1873 LONDON LINE SUBDIVISION

FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

SEPTEMBER 5, 2019
PROJECT 18-569

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1.0 INTRODUCTION

Greck and Associates Limited (Greck) has been retained by JR Capital Holdings Inc. (the Client) to undertake a Functional Servicing Report (FSR) and a preliminary Stormwater Management Report (SWM) of 1873 London Line, Sarnia, Ontario (Subject Property) in support of the proposed subdivision development and in accordance with The City of Sarnia's Pre-Consultation Meeting Notes dated August 27, 2018, see **Appendix A**.

In accordance with the City's requirements, Greck has already completed a Flood Hazard Assessment (FHA) in 2019 to determine flood and erosion hazard limits for the subject property. This report was submitted to and approved by the St. Clair Region Conservation Authority (SCRCA). The results of this analysis along with other technical studies that have been completed have been included as part of the planning and design provided in this report. Any reference documents if not appended can be provided upon request.

This report provides an overview of the current proposed development plans and examines their functional serviceability, including requirements and proposed design works related to:

- General site grading;
- Water distribution;
- Sanitary sewer servicing;
- Utilities;
- Major and minor stormwater drainage systems;
- Stormwater management; and
- Construction erosion and sediment controls.

This functional servicing plan has been prepared in accordance with accepted engineering practices and criteria from the governing approval agencies including the City of Sarnia (City), SCRCA, and the Ontario Ministry of the Environment, Conservation and Parks (MOECP). Following the submission and review of this document, detailed design plans including supporting reports and drawings will be prepared and submitted to the above-noted agencies for review and approvals, as required.

1.1 BACKGROUND

1.1.1 SITE LOCATION AND DESCRIPTION

1873 London Line is currently the location of the Sunset Golf Course. The subject property is 18.96 ha in size and located within the limits of the City of Sarnia, south of the Sarnia Chris Hadfield International Airport and Highway 402, east of Blackwell Sideroad and west of Telfer Road, see **Figure 1**. The site is legally described as Open Space in the City of Sarnia's Official Plan and zoned Major Open Space 1 in the Zoning By-law 85 of 2002, legally described as Part of Lot 12, Concession 6.

The surrounding watershed is primarily undeveloped agricultural lands. The Telfer Diversion borders the property to the south and west. The subject property is within the SCRCA jurisdiction. The SCRCA and the City are the primary agencies that will be the regulators for this development and associated engineering analysis and design.

The subject property is generally flat with little grade variation with the exception of minor landscaping features that support the existing golf course including small hills, sandpits and ponds. Runoff predominantly drains towards an existing large central landscaped pond and the Telfer diversion channel as well as the man-made pond on the adjacent property to the east.

The soil conditions within the limits of the proposed development consist of a surface layer of topsoil overlying an extensive layer of silty-clay-till resulting in poor draining subsurface conditions. Due to the inherently low permeability of the silty-clay-till materials, ground water levels are expected to range approximately 4m-5m deep (elevation 178 m) and are expected to vary slightly when in proximity to existing water features such as the watercourse and surrounding pond features, as indicated by the completed ground water monitoring. A copy of the geotechnical study completed by Geoterre can be found in **Appendix B**.

1.1.2 SURROUNDING LAND USE

The neighboring lands vary in zone type but are mostly rural areas. The eastern neighbouring lands is The Fountain of Memories Cemetery and Crematorium and agricultural farmland further to the east. As mentioned, the Telfer Diversion straddles the properties south and west boundary, fed by Waddell and Upper Perch Creeks. West of the Telfer Diversion, off of Blackwell Sideroad is the Bluewater Country Adult Leisure Living Community consisting of approximately 135 dwellings. At the north end of the property fronting on to London Line is commercial lands of Needham's Marine and Forever Furniture Galleries. Further commercial zones front the north side of London Line.

1.2 ENVIRONMENTAL RESOURCES

In accordance with the City of Sarnia's Pre-Consultation Meeting Notes dated August 27, 2018 the following studies were undertaken and reviewed for consistency with the proposed functional servicing plan:

- **Stage 1 & 2 Archaeological Assessment**
  Timmins Martelle Heritage Consultants Inc. [April 30th, 2019]
- **Species at Risk Assessment**
  Natural Resource Solutions Inc. [March 7, 2019]
- **Environmental Site Assessment One and Two**
  GM BluePlan Engineering [July,2019]

*Reports are to be provided under separate cover

As it pertains to the functional servicing and engineering design requirements proposed in this report, no conflicts were found.

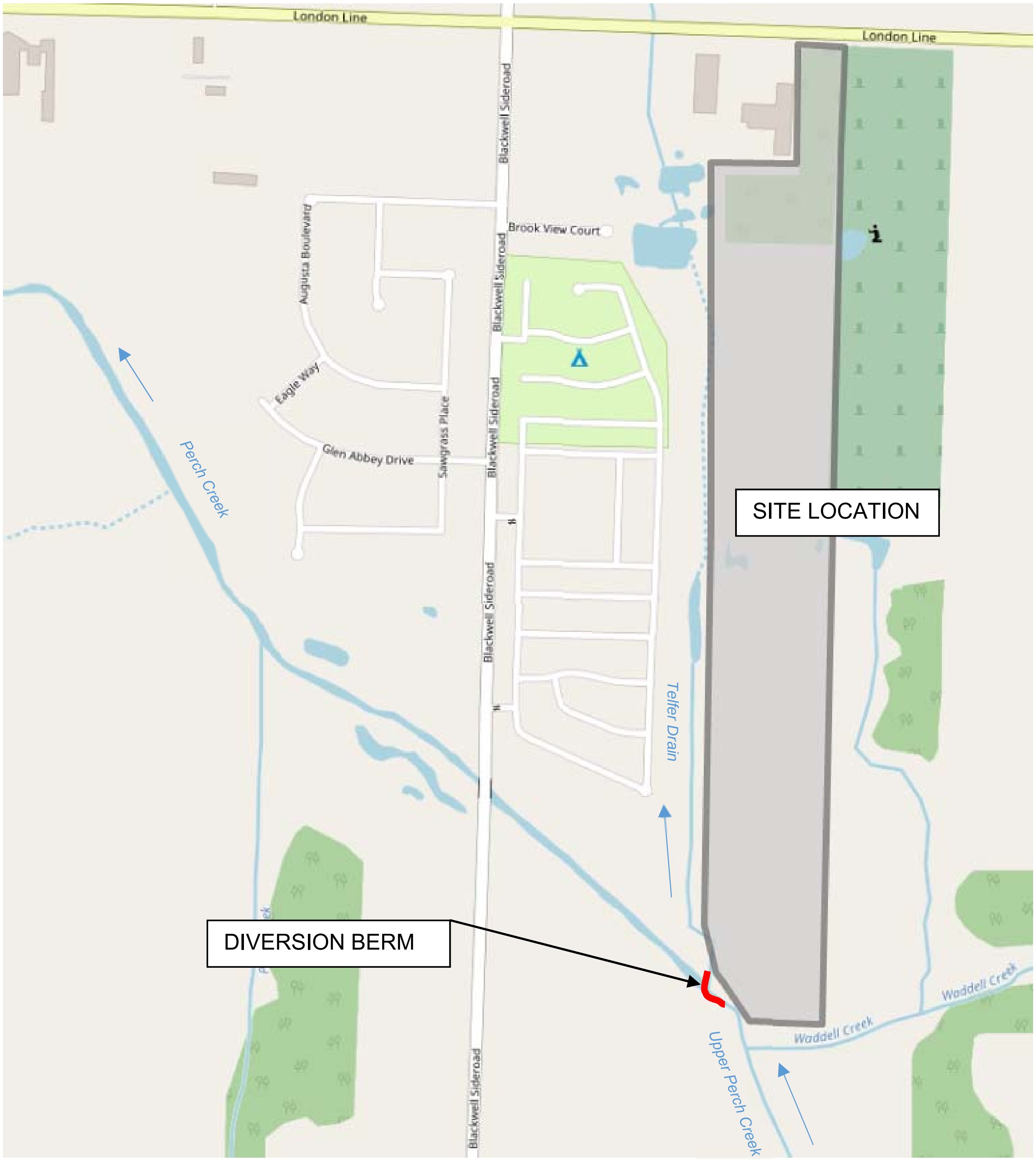


FIGURE 1: SITE LOCATION PLAN – REPLACE WITH PDF.

2.0 PROPOSED DEVELOPMENT

The property is approximately 18.96 ha in size. The proposed development consists of 167 single detached residential lots, a parkland block and a commercial block along with an associated road network and stormwater management facility. The proposed parkland block is to surround the proposed stormwater management facility and run adjacent to the Telfer Diversion Channel, located along the west property line. The proposed draft plan consists of the following:

Land Use		Area (ha)
Residential		9.63
Parkland (open Space)		0.85
Natural Heritage Block		1.93
Commercial		0.56
SWM Block		1.24
Roadway		4.75
	TOTAL	18.96

The proposed development will be serviced by municipal water and sanitary services. For the purpose of sanitary and watermain design, the estimated population of the proposed development is expected to be approximately 478.

The Draft Plan of Subdivision can be found in **Appendix A**

3.0 FLOOD & EROSION HAZARDS

A flood and erosion hazard assessment was completed in 2018 and updated by Greck on March 22, 2019, to define the regulatory floodline adjacent to the property. Further details regarding the flood hazard assessment are provided in the report titled "1873 London Line Development – Flood Hazard Assessment" by Greck and Associates Limited, dated March 22, 2019. The results of this investigation serve to determine development constraints adjacent to the natural watercourse feature known as the Telfer Diversion Channel. The determined flood and erosion hazards have been delineated on the proposed conceptual subdivision layout plans and Draft Plan of Subdivision as required. There is no development proposed within these regulatory hazard control areas.

3.1 FLOOD HAZARD ASSESSMENT

The City defines the regulatory floodplain based on the 100-year storm event, and that no buildings, structures or fill are permitted within the 100-year floodline. The flood hazard assessment concluded that the proposed development works within the subject property is not within the regulatory floodplain. The 100-year floodline has been included in the functional design drawings provided in this report.

3.2 EROSION HAZARD ASSESSMENT

The above noted flood hazard assessment included a desktop analysis of the right (east) bank of the Telfer Diversion Channel located along the western property limit. The desktop analysis concluded that the following combining factors result in a stable slope in accordance with Ministry of Natural Resources and Forestry (MNRF) guidelines:

- 3:1 engineered slope (Telfer Diversion Channel is manmade waterway),
- clay soils and
- Vegetated.

A minimum 9.0 m buffer from the 100-year floodline is currently provided along the west property limit of the site. This buffer will consist of a vegetated slope running along the west limit of the site. The 9.0 m buffer will act as an erosion access allowance, this is greater than the minimum 6.0 m buffer recommended by MNRF guidelines, see Conceptual Grading Plan. Erosion access is required to provide future long-term access for channel maintenance works.

4.0 SITE GRADING

A preliminary grading plan has been provided in Drawing GRA-1 and GRA-2, see **Appendix A**. In order to provide sufficient cover on municipal infrastructure (storm and sanitary sewers), meet drainage requirements and road design, fill will be required to raise the majority of the site. Efforts will be made to reduce fill requirements while adhering to municipal standards.

In general, the site will be graded such that surface runoff is directed towards a low point within the subdivision where the proposed SWM facility will be located. The SWM facility has been strategically designed at the center of the subject property where there is an existing pond associated with the golf course. The placement of the SWM facility at a natural low point minimizes earthworks that would otherwise be associated with constructing a SWM facility. Most drainage will be captured within the property serviced by the SWM facility.

There is no proposed fill within the 100-year regulatory floodplain.

Detailed grading plans will be prepared as part of the detailed design plan of subdivision. This plan will support grading requirements for site services and individual lot development. The plan will follow municipal design standards, as required.

5.0 ROAD ACCESS AND IMPROVEMENTS

Access to the subdivision will be via London Line, located at the northern limit of the property. London Line is a four (4) lane arterial county road with a 30.5 m wide road allowance. A 20.1 m wide road allowance is provided for local access within the subdivision, featuring an 8.5 m wide road, standard curb and gutter along with a 1.5 m sidewalk as per City of Sarnia Drawing 14-4. The overall road network will utilize a minimum 0.5% slope throughout the subdivision to accommodate existing topography and reduce fill requirements while providing the necessary drainage.

Road base design thickness will be confirmed during detail design in accordance with the completed geotechnical analysis and as per the municipal design criteria.

A total of three (3) streets are proposed within the subdivision, referred to as Street A, Street B and Street C. All roadways will form part of the stormwater major drainage system.

A Traffic Impact Study by RC Spencer Associates Inc. was prepared March 2019, provided under separate cover. In short, the proposed development will not have a noticeable effect on local traffic. The proposed detailed road design will incorporate the results of this report as required in accordance with the TAC's *Geometric Design Guide for Canadian Roads* (2017).

6.0 WATER SERVICING

This section serves to provide anticipated water demands and required fire flow calculations in support of functional servicing. A detailed watermain hydraulic analysis will be completed during detailed design to confirm existing and proposed external and internal water supply characteristics, summarized in a detailed report stamped by a qualified engineer in accordance with the Ministry of Environment, Conservation & Parks' (MOECP) *Guidelines for the Design for Drinking-Water Systems* (2008). At such time a Form 1 can be prepared for the municipality in accordance with their Drinking Water Works Program (DWWP) in support of final stamped design plans.

Water servicing for the proposed development will be supplied by connection to the existing 300mm trunk watermain on London Line. A single line is proposed within the ROW's to service the entire development and will include fire hydrants, valves, service laterals, with pipe looping to maintain regulated disinfectant residuals in accordance with municipal standards including Division 4.1 City of Sarnia Watermain Standards, 2019. A preliminary watermain layout including hydrant coverage is depicted on the Conceptual Water Servicing Plan, see Drawing WAT-1 and WAT -2, Conceptual Watermain Distribution Plan **Appendix C.**

6.1 DEVELOPMENT DEMANDS

The design criteria used to determine water demands were based on Ministry of Environment, Conservation & Parks' (MOECP) *Guidelines for the Design for Drinking-Water Systems* and the Fire Underwriters Survey, as required. The proposed development includes 9.63 ha of combined residential blocks consisting of 135 single detached units and a 0.56 ha commercial block.

The estimated water system demands for the proposed development of 135 units and a proposed commercial block are:

- Average Day Demand (ADD): 157,861 L/day = 1.80 L/s;
- Maximum Day Demand (MDD): 421,024 L/day = 4.81 L/s; and
- Peak Hour Demand (PHD): 614,634 L/day = 7.02 L/s.

ADD, MDD and PHD factors were calculated using demand peaking factors and population values as per Table 3-3 of the MOECP *Design Guidelines for Drinking-Water Systems*. A detailed breakdown of the calculated demands and assigned nodes can be found in **Appendix C** and Drawing WAT-1, Conceptual Watermain Distribution Plan, respectfully. External demands will be considered in greater detail during detailed design.

For the proposed commercial block, demands were calculated using an allowance of 0.4 L/s/ha. Demand calculations will be re-assessed during detail design of the commercial block as discussed with the City.

Fire demands have been calculated using the *Water Supply for Public Fire Protection* (1999) prepared by Fire Underwriters Survey (FUS). Detailed fire flow calculations are provided in **Appendix C**, and the results are summarized as follows:

1) Residential Unit: 6,000 L/min = 100.00 L/s;
   a) To calculate the size of a typical residential unit's floor area we assumed:
      Average Floor Area = (40% of Average Lot Size)

2) Commercial Block: 8,000 L/min = 133.33 L/s.
   a) To calculate the size of the commercial block's floor area we assumed:
      Average Floor Area = (50% of the Commercial Block Size)

As such, the MDD plus fire flow is 138.14 L/s (133.33 L/s + 4.81 L/s). Assumptions for fire flow requirements will be revised at the detailed design stage when additional information related to size of buildings and construction methods are known.

A hydrant flow test was conducted by Wallace-Kent Sprinkler Systems Inc. on March 15, 2019 at 10am. The results indicate that that at 20 psi (140 kpa) residual, a flow of 4436 GPM (280 L/s) is available from the hydrant on London Line. The results of the hydrant flow tests can be found in **Appendix C**.

Initial calculations suggest that the existing watermain infrastructure should support the proposed development. However, a detailed watermain distribution analysis will need to be completed.

7.0 SANITARY SERVICING

The proposed development will be serviced with a new 250mm PVC municipal sewer main along the road right of way with individual 150mm service lateral connections for each lot. A minimum sewer grade of 0.5% is proposed to minimize fill requirements necessary to accommodate existing topography. In addition, a sanitary pumping station will be required within the proposed development to accommodate existing topography, grading and fill requirements. A pumphouse is proposed within the current SWM block and is to be designed in accordance with MOECP Guidelines. All sanitary sewer design will be prepared in accordance with municipal and provincial standards, in particular Division 4.2 City of Sarnia Sewer Standards, 2019.

A preliminary sanitary sewer design and calculations has been completed resulting in a peak flow of 14.14 L/s for the entire development. Additional details can be found in the sanitary sewer design sheet and sanitary functional servicing plan found in **Appendix D.**

There is an existing sanitary manhole on London Line that provides service to the existing golf course. The proposed new subdivision sewer main is to utilize this existing connection. The current local external sanitary sewer fronting the subject property within the London Line ROW includes a 400mm diameter concrete sewer that gravity drains 100 m westbound to PS 29 (pumping station). From this station sewage is pumped via a forcemain westward over the Telfer Diversion and along London Line.

The “Sarnia Area 2 Sanitary Servicing Study” by Stantec dated October 2m 2018 was provided by the City and reviewed. However, this study did not include the service area attributing to the subject property development lands. As such, the City has indicated that they will assess the proposed sanitary demands internally to determine available capacity and serviceability of the proposed development. If the system is already at capacity, the City will engage the necessary studies to determine any potential upgrades, if needed. Additionally, a phased development plan approach can be utilized to accommodate the interim sanitary capacity.

8.0 UTILITIES

The utilities for the proposed development will be provided by the following local service providers:

Hydro:	Bluewater Power Distribution
Natural gas:	Union Gas
Telephone:	Bell Canada
Cable:	Cogeco
Mail:	Canada Post

The engineering design of these services will be coordinated with the City and the relevant providers. Utilities will be constructed within the City's ROW as per the applicable City design standards.

9.0 DRAINAGE AND STORMWATER MANAGEMENT

Provided in this section is an outline of the preliminary drainage and SWM strategy of the proposed subdivision. The proposed SWM design will be in accordance with the City of Sarnia's Stormwater Management Design Standards 2017 as well Ministry of the Environment, Conservation and Parks standards and guidelines.

9.1 EXISTING

Under existing conditions, the subject property is relatively flat, with runoff generally draining in a north/eastern direction. The entire site has a total area of ~19 ha and consists of a golf course comprised of primarily pervious surfaces with landscaping and existing ponds distributed throughout. Runoff from the site discharges to the Perch-Wadell Creek, and eventually to the Telfer Diversion Channel, located immediately west of the development.

As per provincial soils mapping, the underlying soils consist of Brookstone Clay, which is confirmed via geotechnical investigations. For the purposes of hydrologic modelling, the soils have been modelled as a Hydrologic Soils Group D, with poor infiltration characteristics.

A PCSWMM hydrologic model was developed to quantify existing condition peak flows for the 2-year through 100-year design storms for the site. A number of storm distributions were simulated, under the proposed condition, to determine the critical storm event. The critical storm event is defined as the storm distribution that generates the highest peak flow under the proposed condition. It was determined that the Chicago 12-hour storm distribution produced the highest 100-year runoff, and therefore was applied for the 2-

year through 100-year events. For the purposes of hydrologic modelling, approximately 16 ha was considered to determine existing peak flow conditions, as a portion of the land is to remain undeveloped, therefore not increasing peak runoff throughout the lands.

A summary of the 2-year through 100-year peak flows under existing conditions are provided below in **Table 9.1**. Detailed model outputs for the 100-year event are provided in **Appendix F**.

TABLE 9.1: EXISTING CONDITIONS - PEAK RUNOFF

Storm Event	Peak Runoff (m^3/s)
2-year	0.30
5-year	0.53
10-year	0.73
25-year	0.99
50-year	1.25
100-year	1.53

9.2 PROPOSED

Under proposed conditions, surface runoff is to be captured by both the minor and major storm sewer system prior to discharge towards a stormwater management facility and ultimately the Telfer Diversion Channel.

9.3 MINOR DRAINAGE SYSTEM

Minor storm runoff, from storms up to the 5-year event, will be collected in a system of catch basins, manholes and storm sewers, ultimately discharging into a stormwater management facility. The proposed development will be serviced with a new 300mm dia. PVC sewer up to 1050mm dia. concrete sewer along the ROW with individual 150mm service lateral connections for each lot. A minimum average sewer grade of 0.2%-0.5% will be utilized to minimize fill required to accommodate the existing topography. In all instances, the proposed minor storm sewer will be designed to not exceed 80% capacity. Sewer design and construction will be in accordance with municipal standards including Division 4.2 City of Sarnia Sewer Standards, 2019.

A preliminary storm sewer design sheet and storm sewer servicing plan has been provided in **Appendix E.**

Rear lot catch basins may be required and will be confirmed during detailed design. If required, rear lot drainage infrastructure will be installed within dedicated city easements and in accordance with City of Sarnia “Rear lot Catch Basin Detail” unless specified otherwise.

A stormwater easement is proposed on the north and south side of the SWM block to convey minor and major drainage directly to the SWM facility.

9.4 MAJOR DRAINAGE SYSTEM

Major storm runoff, greater than the 5-year storm event up to the 100-year storm event, will be collected and conveyed by the ROW major drainage network. Flows through the ROW are designed to ensure a maximum flow depth of 0.15 m, and that the maximum depth-velocity product does not exceed 0.4 m^2/s, as per MNRF guidelines.

The stormwater easement features an overland flow route prior to discharge towards the SWM facility forebay. A summary of the major overland flow conveyance is provided below in **Table 9.2** outlining the road network’s major overland flow capacity. Peak flows were determined from the PCSWMM hydrologic model, as outlined in **Section 10.0**.

TABLE 9.2: ROAD NETWORK – MAJOR OVERLAND FLOW CAPACITY

Parameter	North of SWMF	South of SWMF
5-Year Peak Flow	0.91 m^3/s	0.84 m^3/s
100-Year Peak Flow	1.95 m^3/s	1.78 m^3/s
Major Overland Flow*	1.04 m^3/s	0.94 m^3/s
Minimum Road Grade	0.5%	0.5%
Major Flow Depth through Right of Way	0.15 m	0.13 m
Major Flow Velocity	1.17 m/s	1.08 m/s
Depth Velocity Product	0.18 m^2/s	0.14 m^2/s
*Assumed to be the 100-year peak flow less the 5-year peak flow (minor storm sewer capacity)		

All major overland flows are to be discharged through a proposed 4.0 m wide drainage easement on either side of the SWM facility.

TABLE 9.3: DRAINAGE EASEMENT – MAJOR OVERLAND FLOW CAPACITY

Parameter	North of SWMF	South of SWMF
Major Overland Flow*	1.04 m^3/s	0.94 m^3/s
Grade	3.7%	3.5 %
Major Flow Depth through Right of Way	0.09 m	0.08 m
Major Flow Velocity	2.79 m/s	2.64 m/s
Depth Velocity Product	0.25 m^2/s	0.21 m^2/s
*Based on 3.0m wide asphalt path with 3:1 side slopes to an overall width of 6.0 m		

The conveyance properties of both the road network and major drainage easements are to be refined during detailed design.

10.0 STORMWATER MANAGEMENT REQUIREMENTS

The SWM plan provided in this FSR is subject to the review and approval of the City of Sarnia. SWM criteria are provided below:

Quality Control	Stormwater Quality controls must be provided to satisfy the MOECP *Stormwater Management Planning and Design Manual*. Enhanced level water quality protection, or 80% long term total suspended solids (TSS) removal is required.
Extended Detention / Erosion Control	Natural rates of erosion are necessary for the maintenance of channel form and function. As per the MOECP *Stormwater Management Planning and Design Manual*, the greater of 40 m^3 /ha or runoff volume from the 25 mm 4-hour Chicago storm event must be detained for a minimum of 24 hours.
Quantity Control	Post development peak runoff is to be controlled to pre-development rates to meet flood hazard control objectives.
Water Balance / Infiltration	The property predominantly consists of Brookstone Clay surficial soils which is classified as a USDA Hydraulic Soil Group: D, a very poor draining soil resulting in infiltration rates around no more than 5mm/hr. Ministry requirements recommend a minimum infiltration rate of 15mm/hr to support any infiltration objectives. A water balance analysis will be

completed during detail design in accordance with Ministry guidelines, however, Low Impact Development (LID) strategies and other related infiltration techniques are deemed not suitable for the proposed development.

10.1 PROPOSED STORMWATER MANAGEMENT PLAN

The preliminary SWM strategy implements an end-of pipe stormwater management pond to provide water quality, extended detention and quantity controls for the site. Lot level controls such as Low Impact Development (LID) facilities were not considered due to the underlying clay soils throughout the site.

A minor and major storm sewer network is proposed to collect surface drainage from the site prior to discharge to the end of pipe wet-pond stormwater management facility. A number of drainage easements are required for both minor and major storm conveyance.

10.1.1 WATER QUALITY

To achieve an enhanced level water quality protection (80% TSS removal), an extended detention wet pond with a pre-treatment forebay is proposed. The permanent pool has been sized to exceed the 80% TSS removal rate as per Table 3.2 of the MOECP SWMP Manual.

Several rear yards are to drain uncontrolled towards the Telfer Diversion Channel. Runoff from these catchments will be generated from backyards/parklands and is considered clean. As such, water quality controls are not required for these areas.

A 1.5 m deep pre-treatment forebay is designed to provide initial sedimentation of suspended solids, followed by a 1.5 m deep main cell. A summary of the permanent pool sizing parameters is proved below in **Table 10.1**. The park block was not considered as drainage is considered clean, with no increase in impervious areas.

TABLE 10.1: PERMANENT POOL SUMMARY

Parameter	Provided	Required (MOECP & Sarnia Guidelines)
Drainage Area	13.95 ha*	
Percent Impervious	45%	
TSS Removal Rate	80%	60%
Unitary Volume Requirement	164	
Permanent Pool Volume	2621 m^3	2291 m^3
Permanent Pool Elevation	180.75	

*Excludes clean water from park block and SWM Pond

10.1.2 EXTENDED DETENTION / EROSION CONTROL

The stormwater management facility has been sized to ensure that the greater of 40 m^3/ha (as per MOECP SWMP Manual) or the runoff volume from the 25mm 4-hour Chicago storm is detained for at least 24 hours. The 25 mm 4-hour Chicago storm was modelled in PCSWMM software. A summary of the extended detention volumes are provided below in **Table 10.2**. The park block was not considered as drainage is considered clean, with no increase in impervious areas.

TABLE 10.2: EXTENDED DETENTION SUMMARY

Parameter	Provided	Required (MOECP & Sarnia Guidelines)
Drainage Area	15.61 ha	
Unitary Extended Detention Volume	40 m^3/ha	
25mm 4-hour Chicago Volume	1260 m^3	
Extended Detention Volume	1263 m^3	624.5 m^3
Extended Detention Elevation	181.10 m	
Drawdown Time	25.9 hours	24 hours

Using the falling head orifice equation, the provided extended detention volume is released over a period of 25 hours, exceeding the minimum requirements for water quality and erosion control while providing additional time for infiltration to occur into the native soils. Detailed calculations are provided in **Appendix F**

10.1.3 WATER QUANTITY

The proposed SWM facility provides detention and controlled release rate to attenuate post development peak flows from the site to pre-development rates, as outlined in **Section 9.1**. A post development hydrologic model incorporating the SWM facility has been prepared, with detailed results and calculations in **Appendix F**.

A summary of the proposed pond water levels and outflows are provided in **Table 10.3**. The stormwater management facility has been sized such that there is a freeboard of 0.47 m from the 100-year water elevation to the adjacent lots at the property line.

TABLE 10.3: STORMWATER MANAGEMENT FACILITY QUANTITY CONTROL SUMMARY

	Peak Flow Rate (m^3/s)			Volume (m^3)	Elevation (m)
	Pre-development	Post-Development (uncontrolled)	Post Development (controlled)		
2-year	0.30	1.34	0.20	1788	181.24
5-year	0.53	2.11	0.48	2151	181.32
10-year	0.73	2.69	0.73	2479	181.41
25-year	0.99	3.36	1.00	2883	181.49
50-year	1.25	3.99	1.25	3249	181.56
100-year	1.53	4.59	1.43	3637	181.63
Top of Pond					181.93

Peak flows are controlled from the SWM pond by a number of methods as outlined below.

TABLE 10.4: QUANTITY CONTROL DETAILS

Parameter	Value	Elevation
Quality/Extended Detention Orifice in control manhole	140 mm diameter	180.75 m
2-10 year quantity control weir within control manhole	2.3 m length	181.10 m
10-year to 100-year concrete box weir	3.0 m length	181.45 m
Emergency Spillway Weir	15 m length	181.65 m

Both the Quality/Extended detain and 2-10 year controls will be implemented within a control manhole. The 10-year to 100-year concrete weir will be located adjacent to valley lands. The pond berm will have a depression at an elevation of 181.65 m to act as an emergency overflow weir, should both the control manhole structure or concrete weir become clogged.

All specific details of the control measures presented below are preliminary only, and are to be confirmed during detailed design.

10.1.4 DRAINAGE EASEMENTS

Multiple drainage easements are required to convey minor and major flows within the development, as indicated in Drawing STM-1 and STM-2, **Appendix E**.

- Drainage Easement 1 [Block 170] – conveying minor and major flows through a pedestrian walkway to the stormwater management facility from the north half of the development
- Drainage Easement 2 [Block 170] – conveying minor and major flows through a pedestrian walkway to the stormwater management facility from the south half of the development
- Rear Lot Catch basins (to be determined in detailed design)

10.1.5 STORMWATER MANAGEMENT FACILITY DESIGN

A preliminary grading plan has been prepared for the SWM facility. Details regarding the SWM facility are to be confirmed during the detailed design; however, design components have been summarized below:

- Permanent pool depth of 1.5 m
- 5:1 side slope shelf at 3 m of either side of permanent pool
- 3:1 side slopes below and above permanent pool shelf
- Forebay volume less than 20% permanent pool volume
- Forebay to be lined with cable concrete for scour protection
- Length to width ratio of 2:1 within forebay
- Length to width ratio of 5:1 overall
- 5 m buffer from highwater level
- 900mm outlet pipe with capacity to convey 100-year outflow
- Outfall above Telfer Channel 25-year flood elevation (180.25 m)
- Permanent pool above Telfer Channel 100-year flood elevation (180.71 m)
- Drawdown pipe (to be designed in detailed design)

No sediment drying area is proposed. Sediment removal maintenance should be performed using modernized methods including pumping with sediment bags and vacuum trucks.

10.1.6 FOUNDATION DRAINAGE

The dwelling units will have conventional basements which will require weeping tile. Weeping tiles will be connected to gravity service laterals that will outlet to the storm mains within the ROW. Should a gravity system be deemed unsuitable, a sump pump will be utilized as required, to be discharged to a splash pad and grassed surface.

10.1.7 ROOF DRAINAGE

Roof downspouts are to be discharged over splash pads to sodded ground surface areas where possible. All roof drainage is to be directed to side yard swales which will drain uncontrolled or to the proposed SWM facility.

10.2 SWM INSPECTION AND MAINTENANCE

The proposed SWM system will require regular maintenance. A detailed SWM maintenance plan will be provided with a detailed SWM report during the detailed design stage. Details pertaining to SWM pond, infiltration trench maintenance, cleanout frequency and methodology will be provided to be undertaken by the appropriate landowner before and after assumption in accordance with MOECP protocol and environmental compliance guidelines.

10.3 WATER BALANCE

Urbanization increases impervious cover which, if left unmitigated, results in a decrease in infiltration. This infiltration-decrease reduces groundwater-recharge and soil-moisture replenishment. It also reduces stream baseflow needed for sustaining aquatic life. Therefore, it is important to maintain the natural hydrologic cycle as much as possible.

A water balance analysis will be prepared during detailed design using MOECP's *Stormwater Management Planning and Design Manual* (2003) guidelines. This approach uses the method developed by Thornthwaite and Mather as well as data retrieved from Environment Canada Climate Normals. The results of this exercise will quantify the impacts of the proposed development; however, given the existing poorly draining clay soils on the subject property, mitigative measures will be limited.

11.0 VEHICLE AND PEDESTRIAN ACCESS

The subject property has frontage on the south side of London Line (also known as County Road 22). The road is a highly used east/west four-lane arterial road which provides a major access corridor into Sarnia and is maintained by the municipality. The design and layout of the roads in the subject property will be well-integrated with the existing road network and shall not preclude or prevent the orderly and efficient integration of future development on abutting vacant or underused lands.

Vehicular access to the proposed development will be facilitated by a new municipal roadway to include 20.1 m wide right-of-way in accordance with City standards. The right of way will utilize a single sidewalk with concrete curb and gutter and 2% cross fall. The longitudinal slope will generally be at 0.5% with some slopes ranging up to 3%.

In accordance with City standards and geotechnical recommendations, the minimum pavement structure for the proposed private road is as follows:

Material	***Thickness (mm)***
Asphalt	
Asphalt Surface Course (HL3)	40
Basecourse (HL4)	40
Total Asphalt Depth	80
Base	
Granular A Base (OPSS 1010)	100
Granular B Type 2 Sub-Base (OPSS 1010)	300
Total Roadway Depth	**480**

Internal pedestrian access will be provided by standard concrete walkways to safely guide residents through the development for access to the proposed trail system. All sidewalks will be constructed as detailed in Drawings 108-F, 112-F, 119-F, 122-F, 2485, 2486 and OPSS 350, 353, 904, and 1350. Generally, sidewalks will be constructed with a thickness of 125mm (5”). For sidewalks that cross commercial driveways, the thickness will be 200mm, as directed by the City Engineer and in accordance with Division 4.3 City of Sarnia Concrete Sidewalks, Curbs and Driveways Standards, 2019.

Tactile Warning Plates shall be incorporated at every location with a pedestrian crossing or as specified in the contract documents. Tactile Warning Plates are to be installed on sidewalk ramps to warn visually impaired pedestrians that they are entering the roadway.

For new driveways, an H.L.3 asphalt mixture shall be placed in accordance with OPSS 311 “Construction Specifications for Asphalt Sidewalk, Driveway, Boulevard and Sidewalk Resurfacing”, and shall be laid to a minimum thickness of 50mm.

12.0 EROSION AND SEDIMENT CONTROL

Erosion and sediment controls (ESC) will be implemented for all construction activities, including topsoil striping, material stockpiling, pavement construction, and grading operations. Design details will include a phased approach to minimize disturbance including considerations for restoration.

ESC measures will be provided during detailed design, and will include, but not be limited to:

- Silt fence (light/heavy) – placed in order to divert runoff and contain sediments within the construction area. The fencing consists of a filter fabric secured by posts anchored to the ground. Heavy duty fencing includes wire mesh for reinforcement.
- Sediment Bags – to be used if dewatering is needed during construction. Any work area to be dewatered must discharge the sediment-laden flow through a dewatering filter bag placed in a well vegetated and stabilized area surrounded by Silt Soxx to capture silt from the water.
- Silt Soxx – a tubular mesh netting containing filter media used as a barrier filter for runoff containing excess sediment. To be used in conjunction with sediment bags for dewatering operations as well as a substitute for Silt Fence.
- Rock Check Dams – to be placed within a drainage swale to hold back water and control velocities to prevent erosion and promote sedimentation.
- Silt Sacks – to be installed in active catch basins to filter any stormwater leaving the construction area to prevent sediment from entering the drainage system. The Silt Sack is placed underneath the catch basin grate and holds the sediment until emptied.
- Temporary sediment ponds – allow for the detention of runoff containing excess sediment as a result of construction operations. The detention time allows sedimentation to occur before the run-off is discharged.
- Mud tracking control – mud mats, consisting of a geotextile overlain by clear stone will be placed at the access to the site during construction to prevent equipment and vehicles tracking sediments off-site.
- Dust Suppression – a local water supply or a water truck is to be used to spray and dampen the construction area to reduce dust. With emphasis on hauling and other vehicular traffic routes.

13.0 CONCLUSIONS

As presented in this report, the proposed London Line development will meet the following municipal and provincial standards and regulations specified for:

- General site grading;
- Water distribution;
- Sanitary sewer servicing;
- Utilities;
- Major and minor stormwater drainage systems;
- Stormwater management; and
- Construction erosion and sediment controls.

In summary, it has been determined that the London Line development can be serviced with existing and proposed infrastructure that is in accordance with polices and guidelines required by the City of Sarnia and other regulating agencies.

14.0 REFERENCES

Corporation of the City of Sarnia – Design Standards for Stormwater Management – 2017

Ministry of the Environment – Stormwater Management Planning and Design Manual, March 2003

Ontario Ministry of Natural Resources and Forestry – Technical Guide – River and Stream Systems: Erosion Hazard Limit, 2002

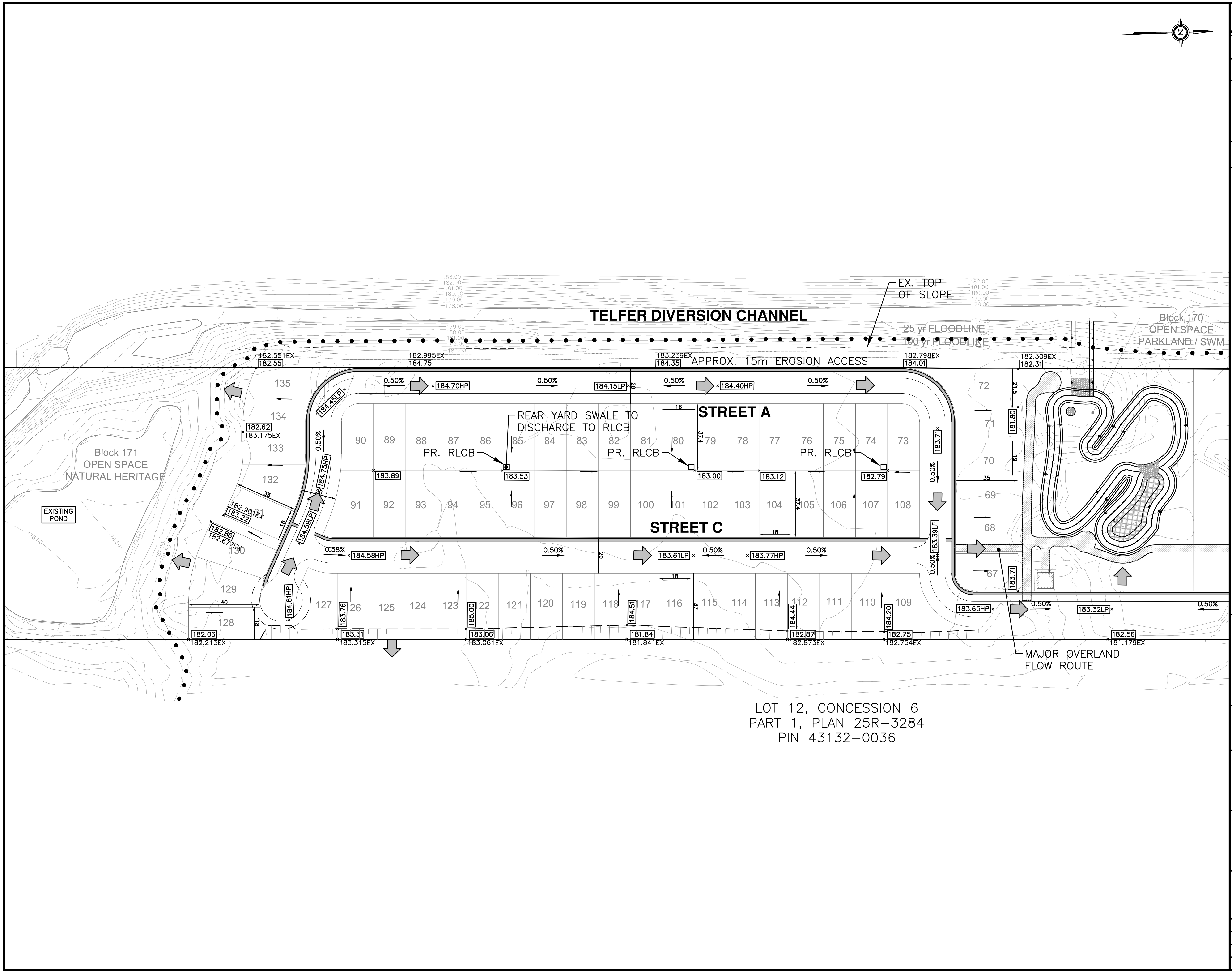
Ministry of the Environment – Design Guidelines for Drinking Water Systems, 2008

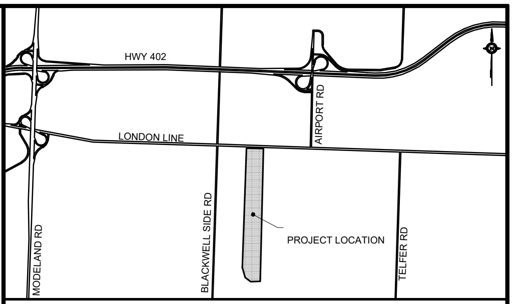
Fire Underwriters Survey – Water Supply for Public Fire Protection, 1999

Ministry of the Environment – Design Guidelines for Sewage Works, 2008

APPENDIX A

Functional Grading Plan & Draft Plan





KEY PLAN

N.T.S.

LEGEND

——	MAJOR CONTOURS	——	PROP. ROW
— — —	MINOR CONTOURS	——	PROP. LOT LINE
→	MINOR FLOW	——	PROP. LIMIT OF SUBDIVISION
⇨	OVERLAND FLOW	— — —	PROP. TOP OF SLOPE
×183.86	PROP. ELEVATION	● ●	REGULATORY FLOODLINE
×184.05HP	PROP. ELEVATION (HIGH POINT)		
×183.06LP	PROP. ELEVATION (LOW POINT)		
×182.510EX	EX. ELEVATION		
0.50% →	PROP. SLOPE		

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542–4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

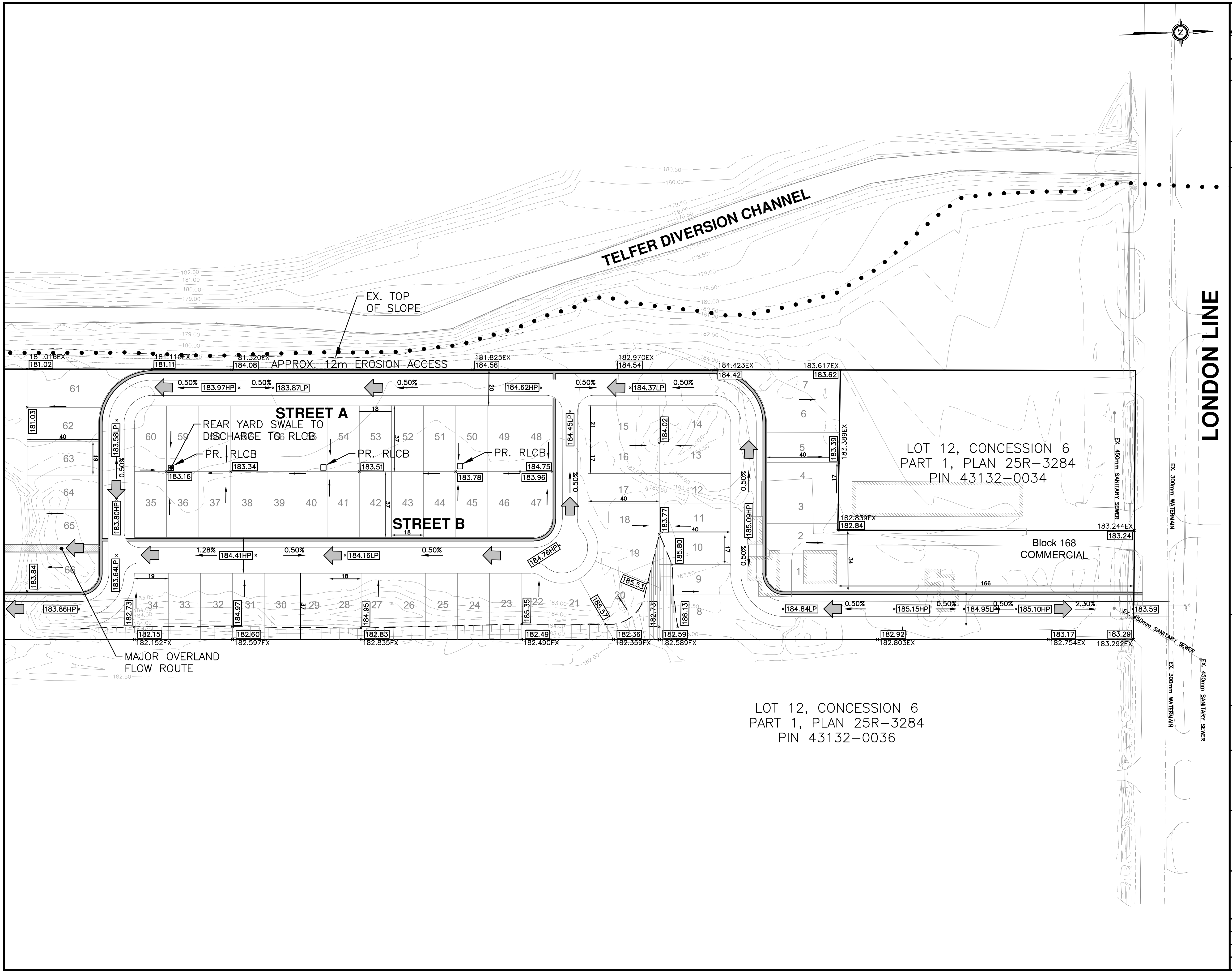
1873 LONDON LINE SARNIA, ON

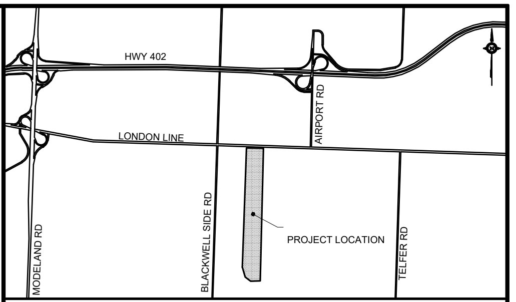
CONCEPTUAL GRADING PLAN

DESIGNED BY:	S.S.	SCALES:		PROJECT No.	18-569
CHECKED BY:	E.G.	HORIZONTAL:	1:2000	DRAWING No.	GRA-1
DRAWN BY:	J.N.	VERTICAL:		SHEET No.	01
DATE: APRIL 24, 2019		SHEET SIZE:	11"x17"		

Z:\Projects\18–569 – 1873 London Line Subdivision\05_Drawings\CAD\GRADING\18–569_GRADING.dwg

Date Plotted: Sep 03, 2019 – 2:53pm





KEY PLAN
N.T.S.

LEGEND

─────	MAJOR CONTOURS	─────	PROP. ROW
─ ─ ─	MINOR CONTOURS	─────	PROP. LOT LINE
→	MINOR FLOW	━━━━━	PROP. LIMIT OF SUBDIVISION
⇨	OVERLAND FLOW	─ ─ ─	PROP. TOP OF SLOPE
183.86	PROP. ELEVATION	● ●	REGULATORY FLOODLINE
184.05HP	PROP. ELEVATION (HIGH POINT)		
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182.510EX	EX. ELEVATION		
0.50%	PROP. SLOPE		

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT SOUTHWEST CORNER OF DWELLING
COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542-4300
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CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

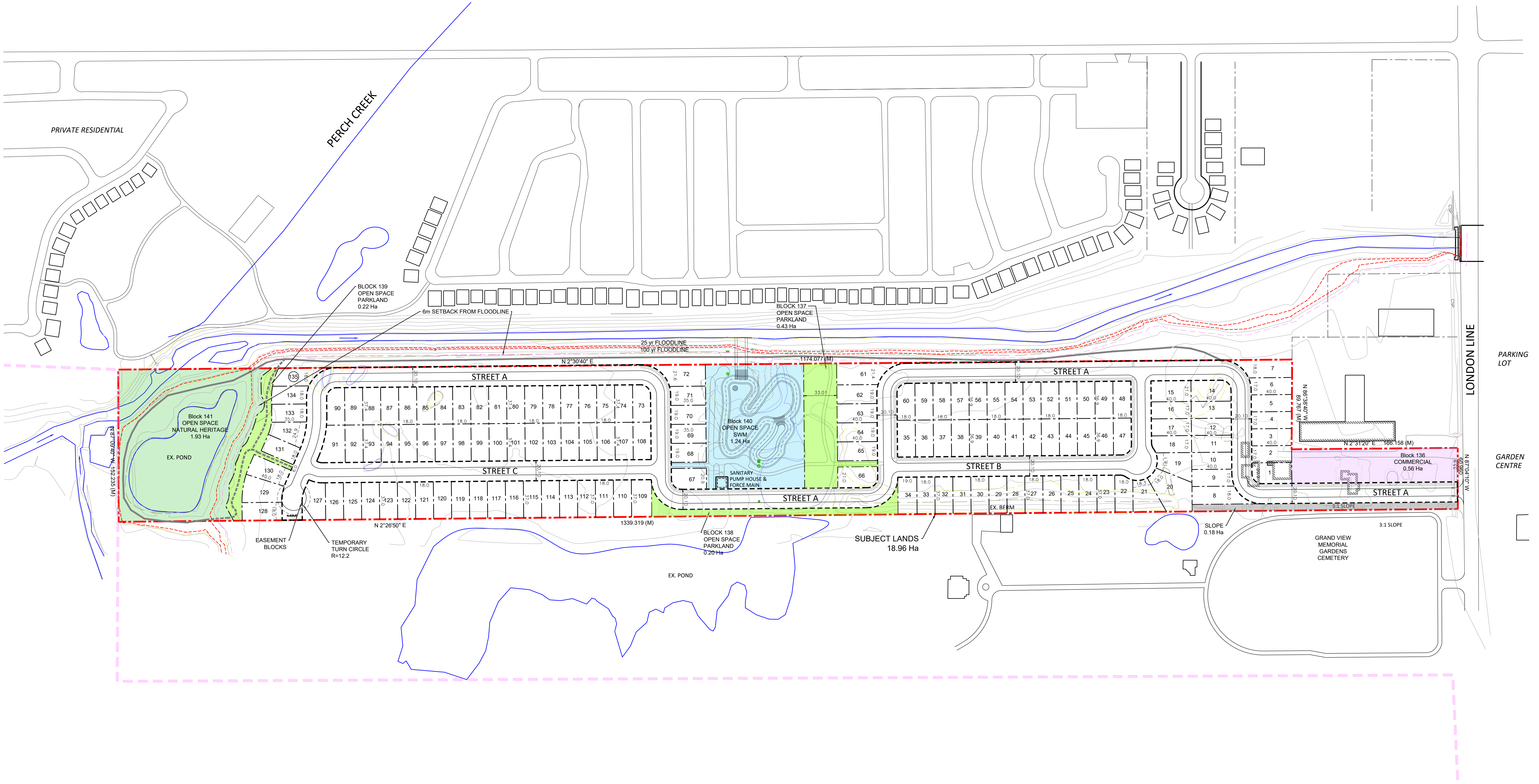
PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL GRADING PLAN

DESIGNED BY: S.S.	SCALES:		PROJECT No. 18-569
CHECKED BY: E.G.	HORIZONTAL:	1:2000	DRAWING No. GRA-2
DRAWN BY: J.N.	VERTICAL:		SHEET No. 02
DATE: APRIL 24, 2019	SHEET SIZE:	11"x17"	



LAND USE SCHEDULE

LAND USE	AREA in Ha	%
SINGLE DETACHED RESIDENTIAL LOTS 1 TO 135	9.63	56.5
COMMERCIAL Block 136	0.56	3.3
PARKLAND Blocks 137 to 139	0.85	5.0
SWM POND Block 140	1.24	7.3
STREETS & SLOPE	4.75	27.9
DEVELOPABLE TOTAL	17.03	100.0
NATURAL HERITAGE Block 141	1.93	
TOTAL SITE AREA	18.96	

LEGEND

- SUBJECT LANDS
- PROPOSED LOTLINE
- PROPOSEDSTREETLINE
- 100 YEAR FLOOLINE (GRECK, 2018)
- PROPOSED MULTI USE PATH
- EXISTING ASPHALT PATH

NOT A LEGAL SURVEY -
LIMITS ARE APPROXIMATE

PRELIMINARY

FOR DISCUSSION PURPOSES ONLY

Aug 20, 2019

Monteith+Brown
planning consultants

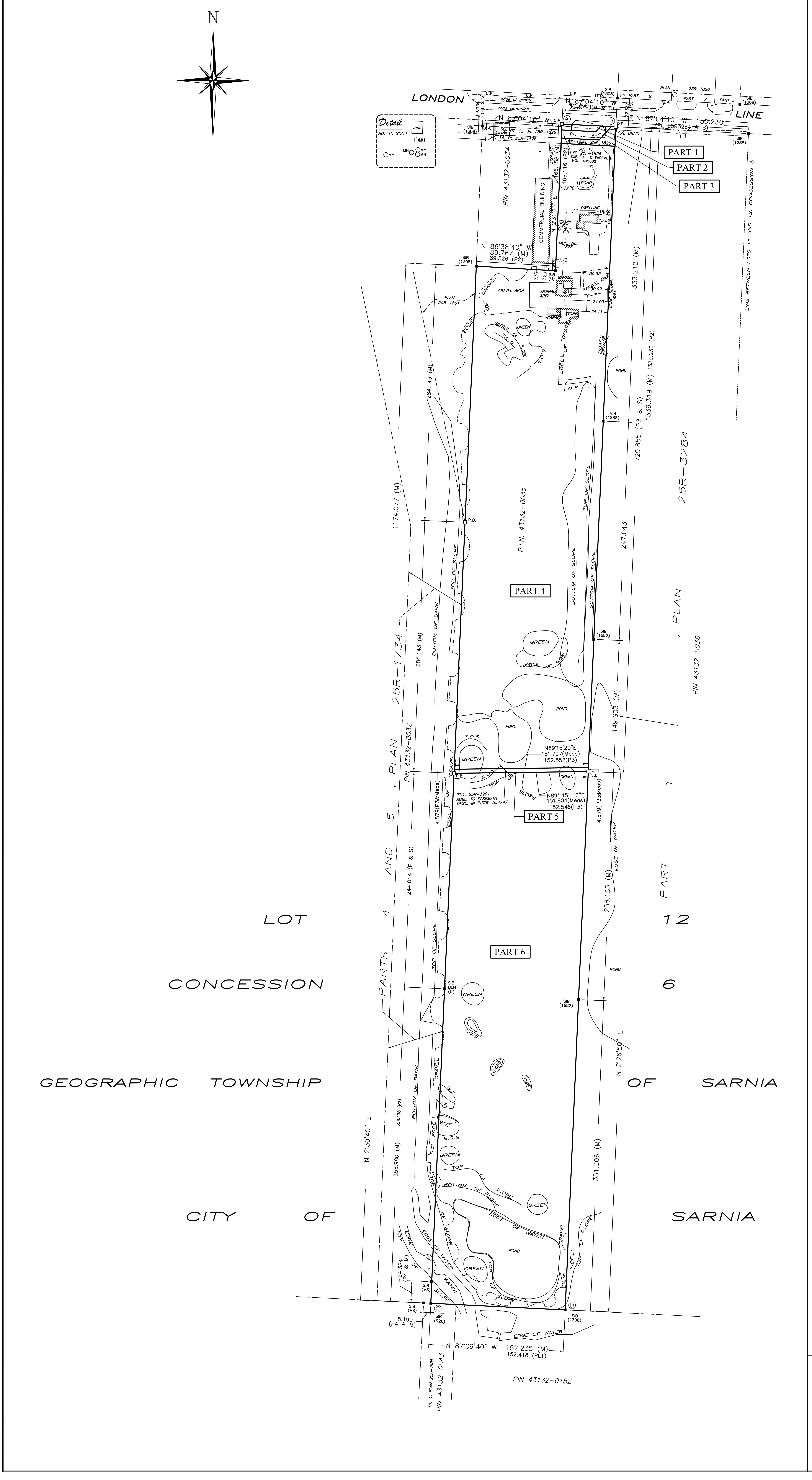
CONCEPTUAL LAYOUT - one
RESIDENTIAL SUBDIVISION

1873 LONDON LINE, SARNIA ONTARIO
JR Capital Holdings Inc.

NORTH

18-2200
1: 4,000 (11x17)

0 20 40 60 100 140m



I REQUIRE THIS PLAN TO BE DEPOSITED UNDER THE LAND TITLES ACT.	PLAN 25R ________ RECEIVED AND DEPOSITED
DATE ____________	DATE ____________
T.M. NISBET ONTARIO LAND SURVEYOR	REPRESENTATIVE FOR THE LAND REGISTRAR FOR LAND TITLES & LAND REGISTRY DIVISION OF LAMBTON (NO. 25).

Plan of Survey of:

OF PART OF LOT 12
CONCESSION 6
GEOGRAPHIC TOWNSHIP OF SARNIA
CITY OF SARNIA
COUNTY OF LAMBTON

scale 1:2000

0 10 20 30 40 50 75 100 125 150 175 200 metres

Bearing Note

BEARINGS ARE DERIVED FROM THE SOUTHERN ONTARIO LEICA SMARTNET RTK REFERENCE NETWORK AND ARE BASED ON THE NAD83 (CSRS)

DISTANCES ON THIS PLAN ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999713.

Legend:

■	DENOTES SURVEY MONUMENT FOUND
□	DENOTES SURVEY MONUMENT SET AND MARKED MS
SIB	DENOTES 25mm X 25mm X 1.22m STANDARD IRON BAR
SSIB	DENOTES 25mm X 25mm X 0.61m SHORT STANDARD IRON BAR
IB	DENOTES 16mm X 16mm X 0.61m IRON BAR
IB ø	DENOTES 19mm diameter X 0.61m ROUND IRON BAR
RIB	DENOTES ROUND IRON BAR.
MS	DENOTES MONTEITH & SUTHERLAND LTD., O.L.S.
U	DENOTES ORIGIN UNKNOWN.
WIT	DENOTES WITNESS.
(1308)	DENOTES R.W. ROBERTSON, O.L.S.
(926)	DENOTES J.D. NISBET, O.L.S.
(1288)	DENOTES D.G. GRAHAM, O.L.S.
(1682)	DENOTES T. MARTIN NISBET, O.L.S.
(P1)	DENOTES PLAN 25R 1826
(P2)	DENOTES PLAN BY R.W. ROBERTSON OLS, (FILE No. S-74-867-B)
(P3)	DENOTES PLAN 25R-3901
(P4)	DENOTES PLAN 25R-8767
UP	DENOTES UTILITY POLE
LP	DENOTES LAMP POLE
CC	DENOTES CUTCROSS
C.P.	DENOTES CONCRETE PIN
P.B.	DENOTES PLASTIC BAR
F.H.	DENOTES FIRE HYDRANT
○MH	DENOTES SANITARY MANHOLE
T.O.S.	DENOTES TOP OF SLOPE

Parts Schedule

PART	LOT	CONCESSION	P.I.N.
1	PART LOT 12	6	43132-0035
2			
3			
4			
5			
6			

* PARTS 1 TO 6 COMPRISE ALL OF P.I.N. 43132-0035
* PART 2 SUBJECT TO EASEMENT NO. L405602
* PART 5 SUBJECT TO EASEMENT NO. L554747

Integration Data

OBSERVED REFERENCE POINTS : UTM ZONE 17, NAD83 (CSRS)
LEICA SMARTNET RTK REFERENCE NETWORK

COORDINATE VALUES ARE TO A RURAL ACCURACY IN ACCORDANCE WITH SECTION 14 (2) OF O.REG 216/10

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

POINT ID	NORTHING	EASTING
A	4759814.99	392655.95
B	4759811.86	392716.81
C	4758481.70	392507.66
D	4758474.16	392659.66

Compliance with Municipal Zoning By-Laws
NOT CERTIFIED BY THIS PLAN

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

Surveyor's Certificate:

I CERTIFY THAT:

1) THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT, THE LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM.

2) THE FIELD SURVEY REPRESENTED ON THIS PLAN WAS COMPLETED ON THE 2ND DAY OF JUNE, 2019.

DATE ____________

T. MARTIN NISBET
ONTARIO LAND SURVEYOR
MONTEITH & SUTHERLAND LIMITED

Monteith & Sutherland Limited
801 Upper Canada Drive Tel.: (519) 542-4300 www.mssurvey.com
Sarnia, Ontario N7W1A3 Fax: (519) 542-1292 housing@mssurvey.com
Ontario Land Surveyors - Professional Engineers - Aerial Surveying - Mapping - HDS Scanning

JOB NUMBER	
ST-3825	

FIELD	DRAWN BY	CHECKED BY	DRAWING NUMBER
ADP/CR /KG	JG/LM	TMN	B-1224-2

APPENDIX B

Geotechnical Investigation

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT
PROPOSED RESIDENTIAL SUBDIVISION
1873 LONDON LINE, SARNIA
ONTARIO

PREPARED FOR

JR CAPITAL HOLDINGS INC.
2963 BRIGDEN ROAD
SARNIA, ONTARIO
N0N 1B0

JULY 10, 2019

GEOTERRE FILE NUMBER: TG18-048

1 DIGITAL COPY – JR CAPITAL HOLDINGS INC.
1 COPY – GEOTERRE LIMITED

GEOTERRE LIMITED
215 ADVANCE BLVD., UNIT 5/6, BRAMPTON, ONTARIO L6T 4V9
TEL: (905) 455-5666 FAX: (905) 455-5639

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APPENDICES

1.0 INTRODUCTION

This report presents the results of a preliminary geotechnical investigation that was completed by GeoTerre Limited (GeoTerre) in relation to a proposed residential subdivision at 1873 London Line, Sarnia, Ontario. The purpose of the investigation was to establish the prevalent soil and groundwater conditions within the limits of the site and, based on that information undertake a preliminary geotechnical assessment of the site in relation to the anticipated primary elements of the development.

This report is subject is subject to the *Limitations and Information Regarding Use of Report* of attached Appendix A.

2.0 SITE AND PROJECT DESCRIPTION

It is understood that JR Capital Holdings Inc. (JRCH) proposes to develop the existing property located at 1873 London Line, Sarnia as located as indicated on attached Figure 1 into a residential subdivision. The site in question is rectangular in shape and quite flat with overall dimensions of approximately 1,300 m in the north-south direction by 150 m and presently serves as a golf course (Sunset Golf). A key feature of the site is the existing north flowing Telfer Diversion Channel just beyond the west property boundary of the proposed subdivision that has a more or less constant top of bank elevation for the entire length of the site to create a minimum effective channel depth of about 3 m. Slopes along the east side of the channel appear to be quite gently inclined, i.e., in the order of 3 Horizonal to 1Vertical (3H:1V) or flatter.

At variance to the raised confining berm of the Telfer Diversion Channel are existing ponds at the approximate north-south mid-point or, low point of the overall site, and south end of the site, which through discussion with JRCH are understood to have been created during construction of the golf course. Both existing manmade ponds are understood to drain into the Telfer Diversion Channel, even though the water levels within these ponds are appreciably below the top of the Telfer Diversion Channel berm. Available site topographic information suggests that the water level in the drainage channel is about elevation 178 m with that of the existing ponds being slightly higher. Average elevations within the north half of the site are about 3 m above the water level of the channel increasing to about 5 m in the south half of the site.

In addition to the above noted man-made site drainage elements, a natural existing wetland/pond feature is also present just east of the east edge of the entire south half of the site. This element in turns seems to drain to the south and west and into the Telfer Diversion Channel.

As indicated on the attached Figure 2B, the conceptual grading plan for the development proposes to maintain the existing central pond as the primary stormwater management facility with a series of low-rise residential developments to the north and south of the existing central pond area. Hence, and in addition to foundation support requirements for the proposed buildings, key engineering components are expected to consist of conventional internal roads and buried services. In addition, due attention must also be given to any required development setbacks from the adjacent Telfer Diversion Channel.

3.0 PHYSIOGRAPHIC AND GEOLOGIC SETTING

Based on information presented in Chapman and Putnam, 1984, the project site is located in the Physiographic Region known as the *Lambton Clay Plain* which represents a quite extensive roughly square area that lies south of Lake Huron and east of the St. Clair River. This area was subject to glaciation during the last Ice Age, including deep submergence by glacial Lake Whittlesey and more shallow coverage by glacial Lake Warren. However, both of these glacial lakes failed to generate extensive deposits of sediment on the underlying glacial till and accordingly, most of the *Lambton Clay Plain* is essentially a till plain that is smoothed out by shallow deposits of lacustrine clay. Hence, based on the foregoing surface geological history, the *Lambton Clay Plain* is an area of quite low relief. Bedrock within the *Lambton Clay Plain* is known to be quite deep.

In terms of soil conditions, based on the foregoing geological history of the site area and review of available surficial geology information for same, expected soil conditions should consist primarily of silty clay till deposits of the St. Joseph Till unit, possibly overlain by a thin layer of surface cohesionless and/or lacustrine clay materials.

In keeping with the low relief nature of the area, surface and groundwater flow is somewhat poorly defined in the *Lambton Clay Plain*. However, in general the flow direction closely adjacent to Lake Huron, including the 1873 London Line site, is toward the north and into Lake Huron. However, within the more southerly reaches of the *Lambton Clay Plain* the flow direction is primarily toward the south and west and into the St. Clair River.

4.0 INVESTIGATION METHODOLOGY AND RESULTS

The investigation aspects of the project consisted of the completion of a total of seven (7) boreholes to total depths of between 6.6 m and 9.6 m at the locations indicated on attached Figures 2A and 2B to the summary details of attached Table 1. Please note that the location of for each borehole presented on attached Figure 2A & B was obtained relative to available on-site features and are considered to accurate about +/- 3 m. The geodetic elevation of each borehole as presented in attached Table 1 was obtained by GeoTerre based on available site topographic data for the estimated borehole locations.

Boreholes were drilled with 200 mm hollow stem augers during November 7 and 8, 2018 using a track mounted drill rig supplied and operated by Aardvark Drilling, London, Ontario. All field drilling investigation work was completed under the supervision of a GeoTerre supervisor. During drilling of deep boreholes BH18-1 and 2, Standard Penetration Tests (SPT) and associated split spoon soil sampling was commenced at surface and thereafter at 0.76 m intervals of depth to 4.5 m after which the sampling interval was increased to 1.5 m. In comparison, during drilling of shallower boreholes BH18-3 and 7, SPT's and associated split spoon soil sampling was commenced at surface and thereafter at 0.76 m intervals for the entire depth of the borehole.

As indicated on the borehole logs of attached Appendix B, SPT 'N' values were completed using an automatic drop hammer that is generally considered to have an 80% energy efficiency rating and hence, field recorded SPT 'N' values are referred to as SPT 'N_{80}' values. The SPT hammer type is important because most empirical geotechnical relationships between SPT 'N' values and strength and/or expected soil performance were based on traditional SPT 'N_{60}'values, i.e., those obtained using a rope and cathead SPT hammer system that up until about 15 years ago was widely used during geotechnical drilling.

Groundwater conditions were noted during and upon completion of drilling of each borehole with five (5) 32 mm diameter piezometers being installed at the bottom of each borehole as noted in attached Table 1. Boreholes with standpipe piezometer installations were backfilled with low permeability bentonite from just above the top of the well screen to ground surface. Borehole BH18-4 that did not have a standpipe piezometer installation was backfilled with low permeability bentonite throughout whereas BH18-6 that also did not have a standpipe piezometer installation was backfilled with a combination of drill cuttings and low permeability bentonite.

Soil samples retrieved from the boreholes were returned to the GeoTerre CCIL (Canadian Council of Independent Laboratories) certified soil testing laboratory for review by a senior engineer and completion of the following geotechnical laboratory soil index testing on select samples:

- Water content on each retrieved intact inorganic sample
- Eight (8) sieve and hydrometer grain size analyses on fine grained samples
- Two (2) Atterberg Limit Soil Plasticity tests determinations

A log of encountered soil conditions within each borehole as derived by GeoTerre based on the above noted senior engineer sample review and associated geotechnical index tests, are presented on the borehole logs of attached Appendix B that also include the results and locations of all in-situ tests, groundwater observations and borehole backfill details. The results of the foregoing water content and Atterberg Limit tests and a summary of the grain size data are also presented on the borehole logs of attached Appendix B, with complete grain size distribution data presented in attached Appendix C. The Atterberg Limits soil plasticity data is also presented on the soil plasticity charts of attached Appendix D.

A summary of groundwater water level readings within the installed wells are presented on attached logs of Appendix B and summarized within attached Table 1.

5.0 SUBSURFACE CONDITIONS

5.1 Summary

Based on the information obtained at the borehole locations as detailed on the logs of attached Appendix B, the soil conditions within the limits of the proposed development consist of a surface layer of topsoil overlying an extensive layer of silty clay till that extended to the maximum investigated depth of each borehole. A key feature of the prevalent silty clay till unit is an upper stronger grey/brown crust that typically extends to approximate elevation 178 m overlying weaker grey material. At variance to the foregoing general stratigraphic summary are the following:

- Discontinuous thin surface layer organic silty clay with total thicknesses of between 0.4 m and 0.7 m at the locations of BH18-2, 3, 5 and 6.
- A 2.1 m thick layer of surface fill materials and related underlying organic materials that seem to be related to infilling of a former marsh/wetland area.

Available water levels within the various installed groundwater monitoring wells tend to suggest that the water levels measured to date within the installed piezometers do not represent stabilized conditions, most likely because of the inherent low permeability of the silty clay till materials. Hence, and subject to obtaining some further confirmatory water levels measurements, it is concluded that the long-term stabilized water table will most likely reflect that of the existing ponds and/or transition between upper grey/brown materials and lower grey materials. More specially, the ambient water table in the vicinity of the central pond feature and along the entire west and south limits of the site are expected to be in the order of approximate elevation 178 m, maybe slightly higher in the middle reaches of this area. Similarly, slightly more elevated water levels are expected within the east side of the north half of the site in the vicinity of BH18-6 and 7.

A more depth assessment of the foregoing conditions is presented in the following sections. However, for specific information, the reader should consult the attached factual data as presented in attached Appendix B to D. In addition, it should be noted that the following summary is based on soil and groundwater conditions that were only confirmed at the borehole locations and that are expected to vary between and beyond these locations.

5.2 Stratigraphic Units

5.2.1 Topsoil

Topsoil material that was typically clayey in nature was encountered at surface at each borehole location with total thicknesses that varied from 100 mm to 330 mm with a typical thickness of about 200 mm.

5.2.2 BH18-4 Surface Fill and Organic Materials

These materials refer to sequence of materials that were encountered at the location of BH18-4 with a total of thickness of 2.1 m comprised of the following below a 180 mm surface layer of topsoil:

- 0.7 m thick layer of silty clay fill material mixed with topsoil
- 0.6 m thick layer of compressed, totally decomposed (amorphous) peat
- 0.6 m thick layer of silty clay with thin organic layers and pieces of decomposed wood

Taken in combination, the foregoing materials are considered to represent backfill of a former marsh/wetland area that was most likely associated with an existing similar feature that is present along the east side of the site adjacent to BH18-4. Field SPT ‘N_{80}’ values of 4 and 6 respectively were obtained the above noted upper and lower silty clay units and based on this data, these layers are described as having a soft to firm consistency. A field SPT ‘N_{80}’ value of 17 was obtained with the compressed peat, indicated a very stiff consistency. However, notwithstanding the foregoing SPT ‘N_{80}’ values, the origin of these suspected marsh/wetland infill materials are unknown and hence, information on the degree of control that was exercised during their placement and associated possible uniformity is also not known.

5.2.3 Surface Organic Silty Clay Materials

This layer refers to an apparent discontinuous thin surface layer of organic silty clay material with total thicknesses of between 0.4 m and 0.7 m that was encountered at the locations of BH18-2, 3, 5 and 6. Field SPT ‘N_{80}’ values of 4 to 8 were obtained within these materials and based on this data, they are described as having a soft to firm consistency.

5.2.4 Silty Clay Till Materials

Silty clay till materials of intermediate plasticity were encountered in each borehole that was advanced as part of the site investigation program either below the surface topsoil and/or fill and/or discontinuous organic silty clay materials, after which they maximum investigated depth of each borehole. Hence, the maximum confirmed thickness of these materials is 9.4 m at the location of BH18-1 or, lowest confirmed underside elevation of 172.0 m. These materials are characterized by an upper grey/brown layer with an underside depth that varied between 3.7 m to 5.2 m (elevation 179.6 m to 176.8 m) at the borehole locations overlying grey material at depth. The results of four (4) grain size distribution analyses that were obtained on samples of the upper grey/brown materials are presented on Figure C1 of Appendix C with similar data as obtained on four (4) samples of the underlying grey materials presented on Figure C2 of Appendix C. The results of Atterberg Limit soil plasticity tests obtained on samples of the upper grey/brown and deeper grey materials are presented respectively on Figures D1 and D2 of Appendix D. However, notwithstanding the grain size make-up aforementioned Figures C1 and C2, some cobbles and occasional boulders should also be expected given the glacial origin of these materials.

Field SPT ‘N_{80}’ values and derived more traditional SPT ‘N_{60}’ values, i.e., SPT ‘N_{90}’ values times 1.33 are presented in the attached Figures 3A & 3B and 4A and 4B as per the following:

- Figure 3A: Field Recorded SPT 'N_{80}' Data versus Depth
- Figure 3B: Derived SPT 'N_{60}' Data versus Depth
- Figure 4A: Field Recorded SPT 'N_{80}' Data versus Elevation
- Figure 4B: Derived SPT 'N_{60}' Data versus Elevation

What is very evident from the data presented on each of the above noted Figures is that the SPT values in the upper grey/brown materials, i.e., those above an approximate depth of 4 m or approximate elevation 179 m are significantly higher than that obtained within the underlying grey materials. Deposits of this nature are referred to as having an upper stronger crust overlying weaker materials at depth. In this regard, and based on the improved data clarity of attached Figures 4A and 4B, the upper crust materials are concluded to be present above approximate elevation 178 m. Please note that the better relationship between strength data with elevation of attached Figures 4A and 4B are consistent with a site where the central pond area of the site was man-made as reported to be the case by JRCH.

In terms of summary strength parameters, typical SPT ‘N_{60}’ values above elevation 178 m vary from about 9 to 35 and based on this data, are referred to as having a stiff to hard consistency. Similarly, typical SPT ‘N_{60}’ values below elevation 178 vary from about 6 to 15 and based on this data, are referred to as having a firm to stiff consistency.

5.3 Groundwater

Water levels within the various installed groundwater monitoring wells that were installed at depth within the prevalent silty clay till materials indicated the following groundwater elevations on November 29, 2018 as obtained some 3 weeks after installation:

- BH18-1: Elevation 173.01 m
- BH18-2: Elevation 175.34 m
- BH18-3: Elevation 183.07 m
- BH18-4: Elevation 175.41 m
- BH18-5: Elevation 178.39 m

Based on the known elevation of the water in the west drainage channel and existing central and south man-made ponds, it is concluded that the above water level measurements do not represent stabilized conditions, most likely because of the inherent low permeability of the silty clay till materials. Hence, and subject to obtaining some further confirmatory water levels measurements it is concluded that the long-term stabilized water table with most likely reflect that of the existing ponds and/or transition between upper grey/brown materials and lower grey materials. More specially, the ambient water table in the vicinity of the central pond feature and along the entire west and south limits of the site, is expected to be in the order of approximate elevation 178 m, maybe slightly higher in the middle reaches of this area. Similarly, slightly more elevated water levels are expected within the east side of the north hale of the site in the vicinity of BH18-6 and 7.

In concert with the foregoing groundwater table attributes, the dominant groundwater flow direction is expected to toward the existing man-made ponds and/or the similarly man-made west drainage channel. Please note however that the foregoing groundwater assessment is based on quite widely spaced observations over a very short period that are not expected at this time to reflect stabilized conditions. In addition, some seasonal variation in the water levels should also be expected.

6.0 PRELIMINARY ENGINEERING ASSESSMENT AND RECOMMENDATIONS

6.1 General

As previously noted and detailed on attached Figure 2B, the conceptual grading plan for the proposed development at the time of preparation of this preliminary geotechnical report consists of maintaining the existing man-made central pond as the development stormwater management facility and thereby allow for low-rise residential development within the remaining north and south site limits. Hence, and in addition to foundation support requirements for the proposed buildings, key engineering components are expected to consist of conventional internal roads, buried services. In addition, a slope stability development setback assessment is also required adjacent the west side drainage channel to define the potentially developable limits for the site.

Generally, with the exception of the existing surface fill materials at the location of a suspected former in-filled marsh/wetland area located in the vicinity of BH18-4, the existing soils at the site are considered suitable for the support of the above noted types of development using conventional strip foundations. Similarly, it is anticipated that the above noted infilled area and/or any other areas with existing fill that may be discovered going forward and/or areas that require raising can either be suitably excavated and/or backfilled using engineered fill to support similar type buildings with a similar foundation support approach. Hence, assuming all of the foregoing works are suitably undertaken as detailed within and the underside of all building foundations are not lower than elevation 179.5 m, maximum allowable SLS (Serviceability Limit State) and related ULS (Ultimate Limit State) bearing capacities of 120 kPa and 180 kPa respectively may be assumed for the purposes of preliminary design, provided the minimum footing width is not less than 0.75 m.

A more detailed preliminary assessment of each of the foregoing key elements, including an assessment of setback requirements from the crest of the adjacent west channel, are presented in the following sections 6.2 to 6.6 with some general design and construction considerations, including suggested additional geotechnical investigations, presented in Section 6.7.

Please note that the engineering assessment and preliminary design recommendations provided in the following sections are intended for the guidance and sole use of the designers and planners associated with the preliminary engineering design of the proposed development. In addition, it should be further noted that the soil and groundwater conditions were only confirmed at the borehole locations and will vary between these locations and on their own, are not considered sufficient for the detailed design of all elements that are expected to be associated with the proposed development.

6.2 Building Foundation Considerations

It is understood that the principal building types within the proposed development will be a series of low-rise townhouse developments (2 and 3 storeys) and similar single residential developments, each with anticipated full basement levels. Subject to confirmation of final site grading levels, it is expected that the likely final surface grades for the developable portions of the site will be in the order of at least 182.5 m to 183.0 m related underside of supporting foundations of not lower than elevation 179.5 m. As detailed on attached Figure 4B, elevation 179.5 m is expected to result in an underside of foundation depth that will be within the lower reaches of the upper stronger grey-brown crust materials and at least 1.5 m above the top of the underlying weaker grey materials. Hence, for the purposes of preliminary design, maximum allowable SLS (Serviceability Limit State) and related ULS (Ultimate Limit State) bearing capacities of 120 kPa and 180 kPa may respectively be assumed provided the following conditions are met:

- No underside of foundations lower than elevation 179.5 m
- Entire base of all foundations is formed within undisturbed silty clay till materials
- Strip foundation width is at least 0.75 m

The maximum total settlement of foundations that are designed in accordance with the foregoing provisions are not expected to exceed 25 mm with maximum differential settlement not expected to exceed 50 % of the estimated maximum total settlement.

Similar preliminary foundation design recommendations may be assumed for any areas where existing fill materials have to be removed as expected in the vicinity of BH18-4 and/or, general site grade raise works, provided all engineering fill works under the entire footprint area of the proposed building lots are completed in accordance with the following:

1. All surface organic materials and/or existing on-site fill materials are removed to expose the top surface of underlying inorganic silty clay till materials
2. The resulting top surface from 1) is compacted to obtain at least 100 % of its Standard Proctor Maximum Dry Density (SPMDD) in the upper 300 mm, with any localized soft areas that are detected during this process to be suitably sub-excavated and backfilled as per following item 3)
3. Grade raise fill consisting of locally sub-excavated materials and/or imported good quality inorganic fill is placed and compacted in lifts not exceeding 300 mm in thickness to achieve at least 100 % of its SPMDD.
4. All engineered fill works are completed while temperatures, including those at night, remain above zero degrees and under the full-time direction of suitably qualified geotechnical personnel.

The maximum total settlement of foundations that are designed and constructed within engineered fill materials that are placed in accordance with the foregoing provisions is not expected to exceed 25 mm with maximum differential settlement not expected to exceed 50 % of the estimated maximum total settlement. However, where any portion of the foundations for a proposed single building and/or co-joined townhouse units will be constructed within the foregoing engineered fill materials, nominal steel reinforcement consisting of at least 2 * 15M bars should be placed within all strip footings to help modulate potential local differential settlement.

All exterior footings or interior footings within unheated portions of the building should be provided with soil or equivalent soil cover as per the recommendations of Section 6.7.1 for the purposes of frost protection. In addition, and as detailed on attached Figure 5, the exterior of all basement walls should be provided with suitable waterproofing connected to continuous sub-drain at the foundation level that is provided with a positive drainage outlet.

Please note that the foregoing foundation design recommendations assume that the base of all footings are free of loose, disturbed, softened and/or other deleterious material in advance of concreting. To this end, it is recommended that the excavation and base preparation of all proposed foundations be inspected by a suitably qualified geotechnical practitioner immediately prior to and during concreting.

If required for seismic design, a Class D site may be assumed as defined by the 2012 version of the Ontario Building Code may be assumed for the purposes of seismic design.

All trench excavations for footings must be completed in accordance with the Occupational Health and Safety Act (and Regulations for Construction Projects).

6.3 Buried Site Services

Based on the soil conditions encountered within the various boreholes, installation of the various required site services to the maximum anticipated depth of 5 m below existing or proposed site grades are generally expected to be completed entirely within low permeability silty clay till materials. While some of these excavations are expected to extend below the expected water table level, actual inflow into the trenches is expected to be very limited due to the intrinsic low permeability nature of the silty clay till. Accordingly, it is anticipated that the base areas of the all proposed trench excavations up to the foregoing maximum anticipated depth of 5 m below existing site grades will largely be dry with sidewalls suitably stable if excavated with temporary side slopes of not greater than 1 Vertical to 1 Horizontal (1V:1H). Notwithstanding this trench stability assessment, where workmen must enter excavations deeper than 1.2 m, the trench excavations should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act (and Regulations for Construction Projects) in Ontario. Specifically, as of April 8, 2013, sub-section 226 of the Occupational Health and Safety Act recognize four (4) broad classifications of soils, which are summarized as follows:

TYPE 1 SOIL

a) is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b) has a low natural moisture content and a high degree of internal strength;
c) has no signs of water seepage; and
d) can be excavated only by mechanical equipment

TYPE 2 SOIL

a) is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b) has a low to medium natural moisture content and a medium degree of internal strength; and
c) has a damp appearance after it is excavated

TYPE 3 SOIL

a) is stiff to firm and compact to loose in consistency or is previously-excavated soil;
b) exhibits signs of surface cracking;
c) exhibits signs of water seepage;
d) if it is dry, may run easily into a well-defined conical pile; and
e) has a low degree of internal strength

TYPE 4 SOIL

a) is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b) runs easily or flows, unless it is completely supported before excavating procedures;
c) has almost no internal strength;
d) is wet or muddy; and
e) exerts substantial fluid pressure on its supporting system

The prevalent silty clay till soils are expected to behave primarily as Type 2 soil above elevation 180 m and as Type 3 soil below approximate elevation 180 m.

Based on the foregoing anticipated trench conditions, the design of the various site services may be completed in accordance with their various applicable OPSD's for an assumed Class B type bedding support. Bedding material and backfill within the various pipe zones should consist of OPSS Granular 'A' compacted to at least 95 % of its SPMDD. Trench backfill may consist of locally excavated material compacted in lifts not exceeding 300 mm in thickness to achieve at least 95 % of its SPMDD throughout and 98 % in the upper 300 mm under paved areas.

With respect to use of the local soils, it is expected that the existing on-site silty clay till materials above approximate elevation 180 m should be quite amenable to re-use as trench backfill, albeit somewhat susceptible to degradation if exposed to precipitation. However, materials below approximate elevation 180 m will have a higher natural water content and thereby less amenable to re-use as trench backfill.

Finally, all site servicing elements prone to freezing should be provided with soil (or equivalent) cover for frost protection purposes in accordance with the recommendations of Section 6.7.1.

6.4 Internal Roads

Based on the available borehole data and anticipated site grading activities, the subgrade soils below any pavement structure are expected to consist primarily of intermediate silty clay till materials. Hence, and with reference to the 2016 City of Sarnia Site Plan Approval Policy Guidelines and Standards, GeoTerre is of the opinion that the following minimum required pavement structure should be satisfactory for all local roads and may be assumed for the purpose of preliminary design provided the subgrade is prepared as noted below and all roadways are provided with a system of positively draining lateral sub-drains:

Asphalt	Surface Course (HL3)	40 mm	
	Basecourse (HL4)	40 mm	
		80 mm	80 mm
Granular A Base (OPSS 1010)			100 mm
Granular B Type 2 Sub-Base (OPSS 1010)			300 mm
			480 mm

Please note that above pavement assumes that the subgrade below any paved area is prepared in accordance with the following recommendations prior to placement of any pavement granular materials:

1. Remove all surface organic materials and/or otherwise unsuitable surface materials to expose the top surface of underlying inorganic materials
2. Exposed base resulting from work element 1) above is thoroughly compacted to achieve at least 98 % of its SPMDD in the upper 300 mm.
3. Any required grade raise fill consist of locally sub-excavated materials and/or imported good quality inorganic fill that is placed and compacted in lifts not exceeding 300 mm in thickness to achieve at least 95 % of its SPMDD throughout increasing to 98% SPMDD in the final 300 mm.

Asphalt materials to be in accordance with the appropriate OPSS and similarly, compacted in accordance with OPSS 310. Granular base and sub-base materials are to be compacted respectively to at least 98 % and 100 % of their SPMDD.

6.5 Stormwater Pond Considerations

At the time of preparation of this report, the conceptual location of the proposed stormwater management pond will essentially be the existing central man-made drainage feature. Hence, given that this element appears to have performed a similar function for some time, no issues are foreseen with developing a stormwater management facility at this location. The foregoing favorable stormwater facility assessment is consistent with the encountered soil conditions at the borehole locations, i.e., predominantly low permeability silty clay till materials over the entire limits of the site. Hence, for the purposes of preliminary design and subject to confirmation when the proposed location of any stormwater management ponds has been finalized, it can be assumed that as long at the design base elevation of any proposed stormwater management ponds are at least 179.5 m or higher, they will not require a liner and that perimeter side-slopes will be suitable stable if constructed with side-slopes no steeper than 1V:2.5H.

6.6 Drainage Channel Stability Considerations

As detailed in Section 2 of this report, the side slopes of the existing berm within the subject site adjacent to the west side existing drainage are inclined at side slopes that are estimated to be no steeper than 1V:3H. Hence, at this inclination it may be assumed that these existing slopes are fundamentally stable and that thereby no stability enhancement works, like for instance, slope flattening is required. However, please note that appropriate minimum “set-back” requirements for development as stipulated by either the City of Sarnia and/or the local conservation authority will have to be adhered to.

6.7 General Design and Construction Considerations

6.7.1 Frost Penetration

The estimated depth of frost penetration for the site is 1.2 m and the underside of all exterior footings and/or elements that are prone to freezing should be provided with this amount of soil or equivalent cover.

6.7.2 Recommendations for Additional Geotechnical Investigations

In addition to routine geotechnical investigation of the final proposed location of all key elements to a level deemed suitable for detailed design and construction of that element, the following specific investigation works are anticipated to better confirm the preliminary design recommendations provided within:

- Series of investigation boreholes in the vicinity of BH18-4 to better confirm the nature and limits of a suspected infilled former marsh/wetland area

6.7.3 Import and Export of Site Soil

Environmental issues related to the proposed works were beyond the scope of this GeoTerre report and the intent of this section is to highlight that the disposal of excess soils from the site and/or the import of required grade raise fill materials must be undertaken in accordance with applicable environmental legislation.

6.7.4 Borehole Abandonment

It is recommended that prior to the damage of any existing boreholes with installed piezometers that the installed piezometer pipes be abandoned in accordance with MOE Regulation 903.

6.7.5 Construction Supervision

While this report is intended for preliminary design purposes, please note that as the project moves forward into detailed design and ultimately construction, all of the works outlined within should be completed under the supervision of suitably qualified geotechnical personnel experienced in such works. In particular, control of anticipated engineering fill placement works, stormwater pond construction, especially required berms and foundation preparation works are deemed to be particularly important.

7.0 CLOSURE

We trust that this report is sufficient for your present requirements. Should you have any questions or require clarification on any matter, please do not hesitate to contact us.

As previously noted, we wish to highlight that the contents of this report are subject to the attached Statement of Limitations of Appendix A.

GEOTERRE LIMITED

LICENSED PROFESSIONAL ENGINEER
I. CORBETT
July 10/19
PROVINCE OF ONTARIO

Ivan Corbett, M.Sc., P.Eng.
President

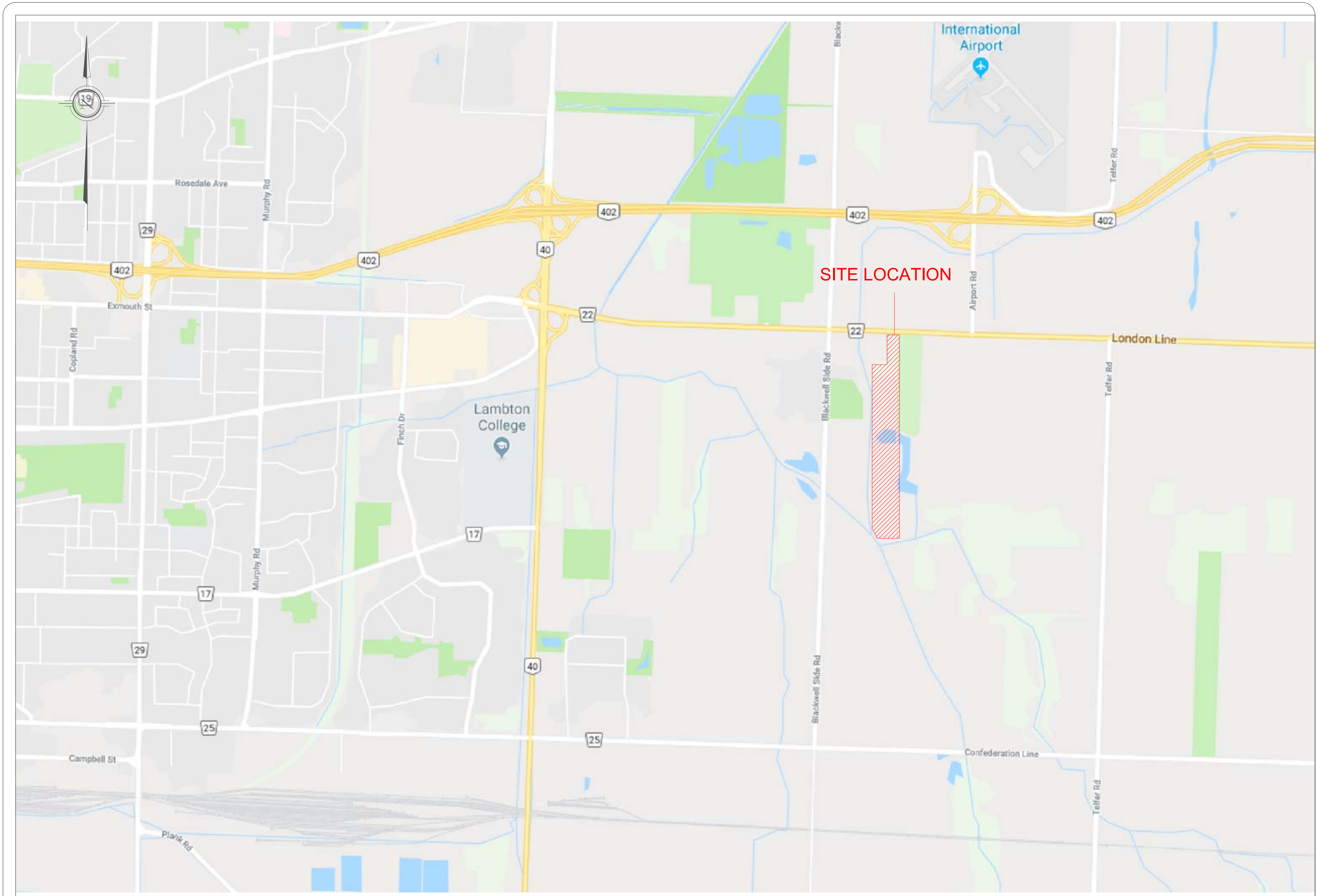
TABLES

TABLE 1
Proposed Residential Subdivision - 1873 London Line, Sarnia
Preliminary Geotechnical Report
Summary of Borehole, Standpipe Piezometer and Groundwater Level Measurements

Borehole No.	Borehole Depth (m)	Ground Elevation (m)(1)	Standpipe Piezometer Details					Measured Groundwater Depth/Elevation (m)		
			Type	Tip Depth (m)	Screen Length (m)	Tip Formation	Installation Date	Upon Installation	29-Nov-18	
BH18-1	9.6	181.60	32 mm PVC Pipe	9.1	3.0	Silty Clay Till	7-Nov-18	dry	8.59/173.01	
BH18-2	9.6	183.30	32 mm PVC Pipe	9.1	3.0	Silty Clay Till	7-Nov-18	dry	7.96/175.34	
BH18-3	6.6	183.20	32 mm PVC Pipe	6.1	1.5	Silty Clay Till	7-Nov-18	6.1/177.12	0.13/183.07	
BH18-4	6.6	182.35	No Standpipe Piezometer Installed							
BH18-5	6.6	181.20	32 mm PVC Pipe	6.1	1.5	Slty Clay Till	8-Nov-18	dry	5.79/175.41	
BH18-6	6.6	182.90	No Standpipe Piezometer Installed							
BH18-7	6.6	182.70	32 mm PVC Pipe	6.1	1.5	Silty Clay Till	8-Nov-18	dry	4.31/178.39	

Notes: (1) Elevations obtained by GeoTerre based on available topographic data at estimated location of each borehole and are understood to be Geodetic.

FIGURES



JR CAPITAL HOLDINGS INC.
PROPOSED RESIDENTIAL DEVELOPMENT-1873 LONDON LINE
PRILIMINARY GEOTECHNICAL INVESTIGATION

SITE LOCATION PLAN

GEOTERRE

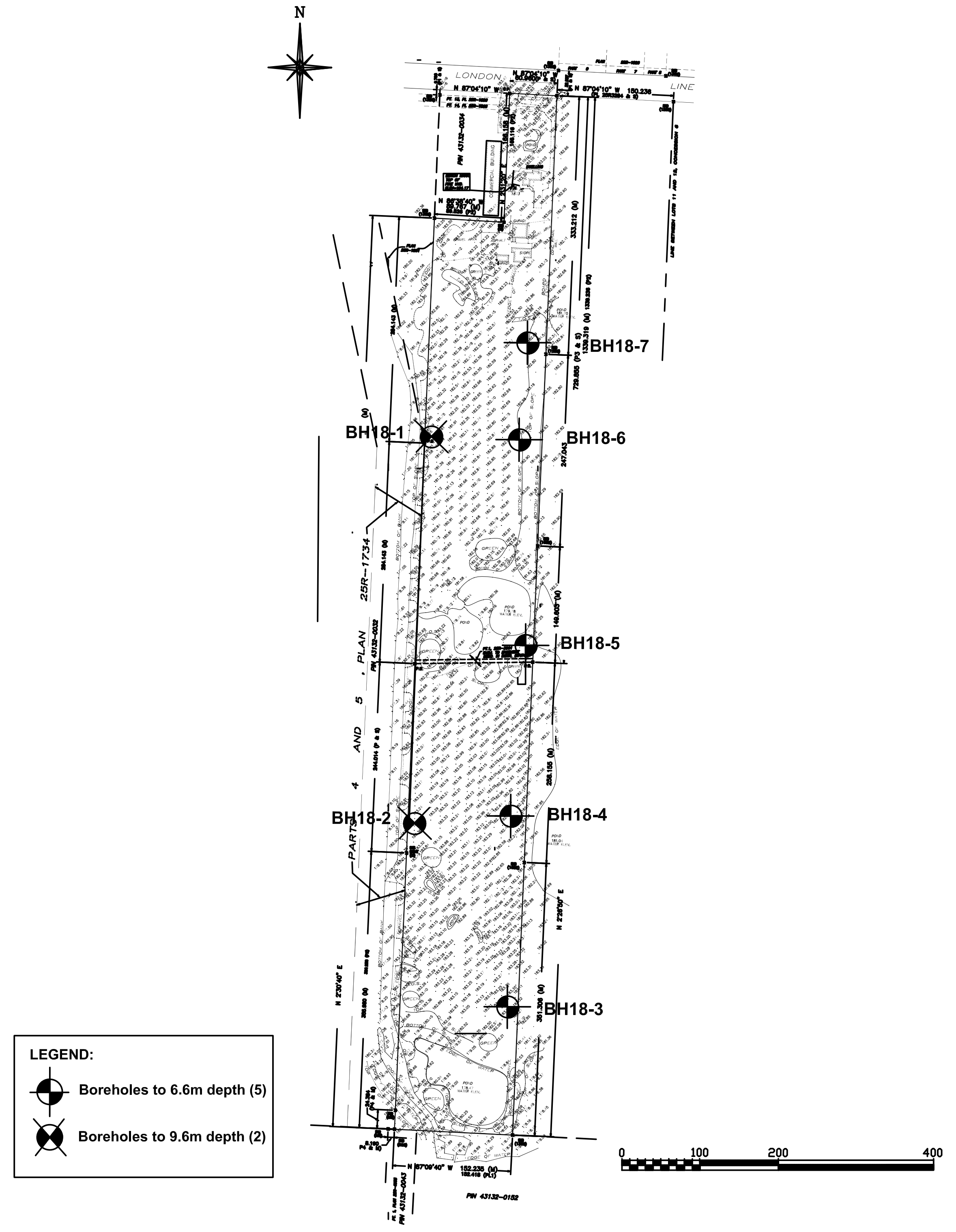
215 ADVANCE BLVD. - UNIT 5/6
BRAMPTON, ONTARIO, L6T 4V9
TEL (905) 455-5666
FAX (905) 455-5639

Date: July 10, 2019

Project No: TG18-048

Scale: AS SHOWN

FIGURE 1



JR CAPITAL HOLDINGS INC.
PROPOSED RESIDENTIAL DEVELOPMENT-1873 LONDON LINE
PRELIMINARY GEOTECHNICAL INVESTIGATION

BOREHOLE LOCATION PLAN vs SITE TOPOGRAPHY

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Date:
July 10, 2019

Scale:
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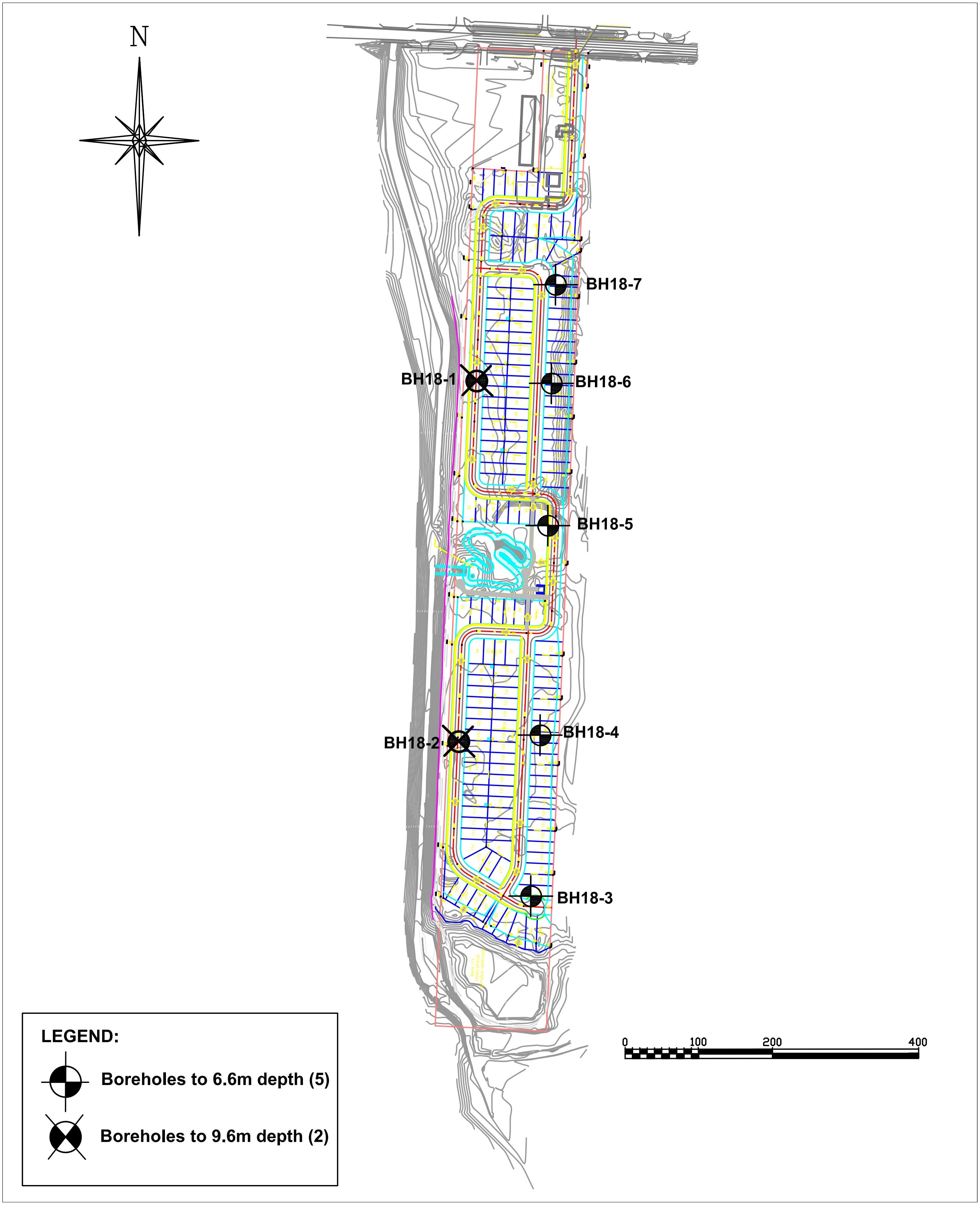
Project No:
TG18-048

FIGURE 2A



JR CAPITAL HOLDINGS INC.
PROPOSED RESIDENTIAL DEVELOPMENT-1873 LONDON LINE
PRELIMINARY GEOTECHNICAL INVESTIGATION

BOREHOLE LOCATION PLAN vs CONCEPTUAL GRADING PLAN

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FIGURE 2B

FIGURE 3A
PROPOSED RESIDENTIAL DEVELOPMENT - 1873 LONDON LINE
PRELIMINARY GEOTECHNICAL INVESTIGATION

SUMMARY OF FIELD RECORDED SPT 'N_{80}' SPT DATA VERSUS DEPTH

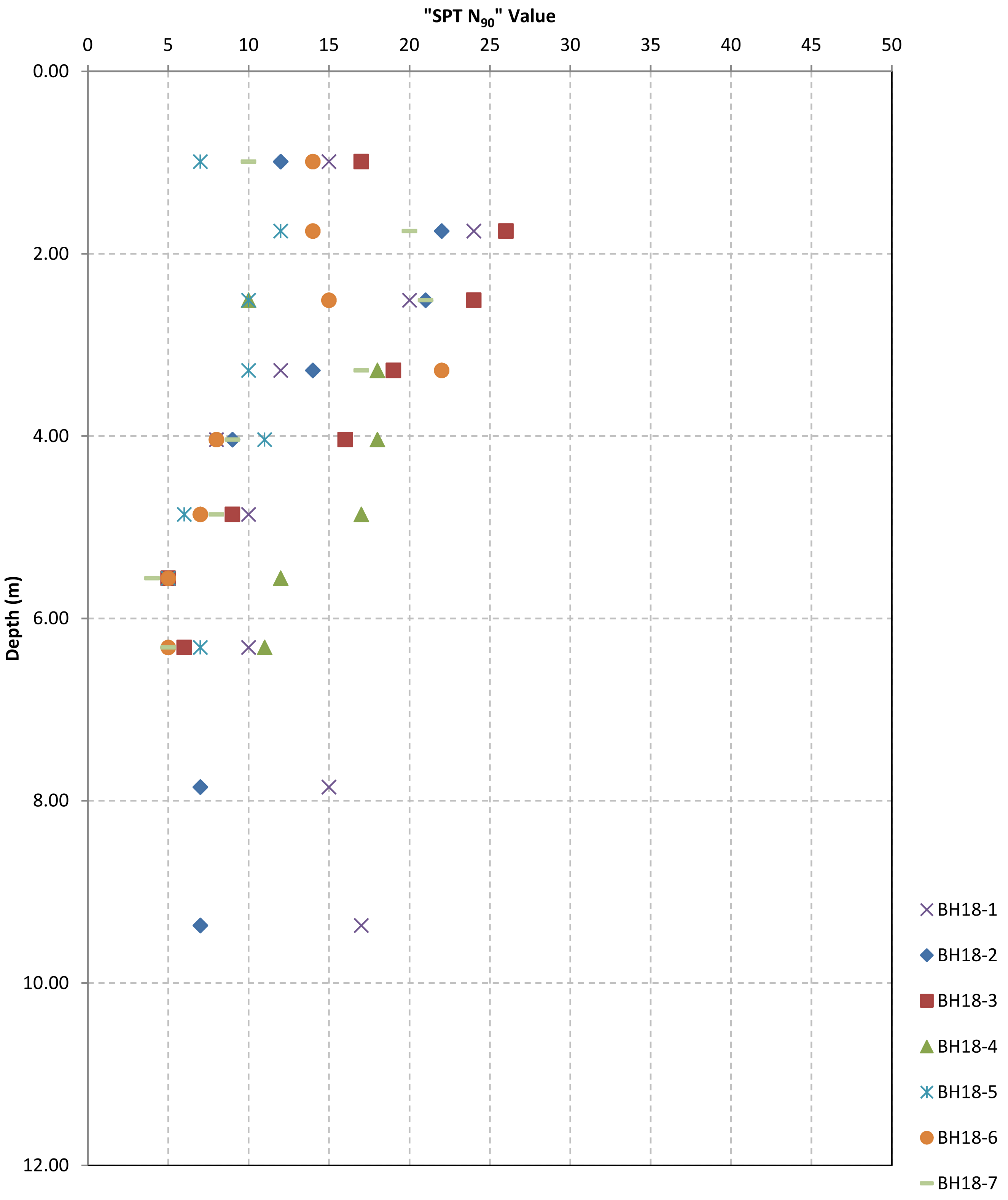


FIGURE 3B

PROPOSED RESIDENTIAL SUBDIVISION - 1873 LONDON LINE, SARNIA

PRELIMINARY GEOTECHNICAL INVESTIGATION

SUMMARY OF DERIVED SPT 'N_{60}' DATA VERSUS DEPTH

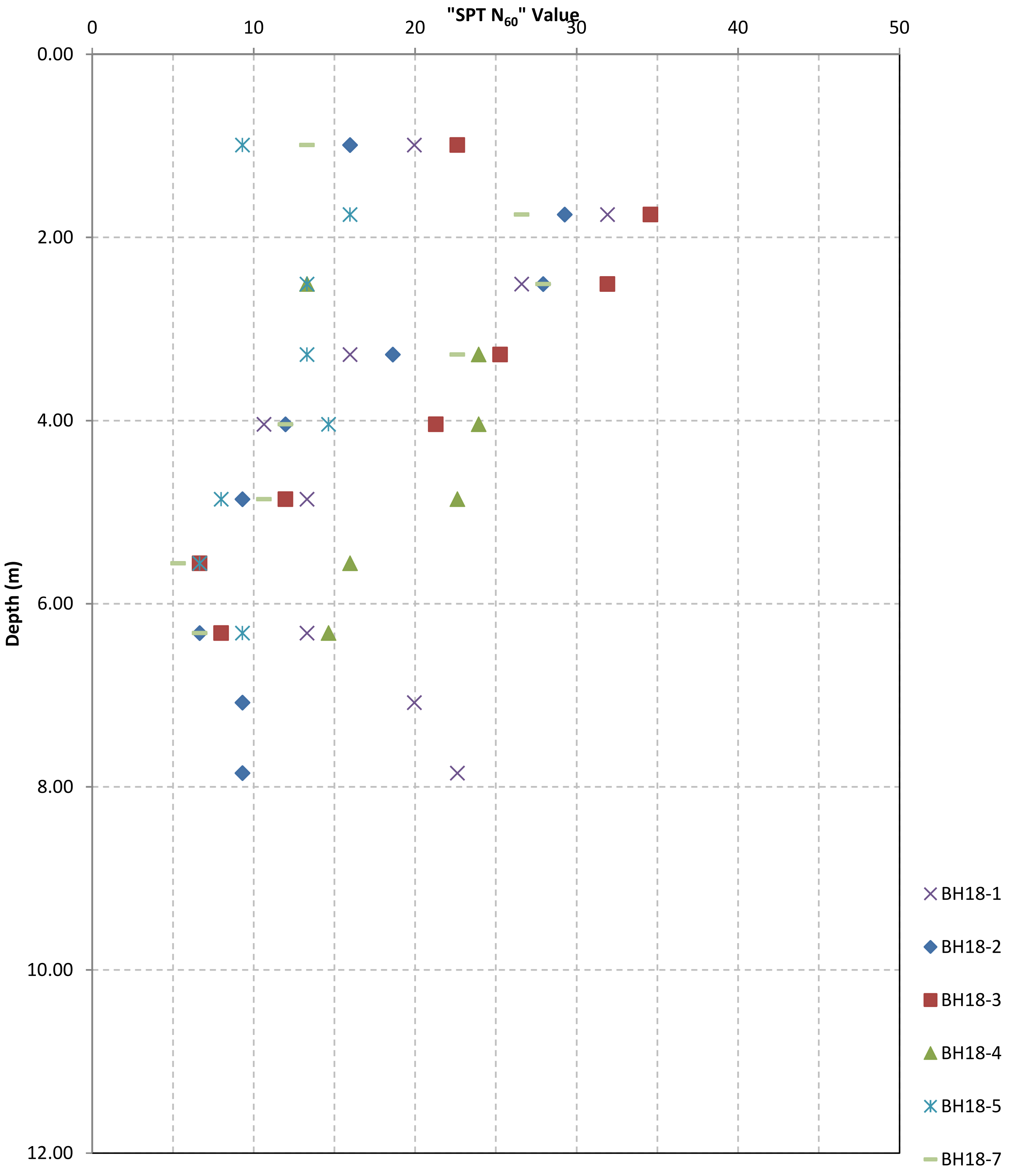


FIGURE 4A
PROPOSED RESIDENTIAL DEVELOPMENT - 1873 LONDON LINE
PRELIMINARY GEOTECHNICAL INVESTIGATION

SUMMARY OF FIELD RECORDED SPT 'N$_{80}$' SPT DATA VERSUS ELEVATION

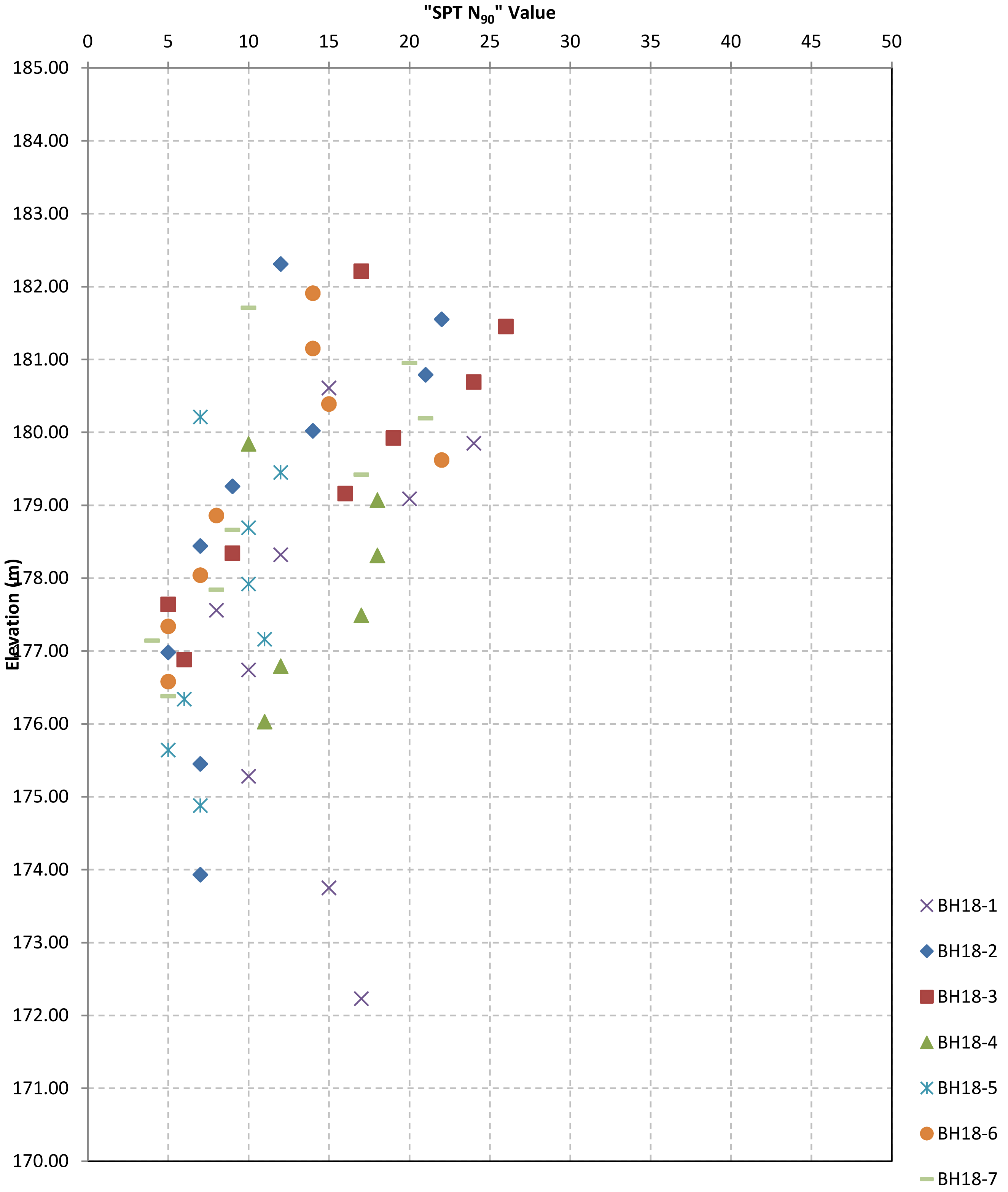
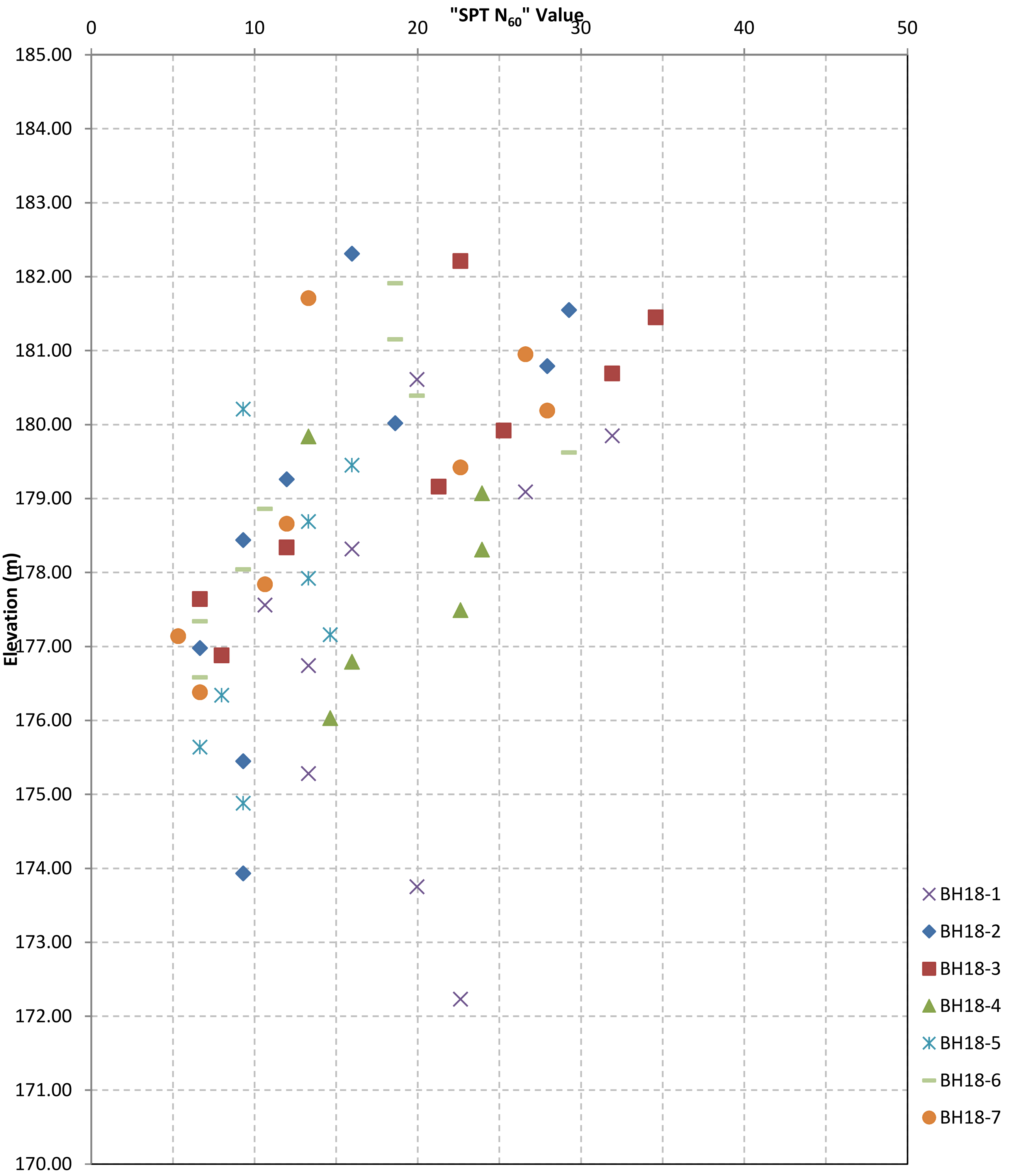
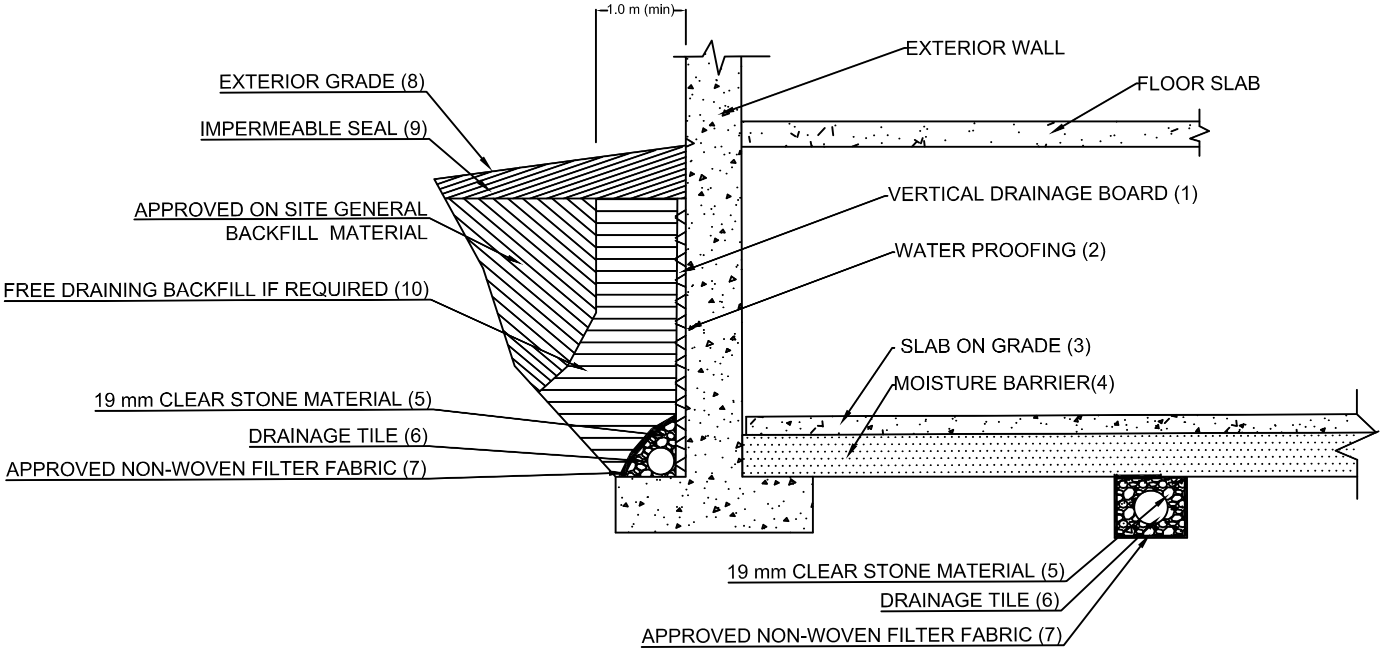


FIGURE 4B
PROPOSED RESIDENTIAL SUBDIVISION - 1873 LONDON LINE, SARNIA
PRELIMINARY GEOTECHNICAL INVESTIGATION

SUMMARY OF DERIVED SPT 'N_{60}' DATA VERSUS ELEVATION





PERIMETER FOOTING

NOTES

1. VERTICAL DRAINAGE BOARD MIRA-DRAIN 6000 OR EQUIVALENT WITH FILTER CLOTH SHOULD BE CONTINUOUS JUST BELOW EXTERIOR FINISHED GRADE TO TOP OF EXTERIOR WALL FOOTING.

2. THE BASEMENT WALLS SHOULD BE WATER PROOFED USING SUITABLE WATER-PROOFING SYSTEM TO BE DETERMINED BY OTHERS.

3. SLAB ON GRADE SHOULD NOT BE STRUCTURAL CONNECTED TO THE EXTERIOR WALL OR FOOTING.

4. MOISTURE BARRIER TO BE AT LEAST 200 mm (8") OF COMPACTED CLEAR 20 mm (3/4") STONE OR EQUIVALENT FREE DRAINING MATERIAL. A VAPOUR BARRIER MAY BE REQUIRED FOR SPECIALTY FLOORS.

5. 19 mm CLEAR STONE BEDDING MATERIAL - MINIMUM OF 75 mm (3") TOP AND BOTTOM OF DRAINAGE TILE AND 100 mm (4") TO EITHER SIDE.

6. DRAINAGE TILE TO CONSIST OF 100 mm (4") DIAMETER, WEEPING TILE OR EQUIVALENT PERFORATED PIPE WITH GEOTEXTILE SOCK LEADING TO A POSITIVE SUMP OR OUTLET.

7. APPROVED NON-WOVEN FILTER FABRIC (TERRAFIX 270R OR EQUIVALENT).

8. EXTERIOR GRADE TO SLOPE AWAY FROM BUILDING.

9. IMPERMEABLE BACKFILL SEAL - COMPACTED CLAY, CLAYEY SILT OR EQUIVALENT. IF ORIGINAL SOIL IS FREE-DRAINING, SEAL MAY BE OMITTED. MAXIMUM THICKNESS OF SEAL TO BE 0.5 m.

10. FREE DRAINING BACKFILL - OPSS GRANULAR B OR EQUIVALENT COMPACTED TO THE SPECIFIED DENSITY. DO NOT USE HEAVY COMPACTION EQUIPMENT WITHIN 2 m OF WALL. FREE DRAINING BACKFILL CAN BE OMITTED OR REDUCED IN THICKNESS IF VERTICAL DRAINAGE BOARD IS USED.

11. DO NOT CONNECT THE UNDERFLOOR DRAIN WITH THE PERIMETER DRAIN.

12. REVIEW THE GEOTECHNICAL REPORT FOR SPECIFIC DETAILS.

JR CAPITAL HOLDINGS INC.
Proposed Residential Subdivision - 1873 London Line
PRELIMINARY GEOTECHNICAL INVESTIGATION

BASEMENT AND UNDERFLOOR DRAINAGE DETAILS

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TEL (905) 455-5666 FAX (905) 455-5639

Date:
July 10, 2019

Project No:
TG18-048

Scale:
NTS

FIGURE 5

APPENDIX A

LIMITATIONS AND INFORMATION REGARDING USE OF REPORT

LIMITATIONS AND INFORMATION REGARDING USE OF REPORT

This report was prepared by GeoTerre Limited (GeoTerre) for the sole use of the named client and for review and use by its designated consultants and government agencies during realization of the project. Any use by a third party of this report other than those named in the preceding sentence, or any reliance on, or decisions to be made based on it, are the responsibility of such third parties. GeoTerre accepts no responsibility for damages, if any, suffered by any third party as of a result of decisions made or actions based on this report.

The conclusions and recommendations presented in this report are intended to be preliminary in nature and are not intended or applicable for detailed design. Furthermore, the preliminary design recommendations given in this report are applicable only to the project described in the text and then only if the project as envisaged during detailed design is substantially in accordance with details stated in this report. Since all details of the final design are not known at this time, we recommend that we be retained during the final design stage to the project to verify that the design is consistent with the preliminary recommendations presented within.

Preliminary comments presented within regarding the prevailing subsurface and groundwater conditions within the limits of the site are provided for illustration only and must be confirmed during the detailed design phase of the project or any elements associated thereto.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

During construction, we recommend that GeoTerre be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those considered by GeoTerre in the preparation of this report and to confirm and document that construction activities do not adversely affect the recommendations, opinions and suggestions contained in the GeoTerre report.

GEOTERRE LIMITED

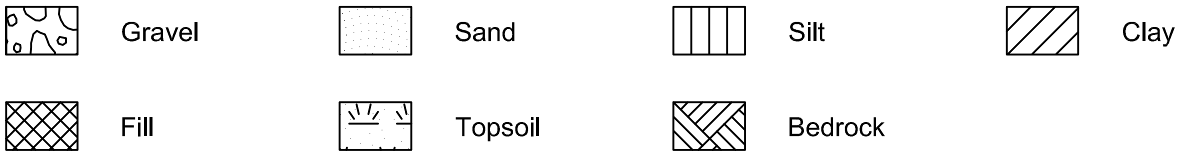
APPENDIX B

BOREHOLE LOGS

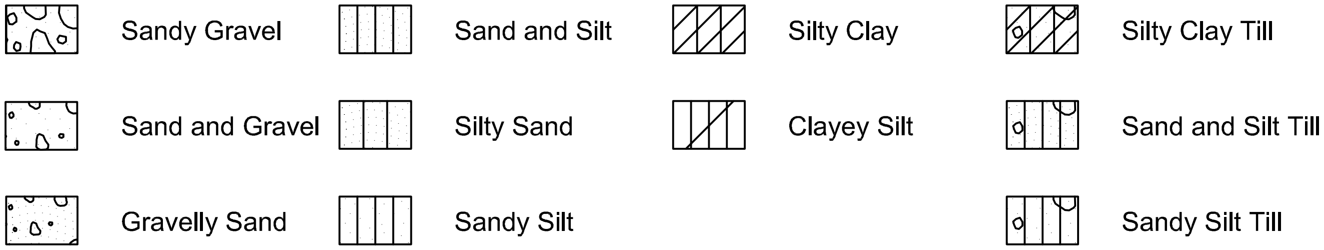
GEOTERRE

SYMBOLS AND TERMS FOR BOREHOLE LOG SOIL DESCRIPTION

BASIC SOIL SYMBOLS



EXAMPLE SOIL REPRESENTATIONS



CLASIFICATION BY PARTICLE SIZE (UNIFIED SOIL CLASSIFICATION SYSTEM)

NAME		PARTICLE SIZE RANGE		
		MM	U. S. STANDARD SIEVE SIZE	
			RETAINED	PASSING
Boulders		>200	8 inch	-
Cobbles		75 to 200	3 inch	8 inch
Gravel	**coarse**	19 to 75	0.75 inch	3 inch
	fine	4.75 to 19	No. 4	0.75 inch
Sand	**coarse**	2 to 4.75	No. 10	No. 4
	medium	0.425 to 2	No. 40	No. 10
	fine	0.075 to 0.425	No. 200	No. 40
Fines (Silt and Clay Particles)		<0.075	-	No. 200

PROPORTION OF MINOR COMPONENTS BY WEIGHT

noun	gravel, sand, silt, clay	>35 % and main fraction
"and"	and gravel, and silt, etc.	35 to 50 %
adjective	gravelly, sandy, silty, clayey, etc.	20 to 35 %
"some"	some sand, some silt, etc.	10 to 20 %
"trace"	trace sand, trace silt, etc.	0 to 10%

DEGREE OF PLASTICITY

DEFINITION	CATEGORY
$W_L<30$	Low
$30<W_L<50$	Medium
$W_L>50$	High

COMPACTNESS OF GRANULAR SOILS BASE ON SPT

COMPACTNESS CONDITION	UNCORRECTED FIELD SPT N-VALUES (BLOWS/300 MM)
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

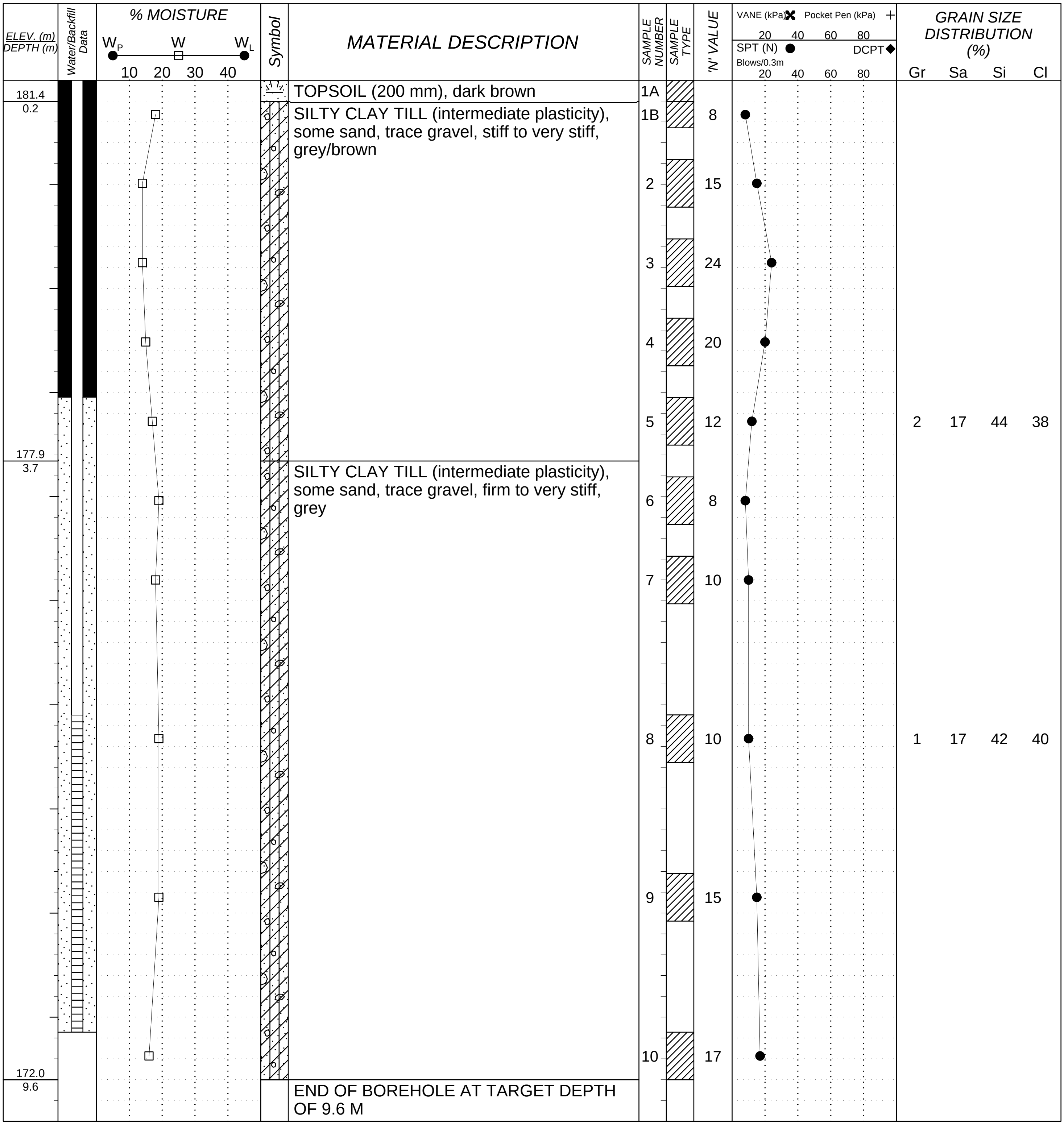
CONSISTENCY AND UNDRAINED SHEAR STRENGTH OF COHESIVE SOILS

CONSISTENCY OF COHESIVE SOILS	UNDRAINED SHEAR STRENGTH (KPA)	UNCORRECTED FIELD SPT N-VALUES (BLOWS/300 MM)
Very Soft	<12	<2
Soft	12 to 25	2 to 4
Firm	25 to 50	5 to 8
Stiff	50 to 100	9 to 15
Very Stiff	100 to 200	16 to 30
Hard	>200	>30

LOG OF BOREHOLE BH18-1

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **181.60 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 7 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE	Gr	Sa	Si	Cl
	TOPSOIL (200 mm), dark brown	1A					
181.4 0.2	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff to very stiff, grey/brown	1B	8				
		2	15				
		3	24				
		4	20				
		5	12	2	17	44	38
177.9 3.7	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm to very stiff, grey	6	8				
		7	10				
		8	10	1	17	42	40
		9	15				
		10	17				
172.0 9.6	END OF BOREHOLE AT TARGET DEPTH OF 9.6 M						

GRAIN SIZE DISTRIBUTION (%)

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SAMPLE TYPE

▤	Auger Sample	☐	Thin Wall Tube Sampler
▨	Split Spoon Sample	▥	Pionjar Sample
░	Bulk Sample	☒	Soil Core (PQ)

BACKFILL LEGEND

▒	Concrete	■	Bentonite	☒	Grout
▒	Drill Cuttings	⁚	Filter Sand	▩	Slough
▓	Asphalt	▥	Slotted Pipe		

LOG OF BOREHOLE JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

LOG OF BOREHOLE BH18-1

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **181.60 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 7 2018**

ELEV. (m) DEPTH (m)	Water/Backfill Data	% MOISTURE W_P W W_L 10 20 30 40	Symbol	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	VANE (kPa) ✖ Pocket Pen (kPa) + 20 40 60 80 SPT (N) ● DCPT ◆ Blows/0.3m 20 40 60 80	GRAIN SIZE DISTRIBUTION (%) Gr Sa Si Cl
				BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING STANDPIPE PIEZOMETER (32 mm diameter) INSTALLED TO A TIP DEPTH OF 9.1 m (3.0 m LONG SCREEN) UPON COMPLETION OF DRILLING STANDPIPE PIEZOMETER WATER LEVEL READINGS DATE Depth(m) Elevation(m) Nov 8, 2018 dry n/a Nov 29, 2018 8.59 m 173.01 m REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER					

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SAMPLE TYPE

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ░ Bulk Sample
- ☐ Thin Wall Tube Sampler
- ▥ Pionjar Sample
- ☒ Soil Core (PQ)

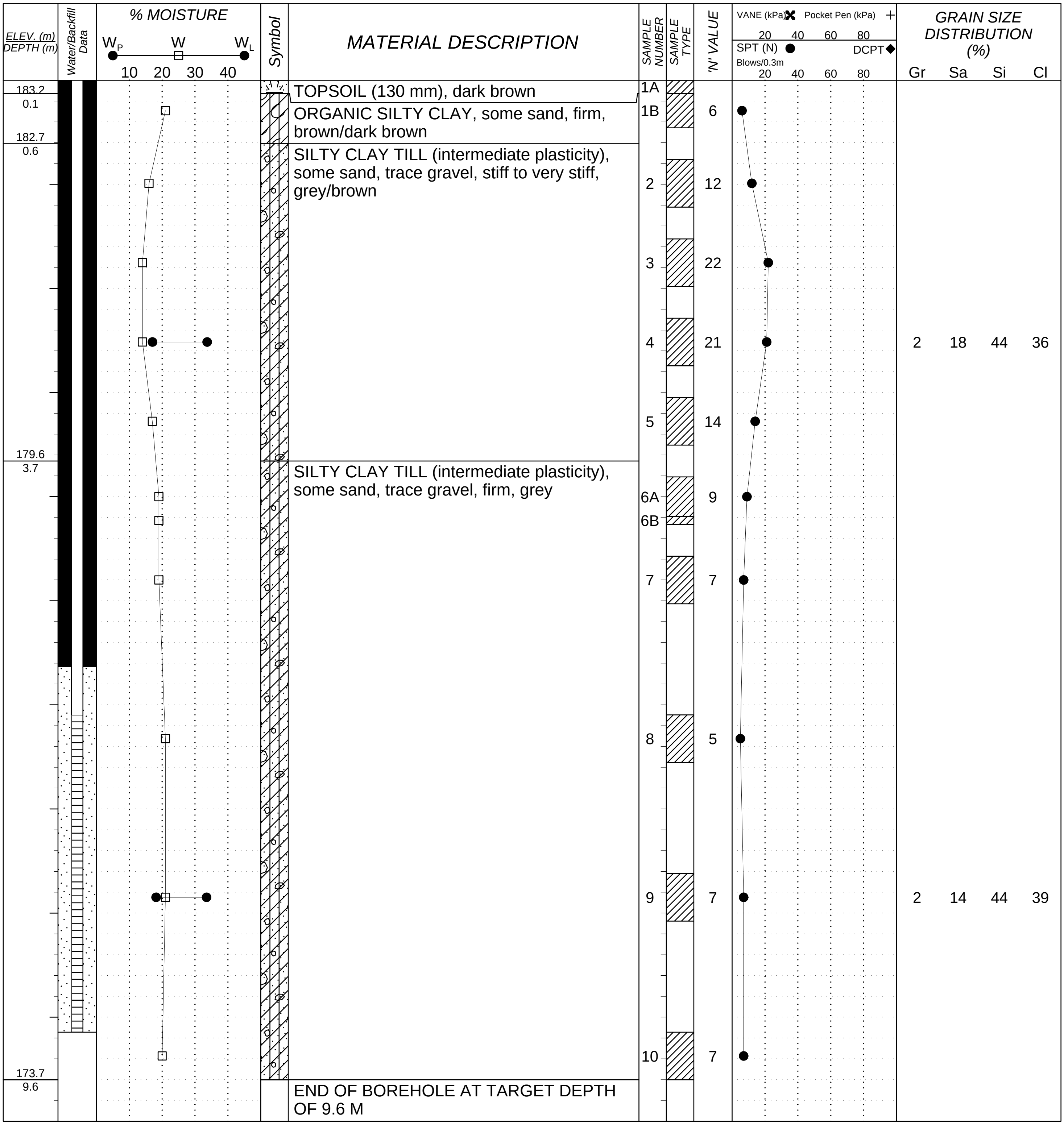
BACKFILL LEGEND

- Concrete
- Drill Cuttings
- Asphalt
- ■ Bentonite
- Filter Sand
- Slotted Pipe
- ☒ Grout
- Slough

LOG OF BOREHOLE BH18-2

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **183.30 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 7 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE	Gr	Sa	Si	Cl
	TOPSOIL (130 mm), dark brown	1A					
183.2 0.1	ORGANIC SILTY CLAY, some sand, firm, brown/dark brown	1B	6				
182.7 0.6	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff to very stiff, grey/brown	2	12				
		3	22				
		4	21	2	18	44	36
		5	14				
179.6 3.7	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm, grey	6A	9				
		6B					
		7	7				
		8	5				
		9	7	2	14	44	39
		10	7				
173.7 9.6	END OF BOREHOLE AT TARGET DEPTH OF 9.6 M						

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SAMPLE TYPE

☰ Auger Sample	☐ Thin Wall Tube Sampler
▨ Split Spoon Sample	▥ Pionjar Sample
░ Bulk Sample	☒ Soil Core (PQ)

BACKFILL LEGEND

▒ Concrete	■ Bentonite	☒ Grout
▒ Drill Cuttings	⬚ Filter Sand	▩ Slough
▓ Asphalt	▤ Slotted Pipe	

LOG OF BOREHOLE BH18-2

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **183.30 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 7 2018**

ELEV. (m) DEPTH (m)	Water/Backfill Data	% MOISTURE W_P ● W ☐ W_L ● 10 20 30 40	Symbol	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	VANE (kPa) ✖ Pocket Pen (kPa) + 20 40 60 80 SPT (N) ● DCPT ◆ Blows/0.3m 20 40 60 80	GRAIN SIZE DISTRIBUTION (%) Gr Sa Si Cl
				BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING STANDPIPE PIEZOMETER (32 mm diameter) INSTALLED TO A TIP DEPTH OF 9.1 m (3.0 m LONG SCREEN) UPON COMPLETION OF DRILLING STANDPIPE PIEZOMETER WATER LEVEL READINGS DATE Depth(m) Elevation(m) Nov 8, 2018 dry n/a Nov 29, 2018 7.96 m 175.34 m REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER					

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SAMPLE TYPE

▤ Auger Sample	☐ Thin Wall Tube Sampler
▨ Split Spoon Sample	▥ Pionjar Sample
░ Bulk Sample	☒ Soil Core (PQ)

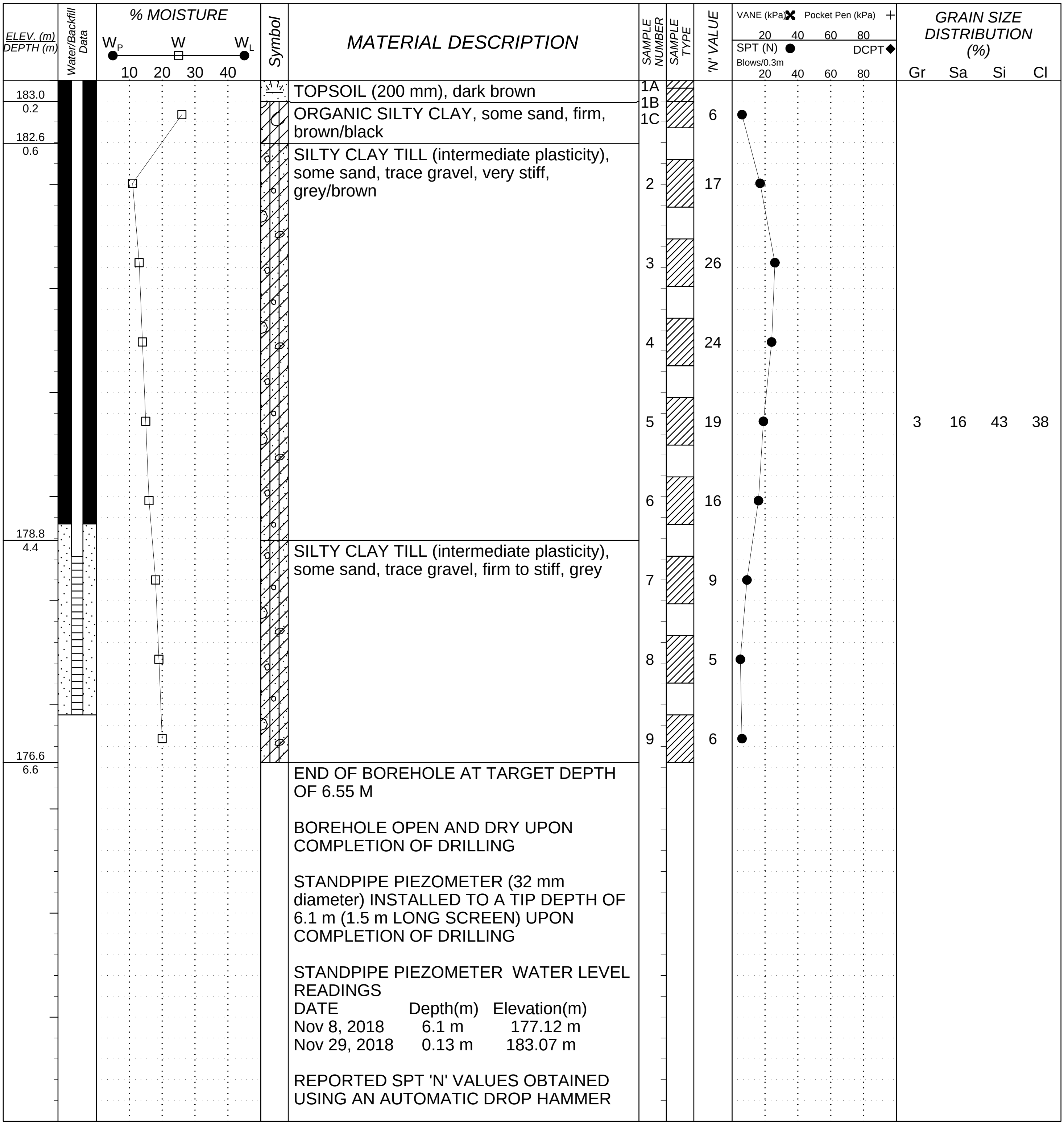
BACKFILL LEGEND

▩ Concrete	■ Bentonite	☒ Grout
▒ Drill Cuttings	⁚ Filter Sand	▩ Slough
▓ Asphalt	▥ Slotted Pipe	

LOG OF BOREHOLE BH18-3

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **183.20 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 7 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE	Gr	Sa	Si	Cl
	TOPSOIL (200 mm), dark brown	1A					
183.0 0.2	ORGANIC SILTY CLAY, some sand, firm, brown/black	1B 1C	6				
182.6 0.6	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, very stiff, grey/brown	2	17				
		3	26				
		4	24				
		5	19	3	16	43	38
		6	16				
178.8 4.4	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm to stiff, grey	7	9				
		8	5				
		9	6				
176.6 6.6	END OF BOREHOLE AT TARGET DEPTH OF 6.55 M						

BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING

STANDPIPE PIEZOMETER (32 mm diameter) INSTALLED TO A TIP DEPTH OF 6.1 m (1.5 m LONG SCREEN) UPON COMPLETION OF DRILLING

STANDPIPE PIEZOMETER WATER LEVEL READINGS

DATE	Depth(m)	Elevation(m)
Nov 8, 2018	6.1 m	177.12 m
Nov 29, 2018	0.13 m	183.07 m

REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER

LOG OF BOREHOLE JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

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SAMPLE TYPE

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ░ Bulk Sample
- ☐ Thin Wall Tube Sampler
- ▥ Pionjar Sample
- ☒ Soil Core (PQ)

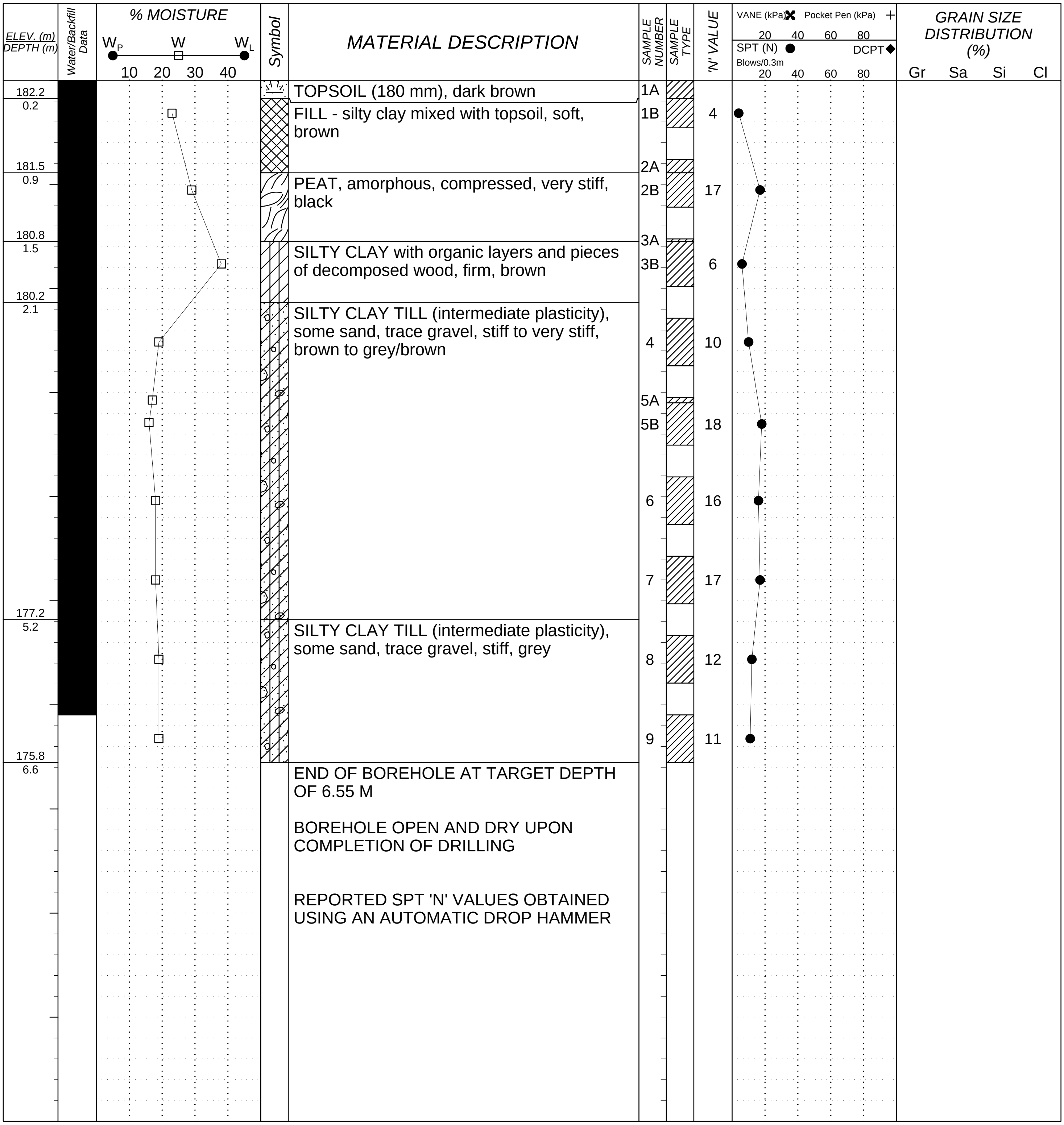
BACKFILL LEGEND

- ▒ Concrete
- ▒ Drill Cuttings
- ▓ Asphalt
- ■ Bentonite
- ⁚ Filter Sand
- ▤ Slotted Pipe
- ☒ Grout
- ▦ Slough

LOG OF BOREHOLE BH18-4

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **182.35 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 8 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE
	TOPSOIL (180 mm), dark brown	1A	
182.2 0.2	FILL - silty clay mixed with topsoil, soft, brown	1B	4
		2A	
181.5 0.9	PEAT, amorphous, compressed, very stiff, black	2B	17
		3A	
180.8 1.5	SILTY CLAY with organic layers and pieces of decomposed wood, firm, brown	3B	6
180.2 2.1	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff to very stiff, brown to grey/brown	4	10
		5A	
		5B	18
		6	16
		7	17
177.2 5.2	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff, grey	8	12
		9	11
175.8 6.6	END OF BOREHOLE AT TARGET DEPTH OF 6.55 M BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER		

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SAMPLE TYPE

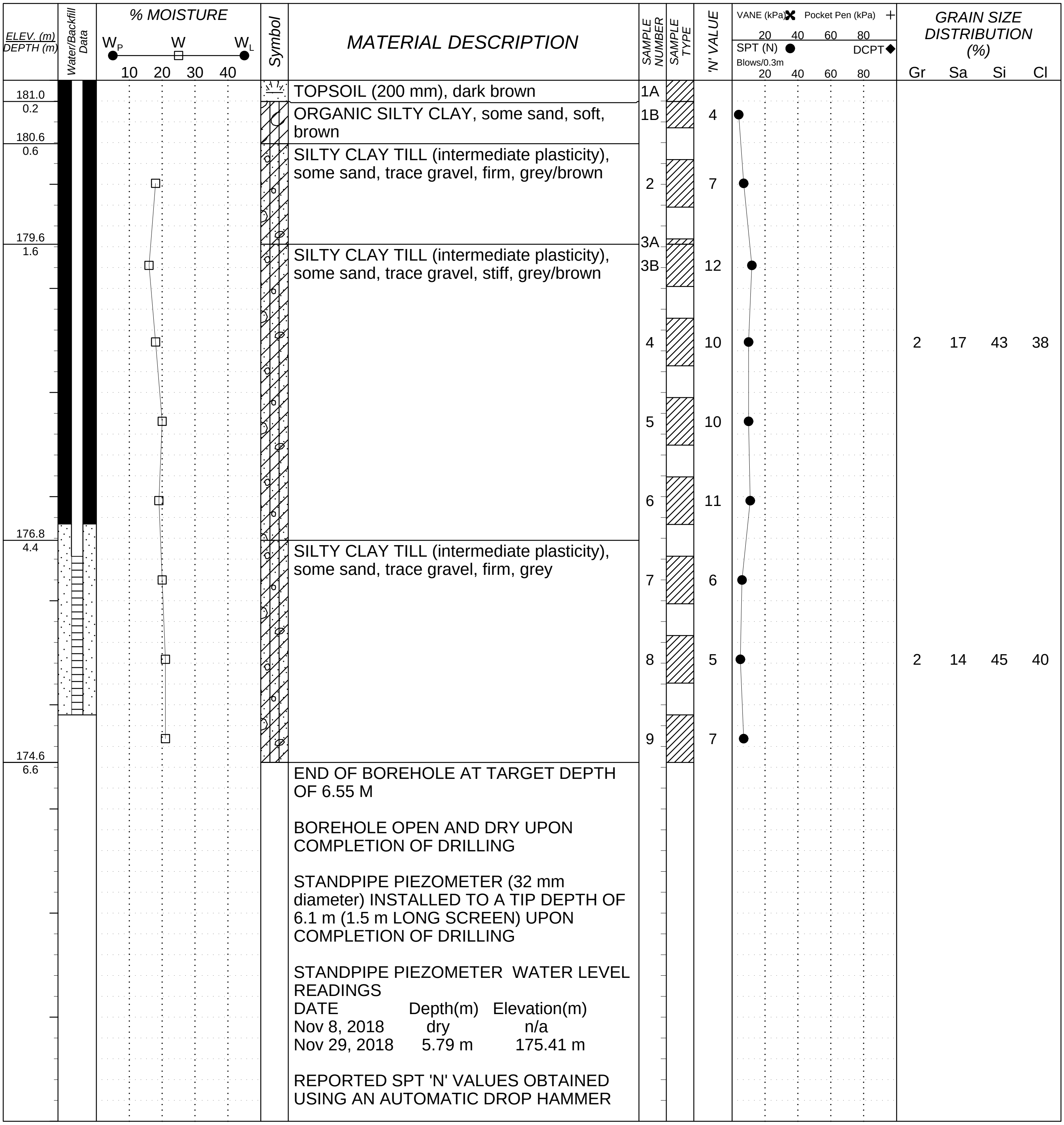
☰ Auger Sample	☐ Thin Wall Tube Sampler
▨ Split Spoon Sample	▥ Pionjar Sample
░ Bulk Sample	☒ Soil Core (PQ)

BACKFILL LEGEND

▦ Concrete	■ Bentonite	▧ Grout
▒ Drill Cuttings	⁙ Filter Sand	▩ Slough
▓ Asphalt	⊞ Slotted Pipe	

LOG OF BOREHOLE BH18-5

PROJECT No.: **TG18-048**	Drilling Data
CLIENT: **JR CAPITAL HOLDINGS INC.**	METHOD: **Hollow Stem Augers**
PROJECT: **New Subdivision - 1873 London Line**	DIAMETER: **200 mm**
LOCATION: **Sarnia, Ontario**	PREP. BY: **VTM** APPR. BY: **IC**
SURFACE ELEV.: **181.20 metres**	DATE: **November 8 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE	Gr	Sa	Si	Cl
	TOPSOIL (200 mm), dark brown	1A					
181.0 0.2	ORGANIC SILTY CLAY, some sand, soft, brown	1B	4				
180.6 0.6	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm, grey/brown	2	7				
179.6 1.6	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff, grey/brown	3A					
		3B	12				
		4	10	2	17	43	38
		5	10				
		6	11				
176.8 4.4	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm, grey	7	6				
		8	5	2	14	45	40
		9	7				
174.6 6.6	END OF BOREHOLE AT TARGET DEPTH OF 6.55 M						

BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING

STANDPIPE PIEZOMETER (32 mm diameter) INSTALLED TO A TIP DEPTH OF 6.1 m (1.5 m LONG SCREEN) UPON COMPLETION OF DRILLING

STANDPIPE PIEZOMETER WATER LEVEL READINGS

DATE	Depth(m)	Elevation(m)
Nov 8, 2018	dry	n/a
Nov 29, 2018	5.79 m	175.41 m

REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER

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SAMPLE TYPE

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ░ Bulk Sample
- ☐ Thin Wall Tube Sampler
- ▥ Pionjar Sample
- ☒ Soil Core (PQ)

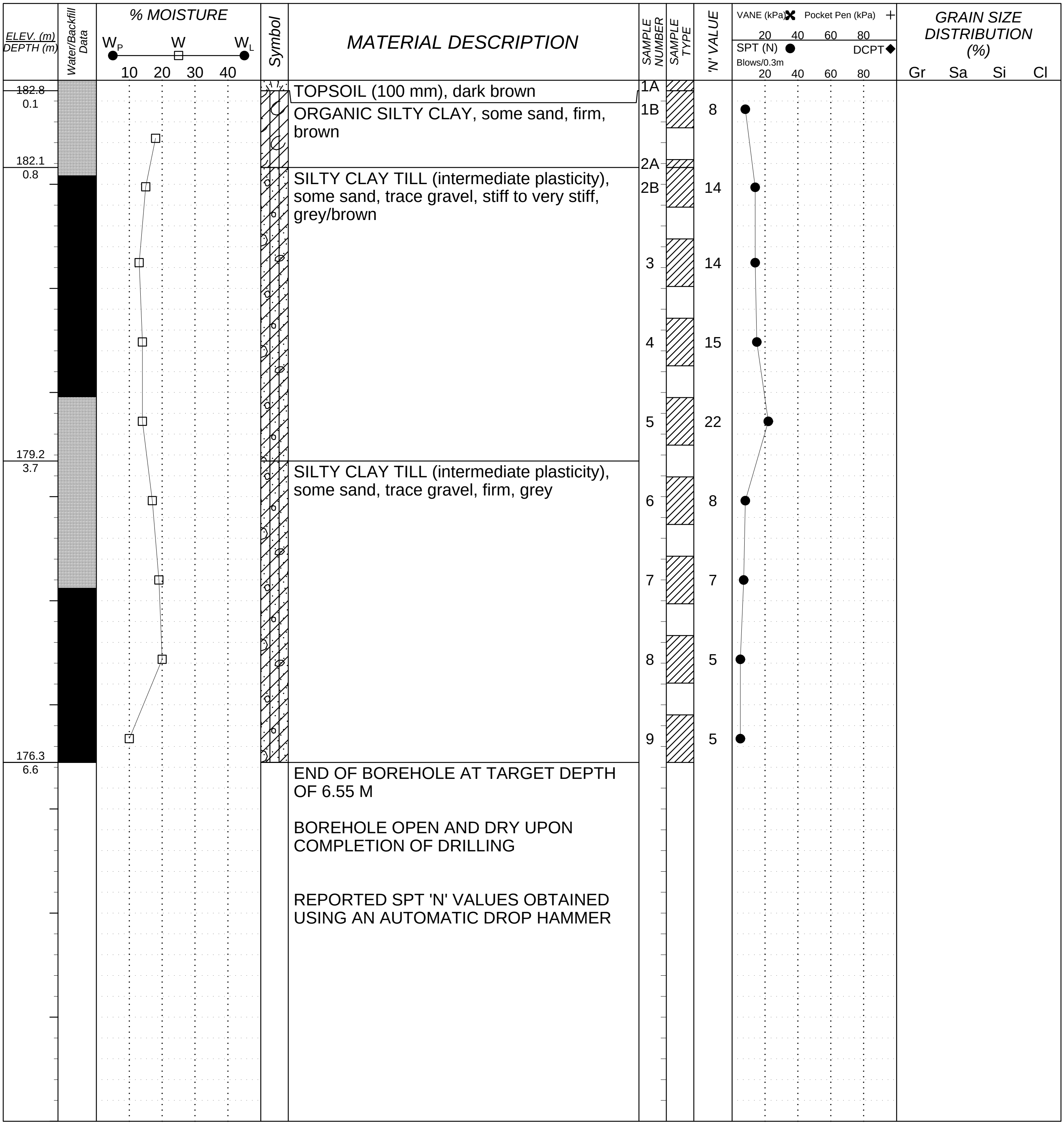
BACKFILL LEGEND

- ▒ Concrete
- ░ Drill Cuttings
- ▓ Asphalt
- ■ Bentonite
- ⁘ Filter Sand
- ▦ Slotted Pipe
- ▧ Grout
- ▩ Slough

LOG OF BOREHOLE BH18-6

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **182.90 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 8 2018**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE
	TOPSOIL (100 mm), dark brown	1A	
182.8 0.1	ORGANIC SILTY CLAY, some sand, firm, brown	1B	8
182.1 0.8	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff to very stiff, grey/brown	2A 2B 3 4 5	 14 14 15 22
179.2 3.7	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, firm, grey	6 7 8 9	8 7 5 5
176.3 6.6	END OF BOREHOLE AT TARGET DEPTH OF 6.55 M BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER		

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SAMPLE TYPE

▤	Auger Sample	☐	Thin Wall Tube Sampler
▨	Split Spoon Sample	▥	Pionjar Sample
░	Bulk Sample	☒	Soil Core (PQ)

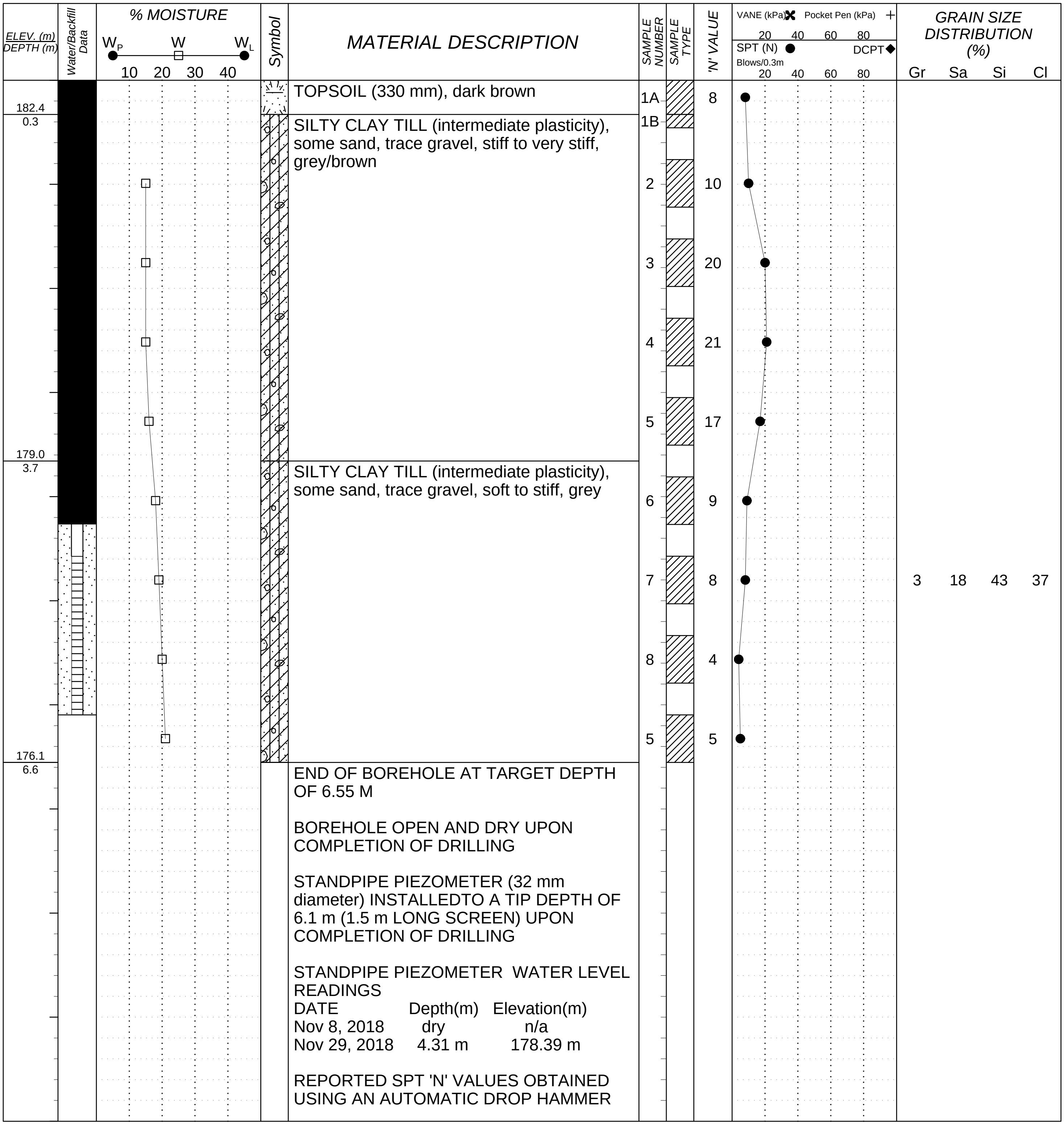
BACKFILL LEGEND

▩	Concrete	■	Bentonite	▧	Grout
░	Drill Cuttings	⁘	Filter Sand	▦	Slough
▓	Asphalt	▥	Slotted Pipe		

LOG OF BOREHOLE BH18-7

PROJECT No.: **TG18-048**
CLIENT: **JR CAPITAL HOLDINGS INC.**
PROJECT: **New Subdivision - 1873 London Line**
LOCATION: **Sarnia, Ontario**
SURFACE ELEV.: **182.70 metres**

Drilling Data
METHOD: **Hollow Stem Augers**
DIAMETER: **200 mm**
PREP. BY: **VTM** APPR. BY: **IC**
DATE: **November 8 2018**



ELEV. (m) DEPTH (m)	Water/Backfill Data	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	GRAIN SIZE DISTRIBUTION (%) Gr	Sa	Si	Cl
	■	TOPSOIL (330 mm), dark brown	1A	▨	8				
182.4 0.3	■	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, stiff to very stiff, grey/brown	1B	▨					
	■		2	▨	10				
	■		3	▨	20				
	■		4	▨	21				
	■		5	▨	17				
179.0 3.7	■	SILTY CLAY TILL (intermediate plasticity), some sand, trace gravel, soft to stiff, grey	6	▨	9				
	⁙		7	▨	8	3	18	43	37
	⁙		8	▨	4				
			5	▨	5				
176.1 6.6		END OF BOREHOLE AT TARGET DEPTH OF 6.55 M BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING STANDPIPE PIEZOMETER (32 mm diameter) INSTALLEDTO A TIP DEPTH OF 6.1 m (1.5 m LONG SCREEN) UPON COMPLETION OF DRILLING REPORTED SPT 'N' VALUES OBTAINED USING AN AUTOMATIC DROP HAMMER							

STANDPIPE PIEZOMETER WATER LEVEL READINGS

DATE	Depth(m)	Elevation(m)
Nov 8, 2018	dry	n/a
Nov 29, 2018	4.31 m	178.39 m

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SAMPLE TYPE

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ░ Bulk Sample
- ☐ Thin Wall Tube Sampler
- ▥ Pionjar Sample
- ☒ Soil Core (PQ)

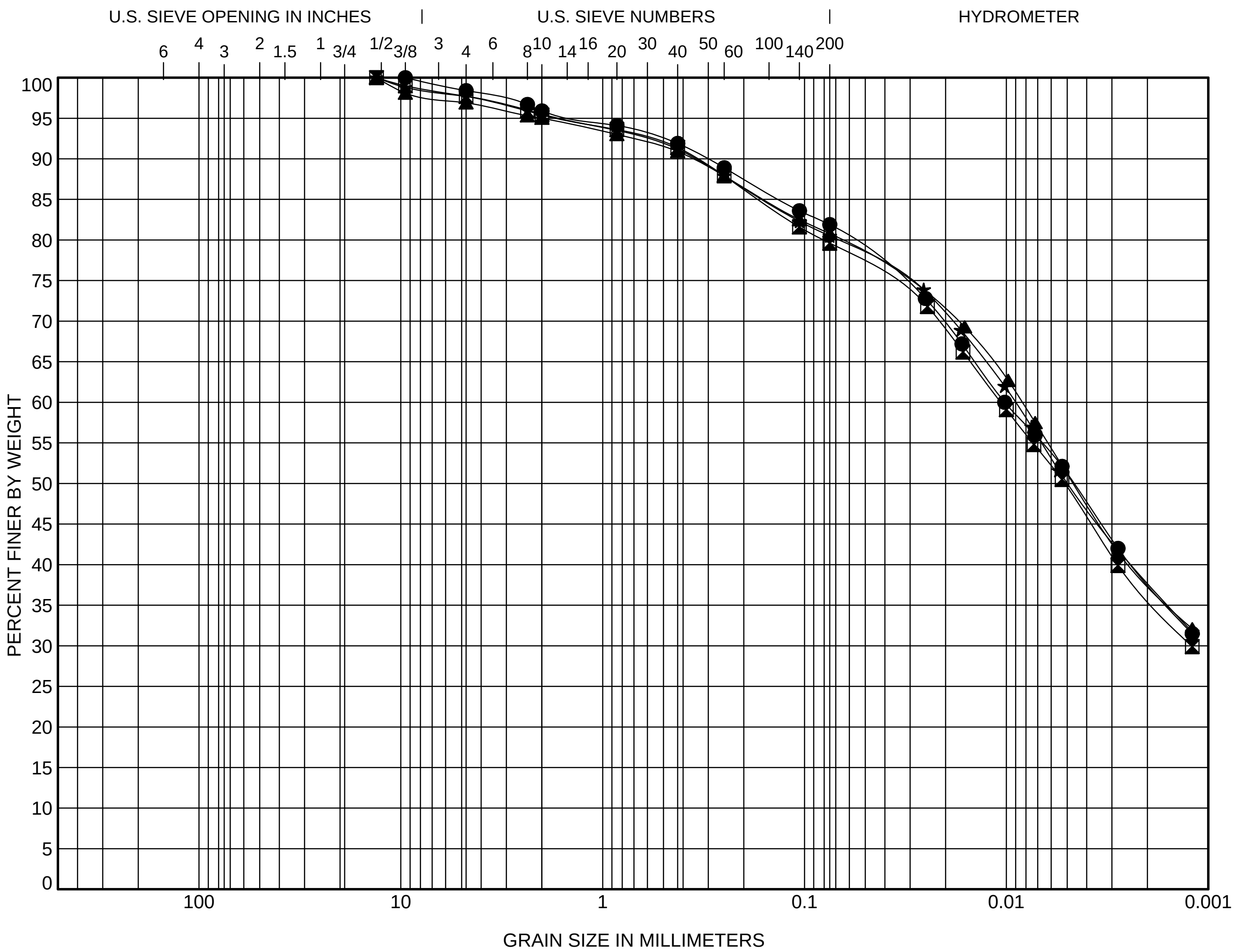
BACKFILL LEGEND

- ▩ Concrete
- ▒ Drill Cuttings
- ▓ Asphalt
- ■ Bentonite
- ⁙ Filter Sand
- ⊞ Slotted Pipe
- ☒ Grout
- ▦ Slough

APPENDIX C

LABORATORY GRAIN SIZE DATA

GRAIN SIZE ANALYSIS
SILTY CLAY TILL MATERIALS - UPPER GREY/BROWN ZONE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification and Depth (m)		Classification	LL	PL	PI	Cc	Cu
●	BH18-1	3.28						
☒	BH18-2	2.51		**34**	**17**	**17**		
▲	BH18-3	3.28						
★	BH18-5	2.51						

GRAINSIZE - GEOTERRE JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

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FIGURE C1

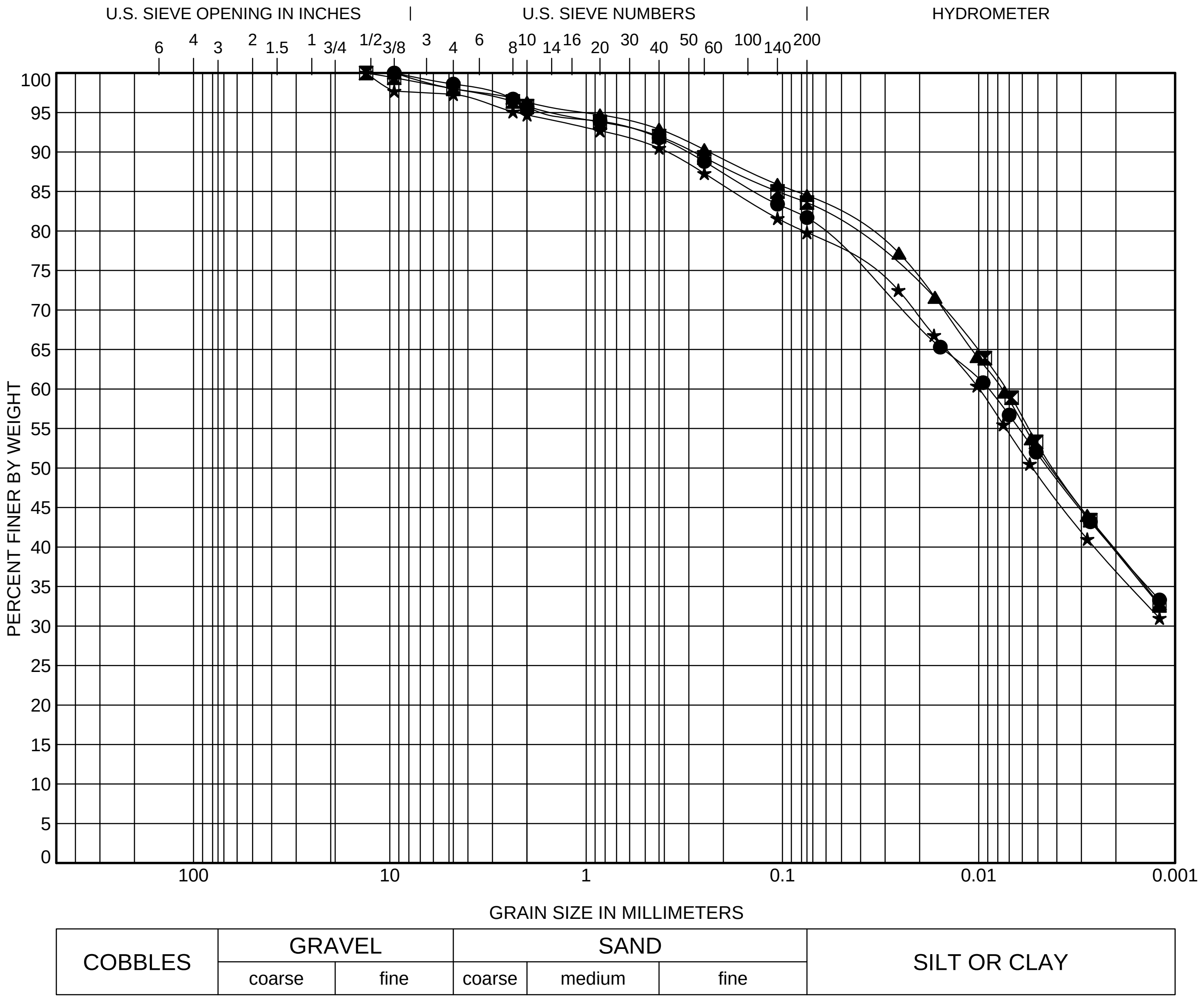
Project No.: TG18-048

Client: JR CAPITAL HOLDINGS INC.

Project: New Subdivision - 1873 London Line

Location: Sarnia, Ontario

GRAIN SIZE ANALYSIS
SILTY CLAY TILL MATERIALS - LOWER GREY ZONE



	Specimen Identification and Depth (m)		Classification	LL	PL	PI	Cc	Cu
●	BH18-1	6.32						
☒	BH18-2	7.85		**33**	**18**	**15**		
▲	BH18-5	5.56						
★	BH18-7	4.80						

GRAINSIZE - GEOTERRE JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

GEOTERRE LIMITED
215 Advance Blvd. - Unit 5/6
Brampton, Ontario L6T 4V9
PH: (905) 455-5666
FX: (905) 455-5639
e-mail: toronto@geoterre.ca

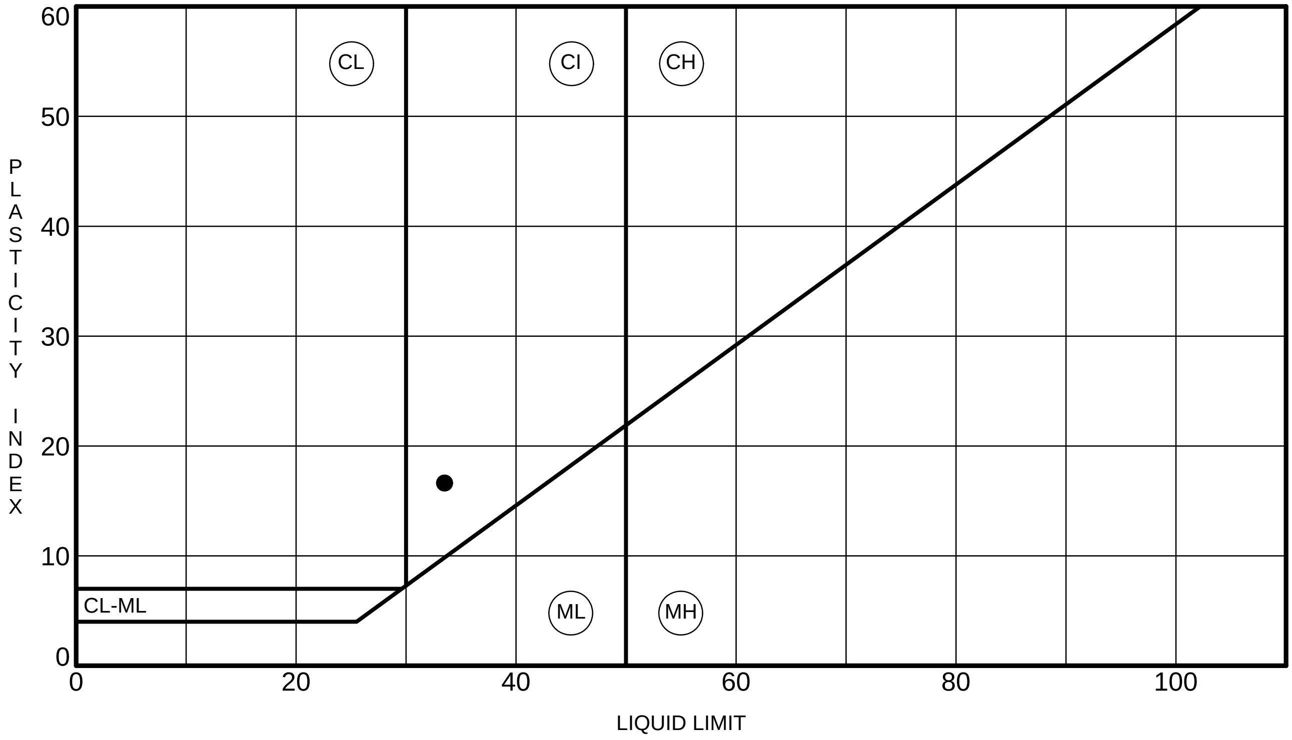
FIGURE C2

Project No.: TG18-048
Client: JR CAPITAL HOLDINGS INC.
Project: New Subdivision - 1873 London Line
Location: Sarnia, Ontario

APPENDIX D

SOIL PLASTICITY DATA

ATTERBERG LIMIT TEST RESULTS
SILTY CLAY TILL MATERIALS - UPPER GREY/BROWN ZONE



	Specimen Identification		LL	PL	PI	Fines	Classification
●	BH18-2	2.51	**34**	**17**	**17**	**80**	

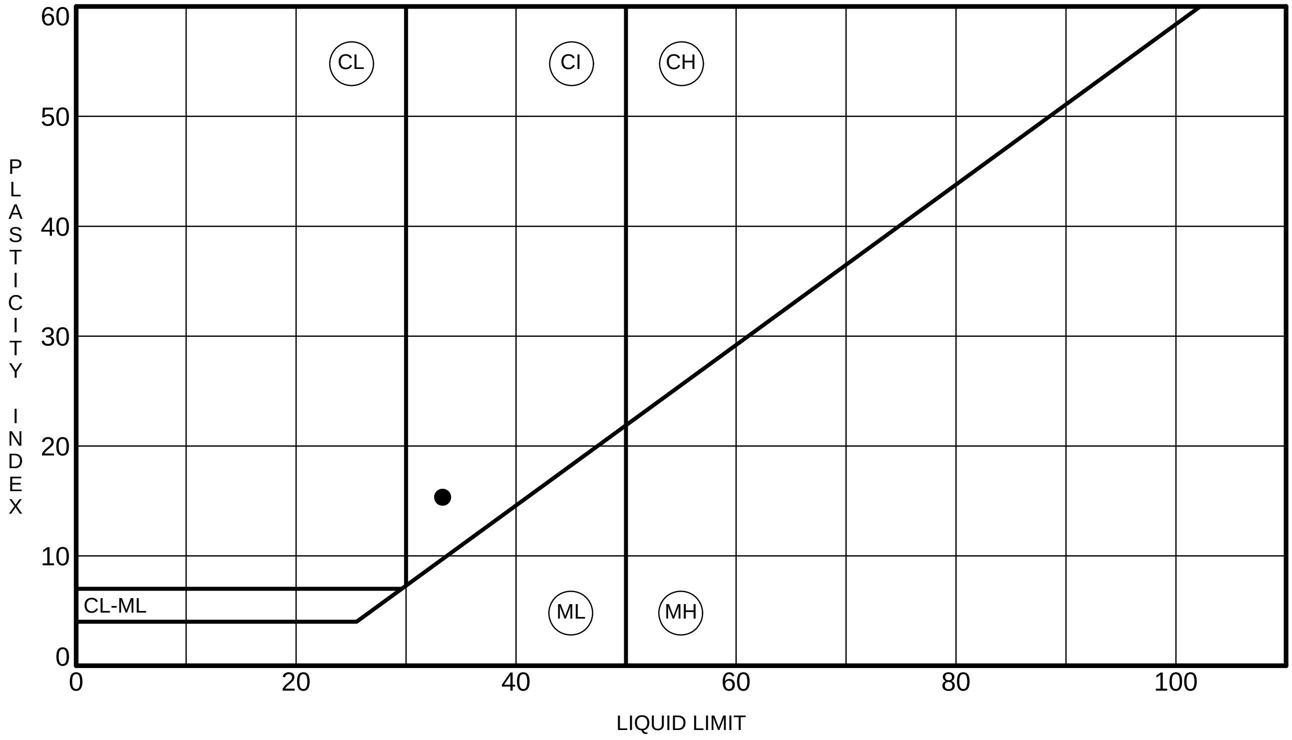
GEOTERRE LIMITED
215 Advance Blvd. - Unit 5/6
Brampton, Ontario L6T 4V9
PH: (905) 455-5666
FX: (905) 455-5639
e-mail: toronto@geoterre.ca

FIGURE D1

Project No.: TG18-048
Client: JR CAPITAL HOLDINGS INC.
Project: New Subdivision - 1873 London Line
Location: Sarnia, Ontario

GEOTERRE ATTERBERG LIMITS JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

ATTERBERG LIMIT TEST RESULTS
SILTY CLAY TILL MATERIALS - LOWER GREY ZONE



	Specimen Identification		LL	PL	PI	Fines	Classification
●	BH18-2	7.85	**33**	**18**	**15**	**84**	

GEOTERRE LIMITED
215 Advance Blvd. - Unit 5/6
Brampton, Ontario L6T 4V9
PH: (905) 455-5666
FX: (905) 455-5639
e-mail: toronto@geoterre.ca

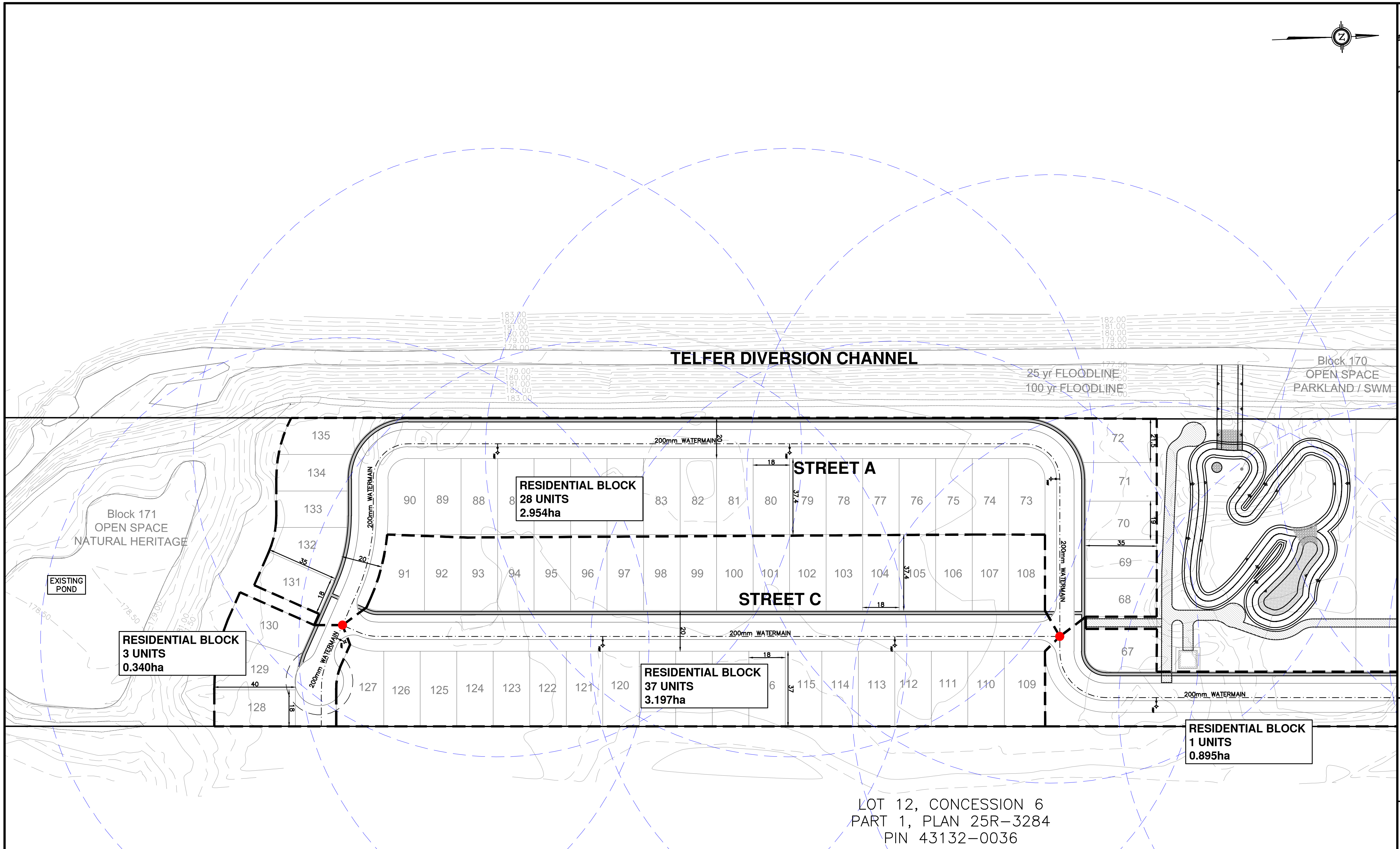
FIGURE D2

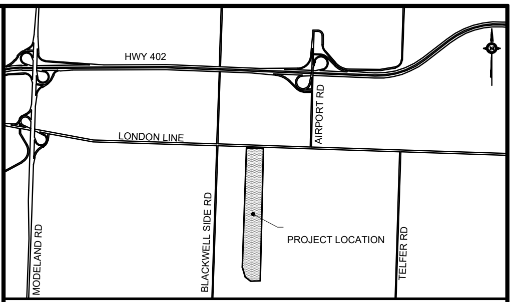
Project No.: TG18-048
Client: JR CAPITAL HOLDINGS INC.
Project: New Subdivision - 1873 London Line
Location: Sarnia, Ontario

GEOTERRE ATTERBERG LIMITS JRCH-SARNIASUBDIVISION.GPJ GEOTERRE.GDT 1/4/19

APPENDIX C

Water Servicing Calculations





KEY PLAN

N.T.S.

LEGEND

HYD&V —⌖	FIRE HYDRANT
VB ⊗	VALVE & BOX
— · —	PROP. WATERMAIN
⊗——	PROP. WATER SERVICE CONNECTION
——	PROP. ROW
——	PROP. LIMIT OF SUBDIVISION
▬ ▬ ▬	WATER SECTOR BOUNDARY
– – –	PROP. HYDRANT COVERAGE (150m RADIUS)
●	PROP. JUNCTION

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542–4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL WATERMAIN DISTRIBUTION PLAN

DESIGNED BY:	S.S.	SCALES:		PROJECT No.	18-569
CHECKED BY:	E.G.	HORIZONTAL:	1:2000	DRAWING No.	WAT-1
DRAWN BY:	J.N.	VERTICAL:		SHEET No.	01
DATE:	APRIL 24, 2019	SHEET SIZE:	11"x17"		

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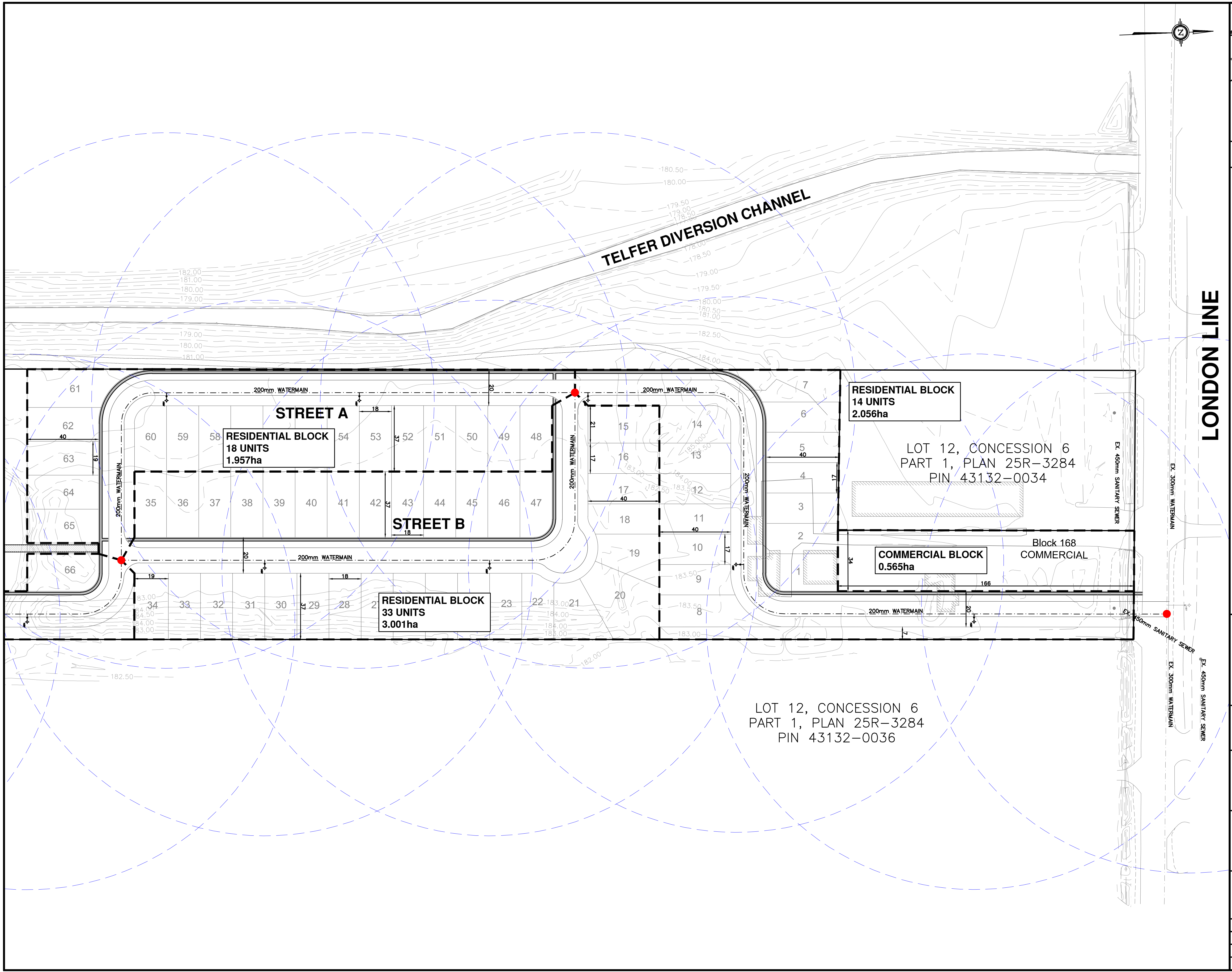
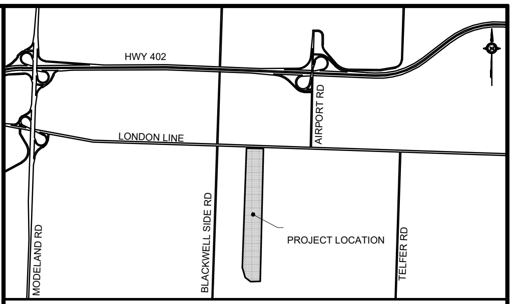
Date Plotted: Sep 03, 2019 – 2:54pm





KEY PLAN
N.T.S.

LEGEND

HYD&V –⌖–	FIRE HYDRANT
VB ⊗	VALVE & BOX
— · —	PROP. WATERMAIN
⊗——	PROP. WATER SERVICE CONNECTION
——	PROP. ROW
——	PROP. LIMIT OF SUBDIVISION
▬ ▬ ▬	WATER SECTOR BOUNDARY
– – –	PROP. HYDRANT COVERAGE (150m RADIUS)
●	PROP. JUNCTION

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542–4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL WATERMAIN DISTRIBUTION PLAN

DESIGNED BY: S.S.	SCALES:		PROJECT No. 18-569
CHECKED BY: E.G.	HORIZONTAL:	1:2000	DRAWING No. WAT-2
DRAWN BY: J.N.	VERTICAL:		SHEET No. 02
DATE: APRIL 24, 2019	SHEET SIZE:	11"x17"	

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Date Plotted: Sep 03, 2019 – 2:54pm

WATER DEMAND CALCULATIONS

PROJECT: London Line Subdivision
LOCATION: Sarnia, ON
DATE: June 2019

DESIGNED BY: Matt Clemente, C.E.T.
REVIEWED BY: Eric Greck, P.Eng.

Design Parameters

Residential		
Persons Per Unit:	3	
Number of Proposed Units:	135	
Average Day Residential flow (L/cap/day):	337	(As per Sarnia Requirements)
Maximum Day Factor:	2.9	(MOE Design Guidelines Sec. 3.4.5.1 Table 3-3)
Peak Hour Factor:	4.3	(MOE Design Guidelines Sec. 3.4.5.1 Table 3-3)
Fire Flow for Single detached dwelling: (L/min)	6,000	Calculated (Fire underwriters survey, 1999)
Fire Flow for Single detached dwelling: (L/s)	100.00	
Commercial		
Total Commercial Land Area (ha):	0.56	
Commercial Allowance (L/s/ha)	0.4	(As per Sarnia Requirements)
Number of Proposed Units:	1	
Fire Flow for Commercial: (L/min)	8,000	Calculated (Fire underwriters survey, 1999)
Fire Flow for Commercial: (L/s)	133.33	

Manual Input
Automatic Output
Total Demand

Demands

	Residential			Commercial			Totals							
Sector	Units	Average Daily Demand (L/Day)	ADD (L/s)	Units	Average Daily Demand (L/Day)	ADD (L/s)	Average Daily Demand (L/Day)	ADD (L/s)	Max. Daily Demand (L/c/d)	MDD (L/s)	Peak Hour Demand (L/c/d)	PHD (L/s)	MDD+FrFL (L/s)	Demand (L/s)
Total	135	**136,485**	**1.58**	1	**19,354**	**0.22**	**155,839**	**1.80**	**415,160**	**4.81**	**606,239**	**7.02**	**138.14**	**138.14**

WATER FLOW TEST REPORT

WALLACE-KENT
SPRINKLER SYSTEMS INC.

HYDRANT # & LOCATION H1500H12-London Line Sarnia Ontario DATE: 2019 03 15

TEST BY: Wallace Kent Sprinkler Systems Day or Week: Friday TIME OF DAY: 10:00am MIN. OF FLOW 5

WATER SUPPLIED BY: Municipal Supply

PURPOSE OF TEST: Water Main Capacity Test

DATA

FLOW HYDRANT(S)	A1	A2	A3
SIZE OPENING:	1.75		
COEFFICIENT:	0.9		
PITOT READING:	48		
GPM:	**570**	0	0

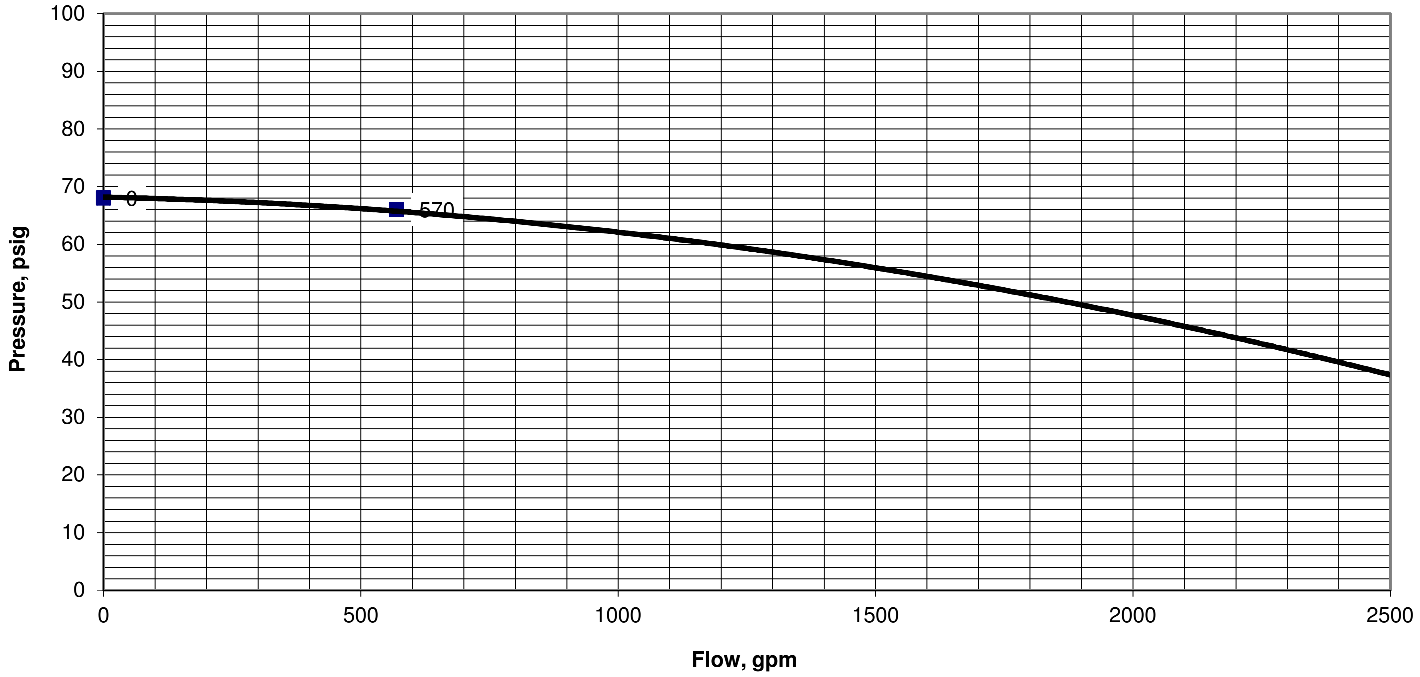
TOTAL FLOW DURING TEST: **570** GPM

STATIC READING: 68 PSI RESIDUAL: 66 PSI

RESULTS: AT 20 PSI RESIDUAL **3169** GPM AT 0 PSI **3825** GPM

ESTIMATED CONSUMPTION: **2848** GAL.

REMARKS:



WATER FLOW TEST REPORT

SPRINKLER SYSTEMS INC.

HYDRANT # & LOCATION H1500H12-London Line Sarnia Ontario DATE: 2019 03 15

TEST BY: Wallace Kent Sprinkler Systems Day or Week: Friday TIME OF DAY: 10:00am MIN. OF FLOW 5

WATER SUPPLIED BY: Municipal Supply

PURPOSE OF TEST: Water Main Capacity Test

DATA

FLOW HYDRANT(S)	A1	A2	A3
SIZE OPENING:	1.125		
COEFFICIENT:	0.9		
PITOT READING:	60		
GPM:	**263**	0	0

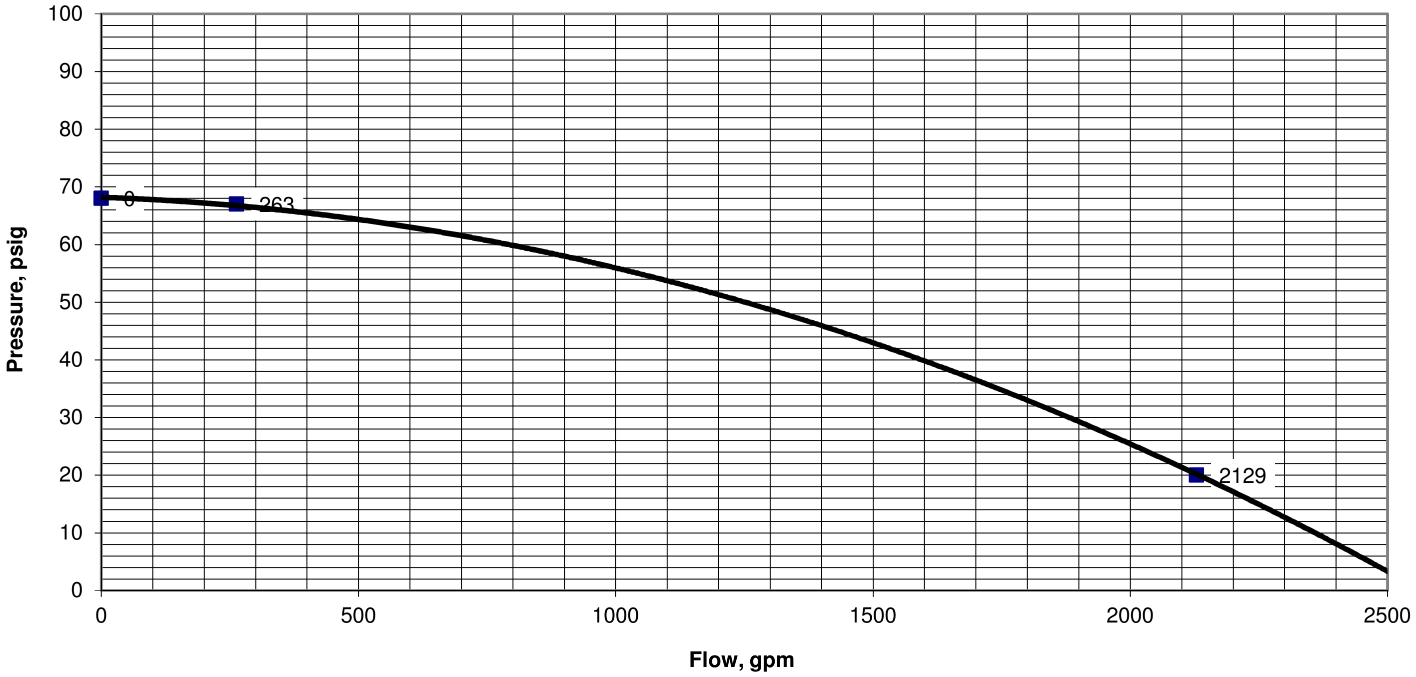
TOTAL FLOW DURING TEST: **263** GPM

STATIC READING: 68 PSI RESIDUAL: 67 PSI

RESULTS: AT 20 PSI RESIDUAL **2129** GPM AT 0 PSI **2569** GPM

ESTIMATED CONSUMPTION: **1316** GAL.

REMARKS:



WATER FLOW TEST REPORT

WALLACE-KENT SPRINKLER SYSTEMS INC.

HYDRANT # & LOCATION H1500H12-London Line Sarnia Ontario DATE: 2019 03 15

TEST BY: Wallace Kent Sprinkler Systems Day or Week: Friday TIME OF DAY: 10:00am MIN. OF FLOW 5

WATER SUPPLIED BY: Municipal Supply

PURPOSE OF TEST: Water Main Capacity Test

DATA

FLOW HYDRANT(S)	A1	A2	A3
SIZE OPENING:	2.5		
COEFFICIENT:	0.9		
PITOT READING:	35		
GPM:	**993**	0	0

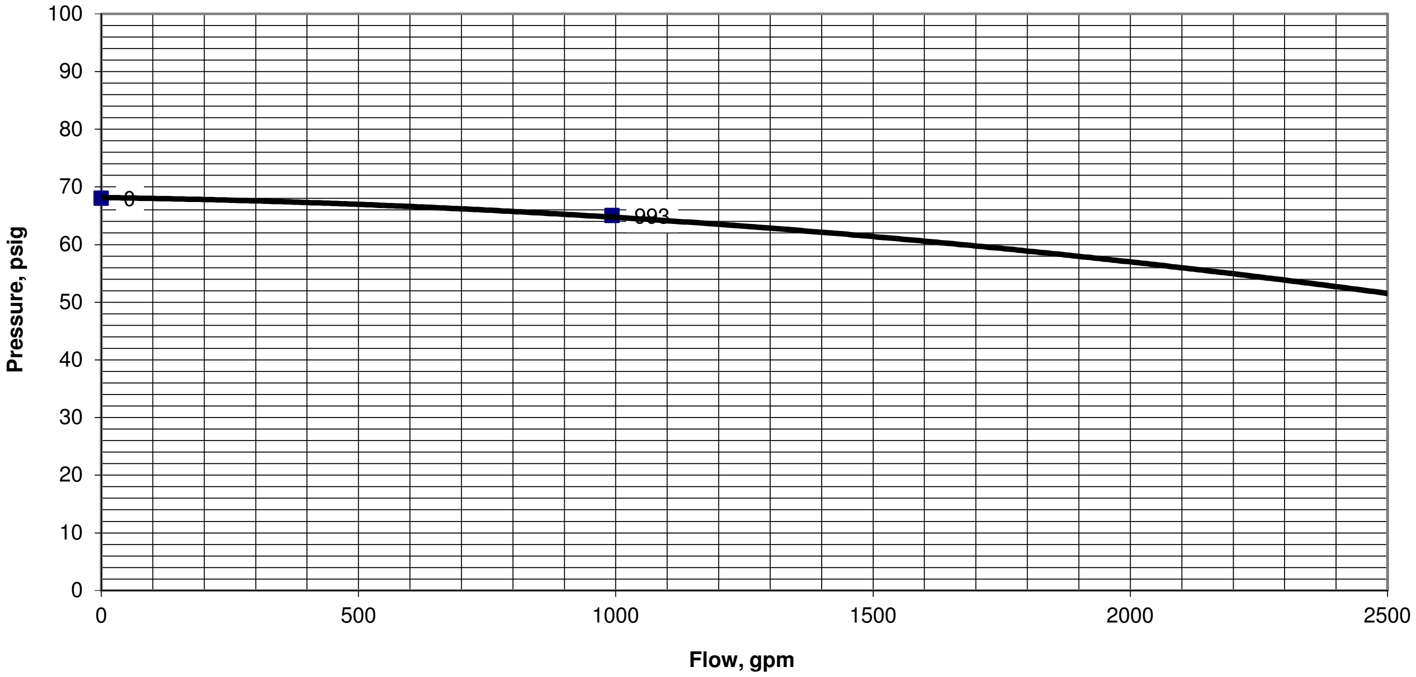
TOTAL FLOW DURING TEST: **993** GPM

STATIC READING: 68 PSI RESIDUAL: 65 PSI

RESULTS: AT 20 PSI RESIDUAL **4436** GPM AT 0 PSI **5355** GPM

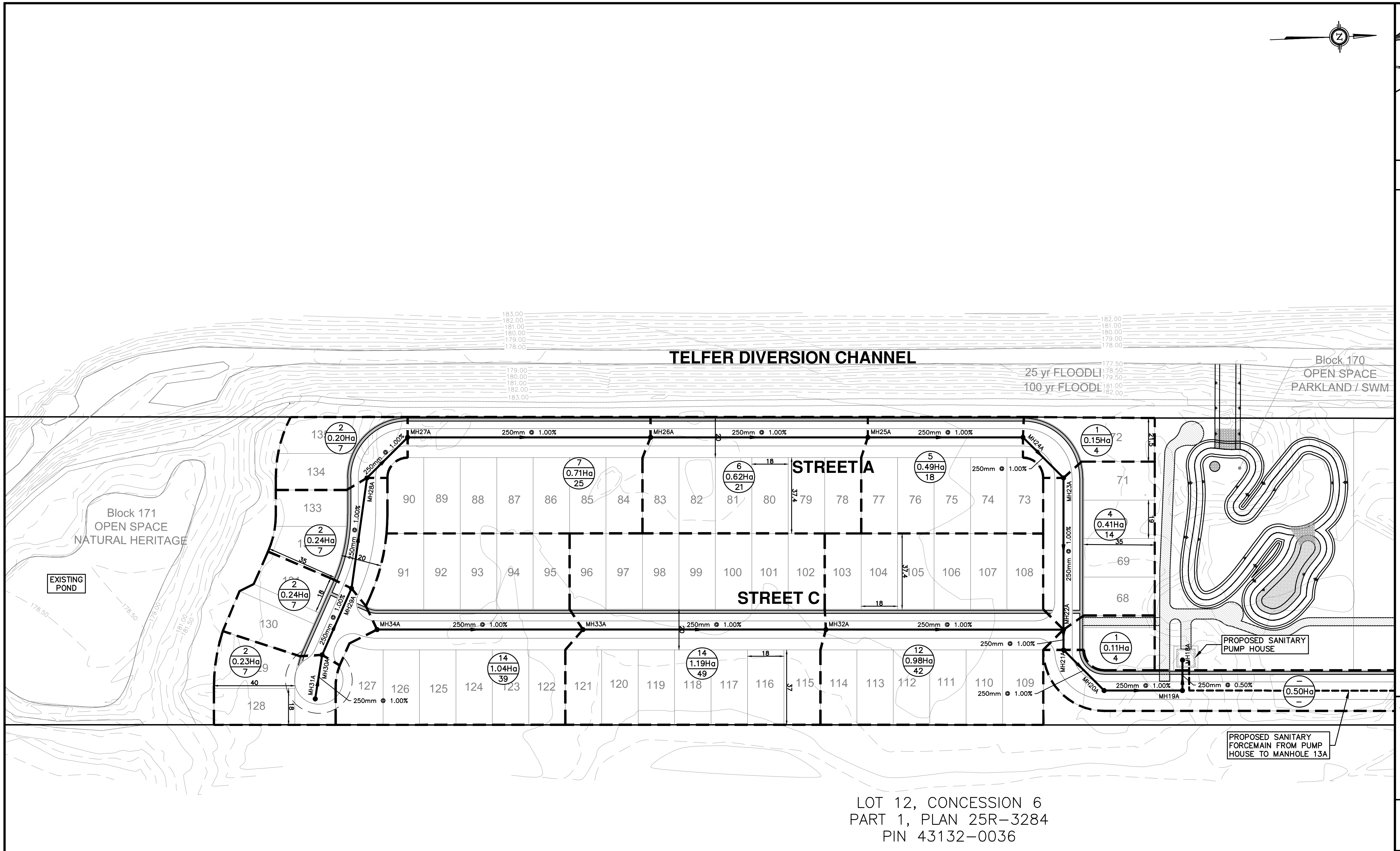
ESTIMATED CONSUMPTION: **4963** GAL.

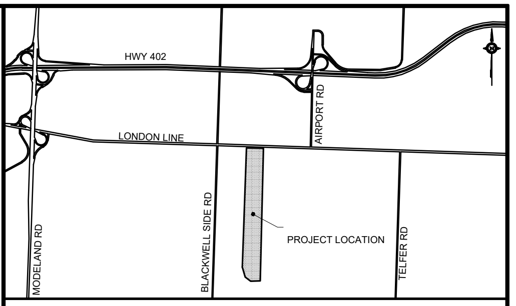
REMARKS:



APPENDIX D

Sanitary Sewer Servicing Plan & Design Sheet





KEY PLAN

N.T.S.

LEGEND

MH1A ● EX. SANITARY MANHOLE
PROP. ROW
PROP. LIMIT OF SUBDIVISION
SANITARY DRAINAGE BOUNDARY
PROPOSED SANITARY SEWER
PROP. SINGLE SANITARY SERVICE CONNECTION
5 — DENOTES NUMBER OF DWELLINGS
0.365Ha — DENOTES AREA IN HECTARES
18 — DENOTES POPULATION

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542–4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL SANITARY DRAINAGE PLAN

DESIGNED BY:	S.S.	SCALES:		PROJECT No.	18-569
CHECKED BY:	E.G.	HORIZONTAL:	1:2000	DRAWING No.	SAN-1
DRAWN BY:	J.N.	VERTICAL:		SHEET No.	01
DATE:	SEPT 3, 2019	SHEET SIZE:	11"x17"		

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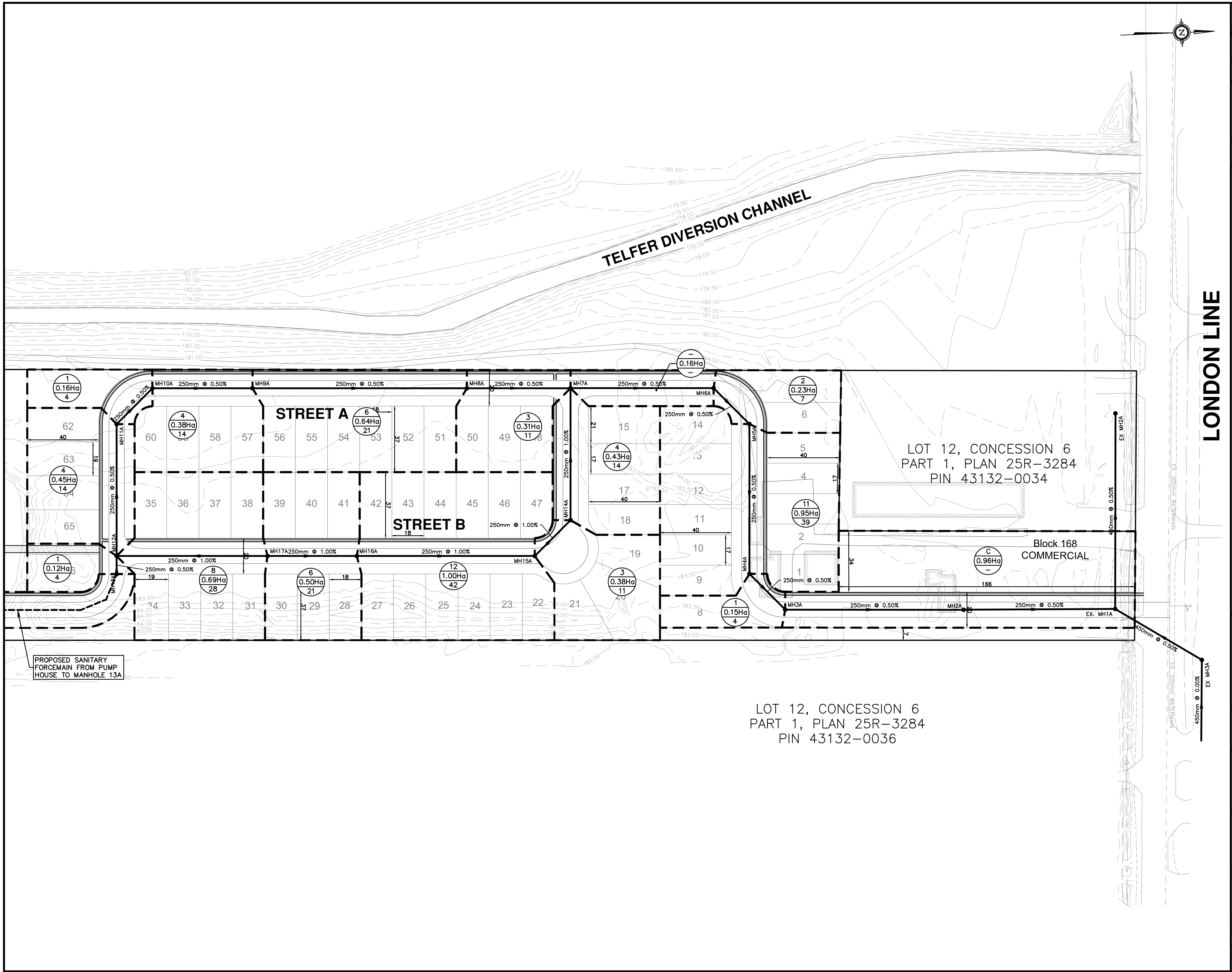
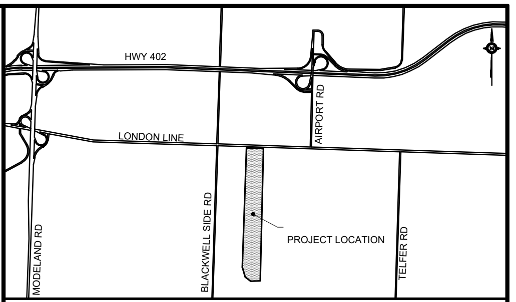
Date Plotted: Sep 05, 2019 – 3:01pm





KEY PLAN
N.T.S.

LEGEND

MH1A ● EX. SANITARY MANHOLE
PROP. ROW
PROP. LIMIT OF SUBDIVISION
SANITARY DRAINAGE BOUNDARY
PROPOSED SANITARY SEWER
PROP. SINGLE SANITARY SERVICE CONNECTION
5 — DENOTES NUMBER OF DWELLINGS
0.365Ha — DENOTES AREA IN HECTARES
18 — DENOTES POPULATION

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542-4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:
1873 LONDON LINE SUBDIVISION
1873 LONDON LINE SARNIA, ON

CONCEPTUAL SANITARY DRAINAGE PLAN

DESIGNED BY: S.S.	SCALES:	PROJECT No. 18-569
CHECKED BY: E.G.	HORIZONTAL: 1:2000	DRAWING No. SAN-2
DRAWN BY: J.N.	VERTICAL:	SHEET No. 02
DATE: APRIL 24, 2019	SHEET SIZE: 11"x17"	

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Date Plotted: Sep 03, 2019 — 2:54pm

CITY OF SARNIA
SANITARY SEWER DESIGN SHEET

Project / Subdivision : 1873 London Line, Sarnia **Prepared by:** James Norris **Last Revised:** September 3, 2019

Consulting Engineer : Greck and Associates Limited **Checked by:** Eric Greck P.Eng

Project No.: 18-569

Design Parameters

Residential Density (Single+Semis) =	3.5 cap/unit	Residential =	450	L/cap/day
Residential Density (Town Houses) =	2.9 cap/unit	Industrial (Light) =		m^3/ha/day
Residential Density (Apartments) =	2.0 cap/unit	Industrial (Heavy)=		m^3/ha/day
Manning 'n' =	0.013	Institutional =		m^3/ha/day
Extran. Flow=	0.26 L/s/ha	Commercial =	65	m^3/ha/day

Notes/Comments: Minimum Allowable Actual Velocity 0.6 m/s, Max 3 m/s. Forcemain from MH18A to MH13A

Design Equations

Q(p) = peak population flow (L/s)

Q(i) = i x A = peak extraneous flow (L/s)

$Q(c) = \frac{0.5 \times c \times A}{86400}$ = peak commercial flow (L/s)

Q(d) = Q(p) + Q(i) + Q(c) = peak design flow (L/s)

P = population

M = peaking factor (Harmon) M (Min) = 2

P = p x # units / 1000 M (Max) =4

$M = 1 + 14 / (4 + P^{1/2})$

Q = (P x q x M) / 86.4

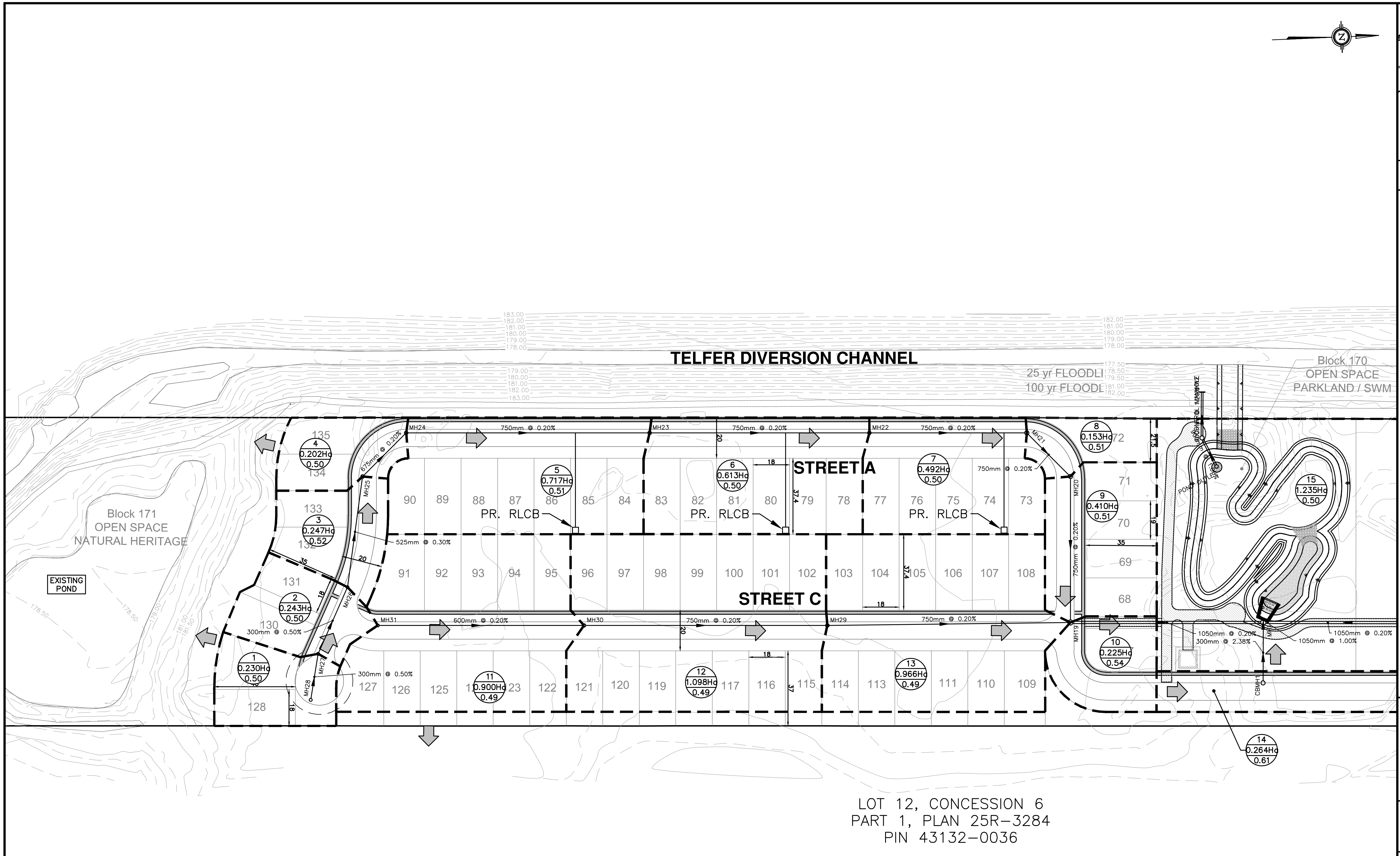
References: *City of London Design Specifications & Requiremnts for Minimum Sanitary Sewer Grades, Section 3.12.2

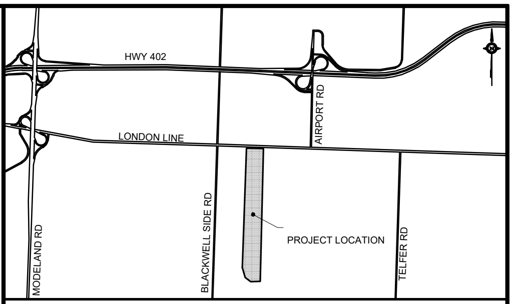
Location						Individual Values						Cumulative Values				Flow Data				Sewer Data							
Area ID	From		To			Commercial Area	Residential Area	Residential Units (Single+Semis)	Residential Units (Town Houses)	Residential Units (Apartments)	Residential Population	Commercial Area	Residential P.F.	Residential Area	Residential Population	Commercial Peak Flow (L/s)	Population Peak Flow (L/s)	Peak Extraneous Flow (L/s)	Total Design Flow (L/s)	Length	Pipe Size	Type of Pipe	Grade	Full Flow Capacity	Full Flow Velocity	Actual Velocity	%Full
	MH #	Inv (m)	MH #	Inv (m)	drop (m)	(ha)	(ha)	#	#	#	cap.	A(c)	M(r)	A(r)	P	Q(c)	Q(r)	Q(i)	Q(d)	(m)	(mm)		(%)	(L/s)	(m/s)	(m/s)	%
STREET B	MH17A	182.930	MH16A	182.430	0.05		0.50	6			21		4.00	0.50	21		0.44	0.13	0.57	50.0	250	PVC	1.00	62.0	1.22	0.37*	0.9
STREET B	MH16A	182.380	MH15A	181.384	0.05		1.00	12			42		4.00	1.50	63		1.31	0.39	1.70	99.6	250	PVC	1.00	62.04	1.22	0.53*	2.7
STREET B	MH15A	181.334	MH14A	181.050	0.05		0.38	3			11		4.00	1.88	74		1.54	0.49	2.03	28.4	250	PVC	1.00	62.09	1.23	0.56*	3.3
STREET B	MH14A	181.000	MH7A	180.262			0.43	4			14		4.00	2.31	88		1.83	0.60	2.43	73.8	250	PVC	1.00	62.03	1.22	0.59*	3.9
STREET B	MH17A	183.037	MH12A	182.193			0.69	8			28		4.00	0.69	28		0.58	0.18	0.76	84.4	250	PVC	1.00	62.02	1.22	0.42*	1.2
STREET C	MH34A	182.550	MH33A	181.533	0.05		1.04	11			39		4.00	1.04	39		0.81	0.27	1.08	101.7	250	PVC	1.00	62.05	1.22	0.46*	1.7
STREET C	MH33A	181.483	MH32A	180.283	0.05		1.19	14			49		4.00	2.23	88		1.83	0.58	2.41	120.0	250	PVC	1.00	62.04	1.22	0.59*	3.9
STREET C	MH32A	180.233	MH22A	179.059	0.05		0.98	12			42		4.00	3.21	130		2.71	0.83	3.54	117.4	250	PVC	1.00	62.05	1.22	0.66	5.7

Location						Individual Values						Cumulative Values				Flow Data				Sewer Data							
Area ID	From		To			Commercial Area	Residential Area	Residential Units (Single+Semis)	Residential Units (Town Houses)	Residential Units (Apartments)	Residential Population	Commercial Area	Residential P.F.	Residential Area	Residential Population	Commercial Peak Flow (L/s)	Population Peak Flow (L/s)	Peak Extraneous Flow (L/s)	Total Design Flow (L/s)	Length	Pipe Size	Type of Pipe	Grade	Full Flow Capacity	Full Flow Velocity	Actual Velocity	%Full
	MH #	Inv (m)	MH #	Inv (m)	drop (m)	(ha)	(ha)	#	#	#	cap.	A(c)	M(r)	A(r)	P	Q(c)	Q(r)	Q(i)	Q(d)	(m)	(mm)		(%)	(L/s)	(m/s)	(m/s)	%
STREET A	MH31A	183.355	MH30A	183.135	0.05		0.23	2			7		4.00	0.23	7		0.15	0.06	0.21	22.0	250	PVC	1.00	62.07	1.22	0.27*	0.3
STREET A	MH30A	183.085	MH29A	182.726	0.05		0.24	2			7		4.00	0.47	14		0.29	0.12	0.41	35.9	250	PVC	1.00	62.03	1.22	0.34*	0.7
STREET A	MH29A	182.676	MH28A	182.125	0.05		0.24	2			7		4.00	0.72	21		0.44	0.19	0.62	55.1	250	PVC	1.00	62.02	1.22	0.39*	1.0
STREET A	MH28A	182.075	MH27A	181.791	0.05		0.20	2			7		4.00	0.92	28		0.58	0.24	0.82	28.4	250	PVC	1.00	62.09	1.23	0.43*	1.3
STREET A	MH27A	181.741	MH26A	180.541	0.05		0.71	7			25		4.00	1.63	53		1.10	0.42	1.53	120.0	250	PVC	1.00	62.04	1.22	0.51*	2.5
STREET A	MH26A	180.491	MH25A	179.418	0.05		0.62	6			21		4.00	2.25	74		1.54	0.59	2.13	107.3	250	PVC	1.00	62.04	1.22	0.56*	3.4
STREET A	MH25A	179.368	MH24A	178.602	0.05		0.49	5			18		4.00	2.74	92		1.92	0.71	2.63	76.6	250	PVC	1.00	62.03	1.22	0.61	4.2
STREET A	MH24A	178.552	MH23A	178.268	0.05		0.15	1			4		4.00	2.90	96		2.00	0.75	2.75	28.4	250	PVC	1.00	62.09	1.23	0.61	4.4
STREET A	MH23A	178.218	MH22A	177.469	0.05		0.41	4			14		4.00	3.31	110		2.29	0.86	3.15	74.9	250	PVC	1.00	62.03	1.22	0.64	5.1
STREET A	MH22A	177.419	MH21A	177.318	0.05		0.11	1			4		4.00	6.62	244		5.08	1.72	6.81	10.1	250	PVC	1.00	62.16	1.23	0.80	10.9
STREET A	MH21A	177.268	MH20A	176.984	0.05		0.50						4.00	7.13	244		5.08	1.85	6.94	28.4	250	PVC	1.00	62.09	1.23	0.81	11.2
STREET A	MH20A	176.934	MH19A	176.547	0.05								4.00	7.13	244		5.08	1.85	6.94	38.7	250	PVC	1.00	62.07	1.22	0.81	11.2
STREET A	MH19A	176.497	MH18A	176.422									4.00	7.13	244		5.08	1.85	6.94	15.1	250	PVC	0.50	43.77	0.86	0.63	15.8
STREET A	MH13A	182.244	MH12A	182.193	0.05		0.12	1			4		4.00	7.25	248		5.17	1.89	7.05	10.1	250	PVC	0.50	44.02	0.87	0.64	16.0
STREET A	MH12A	182.143	MH11A	181.774	0.05		0.45	4			14		4.00	8.39	290		6.04	2.18	8.22	73.8	250	PVC	0.50	43.88	0.87	0.66	18.7
STREET A	MH11A	181.724	MH10A	181.582	0.05		0.16	1			4		4.00	8.56	294		6.13	2.22	8.35	28.4	250	PVC	0.50	43.91	0.87	0.67	19.0
STREET A	MH10A	181.532	MH9A	181.252	0.05		0.38	4			14		4.00	8.94	308		6.42	2.32	8.74	56.0	250	PVC	0.50	43.86	0.87	0.67	19.9
STREET A	MH9A	181.202	MH8A	180.602	0.05		0.64	6			21		4.00	9.57	329		6.85	2.49	9.34	120.0	250	PVC	0.50	43.87	0.87	0.69	21.3
STREET A	MH8A	180.552	MH7A	180.262	0.05		0.31	3			11		4.00	9.89	340		7.08	2.57	9.65	58.0	250	PVC	0.50	43.86	0.87	0.69	22.0
STREET A	MH7A	180.212	MH6A	179.812	0.05		0.16						4.00	12.36	428		8.92	3.21	12.13	80.1	250	PVC	0.50	43.85	0.87	0.74	27.7
STREET A	MH6A	179.762	MH5A	179.620	0.05		0.23	2			7		4.00	12.59	435		9.06	3.27	12.34	28.4	250	PVC	0.50	43.90	0.87	0.74	28.1
STREET A	MH5A	179.570	MH4A	179.151	0.05		0.95	11			39		3.99	13.54	474		9.84	3.52	13.36	83.8	250	PVC	0.50	43.87	0.87	0.76	30.5
STREET A	MH4A	179.101	MH3A	178.959	0.05		0.15	1			4		3.98	13.68	478		9.92	3.56	13.48	28.4	250	PVC	0.50	43.91	0.87	0.76	30.7
STREET A	MH3A	178.909	MH2A	178.410	0.05	0.57	0.96						3.98	14.64	478	0.43	9.92	3.81	14.15	99.8	250	PVC	0.50	43.86	0.87	0.77	32.3
STREET A	MH2A	178.360	MH1A	177.936									3.98	14.64	478	0.43	9.92	3.81	14.15	84.9	250	PVC	0.50	43.84	0.87	0.77	32.3

APPENDIX E

Storm Sewer Servicing Plan & Design Sheet





KEY PLAN

N.T.S.

LEGEND

MH19 ○	STORM MANHOLE
CB ▫	SINGLE CATCHBASIN
—	PROPOSED SINGLE STORM SERVICE CONNECTION
—	PROPOSED STORM SEWER
⇨	MAJOR OVERLAND FLOW DIRECTION
—	MAJOR CONTOUR LABEL
– –	MINOR CONTOUR LABEL
▬ ▬ ▬	STORM DRAINAGE BOUNDARY
—	PROP. ROW
—	PROP. LIMIT OF SUBDIVISION
5	DENOTES AREA NUMBER
0.365Ha	DENOTES AREA IN HECTARES
0.40	DENOTES RUNOFF COEFFICIENT

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542-4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

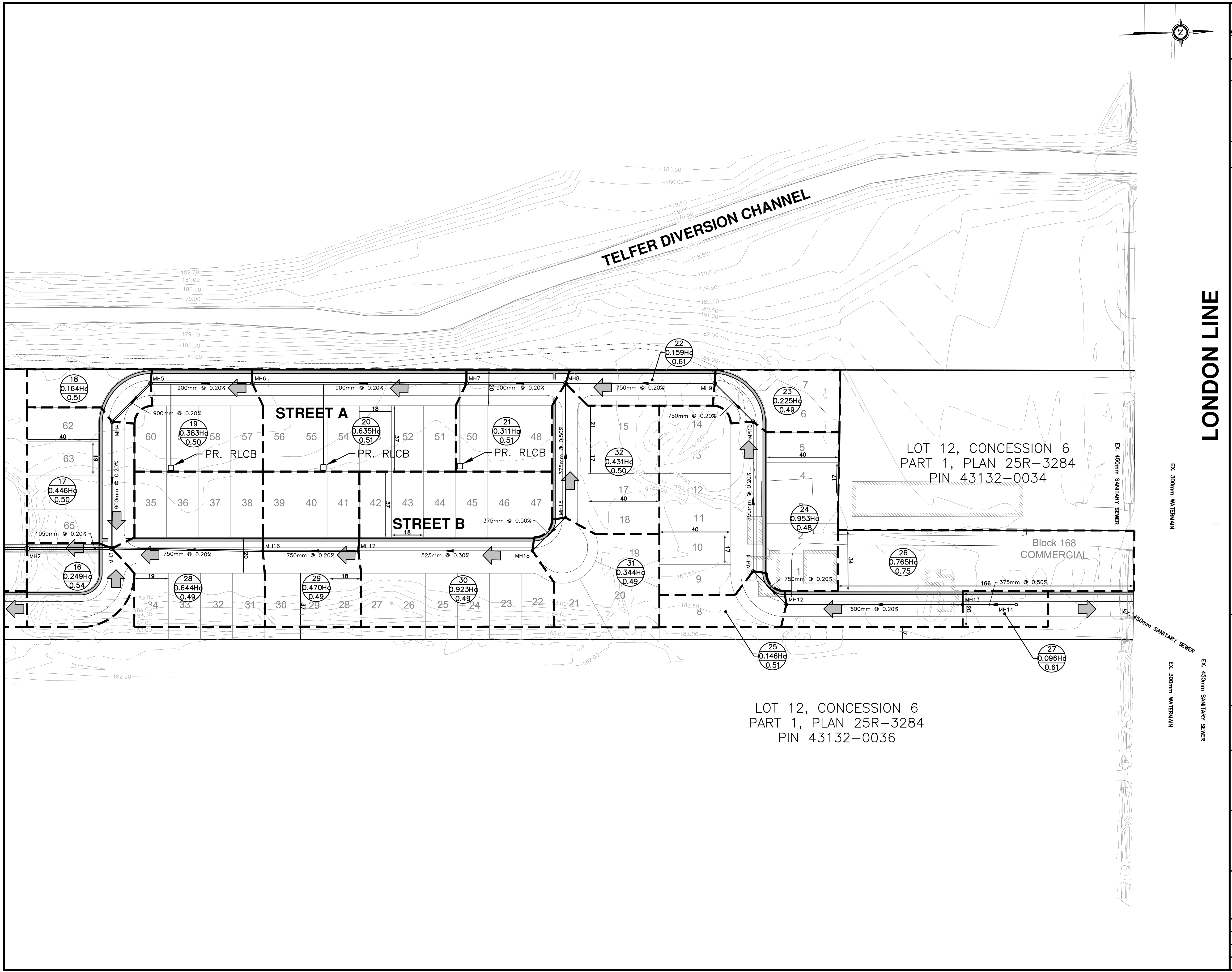
PROJECT NAME:
1873 LONDON LINE SUBDIVISION
1873 LONDON LINE SARNIA, ON

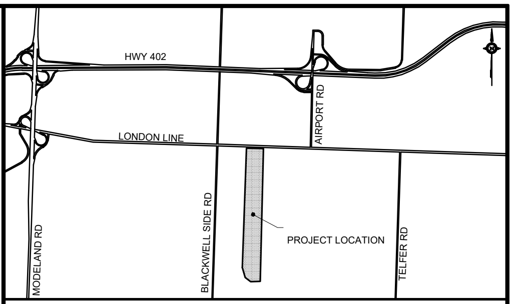
CONCEPTUAL STORMWATER DRAINAGE SYSTEM

DESIGNED BY: S.S.	SCALES:	PROJECT No.	18-569
CHECKED BY: E.G.	HORIZONTAL: 1:2000	DRAWING No.	STM-1
DRAWN BY: J.N.	VERTICAL:	SHEET No.	01
DATE: APRIL 24, 2019	SHEET SIZE: 11"x17"		

Z:\Projects\18-569 — 1873 London Line Subdivision\05_Drawings\CAD\DRAINAGE\18-569_DRAINAGE-STORM.dwg

Date Plotted: Sep 03, 2019 - 9:47am





KEY PLAN

N.T.S.

LEGEND

MH19 ○	STORM MANHOLE
CB ▫	SINGLE CATCHBASIN
	PROPOSED SINGLE STORM SERVICE CONNECTION
	PROPOSED STORM SEWER
⇨	MAJOR OVERLAND FLOW DIRECTION
	MAJOR CONTOUR LABEL
	MINOR CONTOUR LABEL
	STORM DRAINAGE BOUNDARY
	PROP. ROW
	PROP. LIMIT OF SUBDIVISION
5	DENOTES AREA NUMBER
0.365Ha	DENOTES AREA IN HECTARES
0.40	DENOTES RUNOFF COEFFICIENT

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT
SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
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801 UPPER CANADA DR SARNIA, ON (519) 542–4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL STORMWATER DRAINAGE SYSTEM

DESIGNED BY: S.S.	SCALES:		PROJECT No. 18-569
CHECKED BY: E.G.	HORIZONTAL:	1:2000	DRAWING No. STM-2
DRAWN BY: J.N.	VERTICAL:		SHEET No. 02
DATE: APRIL 24, 2019	SHEET SIZE:	11"x17"	

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Date Plotted: Sep 03, 2019 – 9:47am

Greck

CITY OF SARNIA

STORM SEWER DESIGN SHEET

Project / Subdivision : 1873 London Line Sarnia

Consulting Engineer : Greck and Associates Limited

Project No.: 18-569

Prepared by: James Norris

Checked by: Eric Greck

Last Revised: July 16, 2019

Design Parameters (2 Year Storm)

A = drainage area (ha)
C = runoff coefficient
T_c = time of concentration

T_{init}(hr)= 0.167
A= 25.3
B= 0.000
C= 0.715

Design Parameters (5 Year Storm)

A = drainage area (ha)
C = runoff coefficient
T_c = time of concentration

T_{init}(hr)= 0.167
A= 34.1
B= 0.000
C= 0.727

Manning's (n): 0.013

System to be Designed for: 5 Year Storm

Design Equations

$$I = \frac{A}{(t + B)^C}$$

Q= 2.78 x A x C x I

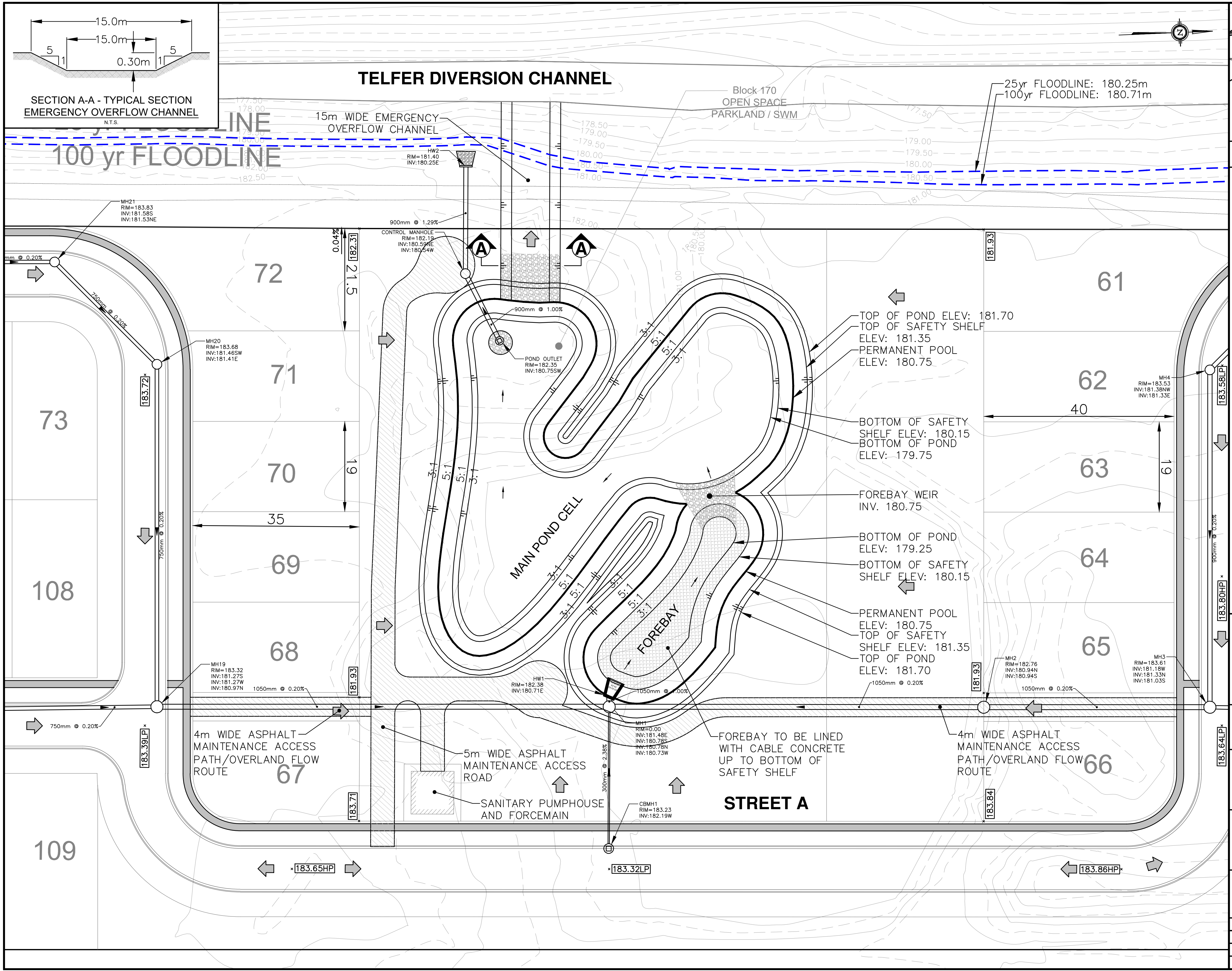
Notes: City IDF Based in Hrs not Minutes
Composite Runoff coefficient determined from the following:
Single Dwelling Residential = 0.45
Commercial = 0.80
Right of Way = 0.61

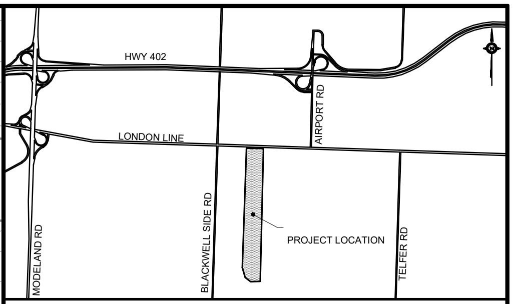
Location							Drainage Area Characteristics						Rainfall / Runoff			Sewer Data								
Street	Area ID	From		To			Area	Area	Cum. Area	Runoff Coeff. R	AR in Section	Cum. AR	Time of Concentratio	Rainfall Intensity (I5)	Runoff Q	Pipe Diameter	Pipe Length	Grade	Total Flow (Q Max)	% FULL	Full Flow Velocity	V (Actual)	Sect. Time	Accum. Time
		MH #	Inv (m)	MH #	Inv (m)	drop (m)	(m2)	(ha)	(ha)				(min)	(mm/hr)	m3/sec	(mm)	(m)	(%)	(m3/s)	%	(m/s)	(m/s)	(Min)	(Min)
STREET B	24	MH14	182.785	MH7	182.564	0	3660.26	0.37	0.37	0.51	0.19	0.19	10.00	125.45	0.065	375	73.8	0.30	0.100	65.1%	0.88	0.97	1.27	11.27
STREET B	23	MH14	182.509	MH17	182.401	0.15	3195.46	0.32	0.37	0.49	0.16	0.16	10.00	125.45	0.054	375	21.6	0.50	0.129	42.0%	1.13	1.05	0.34	10.34
STREET B	21	MH17	182.251	MH16	182.003	0.225	4326.07	0.43	0.80	0.49	0.21	0.37	10.34	122.40	0.125	525	49.7	0.50	0.317	39.4%	1.42	1.27	0.65	11.00
STREET B	19	MH16	181.778	MH15	181.538	0.03	10202.62	1.02	1.82	0.49	0.50	0.86	11.00	117.07	0.281	750	120.0	0.20	0.519	54.2%	1.14	1.18	1.70	12.70
STREET B	17	MH15	181.508	MH2	181.268		9385.95	0.94	2.76	0.49	0.46	1.32	12.70	105.45	0.388	750	120.0	0.20	0.519	74.7%	1.14	1.29	1.55	14.25
STREET C	4	MH30	182.513	MH29	182.403	0.3	1880.67	0.19	0.19	0.49	0.09	0.09	10.00	125.45	0.032	300	22.0	0.50	0.071	45.3%	0.98	0.94	0.39	10.39
STREET C	6	MH29	182.103	MH28	181.928	0.15	6883.06	0.69	0.88	0.49	0.34	0.43	10.39	122.00	0.146	600	87.5	0.20	0.287	50.9%	0.98	0.99	1.48	11.87
STREET C	7	MH28	181.778	MH27	181.538	0.03	10281.36	1.03	1.90	0.49	0.50	0.93	11.87	110.78	0.287	750	120.0	0.20	0.519	55.2%	1.14	1.18	1.69	13.56
STREET C	9	MH27	181.508	MH18	181.268		8525.78	0.85	2.76	0.49	0.42	1.35	13.56	100.56	0.378	750	119.9	0.20	0.520	72.7%	1.14	1.28	1.56	15.11
STREET A	30	MH13	183.585	MH12	183.435	0.225	1113.79	0.11	0.11	0.61	0.07	0.07	10.00	125.45	0.024	375	30.0	0.50	0.129	18.3%	1.13	0.66	0.76	10.76
STREET A	29	MH12	183.21	MH11	182.902	0.15	7624.79	0.76	0.87	0.75	0.57	0.64	10.76	118.97	0.212	600	102.6	0.30	0.351	60.3%	1.20	1.29	1.32	12.08
STREET A	28	MH11	182.752	MH10	182.722	0.05	1167.75	0.12	0.99	0.51	0.06	0.70	12.08	109.34	0.213	750	15.1	0.20	0.518	41.1%	1.14	1.04	0.24	12.32
STREET A	27	MH10	182.672	MH9	182.482	0.05	8560.39	0.86	1.85	0.48	0.41	1.11	12.32	107.77	0.334	750	95.1	0.20	0.519	64.3%	1.14	1.25	1.27	13.59
STREET A	26	MH9	182.432	MH8	182.386	0.05	1807.43	0.18	2.03	0.49	0.09	1.20	13.59	100.35	0.335	750	23.0	0.20	0.519	64.5%	1.14	1.25	0.31	13.90
STREET A	25	MH8	182.336	MH7	182.189	0.15	1422.90	0.14	2.17	0.61	0.09	1.29	13.90	98.73	0.354	750	73.6	0.20	0.519	68.1%	1.14	1.27	0.97	14.87
STREET A	22	MH7	182.039	MH6	181.886	0.02	3338.11	0.33	2.54	0.52	0.17	1.47	15.17	92.67	0.380	900	76.6	0.20	0.844	45.0%	1.29	1.23	1.04	16.21
STREET A	20	MH6	181.866	MH5	181.626	0.03	6239.95	0.62	3.16	0.51	0.32	1.79	16.21	88.31	0.440	900	120.0	0.20	0.845	52.1%	1.29	1.31	1.53	17.74
STREET A	18	MH5	181.596	MH4	181.409	0.05	5301.83	0.53	3.69	0.51	0.27	2.06	17.74	82.70	0.475	900	93.6	0.20	0.844	56.2%	1.29	1.34	1.16	18.90
STREET A	16	MH4	181.359	MH3	181.315	0.05	1078.72	0.11	3.80	0.50	0.05	2.12	18.90	78.98	0.465	900	21.8	0.20	0.848	54.8%	1.29	1.34	0.27	19.17
STREET A	15	MH3	181.265	MH2	181.118	0.15	5772.90	0.58	4.38	0.52	0.30	2.42	19.17	78.16	0.526	900	73.4	0.20	0.845	62.2%	1.29	1.39	0.88	20.05
STREET A		MH2	180.968	MH1	180.778			0.00	7.13		0.00	3.74	20.05	75.66	0.787	1050	95.1	0.20	1.273	61.8%	1.42	1.54	1.03	21.08

Location							Drainage Area Characteristics						Rainfall / Runoff			Sewer Data								
Street	Area ID	From		To			Area	Area	Cum. Area	Runoff Coeff. R	AR in Section	Cum. AR	Time of Concentratio	Rainfall Intensity (I5)	Runoff Q	Pipe Diameter	Pipe Length	Grade	Total Flow (Q Max)	% FULL	Full Flow Velocity	V (Actual)	Sect. Time	Accum. Time
		MH #	Inv (m)	MH #	Inv (m)	drop (m)	**(m2)**	**(ha)**	**(ha)**				**(min)**	**(mm/hr)**	**m3/sec**	**(mm)**	**(m)**	**(%)**	**(m3/s)**	**%**	**(m/s)**	**(m/s)**	**(Min)**	**(Min)**
STREET A	1	MH26	183.153	MH25	183.003	0.225	3245.62	0.32	0.32	0.48	0.16	0.16	10.00	125.45	0.055	300	29.9	0.50	0.071	76.4%	0.98	1.11	0.45	10.45
STREET A	2	MH25	182.778	MH24	182.486	0.15	7562.38	0.76	1.08	0.49	0.37	0.53	10.45	121.51	0.179	525	97.4	0.30	0.246	72.7%	1.10	1.24	1.31	11.76
STREET A	3	MH24	182.336	MH23	182.282	0.075	997.35	0.10	1.18	0.51	0.05	0.58	11.76	111.52	0.180	675	27.0	0.20	0.392	45.8%	1.06	1.02	0.44	12.20
STREET A	5	MH23	182.207	MH22	181.988	0.03	6072.41	0.61	1.79	0.51	0.31	0.89	12.20	108.58	0.268	750	109.7	0.20	0.519	51.7%	1.14	1.15	1.59	13.79
STREET A	8	MH22	181.958	MH21	181.758	0.03	5706.21	0.57	2.36	0.51	0.29	1.18	13.79	99.33	0.325	750	100.0	0.20	0.519	62.7%	1.14	1.24	1.35	15.13
STREET A	10	MH21	181.728	MH20	181.559	0.05	3203.09	0.32	2.68	0.53	0.17	1.35	15.13	92.83	0.348	750	84.6	0.20	0.519	67.0%	1.14	1.26	1.12	16.25
STREET A	11	MH20	181.509	MH19	181.465	0.05	1146.46	0.11	2.79	0.50	0.06	1.41	16.25	88.14	0.345	750	21.8	0.20	0.522	66.0%	1.14	1.26	0.29	16.54
STREET A	12	MH19	181.415	MH18	181.268	0.3	8649.76	0.86	3.66	0.50	0.43	1.84	16.54	87.02	0.445	900	73.6	0.20	0.844	52.7%	1.29	1.31	0.94	17.47
STREET A		MH18	180.968	MH1	180.778	0.05	0.00	0.00	6.42		0.00	3.19	17.47	83.61	0.742	1050	94.9	0.20	1.274	58.2%	1.43	1.51	1.05	18.52
STREET A	13	CBMH1	182.186	MH1	181.478		2597.49	0.26	0.26	0.61	0.16	0.16	10.00	125.45	0.055	300	28.3	2.50	0.120	46.0%	2.19	2.11	0.22	10.22
STREET A		MH1	180.728	HW1	180.71		0.00	0.00	13.81		0.00	7.09	21.59	71.69	1.413	1050	3.6	0.50	2.009	70.3%	2.25	2.52	0.02	21.61

APPENDIX F

Stormwater Management Design Calculations





KEY PLAN

N.T.S.

LEGEND

MH19 ○	STORM MANHOLE
CB ▫	SINGLE CATCHBASIN
═ ═ ═	STORM SEWER
⇨	MAJOR OVERLAND FLOW DIRECTION
───	EXISTING MAJOR CONTOUR LABEL
─ ─	EXISTING MINOR CONTOUR LABEL
───	PROP. ROW
━━━	PROP. LIMIT OF SUBDIVISION
━━━	FLOODLINE
▨	RIP RAP
▦	CABLE CONCRETE LINING
▧	PAVED WALKWAY

BENCHMARK

BENCHMARK No. N/A
ELEVATION = 184.17m
LOCATION: CITY OF SARNIA
DESCRIPTION: TOP OF FIRE HYDRANT AT SOUTHWEST CORNER OF DWELLING

COMPLETED BY:
MONTEITH & SUTHERLAND LTD. ONTARIO LAND SURVEYORS
801 UPPER CANADA DR SARNIA, ON (519) 542-4300
COMPLETED: APR 11, 2018

Greck
5770 Highway 7, Woodbridge, Ontario, L4L 1T8 www.greck.ca

CLIENT NAME:
J.R. CAPITAL HOLDINGS INC.

PROJECT NAME:

1873 LONDON LINE SUBDIVISION

1873 LONDON LINE SARNIA, ON

CONCEPTUAL POND DESIGN

DESIGNED BY:	S.S.	**SCALES:**		**PROJECT No.**	18-569
CHECKED BY:	E.G.	**HORIZONTAL:**	1:750	**DRAWING No.**	POND-1
DRAWN BY:	J.N.	**VERTICAL:**		**SHEET No.**	01
DATE:	SEPT 3, 2019	**SHEET SIZE:**	11"x17"		

Z:\Projects\18-569 – 1873 London Line Subdivision\05_Drawings\CAD\POND\18-569_POND.dwg Date Plotted: Sep 05, 2019 – 3:05pm

Existing Condition - 100-Year Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------


*************
Element Count
*************
Number of rain gages ...... 6
Number of subcatchments ... 1
Number of nodes ........... 1
Number of links ........... 0
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                      Data       Recording
Name                 Data Source                      Type       Interval 
------------------------------------------------------------------------
100-year             100-year                         INTENSITY   10 min.
10year               10year                           INTENSITY   10 min.
25year               25year                           INTENSITY   10 min.
2year                2year                            INTENSITY   10 min.
50year               50year                           INTENSITY   10 min.
5year                5year                            INTENSITY   10 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------
S4                        15.61    247.78      7.00    2.0000 100-year             HW1


************
Node Summary
************
                                           Invert      Max.    Ponded    External
Name                 Type                   Elev.     Depth      Area    Inflow  
-------------------------------------------------------------------------------
HW1                  OUTFALL                 0.00      0.00       0.0


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
```

```
  Water Quality .......... NO
Infiltration Method ...... HORTON
Starting Date ............ 04/29/2019 00:00:00
Ending Date .............. 04/30/2019 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.742       111.620
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         1.145        73.367
Surface Runoff ...........         0.599        38.370
Final Storage ............         0.001         0.079
Continuity Error (%) .....        -0.175


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.599         5.990
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.599         5.990
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total      Total       Total     Pea
                           Precip      Runon       Evap      Infil     Runoff      Runoff   Runof
Subcatchment                   mm         mm         mm         mm         mm    10^6 ltr      CM
--------------------------------------------------------------------------------------------------------
S4                         111.62       0.00       0.00      73.37      38.37        5.99     1.5

Analysis begun on:  Thu Sep 05 15:13:58 2019
Analysis ended on:  Thu Sep 05 15:13:59 2019
Total elapsed time: 00:00:01
```

Proposed Condition - 100-year Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

WARNING 02: maximum depth increased for Node CNRL_MH2

*************
Element Count
*************
Number of rain gages ...... 7
Number of subcatchments ... 5
Number of nodes ........... 3
Number of links ........... 2
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval 
------------------------------------------------------------------------
100-year             100-year                       INTENSITY   10 min.
10year               10year                         INTENSITY   10 min.
25mm_4hr             25mm_hhr                       VOLUME      60 min.
25year               25year                         INTENSITY   10 min.
2year                2year                          INTENSITY   10 min.
50year               50year                         INTENSITY   10 min.
5year                5year                          INTENSITY   10 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet              
-----------------------------------------------------------------------------------------------
S1                         6.29     83.90     43.00    2.0000 100-year             SWMF                
S2                         7.19     73.37     46.00    2.0000 100-year             SWMF                
S3                         0.27     26.80      7.00    2.0000 100-year             SWMF                
S4                         0.26     52.80     59.00    2.0000 100-year             SWMF                
S5                         1.24    190.00     43.00    2.0000 100-year             SWMF                


************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow  
-------------------------------------------------------------------------------
CNRL_MH2             JUNCTION            180.30      1.28       0.0
OF1                  OUTFALL             180.25      0.82       0.0
SWMF                 STORAGE             180.75      0.95       0.0


************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C2               CNRL_MH2         OF1              CONDUIT            8.1    6.1885    0.0130
W1               SWMF             CNRL_MH2         OUTLET  


*********************
Cross Section Summary
*********************
                                        Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape                 Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
C2               CIRCULAR               0.82     0.53     0.21     0.82        1     3.57


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,  
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date ............ 04/29/2019 00:00:00
Ending Date .............. 04/30/2019 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001524 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.702       111.620
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.663        43.444
Surface Runoff ...........         1.040        68.184
Final Storage ............         0.008         0.511
Continuity Error (%) .....        -0.465


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         1.039        10.386
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.958         9.578
Flooding Loss ............         0.000         0.000
```

```
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.081         0.807
  Continuity Error (%) .....         0.000


  ***************************
  Time-Step Critical Elements
  ***************************
  Link C2 (41.89%)


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     0.76 sec
  Average Time Step           :     3.32 sec
  Maximum Time Step           :     5.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.00


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total      Total       Total     Pea
                           Precip      Runon       Evap      Infil     Runoff      Runoff   Runof
  Subcatchment                 mm         mm         mm         mm         mm    10^6 ltr      CM
  ------------------------------------------------------------------------------------------------
  S1                       111.62       0.00       0.00      44.30      67.29        4.23     1.7
  S2                       111.62       0.00       0.00      42.38      69.11        4.97     1.9
  S3                       111.62       0.00       0.00      69.63      42.74        0.11     0.0
  S4                       111.62       0.00       0.00      30.42      81.87        0.22     0.1
  S5                       111.62       0.00       0.00      42.38      69.95        0.86     0.6


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  CNRL_MH2             JUNCTION     0.56     0.81   181.11     0  04:33        0.81
  OF1                  OUTFALL      0.13     0.36   180.61     0  04:33        0.36
  SWMF                 STORAGE      0.46     0.88   181.63     0  04:33        0.88


  *******************
  Node Inflow Summary
  *******************
```

```
  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Fl
                                  Lateral    Total  Time of Max      Inflow      Inflow      Balan
                                   Inflow   Inflow   Occurrence      Volume      Volume       Err
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Perce
  -------------------------------------------------------------------------------------------------
  CNRL_MH2             JUNCTION     0.000    1.426     0  04:33           0        9.58       0.0
  OF1                  OUTFALL      0.000    1.426     0  04:33           0        9.58       0.0
  SWMF                 STORAGE      4.593    4.593     0  04:20        10.4        10.4       0.0


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.


  *********************
  Node Flooding Summary
  *********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************

  -------------------------------------------------------------------------------------------------
                         Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maxi
                          Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outf
  Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min
  -------------------------------------------------------------------------------------------------
  SWMF                     1.728      43     0     0         3.637      90       0  04:33      1.


  ***********************
  Outfall Loading Summary
  ***********************

  -----------------------------------------------------------
                         Flow       Avg       Max       Total
                         Freq      Flow      Flow      Volume
  Outfall Node           Pcnt       CMS       CMS    10^6 ltr
  -----------------------------------------------------------
  OF1                   94.41     0.345     1.426       9.578
  -----------------------------------------------------------
  System                94.41     0.345     1.426       9.578


  ********************
  Link Flow Summary
  ********************

  -----------------------------------------------------------------------------
                                 Maximum  Time of Max   Maximum    Max/    Max/
                                  |Flow|   Occurrence   |Veloc|    Full    Full
  Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
  -----------------------------------------------------------------------------
  C2                   CONDUIT     1.426     0  04:33      6.30    0.40    0.44
  W1                   DUMMY       1.426     0  04:33
```

```
***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
C2                      1.00   0.06  0.00  0.00  0.00  0.94  0.00  0.00  0.32  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Thu Sep 05 15:11:11 2019
Analysis ended on:  Thu Sep 05 15:11:12 2019
Total elapsed time: 00:00:01
```