0	300	104.6	1.48	0.39	0.23
Interior of Lot	8	7	0.04	0.68	0.03	0.42	11.29	85.68	100.04	20.5	0.5	375	134.2	1.21	0.28	0.75
Interior of Lot	7	5	0.10	0.68	0.07	0.49	11.71	84.21	114.41	30.5	0.5	375	134.2	1.21	0.42	0.85
Interior of Lot	6	5	0.21	0.68	0.15	0.15	10.59	88.28	35.66	52	1.0	300	104.6	1.48	0.59	0.34
Interior of Lot	5	3	0.17	0.68	0.11	0.75	12.45	81.75	170.11	61	0.5	450	218.2	1.37	0.74	0.78
Interior of Lot	4	3	0.27	0.68	0.18	0.18	10.60	88.24	45.15	53	1	300	104.6	1.48	0.60	0.43
Interior of Lot	3	1	0.13	0.68	0.09	1.02	13.12	79.66	225.57	61	0.5	525	329.1	1.52	0.67	0.69
Interior of Lot	2	1	0.39	0.68	0.26	0.26	10.62	88.13	64.84	55.5	1	300	104.6	1.48	0.62	0.62
Interior of Lot	1	OGS5	0	0.68	0.00	3.86	13.23	79.30	852.08	14.5	0.5	825	1098.6	2.06	0.12	0.78
Interior of Lot	OGS5	HW3	0	0.68	0.00	3.86	13.48	78.57	844.16	33.5	0.6	825	1203.5	2.25	0.25	0.70

Catchment #300

Location			Runoff							Pipe						
Street Name	**From**	**To**	**Area (A)**	**Runoff Coefficient (C)**	**Section (AC)**	**Accum. (AC)**	**Concentration Time (tc)**	**Rainfall Intensity (I)**	**Peak Flow (Q)**	**Length (L)**	**Slope (S)**	**N. D. (D)**	**Qcap. (full)**	**V (full)**	**Time of flow in pipe (tf)**	**(Q) / Qcap.**
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	59	58	0.38	0.71	0.27	0.27	10.94	86.95	65.30	83.5	1	300	104.6	1.48	0.94	0.62
Interior of Lot	58	56	0.15	0.71	0.11	0.38	11.40	85.30	89.52	37.5	0.5	450	218.2	1.37	0.46	0.41
Interior of Lot	57	56	0.33	0.71	0.24	0.24	10.97	86.84	56.95	86	1	300	104.6	1.48	0.97	0.54
Interior of Lot	56	53	0.13	0.71	0.09	0.70	11.89	83.57	163.20	41	0.5	450	218.2	1.37	0.50	0.75
Interior of Lot	55	54	0.12	0.71	0.09	0.09	10.35	89.18	21.45	31.5	1	300	104.6	1.48	0.35	0.20
Interior of Lot	54	53	0.04	0.71	0.03	0.11	10.51	88.57	27.81	18	1.7	300	136.4	1.93	0.16	0.20
Interior of Lot	53	52	0.11	0.71	0.08	0.89	12.23	82.46	204.82	30.5	0.5	525	329.1	1.52	0.33	0.62
Interior of Lot	52	51	0.29	0.71	0.20	1.10	12.89	80.36	244.78	60	0.5	525	329.1	1.52	0.66	0.74
Interior of Lot	51	50	0.14	0.71	0.10	1.19	13.46	78.64	260.44	52	0.5	525	329.1	1.52	0.57	0.79
Interior of Lot	50	48	0.05	0.71	0.04	1.23	13.64	78.11	266.45	16.5	0.5	525	329.1	1.52	0.18	0.81
Interior of Lot	49	48	0.03	0.71	0.02	0.02	10.06	90.36	4.96	15	8	300	295.9	4.19	0.06	0.02
Interior of Lot	48	OGS3	0.03	0.71	0.02	1.27	13.74	77.82	274.31	29.5	5	525	1040.7	4.81	0.10	0.26
Interior of Lot	OGS3	HW1	0	0.71	0.00	1.27	14.01	77.04	271.56	25	0.5	525	329.1	1.52	0.27	0.83

Catchment #400

Location			Runoff							Pipe						
Street Name	**From**	**To**	**Area (A)**	**Runoff Coefficient (C)**	**Section (AC)**	**Accum. (AC)**	**Concentration Time (tc)**	**Rainfall Intensity (I)**	**Peak Flow (Q)**	**Length (L)**	**Slope (S)**	**N. D. (D)**	**Qcap. (full)**	**V (full)**	**Time of flow in pipe (tf)**	**(Q) / Qcap.**
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	47	45	0.10	0.68	0.07	0.07	10.26	89.56	17.78	23	1.0	300	104.6	1.48	0.26	0.17
Interior of Lot	46	45	0.23	0.68	0.16	0.16	10.68	87.94	38.23	60	1.0	300	104.6	1.48	0.68	0.37
Interior of Lot	45	41	0.10	0.68	0.07	0.29	11.24	85.86	70.06	41	0.5	375	134.2	1.21	0.56	0.52
Interior of Lot	44	41	0.23	0.68	0.16	0.16	10.67	87.96	38.42	59.5	1	300	104.6	1.48	0.67	0.37
Interior of Lot	43	42	0.30	0.68	0.20	0.20	10.58	88.31	50.15	51.5	1.0	300	104.6	1.48	0.58	0.48
Interior of Lot	42	41	0.26	0.68	0.18	0.38	11.39	85.32	91.00	59	0.5	375	134.2	1.21	0.81	0.68
Interior of Lot	41	38	0.15	0.68	0.10	0.94	11.91	83.51	217.14	61.5	0.5	525	329.1	1.52	0.67	0.66
Interior of Lot	40	38	0.28	0.68	0.19	0.19	10.67	87.96	47.00	59.5	1	300	104.6	1.48	0.67	0.45
Interior of Lot	39	38	0.64	0.68	0.44	0.44	10.95	86.91	105.72	98	1.0	375	189.7	1.72	0.95	0.56
Interior of Lot	38	32	0.17	0.68	0.12	1.68	12.53	81.48	380.71	61.5	0.5	600	469.9	1.66	0.62	0.81
Interior of Lot	37	36	0.29	0.68	0.20	0.20	10.65	88.05	47.79	57.5	1	300	104.6	1.48	0.65	0.46
Interior of Lot	36	34	0.23	0.68	0.16	0.35	11.49	84.96	83.26	61.5	0.5	375	134.2	1.21	0.84	0.62
Interior of Lot	35	34	0.90	0.68	0.62	0.62	10.59	88.28	151.74	60.5	1	375	189.7	1.72	0.59	0.80
Interior of Lot	34	33	0.55	0.68	0.37	1.34	12.23	82.46	308.26	73.5	0.5	600	469.9	1.66	0.74	0.66
Interior of Lot	33	32	0.43	0.68	0.29	1.64	12.82	80.57	366.46	59	0.5	600	469.9	1.66	0.59	0.78
Interior of Lot	31	30	0.31	0.68	0.21	0.21	10.46	88.76	52.51	41	1	300	104.6	1.48	0.46	0.50
Interior of Lot	30	OGS4	0.01	0.68	0.01	0.22	10.69	87.88	53.64	14.5	0.5	300	74.0	1.05	0.23	0.73
Interior of Lot	32	OGS4	0.01	0.68	0.01	3.32	12.94	80.19	740.75	14	0.5	750	852.0	1.93	0.12	0.87
Interior of Lot	OGS4	HW2	0	0.68	0.00	3.54	13.32	79.05	778.49	43.5	0.5	750	852.0	1.93	0.38	0.91

Catchment #500

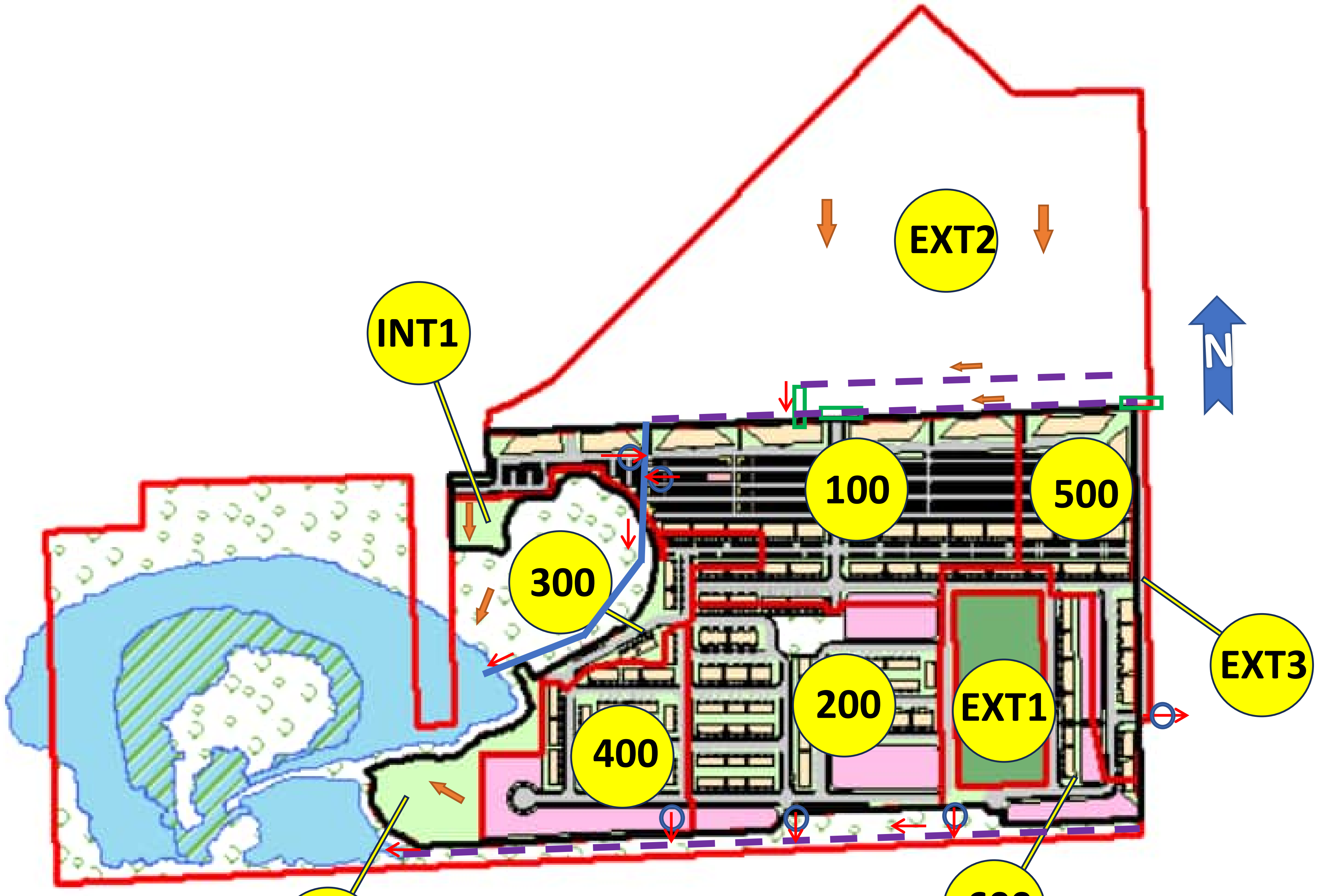
Location			Runoff							Pipe						
Street Name	**From**	**To**	**Area (A)**	**Runoff Coefficient (C)**	**Section (AC)**	**Accum. (AC)**	**Concentration Time (tc)**	**Rainfall Intensity (I)**	**Peak Flow (Q)**	**Length (L)**	**Slope (S)**	**N. D. (D)**	**Qcap. (full)**	**V (full)**	**Time of flow in pipe (tf)**	**(Q) / Qcap.**
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	97	96	0.34	0.74	0.25	0.25	10.97	86.84	61.24	86	1.0	300	104.6	1.48	0.97	0.59
Interior of Lot	98	96	0.88	0.74	0.65	0.65	10.29	89.43	162.62	34	1.0	450	308.5	1.94	0.29	0.53
Interior of Lot	96	94	0.14	0.74	0.11	1.01	11.41	85.24	240.28	40.5	0.5	525	329.1	1.52	0.44	0.73
Interior of Lot	95	94	0.33	0.74	0.25	0.25	11.04	86.57	59.00	92.5	1.0	300	104.6	1.48	1.04	0.56
Interior of Lot	94	93	0.13	0.74	0.10	1.36	11.87	83.64	315.38	46	0.5	600	469.9	1.66	0.46	0.67
Exterior of Lot	99	93	0.18	0.95	0.17	0.17	11.02	86.66	40.52	90.5	1.0	300	104.6	1.48	1.02	0.39
Exterior of Lot	93	89	0.06	0.95	0.06	1.58	12.28	82.29	361.46	40.5	0.5	600	469.9	1.66	0.41	0.77
Interior of Lot	92	91	0.23	0.74	0.17	0.17	10.59	88.28	41.65	52	1	300	104.6	1.48	0.59	0.40
Interior of Lot	91	90	0.28	0.74	0.21	0.38	11.56	84.72	88.78	71	0.5	375	134.2	1.21	0.97	0.66
Interior of Lot	90	89	0.22	0.74	0.17	0.54	12.35	82.06	123.98	65	0.5	450	218.2	1.37	0.79	0.57
Exterior of Lot	89	86	0.06	0.95	0.05	2.18	12.70	80.94	489.56	38	0.5	675	643.3	1.80	0.35	0.76
Interior of Lot	88	87	0.19	0.74	0.14	0.14	10.71	87.79	34.39	63.5	1.0	300	104.6	1.48	0.71	0.33
Interior of Lot	87	86	0.09	0.74	0.07	0.21	11.37	85.40	49.25	41	0.5	300	74.0	1.05	0.65	0.67
Exterior of Lot	86	85	0.11	0.95	0.10	2.49	13.40	78.82	544.94	75	0.5	675	643.3	1.80	0.70	0.85
Exterior of Lot	85	80	0.12	0.95	0.11	2.60	14.13	76.70	554.74	79.5	0.5	675	643.3	1.80	0.74	0.86
Interior of Lot	84	83	0.39	0.74	0.29	0.29	10.75	87.64	70.67	67	1.0	300	104.6	1.48	0.75	0.68
Interior of Lot	83	81	0.36	0.74	0.27	0.56	11.60	84.58	131.11	69.5	0.5	450	218.2	1.37	0.84	0.60
Interior of Lot	82	81	0.33	0.74	0.24	0.24	10.79	87.52	59.30	70	1.0	300	104.6	1.48	0.79	0.57
Interior of Lot	81	80	0	0.74	0.00	0.80	12.10	82.89	184.66	41	0.5	450	218.2	1.37	0.50	0.85
Exterior of Lot	80	OGS7	0	0.95	0.00	3.40	14.48	75.75	716.65	40	0.5	750	852.0	1.93	0.35	0.84
Exterior of Lot	OGS7	135	0	0.95	0.00	3.40	14.62	75.37	713.03	16.5	0.5	750	852.0	1.93	0.14	0.84

Catchment #600

Location			Runoff							Pipe						
Street Name	**From**	**To**	**Area (A)**	**Runoff Coefficient (C)**	**Section (AC)**	**Accum. (AC)**	**Concentration Time (tc)**	**Rainfall Intensity (I)**	**Peak Flow (Q)**	**Length (L)**	**Slope (S)**	**N. D. (D)**	**Qcap. (full)**	**V (full)**	**Time of flow in pipe (tf)**	**(Q) / Qcap.**
	(MH/CB)	(MH/CB)	(ha)		(ha)	(ha)	(min.)	(mm/h)	(L/s)	(m)	(%)	(mm)	(L/S)	(m/s)	(min.)	
Interior of Lot	66	65	0.17	0.66	0.11	0.11	10.62	88.13	27.36	55.5	1.0	300	104.6	1.48	0.62	0.26
Interior of Lot	65	64	0.18	0.66	0.12	0.23	11.66	84.37	54.27	65	0.5	300	74.0	1.05	1.04	0.73
Interior of Lot	64	63	0.40	0.34	0.13	0.36	12.66	81.06	82.21	73	0.5	375	134.2	1.21	1.00	0.61
Interior of Lot	63	62	0.38	0.34	0.13	0.49	13.51	78.50	107.46	61.5	0.5	375	134.2	1.21	0.84	0.80
Interior of Lot	62	61	0.25	0.34	0.09	0.58	14.00	77.07	123.73	41	0.5	450	218.2	1.37	0.50	0.57
Interior of Lot	61	60	0.30	0.38	0.11	0.69	14.85	74.77	143.59	69.5	0.5	450	218.2	1.37	0.84	0.66
Interior of Lot	74	73	0.68	0.43	0.29	0.29	10.60	88.24	71.55	53	1.0	300	104.6	1.48	0.60	0.68
Interior of Lot	73	72	0.94	0.43	0.40	0.69	11.63	84.48	163.06	85	0.5	450	218.2	1.37	1.03	0.75
Interior of Lot	72	71	0.70	0.47	0.33	1.02	12.51	81.56	232.30	80	0.5	525	329.1	1.52	0.88	0.71
Interior of Lot	76	75	0.11	0.66	0.07	0.07	10.12	90.10	18.73	11	1.0	300	104.6	1.48	0.12	0.18
Interior of Lot	75	71	0.42	0.66	0.28	0.35	10.94	86.95	85.37	59.5	0.5	375	134.2	1.21	0.82	0.64
Interior of Lot	71	70	0.40	0.54	0.22	1.59	13.19	79.44	351.79	68	0.5	600	469.9	1.66	0.68	0.75
Interior of Lot	70	60	0.18	0.52	0.09	1.69	13.72	77.87	364.93	53	0.5	600	469.9	1.66	0.53	0.78
Interior of Lot	60	OGS6	0	0.66	0.00	2.38	14.91	74.60	492.87	7	0.5	675	643.3	1.80	0.06	0.77
Interior of Lot	OGS6	HW4	0	0.66	0.00	2.38	15.12	74.07	489.34	34.5	1.2	675	996.6	2.78	0.21	0.49

APPENDIX XII –SWM FLOWCHART

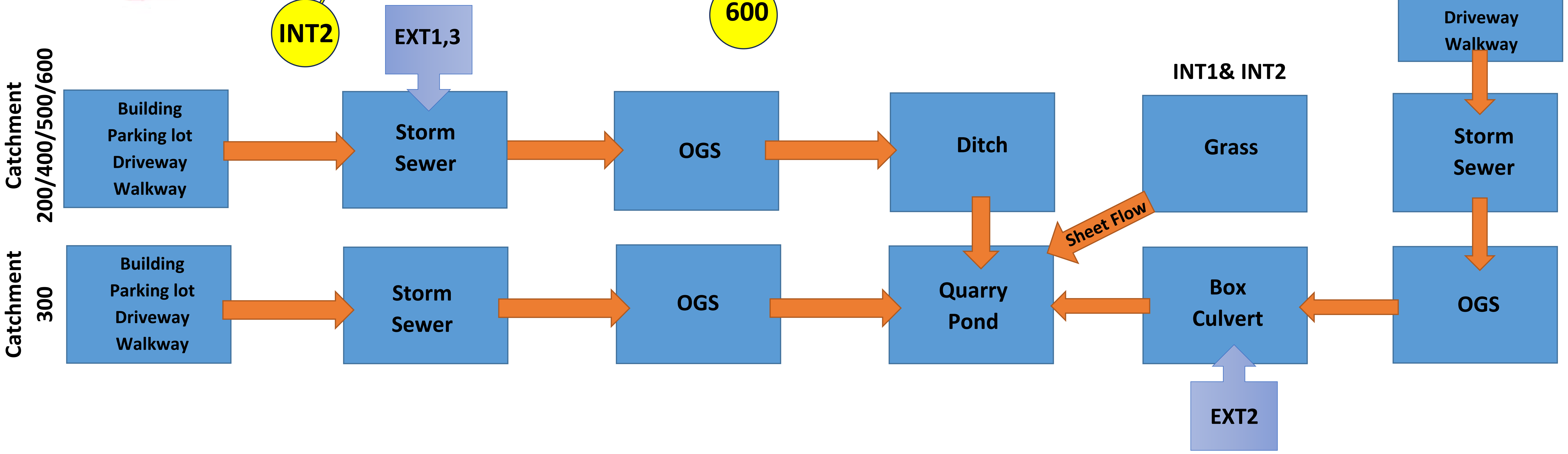
Stormwater Management Flowchart/Diagram



Legend

- ○ Oil Grit Separator (OGS)
- ▬ Box Culvert
- ▭ Culvert
- ╍ Ditch/swale

Catchment 100



Catchment 200/400/500/600: Building, Parking lot, Driveway, Walkway → Storm Sewer (← EXT1,3) → OGS → Ditch → Quarry Pond

Catchment 300: Building, Parking lot, Driveway, Walkway → Storm Sewer → OGS → Quarry Pond

INT1& INT2: Grass → Sheet Flow → Quarry Pond

Catchment 100: Building, Parking lot, Driveway, Walkway → Storm Sewer → OGS → Box Culvert (← EXT2) → Quarry Pond

APPENDIX XIII –WATER BALANCE CALCULATIONS

WATER BUDGET- PRE-DEVELOPMENT

WATER BALANCE/WATER BUDGET ASSESSMENT

Catchment Designation	Site			
	Limestone	Parkland	Grass/Landscape	Total
Area (m^2)	10281	221574	70453	302308
Pervious Area (m^2)	0	221574	485	222059
Impervious Area (m^2)	10281	0	0	10281
Infiltration Factors				
Topography Infiltration Factor	0	0.3	0.3	
Soil Infiltratin Factor	0	0.2	0.2	
Land Cover Infiltration Factor	0	0.15	0.1	
MOE Infiltration Factor	0	0.65	0.6	
Actual Infiltratin Factor	0	0.65	0.6	
Run-Off Coefficient	1	0.35	0.4	
Runoff From Impervious Surfaces *	0.95	0	0	
Inputs (per unit area)				
Precipitation (mm/yr)	1000.9	1000.9	1000.9	1000.9
Run-On (mm/yr)	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0
Total Inputs (mm/yr)	**1000.9**	**1000.9**	**1000.9**	**1000.9**
Outputs (per unit area)				
Precipitation Surplus (mm/yr)	950.9	417.6	417.6	436
Net Surplus (mm/yr)	950.9	417.6	417.6	436
Evapotranspiration (mm/yr)	50.0	583.3	583.3	565
Infiltration (mm/yr)	950.9	417.6	417.6	436
Rooftop Infiltration (mm/yr)	0	0	0	0
Total Infiltration (mm/yr)	950.9	417.6	417.6	436
Runoff Pervious Area	0	0	0	0
Runoff Impervious Area	0.0	0	0	0
Total Runoff (mm/yr)	0.0	0	0	0
Total Outputs (mm/yr)	1000.9	1000.9	1000.9	1000.9
Difference (Inputs-Outputs)	0	0	0	0
Inputs (Volumes)				
Precipitaiton (m^3/yr)	10,290	221,773	70,516	302,580
Run-On (m^3/yr)	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0
Total Inputs (m^3/yr)	10,290	221,773	70,516	302,580
Outputs (Volumes)				
Precipitation Surplus (m^3/yr)	9,776	92,529	29,421	131,726
Net Surplus (m^3/yr)	9,776	92,529	29,421	131,726
Evapotranspiration (m^3/yr)	515	129,244	41,095	170,854
Infiltration (m^3/yr)	9,776	92,529	29,421	131,726
Rooftop Infiltration (m^3/yr)	0	0	0	0
Total Infiltration (m^3/yr)	9,776	92,529	29,421	131,726
Runoff Pervious Area (m^3/yr)	0	0	0	0
Runoff Impervious Area (m^3/yr)	0	0	0	0
Total Runoff (m^3/yr)	0	0	0	0
Total Outputs (m^3/yr)	10,290	221,773	70,516	302,580
Difference (Inputs-Outputs)	0	0	0	0

* Based on the Design Chart 1.07 (MTO, 1997), the runoff coefficients for rooftop and pavement are 0.7 - 0.95 and 0.8 - 0.95, respectively. We used the maxmimum ratio of 95% for Limestone stockpiles (same as rooftop/asphalt) which is 100% impervious.

WATER BUDGET- POST-DEVELOPMENT

WATER BALANCE/WATER BUDGET ASSESSMENT

Catchment Designation	Site						
	Building	Driveway/Parking	Walkway	Single Family	Parkland	Grass/Landscape	Total
Area (m^2)	51762	104830	18354	33555	3099	90708	302,308
Pervious Area (m^2)	0	0	0	16778	3099	90708	110,584
Impervious Area (m^2)	51762	104830	18354	16778	0	0	191,723
Infiltration Factors							
Topography Infiltration Factor	0	0	0	0	0.3	0.3	
Soil Infiltratin Factor	0	0	0	0	0.2	0.2	
Land Cover Infiltration Factor	0	0	0	0	0.15	0.1	
MOE Infiltration Factor	0	0	0	0	0.65	0.6	
Actual Infiltratin Factor	0	0	0	0	0.65	0.6	
Run-Off Coefficient	1	1	1	1	0.35	0.4	
Runoff From Impervious Surfaces *	0.95	0.95	0.95	0.95	0	0	
Inputs (per unit area)							
Precipitation (mm/yr)	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9
Run-On (mm/yr)	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**
Outputs (per unit area)							
Precipitation Surplus (mm/yr)	950.9	950.9	950.9	684.3	417.6	417.6	756
Net Surplus (mm/yr)	950.9	950.9	950.9	684.3	417.6	417.6	756
Evapotranspiration (mm/yr)	50.0	50.0	50.0	316.7	583.3	583.3	245
Infiltration (mm/yr)	0	0	0	171.06	271.44	250.56	97
Rooftop Infiltration (mm/yr)	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	0	0	0	171.06	271.44	250.56	97
Runoff Pervious Area	0	0	0	171.06	146.16	167.04	167
Runoff Impervious Area	950.9	950.9	950.9	342.1	0	0	898
Total Runoff (mm/yr)	950.9	950.9	950.9	513.2	146.16	167.04	659
Total Outputs (mm/yr)	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9
Difference (Inputs-Outputs)	0	0	0	0	0	0	0
Inputs (Volumes)							
Precipitaiton (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Run-On (m^3/yr)	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Outputs (Volumes)							
Precipitation Surplus (m^3/yr)	49,218	99,678	17,452	22,960	1,294	37,880	228,482
Net Surplus (m^3/yr)	49,218	99,678	17,452	22,960	1,294	37,880	228,482
Evapotranspiration (m^3/yr)	2,590	5,246	919	10,625	1,807	52,910	74,098
Infiltration (m^3/yr)	0	0	0	5,740	841	22,728	29,309
Rooftop Infiltration (m^3/yr)	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	0	0	0	5,740	841	22,728	29,309
Runoff Pervious Area (m^3/yr)	0	0	0	2,870	453	15,152	18,475
Runoff Impervious Area (m^3/yr)	49,218	99,678	17,452	5,740	0	0	172,088
Total Runoff (m^3/yr)	49,218	99,678	17,452	8,610	453	15,152	190,563
Total Outputs (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Difference (Inputs-Outputs)	0	0	0	0	0	0	0

* Based on the Design Chart 1.07 (MTO, 1997), the runoff coefficients for rooftop and pavement are 0.7 - 0.95 and 0.8 - 0.95, respectively. We used the maxmimum ratio of 95% for both Asphalt Pavement and Rooftops in accordance with Township and NPCA standards.

WATER BUDGET- POST-DEVELOPMENT WITH MITIGATION

WATER BALANCE/WATER BUDGET ASSESSMENT

Catchment Designation	**Site**						
	Buildings	**Driveway/Parking**	**Walkway**	**Single Family**	**Parkland**	**Grass/Landscape**	**Total**
Area (m^2)	51762	104830	18354	33555	3099	90708	302,308
Pervious Area (m^2)	0	0	0	16778	3099	90708	110,584
Impervious Area (m^2)	51762	104830	18354	16778	0	0	191,723
Infiltration Factors							
Topography Infiltration Factor	0	0	0	0	0.3	0.3	
Soil Infiltratin Factor	0	0	0	0	0.2	0.2	
Land Cover Infiltration Factor	0	0	0	0	0.15	0.1	
MOE Infiltratin Factor	0	0	0	0	0.65	0.6	
Actual Infiltratin Factor	0	0	0	0	0.65	0.6	
Run-Off Coefficient	1	1	1	1	0.35	0.4	
Runoff From Impervious Surfaces *	0.95	0.95	0.95	0.95	0	0	
Inputs (per unit area)							
Precipitation (mm/yr)	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9
Run-On (mm/yr)	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**	**1000.9**
Outputs (per unit area)							
Precipitation Surplus (mm/yr)	950.9	950.9	950.9	684.3	417.6	417.6	756
Net Surplus (mm/yr)	950.9	950.9	950.9	684.3	417.6	417.6	756
Evapotranspiratin (mm/yr)	50.0	50.0	50.0	316.7	583.3	583.3	245
Infiltration (mm/yr)	0	950.9	950.9	342.1	417.6	417.6	555
Rooftop Infiltration (mm/yr)	950.9	0	0	342.1	0	0	201
Total Infiltration (mm/yr)	950.9	950.9	950.9	684.25	417.6	417.6	756
Runoff Pervious Area	0	0	0	0	0	0	0
Runoff Impervious Area	0	0	0	0	0	0	0
Total Runoff (mm/yr)	0	0	0	0	0	0	0
Total Outputs (mm/yr)	1000.9	1000.9	1000.9	1000.9	1000.9	1000.9	701
Difference (Inputs-Outputs)	0	0	0	0	0	0	0
Inputs (Volumes)							
Precipitaiton (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Run-On (m^3/yr)	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Outputs (Volumes)							
Precipitation Surplus (m^3/yr)	49,218	99,678	17,452	22,960	1,294	37,880	228,482
Net Surplus (m^3/yr)	49,218	99,678	17,452	22,960	1,294	37,880	228,482
Evapotranspiratin (m^3/yr)	2,590	5,246	919	10,625	1,807	52,910	74,098
Infiltration (m^3/yr)	0	99,678	17,452	11,480	1,294	37,880	167,783
Rooftop Infiltration (m^3/yr)	49,218	0	0	11,480	0	0	60,698
Total Infiltration (m^3/yr)	49,218	99,678	17,452	22,960	1,294	37,880	228,482
Runoff Pervious Area (m^3/yr)	0	0	0	0	0	0	0
Runoff Impervious Area (m^3/yr)	0	0	0	0	0	0	0
Total Runoff (m^3/yr)	0	0	0	0	0	0	0
Total Outputs (m^3/yr)	51,809	104,924	18,370	33,585	3,101	90,790	302,580
Difference (Inputs-Outputs)	0	0	0	0	0	0	0

* Based on the Design Chart 1.07 (MTO, 1997), the runoff coefficients for rooftop and pavement are 0.7 - 0.95 and 0.8 - 0.95, respectively. We used the maxmimum ratio of 95% for both Asphalt Pavement and Rooftops in accordance with Township and NPCA standards.

WATER BUDGET SUMMARY

WATER BALANCE/WATER BUDGET ASSESSMENT

Characterstic	Site				
	Pre-Development	Post-Development	Change (Pre- to Post-)	Post-Development with Mitigation	Change (Pre- to Post- with Mitigation)
Inputs (Volumes)					
Precipitaiton (m^3/yr)	302,580	302,580	0.0%	302,580	0.0%
Run-On (m^3/yr)	0	0	0.0%	0	0.0%
Other Inputs (m^3/yr)	0	0	0.0%	0	0.0%
Total Inputs (m^3/yr)	**302,580**	302,580	0.0%	302,580	0.0%
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	131,726	228,482	73.5%	228,482	73.5%
Net Surplus (m^3/yr)	131,726	228,482	73.5%	228,482	73.5%
Evapotranspiratin (m^3/yr)	170,854	74,098	-56.6%	74,098	-56.6%
Infiltration (m^3/yr)	131,726	29,309	-77.8%	167,783	27.4%
Rooftop Infiltration (m^3/yr)	0	0	0.0%	60,698	0.0%
Total Infiltration (m^3/yr)	131,726	29,309	-77.8%	228,482	73.5%
Runoff Pervious Area (m^3/yr)	0	18,475	0.0%	0	0.0%
Runoff Impervious Area (m^3/yr)	0	172,088	0.0%	0	0.0%
Total Runoff (m^3/yr)	0	190,563	0.0%	0	0.0%
Total Outputs (m^3/yr)	302,580	302,580	0.0%	203,606	-32.7%

APPENDIX XIV – OGS

THIRD-PARTY TESTING AND VERIFICATION

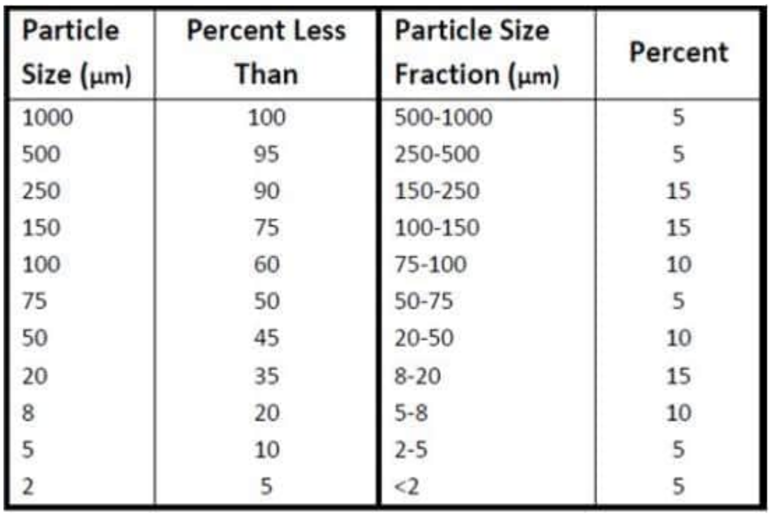
►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

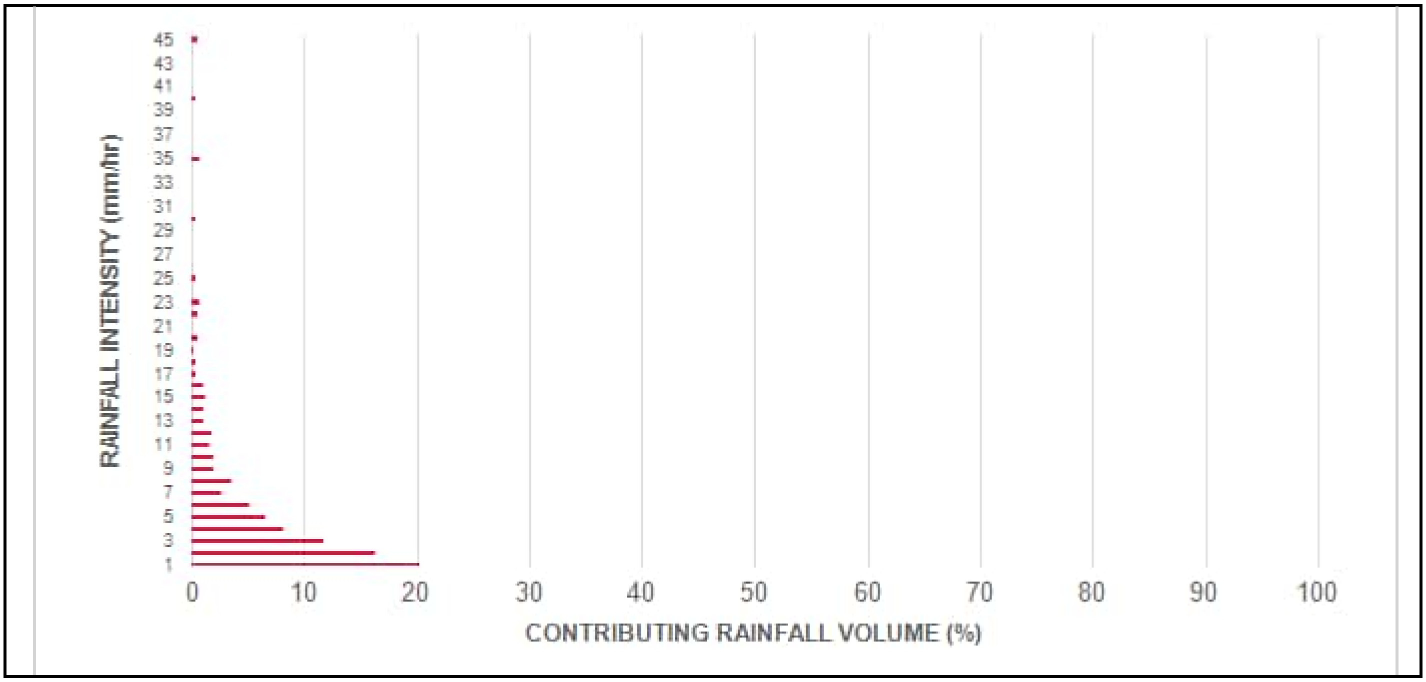
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.



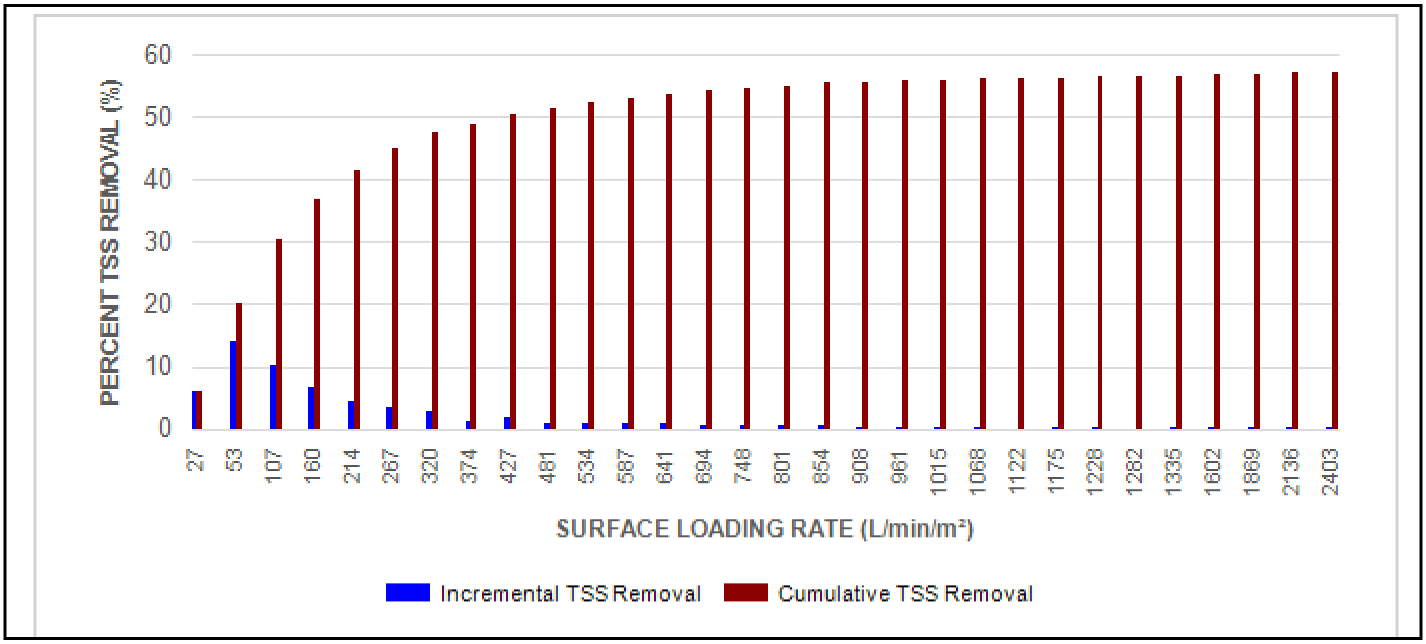
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

RAINFALL DATA FROM TORONTO CITY RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Stormceptor® EF Sizing Report

Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

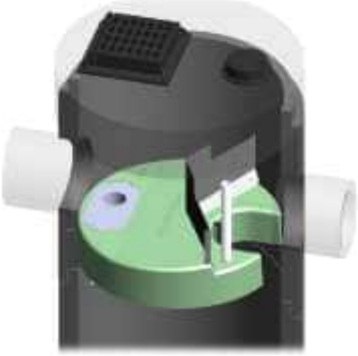
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

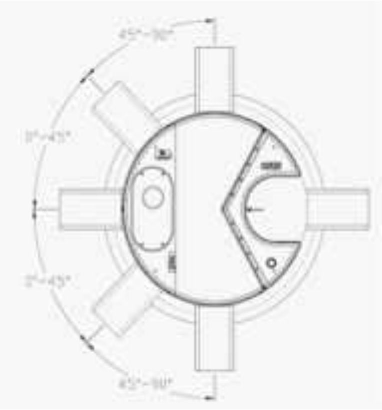
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



Stormceptor® EF Sizing Report



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	42	1320	35	1980	24
30	70	690	42	1350	35	2010	24
60	67	720	41	1380	34	2040	23
90	63	750	41	1410	34	2070	23
120	61	780	41	1440	33	2100	23
150	58	810	41	1470	32	2130	22
180	56	840	41	1500	32	2160	22
210	54	870	41	1530	31	2190	22
240	53	900	41	1560	31	2220	21
270	52	930	40	1590	30	2250	21
300	51	960	40	1620	29	2280	21
330	50	990	40	1650	29	2310	21
360	49	1020	40	1680	28	2340	20
390	48	1050	39	1710	28	2370	20
420	47	1080	39	1740	27	2400	20
450	47	1110	38	1770	27	2430	20
480	46	1140	38	1800	26	2460	19
510	45	1170	37	1830	26	2490	19
540	44	1200	37	1860	26	2520	19
570	43	1230	37	1890	25	2550	19
600	42	1260	36	1920	25	2580	18
630	42	1290	36	1950	24	2600	26

STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program’s **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada. Sizing shall also be determined by use of the sediment removal performance data derived from the ISO 14034 ETV third-party verified laboratory testing data from testing conducted in accordance with the Canadian ETV protocol Procedure for Laboratory Testing of Oil-Grit Separators, as follows:

3.2.1 Sediment removal efficiency for a given surface loading rate and its associated flow rate shall be based on sediment removal efficiency demonstrated at the seven (7) tested surface loading rates specified in the protocol, ranging 40 L/min/m^2 to 1400 L/min/m^2, and as stated in the ISO 14034 ETV Verification Statement for the OGS device.

3.2.2 Sediment removal efficiency for surface loading rates between 40 L/min/m^2 and 1400 L/min/m^2 shall be based on linear interpolation of data between consecutive tested surface loading rates.

3.2.3 Sediment removal efficiency for surface loading rates less than the lowest tested surface loading rate of 40 L/min/m^2 shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m^2. No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m^2.

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m^2 shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m^2, and shall be calculated using a simple proportioning formula, with 1400 L/min/m^2 in the numerator and the higher surface loading rate in the denominator, and multiplying the resulting fraction times the sediment removal efficiency at 1400 L/min/m^2.

The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

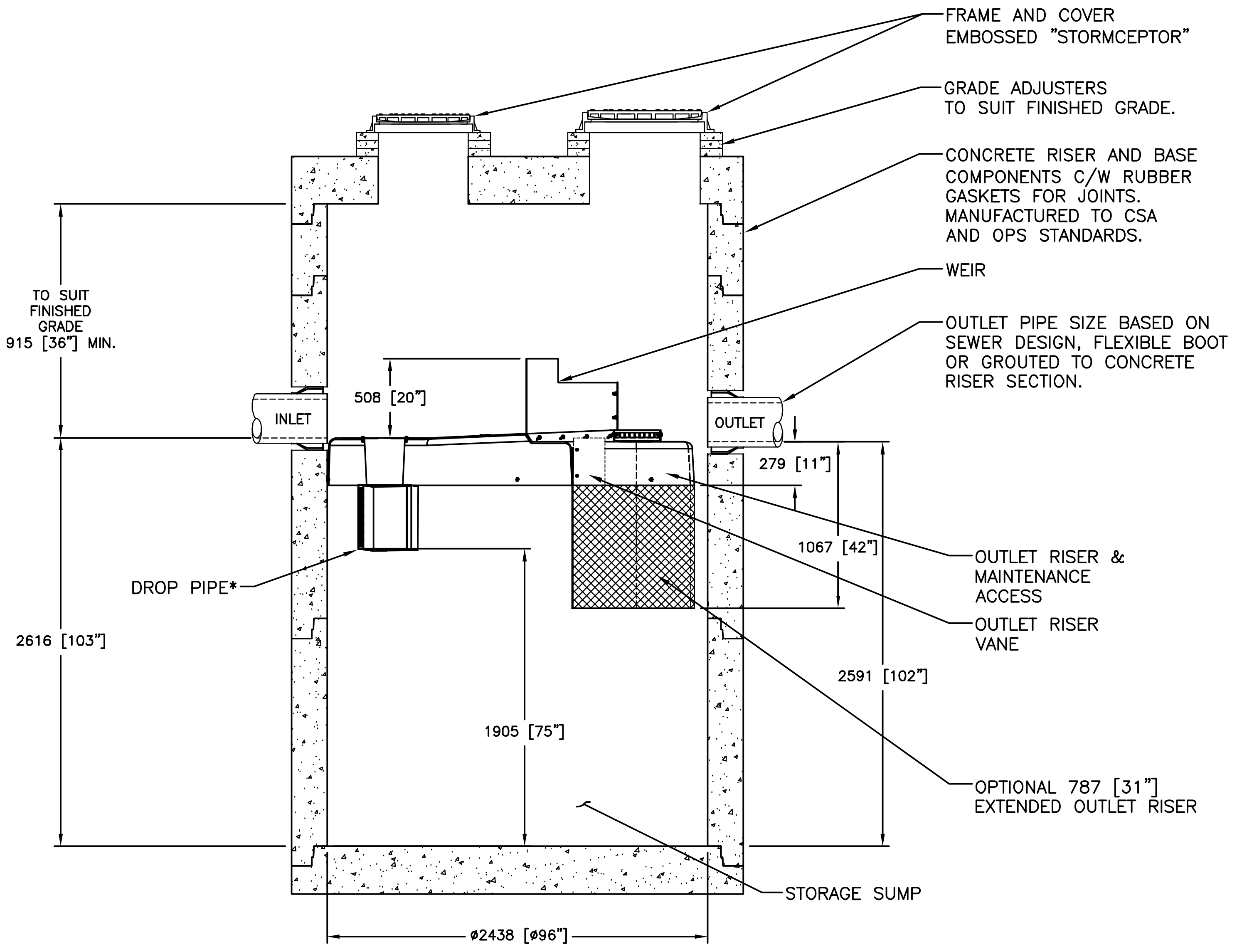
3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

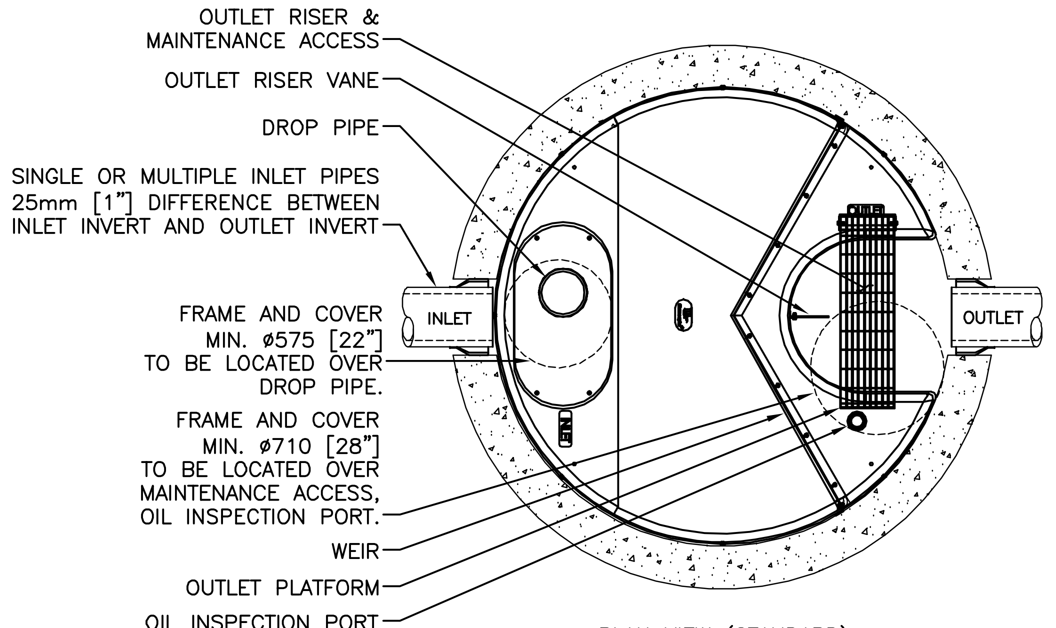
The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.** However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

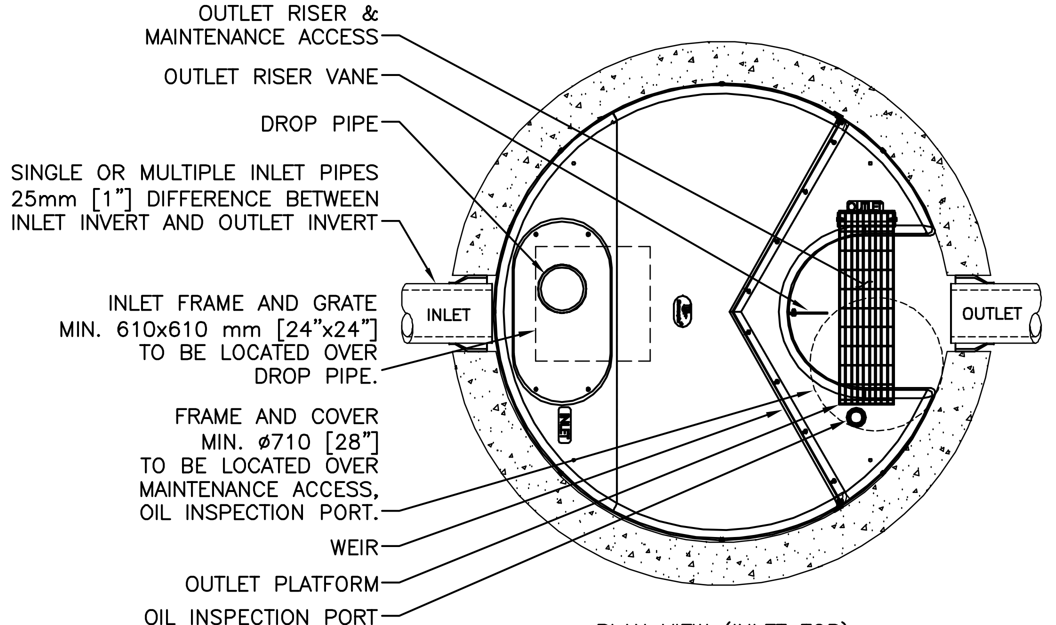
DRAWING NOT TO BE USED FOR CONSTRUCTION



SECTION VIEW



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

GENERAL NOTES:

* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m^2 (27.9 gpm/ft^2) FOR STORMCEPTOR EF8 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO8 (OIL CAPTURE CONFIGURATION).

1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
2. STORMCEPTOR STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE STORMCEPTOR SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL STORMCEPTOR REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE (IF REQUIRED).

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT THE DEVICE FROM CONSTRUCTION-RELATED EROSION RUNOFF.
E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

STANDARD DETAIL
NOT FOR CONSTRUCTION

SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL	EFO8				
STRUCTURE ID					*
HYDROCARBON STORAGE REQ'D (L)					*
WATER QUALITY FLOW RATE (L/s)					*
PEAK FLOW RATE (L/s)					*
RETURN PERIOD OF PEAK FLOW (yrs)					*
DRAINAGE AREA (HA)					*
DRAINAGE AREA IMPERVIOUSNESS (%)					*
PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

The design and information shown on this drawing is provided as a service to the project owner, engineer and contractor by Imbrium Systems ("Imbrium"). Neither this drawing, nor any part thereof, may be used, reproduced or modified in any manner without the prior written consent of Imbrium. Failure to comply is done at the user's own risk and Imbrium expressly disclaims any liability or responsibility for such use.

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MARK	DATE	REVISION DESCRIPTION	BY
0	5/26/17	INITIAL RELEASE	JSK
1	6/8/18	OUTLET PLATFORM	JSK
######	######	######	######
######	######	######	######
######	######	######	######

Stormceptor® EF

SCALE = NTS

imbrium®

407 FAIRVIEW DRIVE, WHITBY, ON L1N 3A9
TF 800-565-4801 CA 416-960-9900 INTL +1-416-960-9900

THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OF THE FOLLOWING PATENTS
Australia Patent No. 693,164 • 707,133 • 729,096 • 779401 | Austrian Patent No. 289,647 | Canadian Patent No. 2,009,280 • 2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 | China Patent No. 1,168,439 | Denmark DK 711,879 | German DE 69,534,021 | Indonesian Patent No 16,688 | Japan Patent No. 9-11476 (Pending) | Korea Patent No. 10-2000-0026101 (Pending) | Malaysia Patent No. PI9701737 (Pending) | New Zealand Patent No. 314646 | United States Patent No. 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690

DATE: 10/13/2017	
DESIGNED: JSK	DRAWN: JSK
CHECKED: BSF	APPROVED: *
PROJECT No.: EFO8	SEQUENCE No.: *
SHEET: 1 OF 1	

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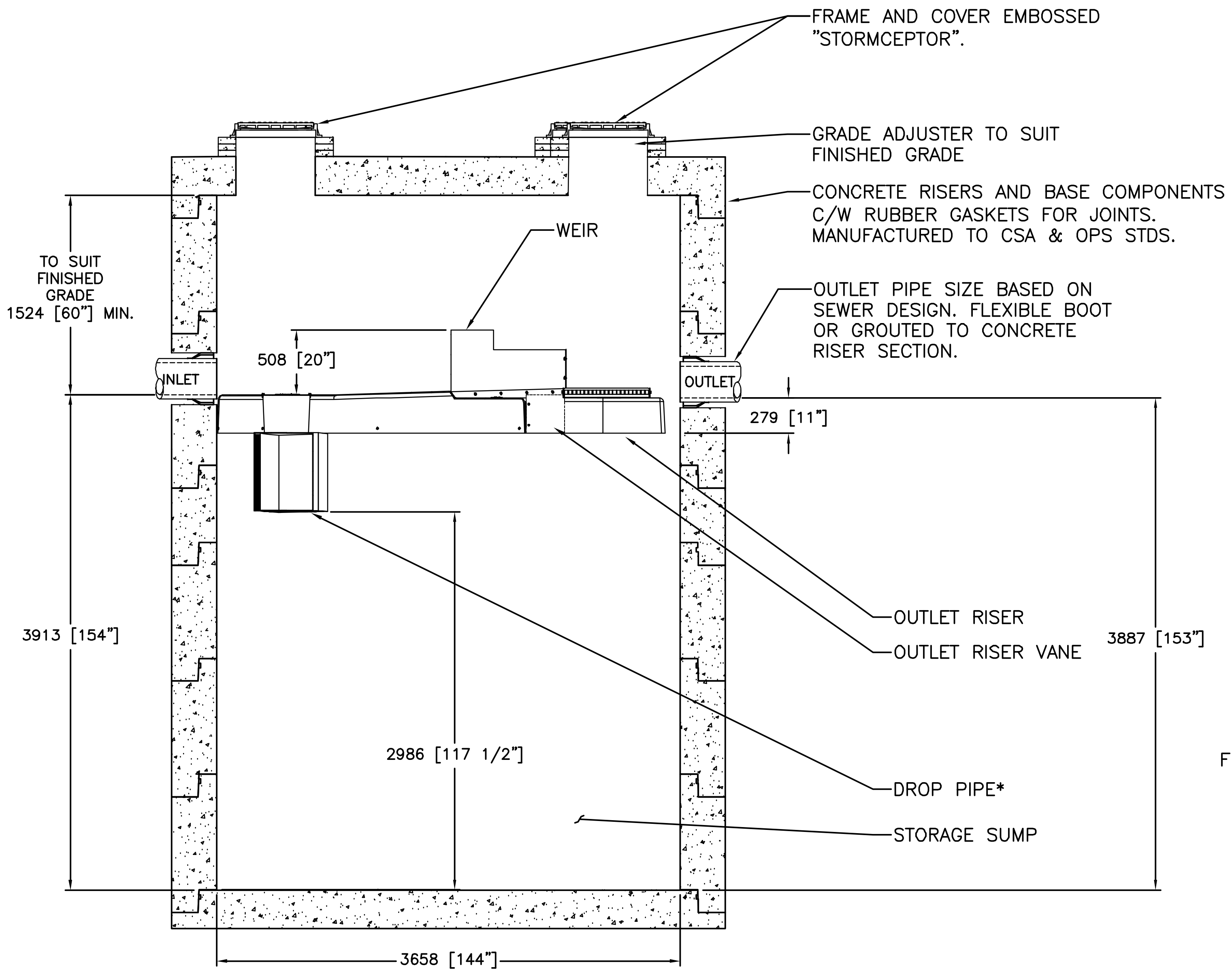
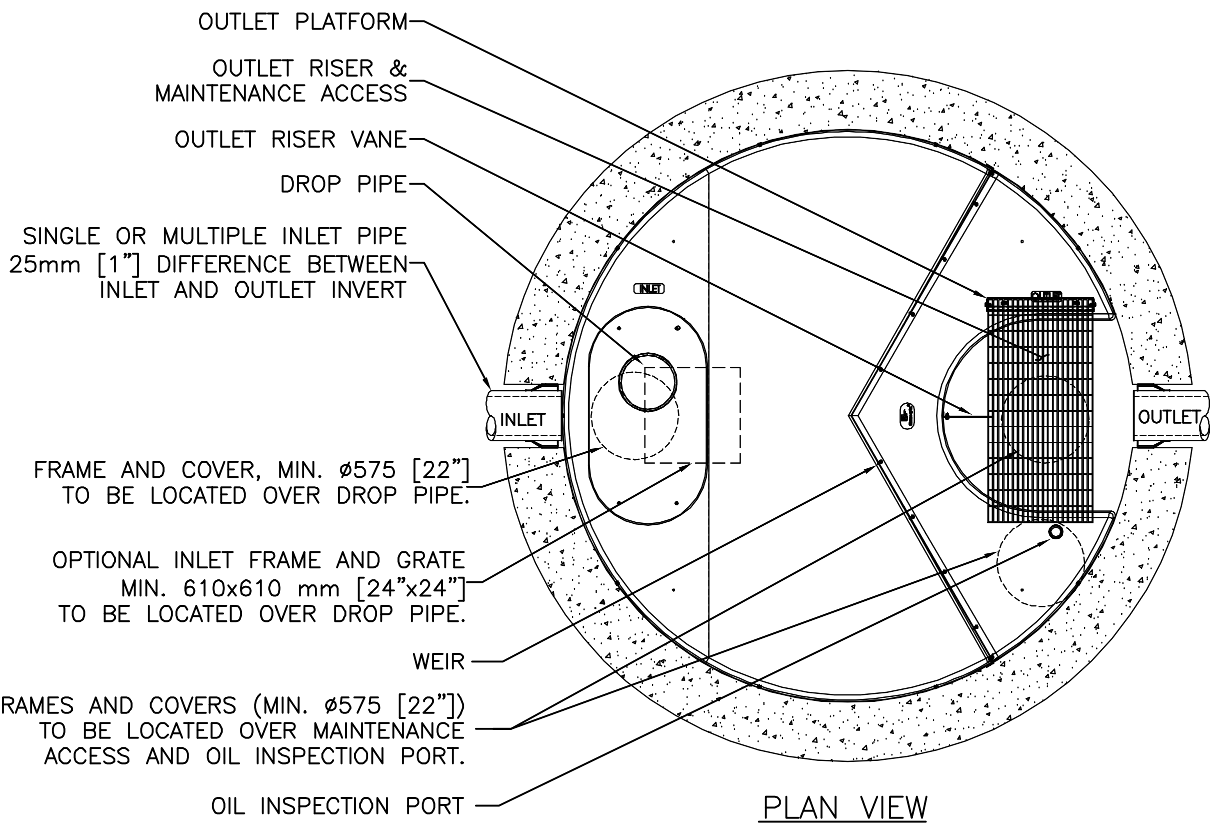


SECTION VIEW



PLAN VIEW

GENERAL NOTES:

* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m^2 (27.9 gpm/ft^2) FOR STORMCEPTOR EF12 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO12 (OIL CAPTURE CONFIGURATION).

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E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

STANDARD DETAIL
NOT FOR CONSTRUCTION

SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL	EFO12
STRUCTURE ID	*
HYDROCARBON STORAGE REQ'D (L)	*
WATER QUALITY FLOW RATE (L/s)	*
PEAK FLOW RATE (L/s)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
DRAINAGE AREA (HA)	*
DRAINAGE AREA IMPERVIOUSNESS (%)	*

PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

#####	#####	#####	#####
#####	#####	#####	#####
#####	#####	#####	#####
1	6/8/18	OUTLET PLATFORM	JSK
0	5/26/17	INITIAL RELEASE	JSK
MARK	DATE	REVISION DESCRIPTION	BY

Stormceptor® EF

SCALE = NTS

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TF 800-565-4801 CA 416-960-9900 INTL +1-416-960-9900

THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OF THE FOLLOWING PATENTS
Australia Patent No. 693,164 • 707,133 • 729,096 • 779401 | Austrian Patent No. 289,647 | Canadian Patent No. 2,009,260 • 2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 | China Patent No. 1,168,439 | Denmark DK 711,879 | German DE 69,634,021 | Indonesian Patent No 16,688 | Japan Patent No. 9-11476 (Pending) | Korea Patent No. 10-2000-0026101 (Pending) | Malaysia Patent No. PI9701737 (Pending) | New Zealand Patent No. 314646 | United States Patent No. 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690

DATE: 10/24/2017	
DESIGNED: JSK	DRAWN: JSK
CHECKED: BSF	APPROVED: SP
PROJECT No.: EFO12	SEQUENCE No.: *
SHEET: 1 OF 1	

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Rinker Materials Quality Assurance Program (QAP)

Rinker Materials is committed to providing the most effective, environmentally friendly, and economical Oil Grit Separators (OGS), leading the way in protecting our water resources.

We've got you covered

Your QAP starts with post construction inspection to ensure the unit has been installed as designed. The unit is recorded in our expansive database summarizing all installed units with their GPS locations. When you inspect and maintain these OGS units, you play an important part in protecting the environment, while ensuring your stormwater assets remain in compliance with environmental regulations

Rinker Materials's industry leading line of Stormceptor products are one of the lowest-cost OGS units in the market, functioning effectively in all aspects of keeping pollutants out of our waterways. The Rinker Quality Assurance Program is in place at no extra cost to the asset's owner, providing inspections for up to 5 years.

Improving products, improving service.

Our commitment to providing the best storm water quality devices continues as we have recently expanded our already impressive line of Stormceptor® products with the addition of the ISO14034/ETV verified Stormceptor EF and EFO - simply the most cost competitive stormwater quality device on the market. Now we're improving our service by ensuring inspections on our entire Stormceptor product line for up to 5 years after installation.

At Rinker Materials, we understand that maintaining a high standard of water quality is crucial to the environment and to our lives. That's why, 20 years ago, we introduced a 2-year inspection plan with every Stormceptor unit sold. As municipalities continue to focus on OGS units operating as designed, we felt it was time to strengthen our program even further. We are now offering at no additional cost to the asset's owner, a 5-year QAP with every Stormceptor unit to ensure water quality continues to be at its best.

Stormceptor® Quality Assurance Program

Based on initial inspection results, there are two ways to ensure Stormceptor® performance:

First way (5 years, cleaning not included)

•Six inspections over a 5-year period, cleaning not included

•First inspection when installed

•At 6 months a second inspection.

•Inspections every 12 months thereafter for 5 years

• Oil and sediment level are documented along with maintenance recommendations,

Second way (2.5 years, includes one cleaning)

•Initial inspection of the unit
• One post construction sediment (clean material) cleaning at 6 months
•Two additional annual inspections, resulting in the unit being maintained for the first 30 months

All QAP programs are Completed by Minotaur