

**FUNCTIONAL SERVICING & STORMWATER
MANAGEMENT REPORT**

**524 YORK ROAD
PHASE 2**

NIAGARA-ON-THE-LAKE

**PREPARED FOR:
NIAGARA YORK ROAD INC.**

**PREPARED BY:
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DECEMBER 2025

CFCA FILE NO. 2570-7661

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Revision Number	Date	Comments
Rev. 0	December 18, 2025	Issued for OPA & ZBA.

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SUPPLEMENTAL INFORMATION

1. Stormwater Management Report – Intercontinental Combo Hotel – 524 York Road, October 2015
2. Addendum Stormwater Management Report to October 2015 Submission – Intercontinental Combo Hotel – 524 York Road, Dec 2016

1.0 Introduction

C.F. Crozier & Associates Inc. (Crozier) was retained by Niagara York Road Inc. (Client) to prepare a Functional Servicing Report to support the Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) for Phase 2 of the property located at 524 York Road in the Town of Niagara-on-the-Lake (Town). This report demonstrates that the proposed Site can be developed in accordance with the Town of Niagara-on-the-Lake and Niagara Region guidelines from a functional servicing and stormwater management perspective.

2.0 Site Description

2.1 Existing Conditions

The subject property is bounded by York Road to the south, Counsell Street to the east, and Glendale Avenue to the west. Phase 1, constructed in 2018, features a 6-storey dual branded hotel with associated at-grade parking and an access roadway between Glendale Avenue to Counsell Street. Phase 2 (subject Site) covers an area of 1.46 ha and consists of the remainder of the site lands south of the access roadway to York Road which is currently undeveloped. See the Site Aerial figure below for reference.

A copy of the topographic survey and Phase 1 engineering plans are included in **Appendix A** for reference.



Site Aerial

2.2 Proposed Development Concept

The proposed Phase 2 development includes the construction of a 7-storey hotel with a total of 227 rooms (Fairfield 114 rooms, Towneplace 113 rooms) with common area between hotels and a swimming pool. Additionally, a ground floor restaurant building detached from the hotel is proposed, located to the west of the proposed hotel. A parking lot is proposed to the north of the hotel and restaurant. Vehicular site access will be provided via the private access roadway at the north limit of Phase 2. See **Appendix A** for a copy of the architectural Site Plan.

3.0 Water Servicing

The following section of the report analyzes the existing and proposed water servicing demands for the subject Site. The proposed water servicing demand for the Site was calculated based on the equivalent population density and design demand factors outlined in the Ontario Building Code (OBC) Sewage Design Flows and the Ministry of the Environment and Climate Change (MOECC) Design Guidelines for Drinking-Water Systems (2023). Hotel unit information obtained from the Site Plan and Site Statistics provided by Mataj Architects Inc., which is included in **Appendix A** for reference.

3.1 Existing Water Servicing

A review of the 2018 construction records drawings, indicates the following water infrastructure exists in the proximity of the subject property:

- A 300 mm diameter watermain located on Townline Road, east of the Site.
- A 250mm diameter, 240m long DR-18 PVC water service connection in a 6.3m wide easement from Phase 1 through external lands to Townline Road
- A 200mm PVC private water looped system in Phase 1 with a stub for Phase 2.

The locations of the existing watermains are shown on the Site Servicing Plan **Drawing C102** and included record drawings in **Appendix A**.

Based on pre-development conditions, the approved design for Phase 1 established the existing maximum daily and peak hourly demands to be 10.3 L/s and 15.5 L/s, respectively. It is understood that the Phase 1 hotel is equipped with full sprinkler systems and are classified as non-combustible construction under the Ontario Building Code, as indicated in the 2017 building permit.

3.2 Proposed Water Servicing

Phase 2 will be serviced by the existing 200mm watermain stub constructed as part of Phase 1. The hotel will be provided with separate fire protection and domestic water service connections, both entering the building's north side at the mechanical room. The domestic line will be metered internally.

A single restaurant building is proposed to be un-sprinklered and located the west of the proposed hotel. The restaurant will be supplied by a single domestic water service which will be metered by the within the building.

One (1) on-site fire hydrant is proposed in Phase 2 within 45 meters of the hotel building siamese connection and within 90 meter radius of the restaurant building as required by the Ontario Building Code.

Refer to the Site Servicing Plan **Drawing C102** for further details.

3.3 Domestic Water Demand

The domestic water demand for the Site was calculated with reference to the Ontario Building Code (OBC) Sewage Design Flows and the Ministry of the Environment and Climate Change (MOECC) Design Guidelines for Drinking-Water Systems (2023). An average daily water demand of 250 L/Bed-space was used for the dual-hotel, 125 L/seat was used for the restaurant, and a water demand of 40 L/m²/day was used for the swimming pool.

A summary of the results is presented in **Table 1**, with detailed calculations provided in **Appendix B**.

Table 1: Proposed Domestic Water Demand

Type of Use	Average Daily Demand (L/s)	Maximum Day Demand (L/s)	Max Hourly Demand (L/s)
Hotel	1.57	7.71	11.56
Restaurant	0.27	0.81	1.21
Total	1.84	8.51	12.77

As shown in **Table 1**, it is proposed that following development, the peak hourly water demand will be 12.77 L/s and maximum day demand will be 8.51 L/s.

3.4 Fire Flow Demand

The hotel is planned to be fully sprinklered in accordance with applicable code requirements.

The fire flow requirements for the proposed development were calculated based on the methodology identified in the current version of the *Water Supply for Public Fire Protection: A Guide to Recommended Practice in Canada (2020)* prepared by the Fire Underwriters' Survey (FUS).

Fire flow requirements were calculated based on the following parameters in Table 2.

Table 2: Proposed Fire Demand

FUS 2020 Description	Dual-Hotel	Restaurant	Details
Construction Type	(Type II) Non-Combustible Construction		All structural elements, walls, columns, arches, floors, and roofs are constructed with a minimum 2-hour fire resistance rating, and all materials are used in the construction of the structural elements, walls, columns, arches, floors, and roofs are constructed with non-combustible materials.
Construction Coefficient	0.8		
Total Effective Area	7,979 m ²	372 m ²	Construction coefficient below 1.0, with all vertical openings and exterior vertical communications properly protected in accordance with the National Building Code, based on the largest floor

			areas plus 25% of 2 adjoining floors (per site statistics by Mataj Architects Inc.)
Sprinkler protection system	30%	0%	The credit for the system will be a maximum of 30% for an adequately designed system conforming to NFPA 13 and other NFPA sprinkler standards.
Exposure charges	Included in calculations to account for existing and proposed properties in proximity to the subject site.		
Required Fire Flow	83.3 L/s	50.0 L/s	
Fire Flow + Max Day	91.8 L/s	58.5 L/s	

As shown in **Table 2**, the fire flow demand is calculated to be 83.3 L/s (5,000 L/min). Detailed calculations are included in **Appendix B**.

3.5 Hydrant Flow Tests and Capacity Summary

Hydrant flow testing were performed by Aquacom on November 19, 2025 on:

- 300mm watermain in Townline Road, in the vicinity of the site connection
- 200-250mm private water network within Phase 1 of the site

The results indicate that at 20 psi residual pressure, a maximum of 170 L/s (2702 USGPM) projected flow is available within the watermain on Townline Road and 177 L/s (2814 USGPM) within the Phase 1 lands. It is noted that the increase in flow and pressure observed in the results from Townline Road to the Phase 1 lands is likely due to the decrease in elevation of Phase 1 relative to Townline Road of approximately 2m

Based on the proposed water demand (Max Day + Fire Flow = 91.8 L/s) and hydrant flow tests results, the existing municipal water supply can support the proposed development. Refer to the hydrant flow test results provided in **Appendix B**.

It is also noted that the Niagara Region 2021 Water and Wastewater Master Servicing Plan identifies the Townline Road watermain with a peak hour system pressure of 60-80psi under Existing and 2051 scenarios (Figures 3.C.4 & 3.C.9) and that the nearby Regional watermain in York Road is shown with Available Fire Flows >250 L/s at 30 psi residual pressure in both the Existing and 2051 scenarios (Figure 3.C.5 & 3.C.10).

4.0 Sanitary Servicing

The following section of the report analyzes the existing and proposed sanitary servicing conditions for the subject Site. The proposed sanitary servicing demand for the Site was calculated based on the equivalent population density and design demand factors outlined in the Ontario Building Code (OBC) Sewage Design Flows and the Ministry of the Environment and Climate Change (MOECC) Design Guidelines for Drinking-Water Systems (2023).

4.1 Existing Sanitary Servicing

A review of the construction records drawings indicates no municipal sanitary sewer exists on York Road, Glendale Avenue, or Counsell Street.

Per the Phase 1 construction, the following water infrastructure exists in the proximity of the subject property:

- 250mm diameter sanitary stubs were provisioned on Phase 2 lands during the construction on Phase 1.
- A 525mm diameter municipal sewer in Townline Road, through a 6.3m-wide easement.

The existing 250 mm diameter PVC sanitary stubs at MH10A will be extended to the east and west to service the proposed Phase 2 buildings. As no basements are planned, all sanitary flows will be conveyed by gravity, with the exception of the pool and elevator pit floor drains. The locations of the existing sanitary stubs sewers are shown on the **Site Servicing Plan - Drawing C102**.

Since there are no existing sanitary services within Phase 2 of the site, no sanitary flows are present under existing conditions.

4.2 Proposed Sanitary Servicing

The Site is proposed to be serviced using a 250 mm diameter PVC sanitary service connection to the existing 250 mm diameter sanitary stubs fronting the Site to the north, which were constructed as part of Phase 1. Sewer lines will be extended to both the hotel and the restaurant accordingly and stubbed at the limit of the building, to be extended into the structure by mechanical. Refer to the Site Servicing Plan **Drawing C102** for further details.

4.3 Design Sanitary Flow

The sanitary design flow for the Site was calculated with reference to the Ontario Building Code (OBC) Sewage Design Flows and the Ministry of the Environment and Climate Change (MOECC) Design Guidelines for Drinking-Water Systems (2023). A unit sewage flow of 225 L/d/Bed-space was used for the dual-hotel and 125 L/seat was used for the restaurant. A peaking factor was applied to the unit sewage flow to obtain the total estimated design sewage flow for the dual-hotel.

Table 3 summarizes the results and **Appendix C** contains the detailed design sanitary flow demand for the proposed development.

Table 3: Proposed Sanitary Design Flows

	Hotel Peak Flow (L/s)	Restaurant Peak Flow (L/s)	Infiltration Flow (L/s)	Total Peak Flow (L/s)
Phase 2	8.61	0.81	0.42	9.84

As shown in **Table 3**, the total peak sanitary flow for the proposed development is calculated to be 9.84 L/s, which will be discharged to the 525 mm diameter municipal sanitary sewer in Townline Road via the 250mm sewer line in the easement.

The existing 525mm sewer in Townline Road is at a slope of 0.33% with a full flow capacity of 247 L/s. Therefore the proposed Phase 2 flows represent an increase in occupied capacity of 4.0%.

The total development (Phase 1 and Phase 2) is expected to generate a total peak flow rate of approximately 17.3 L/s, which includes 7.1 L/s from Phase 1 (per original design), 9.4 L/s from Phase 2, and 0.8 L/s infiltration over the entire site.

5.0 Stormwater Management

5.1 Phase 1 and Phase 2 Stormwater Summary

The original stormwater design of the overall site (Phase 1 & 2) was done by Quartek Group Inc. and is comprised of the following approved reports:

- i) Stormwater Management Report – Intercontinental Combo Hotel – 524 York Road, date of October 2015
- ii) Addendum Stormwater Management Report to October 2015 Submission – 524 York Road, date of December 2016

These reports focused primarily on the Phase 1 lands but also incorporated future development of Phase 2 lands into the overall design. A summary of Phase 1, now constructed, is as follows:

- No stormwater quantity controls implemented as the site met its criteria of no greater than 70% overall imperviousness
- All storm flows are treated for quality control by an oil-grit-separator
- Storm sewers convey all Phase 1 flows via 900mm pipe and headwall outlet to the existing drainage feature at the west limit of the site
- A separate 450mm sewer stub was constructed at the limit of Phase 2, with the intent that all future flows from Phase 2 are conveyed to the Phase 1 outlet headwall
- A separate oil-grit separator (STC-750) was installed for quality control of the future Phase 2 lands

The Phase 2 development is intended to utilize the pre-built infrastructure provided by Phase 1 but also meet up-to-date stormwater management criteria, specifically related to stormwater quantity controls, identified by the Town of Niagara-on-the-Lake. A summary of the Phase 2 design is as follows:

- Stormwater quantity control is required to restrict post-development flows up to the 100-year down to the 5-year predevelopment rate – per comments made by the Town
- A combination of rooftop control and storage, below-grade orifice control and storage, as well as above-grade ponding storage will be implemented to meet the new quantity control criteria
- Phase 2 will utilize the Phase 1 sewer network, outlet, and OGS for conveyance, treatment, and discharge of stormwater to the existing drainage feature without creating a new outlet

5.2 Existing Site Drainage Conditions

Based on a review of the existing topographic survey completed by J.D. Barnes Limited, the Site currently comprises of vacant land. The Site generally slopes towards from the east to west towards a natural drainage feature. As part of the Phase 1 development, two storm sewer connections were left for the future Phase 2 lands at the north limit:

- A 450 mm diameter storm sewer flowing north located on the northwest of the Site, into Phase 1 Lands.
- A 250 mm diameter storm sewer flowing north located on the northeast of the Site, into Phase 1 Lands.

Under predevelopment conditions, the majority of the site (C101) conveys runoff overland either directly to the drainage feature at the west limit of the site and a small frontage area (C102) conveys runoff overland directly to York Street.

Table 4 provides a breakdown of pre-development site area and the associated runoff coefficient with the existing drainage conditions on the Pre-Development Drainage Plan (**Figure 1**).

Table 4: Pre-Development Catchment Summary

Catchment	Area (ha)	C	Q5 (L/s)	Q100 (L/s)
101	1.05	0.20	52.5	84.2
102	0.13	0.20	6.5	10.4
Total	1.05	0.20	59.0	94.6

Runoff from C101 flows westward to the drainage feature which then proceeds northward through an existing box culvert under the private driveway at the east limit of the Glendale Ave cul-de-sac. This drainage feature and then continues northward through the drainage feature into undeveloped lands where flows from the Phase 1 headwall are discharged into.

Runoff from C102 flows directly onto York Road and is received by roadway catchbasins which discharged flows eventually proceed through the same drainage feature northward.

5.3 Proposed Drainage Conditions and Quantity Controls

The post-developed site is comprised of two catchments consisting of 1) the majority of the site (C201) including both buildings, at-grade parking, and landscaping elements which will be captured and discharged to the 450mm Phase 1 storm stub and headwall outlet, and 2) a small portion of York Road frontage (C202) which will continue to flow to York Road as it cannot be captured.

Table 5 provides a breakdown of the post-development site areas and the associated runoff coefficient with the proposed drainage conditions shown on the Post-Development Drainage Plan (**Figure 2**).

Table 5: Post-Development Catchment Summary

Catchment	Area (ha)	C	Q5-Uncontrolled (L/s)	Q100-Uncontrolled (L/s)
201	1.12	0.86	240.5	386.1
202	0.07	0.30	5.2	8.4
Total	1.32	0.20	59.0	94.6

In order to control post-development flows to the 5-year allowable rate, an orifice will be installed on the Phase 2 stormwater network to restrict all flows discharging to the Phase 1 stub. Storage will be provided on-site as required to attenuate the flows up to the 100-year event. A combination of rooftop storage, below-grade storage (pipes, manholes, and plastic modular system), and above-grade ponding storage in the parking area. The below **Table 6** summarizes the proposed quantity controls. Refer to Appendix D for additional calculations.

Table 6: Summary of Quantity Controls

Catchment	Orifice Size	Storage Required (m ³)	Storage Provided (m ³)	Allowable Release Rate = 5yr (L/s)	Actual Release Rate @ 100-yr (L/s)
201	100mm	413	459	52.5	38.3
202	None	None	None		8.4
Total				52.5	48.7

By implementing the quantity control and storage systems on-site, the Phase 2 development can achieve the allowable equivalent 5-year release rate at the 100-year event. At the Site Plan stage, stormwater management will be further refined to a detailed level as required.

5.4 Pre and Post Flow Comparison

Implementation of quantity controls to restrict the post development flow rate to the 5-year predevelopment rate results in a total reduction in peak flows at every storm event (2 to 100-year) for all flows leaving the site. Additionally, the reduction in frontage area along York Road also results in less uncontrolled Peak flows flowing to York Road. **Table 7** summarizes the total reduction in post-development peak flows compared to the pre-development undeveloped condition.

Table 7: Total Post-Development Peak Flow Reduction (L/s)

Catchment	2-year	5-year	10-year	25-year	50-year	100-year
201	-10.5	-18.5	-24.2	-32.9	-39.5	-45.9
202	-1.0	-1.2	-1.4	-1.6	-1.8	-2.0
	-11.5	-19.7	-25.6	-34.5	-41.4	-48.0

The existing sewer stub left for Phase 2 is 450mm @ 0.48 % which has a full-flow capacity of 206 L/s, of which only Phase 2 flows are designed to enter. Phase 2 flows combine with all Phase 1 in the outlet sewer 900mm @ 0.9% which discharges via headwall to the natural drainage feature.

The original stormwater design by Quartek for Phase 2 comprises an area of 1.242 ha and 91.8% imperviousness, which equates to a 5-year peak flow rate of ~260 L/s. The proposed Phase 2 now with quantity controls will restrict peak flows at the 100-year event to 38 L/s, which is a significant decrease from the original design condition at all storm events. Therefore the existing 450mm sewer stub and 900mm outlet pipe has capacity to receive the attenuated Phase 2 flows.

Additionally, due to the overall decrease in peak flows at every storm event from the predevelopment condition, as identified in **Table 7**, there are no adverse effects on the receiving downstream water feature.

Refer to Appendix D for additional calculations.

5.5 Water Quality Management

An STC-750 Oil-Grit Separator (OGS) was installed as part of Phase 1 development on the 450mm storm line left for Phase 2. This OGS is isolated entirely from Phase 1 and will therefore only treat Phase 2 flows. The OGS was originally designed for a total catchment area of 1.242 ha and 91.8% imperviousness (equivalent to 1.14 ha impervious area), which exceeds the current catchment contribution of 1.12 ha and 94% imperviousness (equivalent to 1.05 ha impervious area), therefore the OGS is sufficient to treat the Phase 2 flows. Refer to the Servicing Plan for location of the existing STC-750 OGS within the Phase 1 lands.

5.6 MTO Drainage System Impact Assessment

The location of the site is identified as within permit control area of the MTO due to the Glendale Avenue and QEW interchange. As such, the MTO has commented to:

“Undertake an evaluation of SWM system assuming that rooftop storage system is lost and confirm that there is no impact on MTO's drainage system. Ponding limit for 100-year storm event should be provided to confirm that the proposed development will not impact the MTO's drainage system under such condition.”

It should be stated that, under no circumstances or under any storm event is the MTO drainage system impacted by this development, for the following reasons:

1. The large majority of site flows are directed to the Phase 1 sewer network which discharges via headwall to the natural drainage feature which flows northward, away from all MTO infrastructure. This outlet directs flow away from all MTO infrastructure as well as bypasses the culvert under the private driveway between Phase 1 and Phase 2.
2. In an emergency scenario, should on-site storage be exceeded, runoff from the Phase 2 lands will 'spill' northward onto the private driveway where flows are carried west to Glendale Ave and through an existing curb-cut into the natural drainage feature at the north limit of the cul-de-sac. This overland flow mechanism also directs flow away from all MTO infrastructure as well as bypasses the existing culvert under the private driveway between Phase 1 and Phase 2.

Therefore, in any scenario, whether the site is fully functional or in an emergency situation, whether there are rooftop controls or none considered, there is no impact to the MTO drainage system.

In the specific scenario where no rooftop controls are considered, the site therefore loses approximately 119m³ of storage within the roofs, which uncontrolled roof flows are first directed to underground storage and then ponding storage above-grade. The ponding limits within the site remain the same as in the original design scenario, however, the ponding storage will be fully occupied at a lesser storm events than per the original design and therefore result a 'spill' condition at the 50 to 100 year events. As per statement 2. above, the spill condition results in flows from the Phase 2 parking area running off overland via the private driveway to Glendale Ave and discharge via curb cut to the natural drainage feature to the north. This scenario, as it directs flow away from all MTO infrastructure as well as bypasses the existing culvert under the private driveway between Phase 1 and Phase 2, also has no impact on any MTO drainage systems.

6.0 Conclusion

Based on the information contained within this report, we offer the following conclusions:

1. Phase 2 will utilize existing stubbed pipes for water, sanitary, and storm which were constructed as part of Phase 1 and sized appropriately for the Phase 2 development. Water and sanitary connections will be extended through the Phase 2 lands to both the hotel and the restaurant buildings with one service each.
2. No new connections to public infrastructure or roads are required for servicing. Sanitary and watermain which are brought to Phase 1 from Townline Road via easement will also be utilized by Phase 2. The existing headwall outlet in Phase 1 will also be utilized by Phase 2 for stormwater discharge.
3. Stormwater quantity management will be implemented within the Phase 2 lands to control post-development flows up to the 100-year event down to the 5-year predevelopment rate. A combination of rooftop, below-grade, and above-grade ponding storage will be utilized in combination with an orifice tube to attenuate and restrict flows to the allowable rate.
4. Stormwater quality will be achieved by the existing STC-750 oil-grit separator installed within the Phase 1 lands designed to receive Phase 2 flows.

Based on the above, we recommend the approval of the Zoning By-Law Amendment from a functional servicing perspective.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.



Alexa Minichillo, E.I.T.
Engineering Intern

/am

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C.F. CROZIER & ASSOCIATES INC.



Rob Babic, P.Eng.
Project Manager



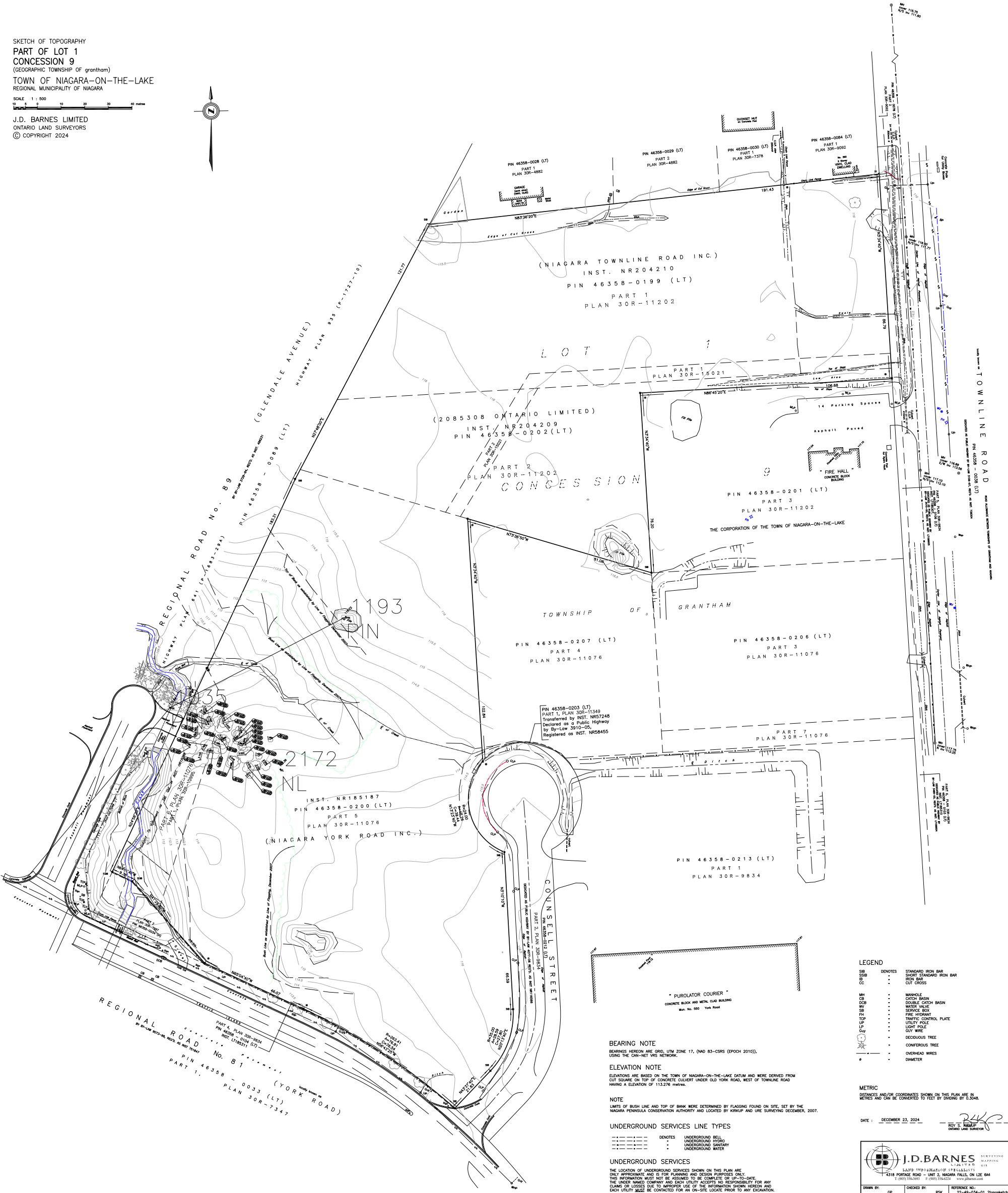
APPENDIX A

Background Information

SKETCH OF TOPOGRAPHY
 PART OF LOT 1
 CONCESSION 9
 (GEOGRAPHIC TOWNSHIP OF GRANTHAM)
 TOWN OF NIAGARA-ON-THE-LAKE
 REGIONAL MUNICIPALITY OF NIAGARA

SCALE 1 : 500

J.D. BARNES LIMITED
 ONTARIO LAND SURVEYORS
 © COPYRIGHT 2024



LEGEND

SIB	DENOTES	STANDARD IRON BAR
SIBB		SHORT STANDARD IRON BAR
IB		IRON BAR
CC		CUT CROSS
MB		MANHOLE
CB		CATCH BASIN
DCB		DOUBLE CATCH BASIN
WB		WATER VALVE
SB		SERVICE BOX
PH		FIRE HYDRANT
TCF		TRAFFIC CONTROL PLATE
UP		UTILITY POLE
LP		LIGHT POLE
GT		GRASS TREE
DT		DECIDUOUS TREE
CT		CONIFEROUS TREE
OW		OVERHEAD WIRES
Ø		DIAMETER

BEARING NOTE
 BEARINGS HEREON ARE GRID, UTM ZONE 17, (NAD 83-CSR5 (EPOCH 2010)), USING THE CANADIAN VES NETWORK.

ELEVATION NOTE
 ELEVATIONS ARE BASED ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE ON TOP OF CONCRETE CULVERT UNDER OLD YORK ROAD, WEST OF TOWNSHIP ROAD, HAVING AN ELEVATION OF 113.276 METRES.

NOTE
 LIMITS OF BUSH LINE AND TOP OF BANK WERE DETERMINED BY FLAGGING FOUND ON SITE, SET BY THE NIAGARA PENINSULA CONSERVATION AUTHORITY AND LOCATED BY KIRKUP AND IRE SURVEYING DECEMBER, 2007.

UNDERGROUND SERVICES LINE TYPES

---	DENOTES	UNDERGROUND BELL
---		UNDERGROUND HYDRO
---		UNDERGROUND SANITARY
---		UNDERGROUND WATER

UNDERGROUND SERVICES
 THE LOCATION OF UNDERGROUND SERVICES SHOWN ON THIS PLAN ARE ONLY APPROXIMATE AND IS FOR PLANNING AND DESIGN PURPOSES ONLY. THIS INFORMATION MUST NOT BE ASSUMED TO BE COMPLETE OR UP-TO-DATE. THE UNDER NAMED COMPANY AND EACH UTILITY ACCEPTS NO RESPONSIBILITY FOR ANY CLAIMS OR LOSSES DUE TO IMPROPER USE OF THE INFORMATION SHOWN HEREON AND EACH UTILITY MUST BE CONTACTED FOR AN ON-SITE LOCATE PRIOR TO ANY EXCAVATION.

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

DATE: DECEMBER 23, 2024

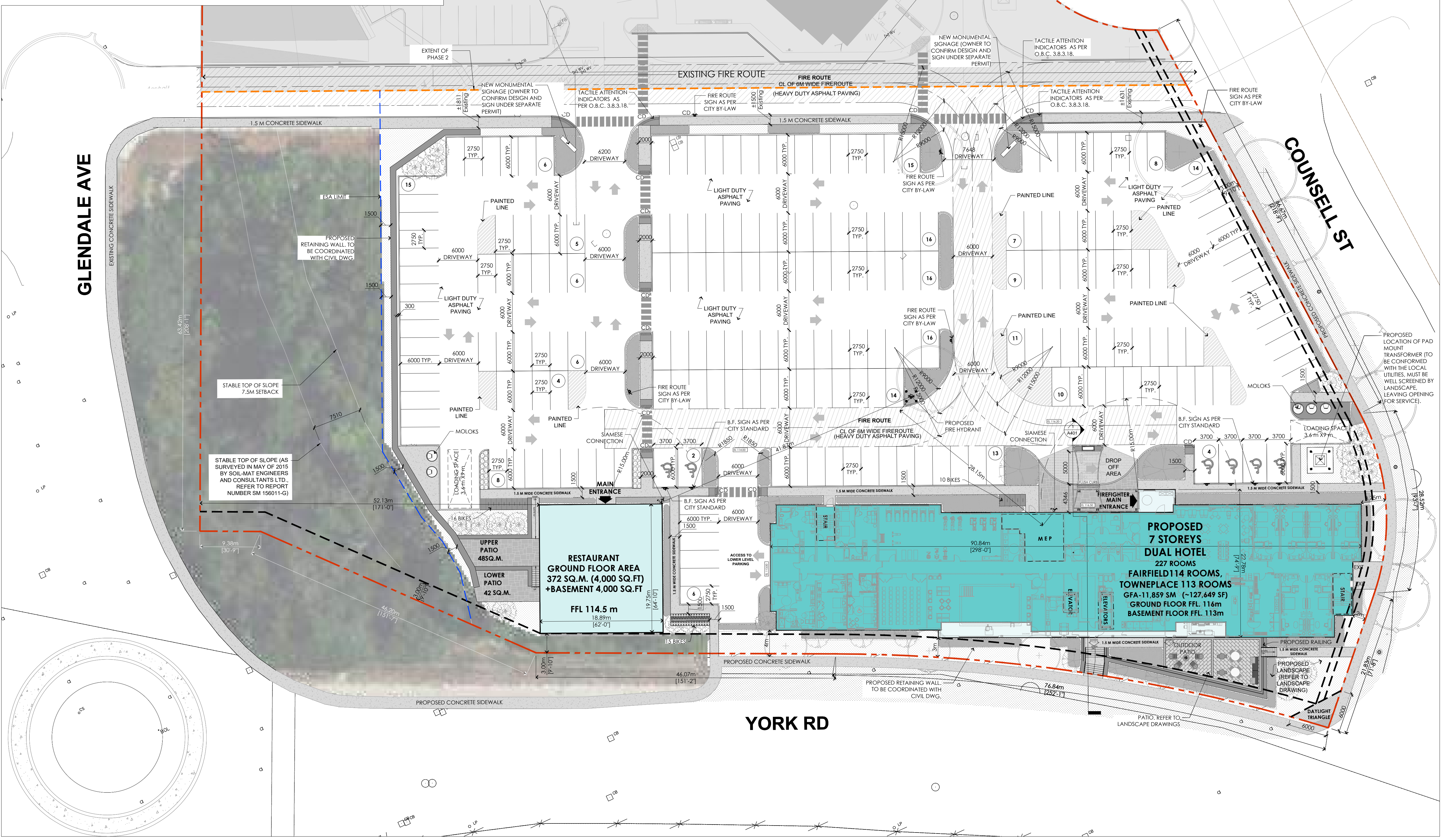
ROY S. KIRKUP
 CHIEF SURVEYOR

J.D. BARNES SURVEYING & MAPPING
 4318 PORTAGE ROAD - UNIT 2, NIAGARA FALLS, ON L2E 6A4
 T: (905) 356-3000 F: (905) 356-3024

DRAWN BY: GP CHECKED BY: RSK REFERENCE NO.: 22-49-034-01_2toposketch
 PLOTTED: DECEMBER 23, 2024 DATED: DECEMBER 23, 2024

SITE PLAN LEGEND	
	PROPERTY LINE
	BUILDING SETBACK LINE
	LANDSCAPE BUFFER
	CURB RAMP AS PER OBC 3.8.3.2
	PRINCIPLE ENTRANCE
	OTHER ACCESS POINTS
	EXISTING TOWN HYDRANT
	PROPOSED LOCATION OF NEW FIRE HYDRANT W/ STEEL BOLLARDS
	FIRE DEPARTMENT CONNECTION
	HOSE BIB (REFER TO MECHANICAL DWGS)
	PAD MOUNTED HYDRO TRANSFORMER W/ STEEL BOLLARDS

	SINGLE HEADED LIGHT FIXTURE ON CONCRETE BASE
	DOUBLE HEADED LIGHT FIXTURE ON CONCRETE BASE
	WALL MOUNTED LIGHT FIXTURE
	NEW HEAVY DUTY ASPHALT PAVING (REMINDER OF THE SITE TO RECEIVE LIGHT DUTY ASPHALT PAVING)
	LANDSCAPED AREA
	UNIT PAVING (REFER TO LANDSCAPE DWGS)



Key Plan:			
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No.	Date:	Issue/Revision	By:
2	25/12/08	Issued for Rezoning_Resubmission	A.B.
1	25/01/27	Issued for Rezoning	A.B.

Note:
 • ALL DIMENSIONS AND INFORMATION SHOWN ON THESE DRAWINGS MUST BE CHECKED AND VERIFIED ON SITE AND ANY DISCREPANCIES REPORTED TO THE ARCHITECT PRIOR TO CONSTRUCTION AND FABRICATION OF ITS COMPONENTS. SHOULD EXISTING CONDITIONS OR SERVICES BE FOUND TO VARY FROM THAT INDICATED ON THE DRAWINGS, THE ARCHITECT MUST BE NOTIFIED IMMEDIATELY.
 • FEATURES OF CONSTRUCTION NOT FULLY SHOWN ARE ASSUMED TO BE THE SAME CHARACTER AS THOSE NOTED FOR SIMILAR CONDITIONS.
 • UNLESS SPECIFICALLY NOTED OTHERWISE ON THE DRAWINGS, NO PROVISION HAS BEEN MADE IN THE DESIGN FOR CONDITIONS OCCURRING DURING CONSTRUCTION. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE ALL NECESSARY BRACING, SHORINGS, SHEET PILING OR OTHER TEMPORARY SUPPORTS, TO SAFEGUARD ALL EXISTING OR ADJACENT STRUCTURES AFFECTED BY THIS WORK.
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 • USE LATEST REVISED DRAWINGS. DO NOT SCALE DRAWINGS.

Architect's Stamp

MATAJ ARCHITECTS INC.
 LICENCE 9331

MATAJ ARCHITECTS INCORPORATED
 206-418 Incaulos Shore Rd
 Oakville, ON L6H 0K7
 T.905.281.4444

Project:
TOWNEPLACE SUITES & FAIRFIELD COMBO HOTEL

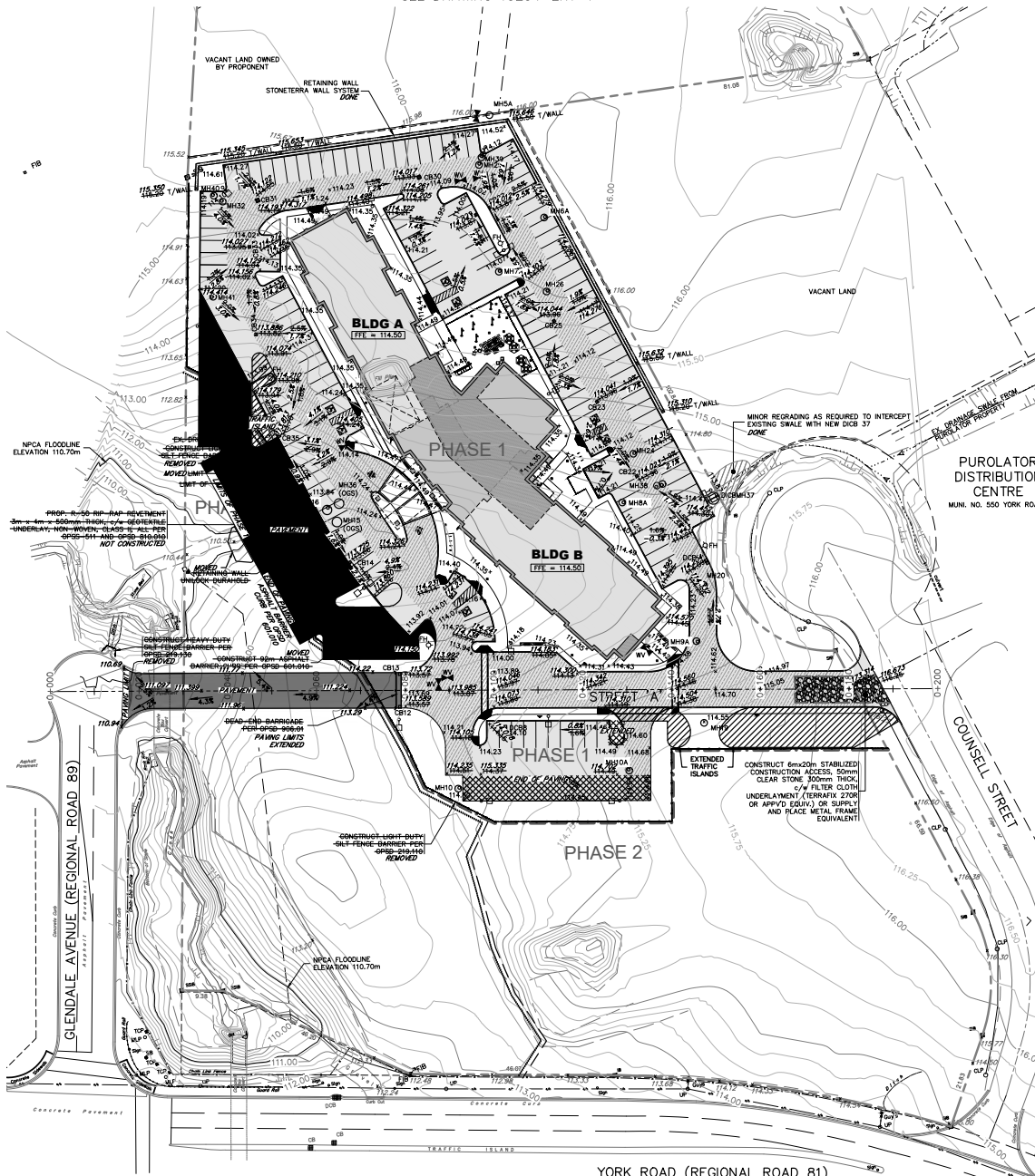
524 YORK ROAD, NIAGARA ON THE LAKE

Sheet Title:
SITE PLAN

Design By: M.A./A.B.	Drawn By: A.B.	Approved By: A.M.
Scale: 1:300	Date: 25/11/11	Project No.: 24-012

Drawing No.:
ASP-1
 Drawing Series:
 SITE PLAN-REZONING

SEE DRAWING 13254-EXT-1



TOPOGRAPHIC NOTE

INFORMATION SHOWN ON THIS DRAWING IS BASED ON TOPOGRAPHICAL DATA PROVIDED BY OTHERS. QUARTER GROUP INC. DOES NOT ACCEPT ANY RESPONSIBILITY FOR THE COMPLETENESS OR ACCURACY OF THE INFORMATION SHOWN, NOR FOR THE WAY IN WHICH THIS INFORMATION IS USED BY OTHERS. REPORT ANY CONFLICTING INFORMATION TO QUARTER GROUP INC. IMMEDIATELY.

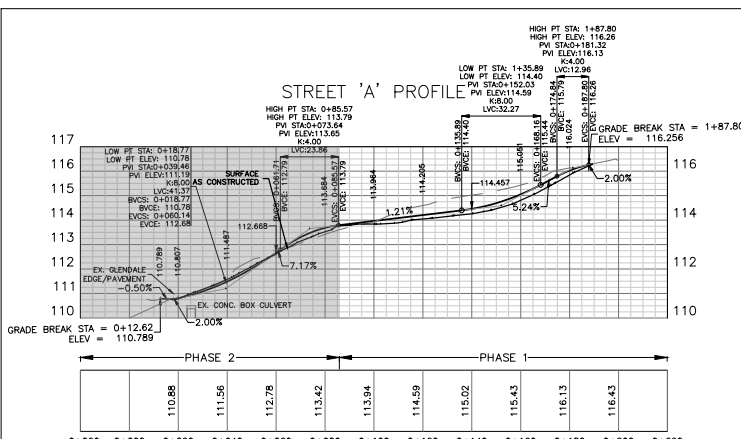
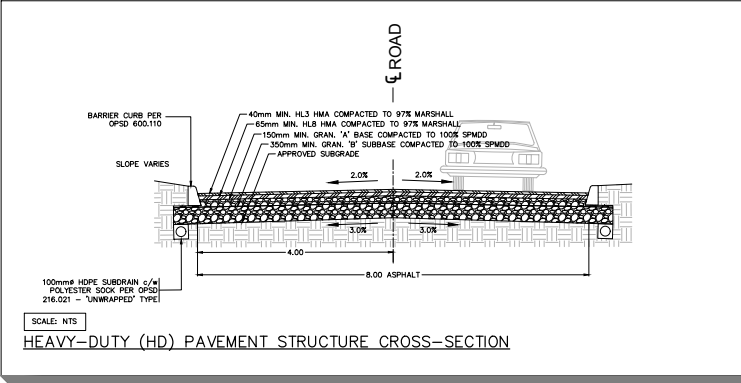
ELEVATIONS ARE BASED ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE ON TOP OF CONCRETE CULVERT UNDER OLD YORK ROAD, WEST OF TOWNLINE ROAD HAVING AN ELEVATION OF 113.576 METRES.

- EXTENDED PAVING AREA
- ADDITIONAL ELEMENTS
- ELEMENTS REMOVED/NOT CONSTRUCTED

NOTE:
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NOTES

1. EXISTING DRAINAGE OF ADJUTING LANDS IS NOT TO BE DISTURBED
2. ALL SITE TRAFFIC TO ENTER/EGRESS THROUGH A STABILIZED CONSTRUCTION ACCESS AS DETAILED ON DRAWING.
3. RETAINING WALLS, 1.0m HIGH OR GREATER, ARE TO BE DESIGNED BY AND CONSTRUCTED TO THE SPECIFICATIONS OF A REGISTERED PROFESSIONAL ENGINEER IN ACCORDANCE WITH THE ONTARIO BUILDING CODE.
4. ALL CONSTRUCTION VEHICLES SHALL ENTER AND EXIT THE SITE AT THE STABILIZED CONSTRUCTION ACCESS POINT.
5. ALL TOPSOIL STOCKPILES SHALL BE SURROUNDED WITH SEDIMENTATION CONTROL FENCING
6. PROVIDE A 1-METRE WIDE UNSTRIPPED BUFFER AROUND THE PERIMETER OF THE PROPERTY.
7. PROTECT ALL EXPOSED SURFACES AND CONTROL ALL RUNOFF DURING CONSTRUCTION.
8. ALL EROSION CONTROL MEASURES ARE TO BE IN PLACE BEFORE STARTING CONSTRUCTION AND REMAIN IN PLACE UNTIL RESTORATION IS COMPLETE.
9. ALL COLLECTED SEDIMENT MUST BE DISPOSED OF AT AN APPROVED LOCATION.
10. PROTECT ALL CATCHBASINS, MAINTENANCE HOLES AND PIPE ENDS FROM SEDIMENT INTRUSION WITH GEOTEXTILE (TERRAFIX 2708 OR APPROVED EQUIVALENT)
11. CHECK SUMPS PERIODICALLY AND CLEAN WHEN HALF FULL.
12. PREVENT WIND-BLOWN DUST.
13. STRAW BALES TO BE TERMINATED BY ROUNDING BALES TO CONTAIN AND FILTER RUNOFF.
14. ALL SILT FENCING AT THE MINIMUM TO BE CONSTRUCTED IN ACCORDANCE WITH THE MINISTRY OF NATURAL RESOURCES GUIDELINES ON EROSION AND SEDIMENT CONTROL FOR URBAN CONSTRUCTION SITES.
15. ALL THE ABOVE NOTES AND ANY SEDIMENT AND EROSION CONTROL MEASURES ARE AT THE MINIMUM TO BE IN ACCORDANCE WITH THE NATURAL RESOURCES GUIDELINES ON EROSION AND SEDIMENT CONTROL FOR URBAN CONSTRUCTION SITES.
16. ANY MONITORING WELLS IDENTIFIED MUST BE DECOMMISSIONED BY AN APPROPRIATELY LICENSED CONTRACTOR PER ONTARIO WATER RESOURCES ACT [R.R.O. 1990, REG. 903]
17. REFER TO SITE PLAN FOR DIMENSIONS.
18. THIS DRAWING TO BE READ IN CONJUNCTION WITH 13254-LP SERIES, 13254-SS-1, AND 13254-EXT-1 AND SITE PLAN ASP-100 AND MSP-100.
19. SEE DRAWING 13254-EXT-1 FOR ADDITIONAL NOTES AND LEGEND.



CONSTRUCTION RECORD	25
REVISED RETAINING WALL	2
REVISED SITE PLAN ADDRESS	1
REVISED BUILDING LETTERS	3
BUILDING PERMIT	2
CONSTRUCTION	1
TENDER	1
REVIEW	1
DATE	ISSUED BY

Do not scale drawings. Report any discrepancies immediately.

Drawings must be sealed by the Architect and used for any building permit applications and for work to be done on the site. The Architect and Engineer shall be responsible for the accuracy and completeness of the drawings and shall be liable for any errors and omissions.

All construction to be in accordance with the Code and all applicable Ontario regulations.

Other drawings to be read in conjunction with this drawing.

Quarter

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 • Planners • Project Managers
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INTERCONTINENTAL COMBO HOTEL

524 YORK ROAD, NIAGARA FALLS, ONTARIO

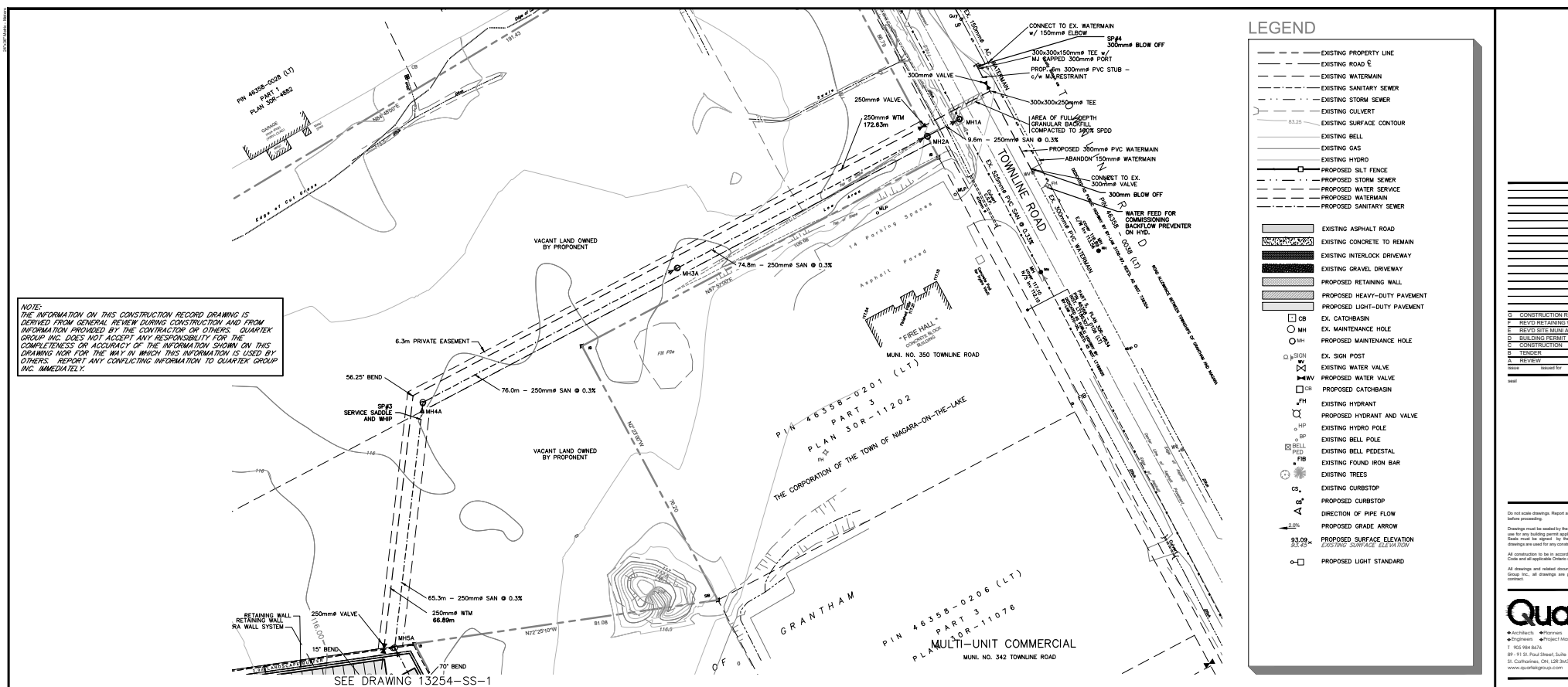
PROPOSED GRADING

PHASE 1

Drawn by: JTB/JRP/KH JRP

Scale: 1:500

Sheet: 30 of 30



NOTE:
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LEGEND		
(---)	EXISTING PROPERTY LINE	
(---)	EXISTING ROAD E	
(---)	EXISTING SANITARY SEWER	
(---)	EXISTING STORM SEWER	
(---)	EXISTING CULVERT	
(---)	EXISTING SURFACE CONTOUR	
(---)	EXISTING BELL	
(---)	EXISTING GAS	
(---)	EXISTING HYDRO	
(---)	PROPOSED SILT FENCE	
(---)	PROPOSED STORM SEWER	
(---)	PROPOSED WATER SERVICE	
(---)	PROPOSED WATERMAIN	
(---)	PROPOSED SANITARY SEWER	
(---)	EXISTING ASPHALT ROAD	
(---)	EXISTING CONCRETE TO REMAIN	
(---)	EXISTING INTERLOCK DRIVEWAY	
(---)	EXISTING GRAVEL DRIVEWAY	
(---)	PROPOSED RETAINING WALL	
(---)	PROPOSED HEAVY-DUTY PAVEMENT	
(---)	PROPOSED LIGHT-DUTY PAVEMENT	
(---)	CB	EXIST. CATCHBASIN
(---)	MH	EXIST. MAINTENANCE HOLE
(---)	MH	PROPOSED MAINTENANCE HOLE
(---)	SP	EXIST. SIGN POST
(---)	SP	EXISTING WATER VALVE
(---)	CB	PROPOSED CATCHBASIN
(---)	HP	EXISTING HYDRANT
(---)	HP	PROPOSED HYDRANT AND VALVE
(---)	HP	EXISTING HYDRO POLE
(---)	BELL	EXISTING BELL POLE
(---)	PED	EXISTING BELL PEDESTAL
(---)	IR	EXISTING FOUND IRON BAR
(---)	TS	EXISTING TREES
(---)	CS	EXISTING CURBSTOP
(---)	CS	PROPOSED CURBSTOP
(---)	CS	DIRECTION OF PIPE FLOW
(---)	CS	PROPOSED GRADE ARROW
(---)	CS	PROPOSED SURFACE ELEVATION
(---)	CS	PROPOSED SURFACE ELEVATION
(---)	CS	PROPOSED LIGHT STANDARD

NOTES

GENERAL

- LOCATION AND SIZE OF EXISTING UTILITIES WAS DERIVED FROM VARIOUS DRAWINGS FROM OTHERS. THE POSITION OF ALL POLE LINES, CONDUITS, WATERMANS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES ARE NOT NECESSARILY SHOWN AND, WHERE SHOWN, THE ACCURACY OF THE LOCATION SHOWING OF SUCH UTILITIES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL CONTACT ALL SUCH UTILITIES INVOLVED AND INFORM HIMSELF AS TO THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME LIABILITY FOR DAMAGE TO THEM. CONTRACTOR TO REPORT ANY CONFLICTS OR DISCREPANCIES WITH THIS DRAWING TO THE CONTRACT ADMINISTRATOR IMMEDIATELY.
- ALL MEASUREMENTS ARE IN METRES UNLESS OTHERWISE NOTED.
- ALL WORK SHALL BE IN ACCORDANCE WITH THE RELEVANT SECTIONS OF THE ONTARIO PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS, AND THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT (NPSCD) UNLESS OTHERWISE NOTED ON THE DRAWINGS OR IN THE SPECIFICATIONS.
- COMPUTER DRAWING FILE CO-ORDINATES FOR THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION LAYOUT UNLESS SPECIFICALLY DIRECTED BY THE ENGINEER.
- ALL GRANULAR MATERIAL SHALL BE COMPACTED TO 100% STANDARD PROCTOR DENSITY AND ALL NATIVE BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR DENSITY UNLESS OTHERWISE NOTED.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD INCLUDING THE SUPPLY, INSTALLATION AND REMOVAL OF ALL NECESSARY SIGNALS, DELIMITERS, MARKERS, AND BARRIERS. ALL SIGNS, ETC., SHALL CONFORM TO THE STANDARDS OF THE ONTARIO TRAFFIC MANUAL - BOOK 7.
- ALL EXCAVATION IN EXISTING ROADWAYS OR OTHER PAVED SURFACES SHALL BE BACKFILLED WITH GRANULAR 'A' COMPACTED TO 100% SPD. MINIMUM.
- PROPOSED GRADES SHALL NOT ADVERSELY AFFECT ADJACENT PROPERTIES.
- EXISTING SITE BOUNDARY AND TOPOGRAPHIC INFORMATION DERIVED BY KIRKPUR & URE SURVEYING AS SHOWN ON PLANS PROVIDED BY AP DEVELOPMENT CONSULTANTS INC.
- REFER TO SITE PLAN BY AP DEVELOPMENT CONSULTANTS INC. FOR SITE LAYOUT AND DIMENSIONS. REFER TO LANDSCAPE DRAWINGS FOR PLANTING AND HARD LANDSCAPE DETAILS. REFER TO ELECTRICAL DRAWINGS FOR SITE LIGHTING.
- WHERE EXISTING FINISHED SURFACES ARE DISTURBED OR DAMAGED, RESTITUTE AS FOLLOWS:
 - EXISTING PUBLIC ROADWAYS: COMPLY WITH REQUIREMENTS OF ROAD AUTHORITY, OPSS 310 AND OPSS 509.010. MINIMUM REQUIRED ASPHALT THICKNESSES TO MATCH EXISTING. PROVIDE TEMPORARY SURFACE RESTAINTMENT IN ACCORDANCE WITH ROAD AUTHORITY REQUIREMENTS.
 - EXISTING PRIVATE PAVED AREAS: COMPLY WITH PAVEMENT REQUIREMENTS AS SPECIFIED UNDER 'ROADS AND EARTHWORKS'.
 - EXISTING GRAVEL AREAS: 100mm TOP SOIL PER OPSS 801 AND No. 1 NURSERY SOIL PER OPSS 803.
 - EXISTING PLANTING AREAS: RESTITUTE TO ORIGINAL CONDITION IN CONSULTATION WITH OWNER.

SILTATION/SEDIMENT CONTROL

- ALL CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A WAY THAT SILTATION OR OTHER DAMAGE TO WATER COURSES DOES NOT OCCUR. THE REQUIREMENTS OF THE N.P.C.A. AND MINISTRY OF NATURAL RESOURCES ARE TO BE ADHERED TO IN THIS RESPECT.
- SILT FENCE PER OPSS 218.110 SHALL BE INSTALLED AS SHOWN PRIOR TO CONSTRUCTION AND SHALL BE MAINTAINED IN GOOD CONDITION THROUGHOUT CONSTRUCTION.

PRE-DISTURBED STATE OR BETTER. NATIVE BACKFILLED AREAS TO BE REVEGETATED SHALL BE FREE OF GRANULAR PARTICLES OR OTHER MATERIALS DELETERIOUS TO PLANT GROWTH.

- ALL CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A WAY THAT SILTATION OR OTHER DAMAGE TO WATER COURSES DOES NOT OCCUR. THE REQUIREMENTS OF THE MINISTRY OF NATURAL RESOURCES ARE TO BE ADHERED TO IN THIS RESPECT. AT A MINIMUM, PROVIDE SILT FENCE AND STABILIZED CONSTRUCTION ACCESS AND MAINTAIN SAME FOR DURATION OF CONSTRUCTION. REMOVE CONSTRUCTION ACCESS GRANULAR FOLLOWING COMPLETION OF CONSTRUCTION, DISPOSE OFF SITE AND RESTITUTE PER RD 55 BOUNDARY WITH MIN. 75mm TOPSOIL AND No. 1 NURSERY SOIL. MAINTAIN SILT FENCE UNTIL GRASS OR OTHER GROUND COVER IS ESTABLISHED ADJACENT.

WATER SUPPLY

- CONTRACTOR SHALL OBTAIN EXPLOIT APPROVAL FROM TOWN OF NIAGARA-ON-THE-LAKE WATER DEPARTMENT PRIOR TO MAKING A CONNECTION TO THE EXISTING TOWN WATERMAIN.
- ALL WATERMANS 100mm IN DIAMETER OR LARGER SHALL BE PVC OR PVED, CERTIFIED TO CSA B137.3 OR 137.3 RESPECTIVELY. COOD, DR-18, CLASS 235 (RATED TO 235PSI); DELIVERED TO SITE WITH END-CAPS SECURELY IN PLACE. WATERMAIN TO BE INSTALLED PER OPSS-701 WITH CRUSHER-RUN GRANULAR 'A' BEDDING & COVER PER OPSS-802.010.
- A MINIMUM CLEAR HORIZONTAL SEPARATION OF 2.5m SHALL BE MAINTAINED BETWEEN ANY SEWER & ANY PARALLEL WATERMAIN. A MINIMUM CLEAR VERTICAL SEPARATION OF 0.5m SHALL BE MAINTAINED AT SEWER CROSSINGS.
- POTABLE WATER SERVICES TO BE 80mm (2") WATER SERVICES SHALL BE TYPE 'N' SOFT COPPER OR MINICUPEX OR APPROVED EQUIVALENT. MINIMUM COVER OVER WATERMANS & SERVICES SHALL BE 1.5m UNLESS OTHERWISE INDICATED.
- ALL METAL, CROSSIES, TEES, BENDS, VALVES AND OTHER FITTINGS SHALL HAVE CATHODIC PROTECTION CONSISTING OF ZINC ANODE 500-12 (1X LB.) ALL HYDRANT ASSEMBLIES SHALL HAVE CATHODIC PROTECTION CONSISTING OF ZINC ANODE 1100-34 (24 LB.).
- ALL BENDS, TEES, HYDRANTS & OTHER FITTINGS AS REQUIRED SHALL HAVE THRESH BLOCKS IN ACCORDANCE WITH OPSS 1103.010 & 1103.020.
- VALVES SHALL CONFORM TO ANWA C500 & C509 & SHALL BE IRON-BODY THREADED-GATE GATE VALVES WITH 1/2-ANG STEEL PACKING, MECHANICAL JOINTED & SHALL OPEN LEFT-HANDED WITH 50mm SQUARE OPERATING NUT. VALVE BOXES SHALL BE CAST IRON, SLIDE TYPE.
- HYDRANTS SHALL CONFORM TO OPSS 401 AND NPSCO SPECIAL PROVISION D3. HYDRANTS SHALL BE TWO-PIECE BARREL AND STEM WITH MINIMUM 1.7 METRE BURY AND SHALL BE SET WITH BOTTOM FLANGE BETWEEN 100 mm AND 200 mm ABOVE FINISHED GROUND. THEY SHALL HAVE TWO (2) 63 mm DIAMETER HOSE OUTLETS WITH CSA THREADS, ONE (1) 114 mm O.D. PUMPER NOZZLE WITH STORZ FITTING FOR QUICK CONNECTION AND SHALL OPEN LEFT-HANDED. THEY SHALL HAVE DRAIN HOLES OPEN AND SHALL BE PAINTED CHROME YELLOW. HYDRANTS SHALL BE DARRING B6, MCANNY M-67, BERRY SENTINEL OR APPROVED EQUIVALENT.
- ALL WATER SUPPLY PIPING SHALL BE FLANGED, PRESSURE TESTED & COMPLETED IN ACCORDANCE WITH OPSS 701 & NPSCO SP-013 UNDER THE DIRECTION OF THE TOWN'S ENGINEERING PERSONNEL, & TO THE SATISFACTION OF PUBLIC WORKS.
- FOR ALL NON-METALLIC WATERMANS AND SERVICES, 8-GAUGE COPPER TRACING WIRE SHALL BE INSTALLED ALONG THE SPRING-LINE ALONG ITS ENTIRE LENGTH, ALONG HYDRANT LINES AND EXTENDED ABOVE EXPOSED FLANGE AT HYDRANT.

ROADS AND EARTHWORKS

- ALL FILL FOR ROADWAY AND PARKING AREAS TO BE CONSTRUCTED IN ACCORDANCE WITH OPSS 201 IN 200mm THICK LIFTS, USING SUITABLE NATURAL OR IMPROVED MATERIAL APPROVED BY CONTRACT ADMINISTRATOR AND GEOTECHNICAL ENGINEER. THE SUBSOL BELOW ANY ROADWAY OR PARKING AREA SHALL BE PROOF ROLLED AND INSPECTED BY THE GEOTECHNICAL ENGINEER OR HIS AGENT.

- ALL DISTURBED OR DAMAGED, RESTITUTE OF EXISTING ROADS SHALL COMPLY WITH THE REQUIREMENT OF THE ROAD AUTHORITY. PAVEMENT RESTAINTMENT SHALL COMPLY WITH OPSS 509.010 AND OPSS 310.
- MINIMUM ASPHALT AND GRANULAR THICKNESSES FOR ROAD AND PARKING AREA PER OPSS 310 & 314 AS FOLLOWS:

SURFACE COURSE	40mm HLS	65mm HLS
BINDER COURSE	65mm HLS	N/A
GRANULAR 'A' BASE	200mm GRAN. 'A'	150mm GRAN. 'A'
GRANULAR 'B' BASE	350mm GRAN. 'B'	200mm GRAN. 'B'
TOTAL THICKNESS	655mm	415mm
- AREAS TO BE SOODED SHALL INCLUDE MINIMUM 75mm TOPSOIL PER OPSS 801, SOO TO BE IN ACCORDANCE WITH OPSS 803. NATIVE BACKFILLED AREAS TO BE SOODED SHALL BE FREE OF GRANULAR PARTICLES OR OTHER MATERIALS DELETERIOUS TO PLANT GROWTH. PAINTS SHALL APPLY FOR PAVEMENT MARKINGS EXCEPT AS AMENDED HEREON. LINE MARKINGS SHALL BE APPLIED TO CONFORM TO THE PROVISIONS OF BOOK 11 - PAVEMENT, HAZARD AND DELINEATION MARKINGS, OF THE ONTARIO TRAFFIC MANUAL. PAVEMENT MARKINGS WHERE SPECIFIED AS PAINT SHALL BE YELLOW AND WHITE REFLECTORIZED WATER-BORNE TRAFFIC PAINT OR APPROVED EQUAL. REFLECTORIZED FIELD REACTED POLYMERIC ALSO KNOWN AS DURABLE SHALL BE USED AT INTERSECTIONS FOR CROSSWALKS, STOP BARS AND ALL LINES WITHIN 15 METRES OF THE STOP BARS. PAVEMENT MARKINGS SHALL BE UNDERTAKEN BY THE CONTRACTOR AND APPROVED BY THE ENGINEER'S SUPERVISOR SIGNS & PAVEMENT MARKING OPERATIONS PRIOR TO THE APPLICATION OF PERMANENT MARKINGS. THE CONTRACTOR IS RESPONSIBLE FOR TEMPORARY PRE-MARKINGS IMMEDIATELY FOLLOWING ASPHALT OPERATIONS. PAVEMENT MARKING REMOVAL WHERE REQUIRED SHALL MAINTAIN DAMAGE TO THE EXISTING PAVEMENT SURFACE. THE METHOD OF REMOVAL (SODA BLAST, SHOT BLAST OR GRINDING) SHALL BE APPROVED BY THE ENGINEER.

SEWERS

- ALL SEWERS, LEADS AND LATERALS SHALL BE INSTALLED IN ACCORDANCE WITH OPSS 401. ALL FLEXIBLE PIPE TO HAVE CRUSHER-RUN GRANULAR 'A' EMBEDMENT PER OPSS 802.010 AND SELECT NATIVE BACKFILL COMPACTED TO 95% SPD. ALL GRANULAR MATERIAL TO BE COMPACTED TO 100% SPD UNLESS NOTED OTHERWISE.
- ALL STORM SEWERS AND CATCHBASIN LEADS, 600mm OR LESS, TO BE CONCRETE, CLASS III PER CSA A257.2 WITH CLASS 'B' BEDDING TO OPSS 802.030 OR PVC DR-35 PER CSA 182.1 & 182.2 WITH CRUSHER RUN GRANULAR 'A' BEDDING TO OPSS 802.010 UNLESS OTHERWISE NOTED.
- STORM SEWERS 675mm DIAMETER AND LARGER TO BE CONCRETE PIPE, CLASS III PER CSA A257.2 WITH CLASS 'B' BEDDING TO OPSS 802.010 AND 802.033 OR HOPE PER CSA 182.4 WITH CRUSHER-RUN GRANULAR 'A' EMBEDMENT PER OPSS 802.010.
- ALL SANITARY SEWERS TO BE PVC DR-35 PER CSA 182.2 WITH CRUSHER-RUN GRANULAR 'A' BEDDING TO OPSS 802.010 UNLESS OTHERWISE NOTED.
- OIL AND GRIT SEPARATORS TO BE STORMCOPPER MODEL STC-750 OR APPROVED EQUIVALENT.
- COORDINATE CONNECTIONS TO EXISTING SEWERS WITH TOWN OF NIAGARA-ON-THE-LAKE PUBLIC WORKS STAFF AND QUARTER GROUP INC.
- ALL CONNECTIONS OF R/C SANITARY SEWER PIPE TO CONCRETE STRUCTURES SHALL BE BY MEANS OF NON-METAL SEALED RUBBER

TOPOGRAPHIC NOTE

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ELEVATIONS ARE BASED ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE OR TOP OF CONCRETE CULVERT UNDER OLD YORK ROAD, WEST OF TOWNLINE ROAD HAVING A ELEVATION OF 113.274 METRES.

INTERCONTINENTAL COMBO HOTEL

524 YORK ROAD, NIAGARA FALLS, ONTARIO

PROPOSED SITE SERVICE EXTENSION

PHASE 1

DATE: 15/01/2010

PROJECT: JTBUR/PRKH

SCALE: 1:500

QUARTER GROUP INC.

1509 9th Street, Suite 100, Scarborough, ON, M1B 2X3
 www.quartergroup.com

CONSTRUCTION RECORD

NO. 1: REVD RETAINING WALL 25
 NO. 2: REVD SITE MUN ADDRESS 13
 NO. 3: CONSTRUCTION 14
 NO. 4: TENDER 14
 NO. 5: REVISED 02

DATE: 15/01/2010

PROJECT: JTBUR/PRKH

SCALE: 1:500

APPENDIX B

Water Servicing Calculations

Proposed Domestic Water Demand

Dual Hotel:

Site Area: 1.463 ha

	Fairfield	TownePlace	Total	
Water Demand:	250	250	250	L/bed-space
Number of Rooms:	114	113	227	Rooms
Number of Bed Spaces (Population):	274	226	454	Bed-space
Average Daily Demand (m ³):	68.4	56.5	113.5	m ³
Average Daily Demand (L/s):	0.79	0.65	1.31	L/s
Max Day Demand (L/s):	2.38	1.96	3.94	L/s
Max Hour Demand (L/s):	3.56	2.94	5.91	L/s

Hotel Common Area:

	Swimming Pool	Public-use Washrooms(4)	
Water Area:	551	-	m ²
Water Demand:	40	-	L/m ² /day
Average Daily Demand (L/d):	22040	-	L/d
Average Daily Demand (L/s):	0.26	-	L/s
Max Day Demand (L/s):	0.77	3.00	L/s
Max Hour Demand (L/s):	1.15	4.50	L/s

Restaurant:

	Restaurant	
Gross Area:	372	m ²
Seats:	186	seats
Demand Volume:	125	L/seat
Average Daily Demand (m ³):	23.3	m ³
Average Daily Demand (L/s):	0.27	L/s
Max Day Demand (L/s):	0.81	L/s
Max Hour Demand (L/s):	1.21	L/s

Summary Table

Building Type	Total Daily Demand (L/s)	Total Max. Day Demand (L/s)	Total Max. Hour Demand (L/s)
HOTEL	1.57	7.71	11.56
RESTAURANT	0.27	0.81	1.21
TOTAL	1.84	8.51	12.77

Notes & References

The Ontario Building Code (OBC) Residential Occupancy: Hotels and Motels (excluding bars and restaurants), Regular per room, (OBC, Table 8.2.1.3.A)

2 occupied bed-spaces (population) per room (industry statistic - conservative).

1 day = 86400 seconds

Peaking Factors: MOECC Design Guideline for Drinking-Water Systems, Peaking Factors for Serving Fewer than 500 People (MOECC, Table 3-3)

*assume 1 person/m²

The Ontario Building Code (OBC) Other Occupancies: Swimming and bathing facilities (OBC, Table 8.2.1.3.B Sewage)

55% of restaurant floorplate for seating patrons. 1.1 m² per restaurant patron (OBC, Table 3.1.17.1)

The Ontario Building Code (OBC) Other Occupancies: Food Service Operations, Restaurant (not 24hr) (OBC, Table 8.2.1.3.B)

1 day = 86400 seconds

Water Supply for Public Fire Protection - 2020
Fire Underwriters Survey
Part II - Guide for Determination of Required Fire Flow

1. An estimate of fire flow required for a given area may be determined by the formula:

$$RFF = 220 * C * \text{sqrt } A$$

where

RFF = the required fire flow in litres per minute

C = coefficient related to the type of construction:

=	1.5	for Type V Wood Frame Construction (structure essentially all combustible)
=	0.8	for Type IV-A Mass Timber Construction (encapsulated mass timber)
=	0.9	for Type IV-B Mass Timber Construction (rated mass timber)
=	1.0	for Type IV-C Mass Timber Construction (ordinary mass timber)
=	1.5	for Type IV-D Mass Timber Construction (un-rated mass timber)
=	1.0	for Type III Ordinary Construction (brick or other masonry walls, combustible floor and interior)
=	0.8	for Type II Non-combustible Construction (unprotected metal structural components)
=	0.6	for Type I Fire-resistive Construction (fully protected frame, floors, roof)

Proposed Buildings

Floor 1	1,773.0	sq.m	100%
Floor 2	1,773.0	sq.m	25%
Floor 3	1,773.0	sq.m	25%
Floor 4	1,773.0	sq.m	0%
Floor 5	1,773.0	sq.m	0%
Floor 6	1,773.0	sq.m	0%
Floor 7	1,773.0	sq.m	0%

Area = **2,660** sq.m

Note: Assuming that all vertical openings and exterior vertical communications are properly protected in accordance with the National Building Code.

C = 0.8

Assumes Type II Non-combustible Construction (unprotected metal structural components)

Therefore RFF = 9,077 L/min

2. Values obtained in No. 1 may be reduced by as much as 25% for occupancies having low contents fire hazard or may be increased by up to 25% surcharge for occupancies having a high fire hazard.

Non-Combustible	-25%	Free Burning	15%
Limited Combustible	-15%	Rapid Burning	25%
Combustible	0% (No Change)		

Limited Combustible	-15% reduction
---------------------	----------------

-1,362 L/min reduction
7,716 L/min

Note: Flow determined shall not be less than 2,000 L/min

3. Sprinklers - The value obtained in No. 2 above maybe reduced by up to 50% for complete automatic sprinkler protection. The credit for the system will be a maximum of 30% for an adequately designed system conforming to NFPA 13 and other NFPA sprinkler standards.

As part of this analysis, the building will have sprinkler protection:

50%

3,858 L/min reduction

**Water Supply for Public Fire Protection - 2020
 Fire Underwriters Survey**

Part II - Guide for Determination of Required Fire Flow

4. Exposure - To the value obtained in No. 2, a percentage should be added for structures exposed within 30 metres by the fire area under consideration. The percentage shall depend upon the height, area, and construction of the building(s) being exposed, the separation, openings in the exposed building(s), the length and height of exposure, the provision of automatic sprinklers and/or outside sprinklers in the building(s) exposed, the occupancy of the exposed building(s) and the effect of hillside locations on the possible spread of fire.

Separation	Charge	Separation	Charge
0 to 3 m	25%	20.1 to 30 m	10%
3.1 to 10 m	20%	> 30 m	0%
10.1 to 20 m	15%		

Exposed buildings

Name	Distance (m)	Charge (%)	Surcharge (L/min)
E	>30	0%	-
W	16.5	15%	1,157
N	>30	0%	-
S	>30	0%	-
			1,157 L/min Surcharge

Determine Required Fire Flow

No.1	9,077		
No. 2	-1,362 reduction		
No. 3	-3,858 reduction		
No. 4	<u>1,157</u> surcharge		
Required Flow:	5,015 L/min		
Rounded to nearest 1000 L/min:	5,000 L/min	or	83.3 L/s 1,321 USGPM

**Water Supply for Public Fire Protection - 2020
 Fire Underwriters Survey**

Part II - Guide for Determination of Required Fire Flow

4. Exposure - To the value obtained in No. 2, a percentage should be added for structures exposed within 30 metres by the fire area under consideration. The percentage shall depend upon the height, area, and construction of the building(s) being exposed, the separation, openings in the exposed building(s), the length and height of exposure, the provision of automatic sprinklers and/or outside sprinklers in the building(s) exposed, the occupancy of the exposed building(s) and the effect of hillside locations on the possible spread of fire.

Separation	Charge	Separation	Charge
0 to 3 m	25%	20.1 to 30 m	10%
3.1 to 10 m	20%	> 30 m	0%
10.1 to 20 m	15%		

Exposed buildings

Name	Distance (m)	Charge (%)	Surcharge (L/min)
E	16.5	15%	433
W	>30	0%	-
N	>30	0%	-
S	>30	0%	-
			433 L/min Surcharge

Determine Required Fire Flow

No. 1	3,395		
No. 2	-509 reduction		
No. 3	0 reduction		
No. 4	433 surcharge		
Required Flow:	3,319 L/min		
Rounded to nearest 1000 L/min:	3,000 L/min	or	50.0 L/s 793 USGPM



627 RENNIE STREET HAMILTON ONTARIO L8H 3P8
(o) 905-467-5853 (c) 905-971-9956 (e) mark@aquacom.ca

December 5, 2025

Peter Horn
Horn Design & Consulting Inc.
1827 Will Scarlet Drive
Mississauga, Ontario
L5K 1J6

**Reference: 303 / 324 Townline Road
Town of Niagara on the Lake
Hydrant Flow Testing**

The flow testing was completed Thursday 20 November 2025 as scheduled.

We advised the Town of Niagara on the Lake water operations staff of this schedule and they provided an operator to assist with the operation of the **municipal hydrants** and to assist with the test.

Please find the attached summary of test results. For your information;

a hydrant was flowed from one than two nozzles, using flow diffusers
residual pressures were recorded from an upstream fire hydrant on the municipal system
theoretical flows were produced from the attached chart, using a .90 nozzle coefficient
all discharge water was dechlorinated as per Ministry requirements
the hydrants were not colour coded at the time of the test

If you should require any further information please do not hesitate to contact the undersigned.

Sincerely yours,

Aquacom Contracting
Mark Kilbourne

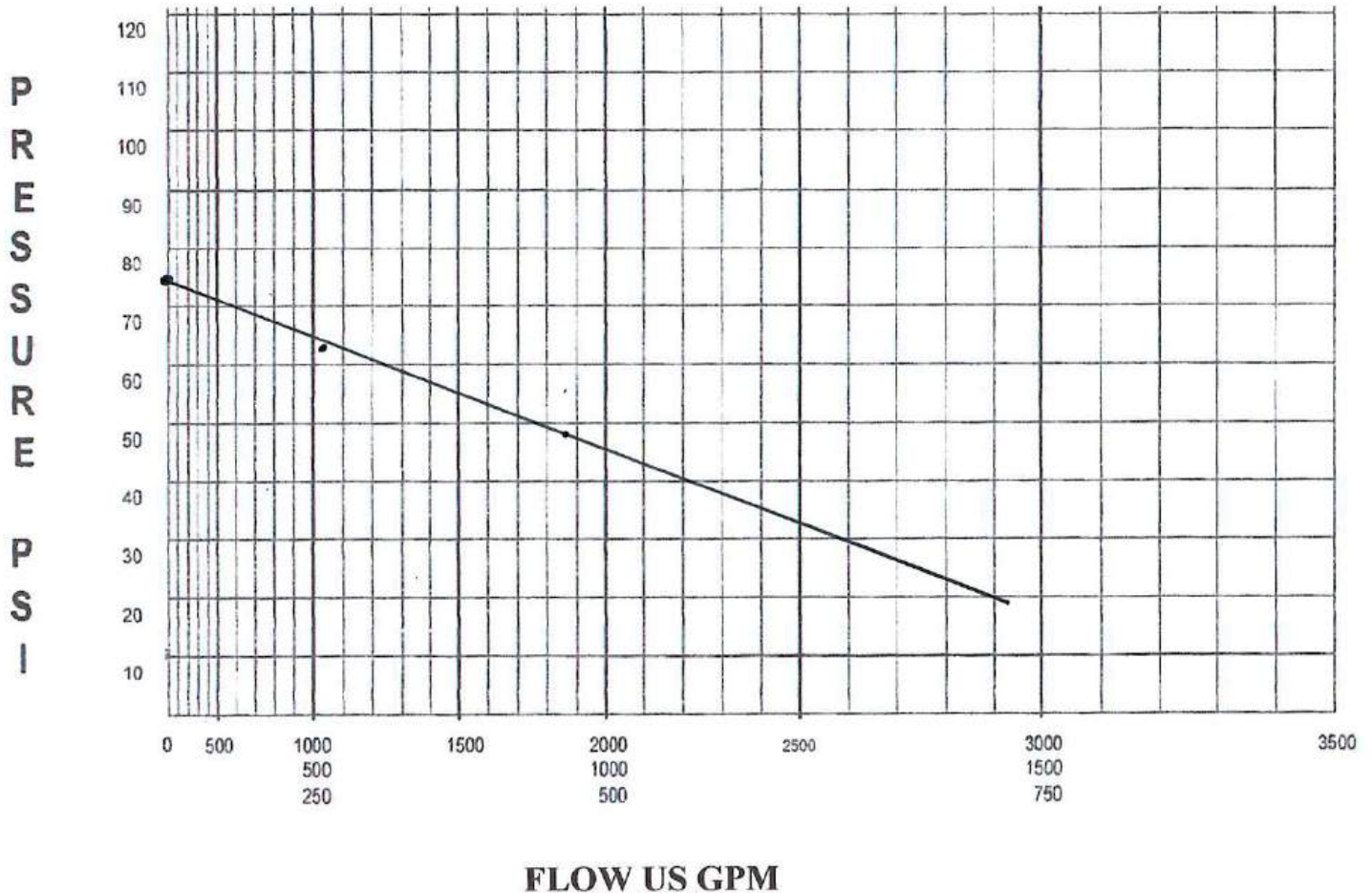
SITE NAME	TOWN LINE ROAD. NIAGARA ON THE LAKE
TEST DATE TIME	THURSDAY 20 NOVEMBER 2025 @ 9:30AM
SITE ADDRESS	303 & 324 TOWNLINE ROAD
TECHNICIANS	JEFF DAM & MARC COULTER
COMMENTS	MUNICIPAL HYDRANTS

LOCATION OF FLOW HYDRANT
LOCATION OF RESIDUAL HYDRANT

303 TOWNLINE ROAD

324 TOWNLINE ROAD

# OUTLETS	SIZE INCHES	PITO PSI	FLOW USGPM	RESIDUAL PSI	STATIC PSI	PIPE DIA. MM
ONE	2.50	44	1113	62	75	300MM
TWO	2.50	30	1840	48		PVC
		THEORETICAL	2702	20	TEST #	ONE
NOZZLE COEFF.		.90				





HYDRANT FLOW TEST REPORT

627 RENNIE STREET HAMILTON ONTARIO L8H3P8
 (o) 905-467-5853 (c) 905-971-9956 (e) mark@aquacom.ca

		HYDRANT	SEC. VALVE	TECH.	TIME	STATIC	PITO 1-2.50"	FLOW 1-2.50"	RESIDUAL 1-2.50"	PITO 2-2.50"	FLOW 2-2.50"	RESIDUAL 2-2.50"	THEORETICAL FLOW @ 20PSI	COLOUR
	MAKE	CONDITION				PSI	PSI	US GPM	PSI	PSI	US GPM	PSI	RESIDUAL	CODE
F1	303 TOWNLINE ROAD	AVK	OK/OPEN	JD	9:30		44	1113		30	1840		2702	BLUE
R1	324 TOWNLINE ROAD	CENTURY	OK/OPEN	MC		75			62			48		
F2														
R2														
F3														
R3														

CUSTOMER

S. F. CROZIER AND ASSOCIATS
HORN DESIGN

SERVICE DATE

20-11-2025

LOCATION

TOWNLINE ROAD
NIAGARA ON THE LAKE

CONTACTS ON SITE HALTON REGION

NIAGARA ON THE LAKE OPERATOR



627 RENNIE STREET HAMILTON ONTARIO L8H 3P8
(o) 905-467-5853 (c) 905-971-9956 (e) mark@aquacom.ca

December 5, 2025

Peter Horn
Horn Design & Consulting Inc.
1827 Will Scarlet Drive
Mississauga, Ontario
L5K 1J6

**Reference: Holiday Inn, 524 York Road
 Town of Niagara on the Lake
 Hydrant Flow Testing**

The flow testing was completed Thursday 20 November 2025 as scheduled.

As these are **private hydrants** we did not require assistance from the Town of Niagara Lake water operations.

With coordination thru Peter our crew met Derrick Metcalfe with the Holiday Inn and reviewed the process to ensure that there were no issues that inconvenienced their staff and / or guests.

Please find the attached summary of test results. For your information;

- a hydrant was flowed from one than two nozzles, using flow diffusers
- residual pressures were recorded from an upstream fire hydrant on the municipal system
- theoretical flows were produced from the attached chart, using a .90 nozzle coefficient
- all discharge water was dechlorinated as per Ministry requirements
- the hydrants were not colour coded at the time of the test

If you should require any further information please do not hesitate to contact the undersigned.

Sincerely yours,

Aquacom Contracting
Mark Kilbourne



627 RENNIE STREET HAMILTON ONTARIO L8H3P8

(o) 905-467-5853 (C) 905-971-9956 (e) mark@aquacom.ca

SITE NAME HOLIDAY INN. NIAGARA ON THE LAKE

TEST DATE TIME THURSDAY 20 NOVEMBER 2025 @ 10:15 AM

SITE ADDRESS 524 YORK ROAD

TECHNICIANS JEFF DAM & MARC COULTER

COMMENTS PRIVATE HYDRANTS

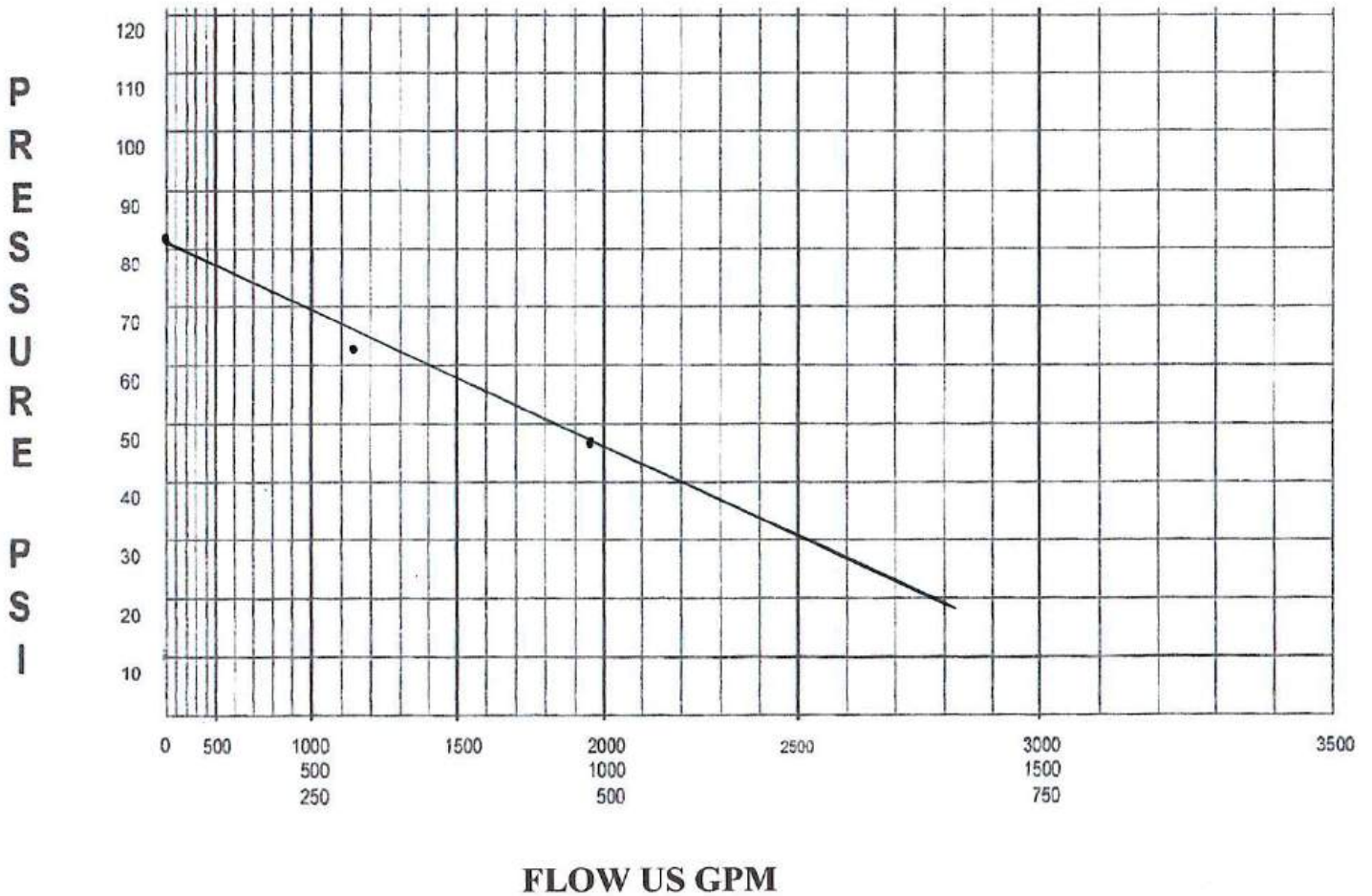
LOCATION OF FLOW HYDRANT

LOCATION OF RESIDUAL HYDRANT

NEC CORNER PARKING LOT

SWC CORNER PARKING LOT

# OUTLETS	SIZE INCHES	PITO PSI	FLOW USGPM	RESIDUAL PSI	STATIC PSI	PIPE DIA. MM
ONE	2.50	46	1138	62	81	200MM
TWO	2.50	35	1986	49		UNKNOWN
		THEORETICAL	2814	20	TEST #	ONE
NOZZLE COEFF.		.90				





HYDRANT FLOW TEST REPORT

627 RENNIE STREET HAMILTON ONTARIO L8H3P8

(o) 905-467-5853 (c) 905-971-9956 (e) mark@aquacom.ca

	HYDRANT	SEC. VALVE	TECH.	TIME	STATIC	PITO 1-2.50"	FLOW 1-2.50"	RESIDUAL 1-2.50"	PITO 2-2.50"	FLOW 2-2.50"	RESIDUAL 2-2.50"	THEORETICAL FLOW @ 20PSI	COLOUR	
	MAKE	CONDITION			PSI	PSI	US GPM	PSI	PSI	US GPM	PSI	RESIDUAL	CODE	
F1	NWC PARKING LOT	AVK	OK/OPEN	JD	10:15		46	1138		35	1986		2814	BLUE
R1	SWC PARKING LOT	CENTURY	OK/OPEN	MC		81						49		
F2														
R2														
F3														
R3														

CUSTOMER

S. F. CROZIER AND ASSOCIATS
HORN DESIGN

SERVICE DATE

20-11-2025

LOCATION

HOLIDAY INN, 524 YORK ROAD
NIAGARA ON THE LAKE

CONTACTS ON SITE HALTON REGION

DERRICK HOLIDAY INN

APPENDIX C

Sanitary Servicing Calculations

Proposed Domestic Sanitary Design Flow

	Notes & References																																																										
<p>Site Area: 1.463 ha</p> <p>Dual Hotel:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th></th> <th style="text-align: center;">Fairfield</th> <th style="text-align: center;">TownePlace</th> <th style="text-align: center;">Total</th> <th></th> </tr> </thead> <tbody> <tr> <td>Unit Sewage Flow:</td> <td style="text-align: center;">225</td> <td style="text-align: center;">225</td> <td style="text-align: center;">225</td> <td>(L/d)/Bed-space</td> </tr> <tr> <td>Number of Rooms:</td> <td style="text-align: center;">114</td> <td style="text-align: center;">113</td> <td style="text-align: center;">227</td> <td>Rooms</td> </tr> <tr> <td>Number of Bed Spaces/Population:</td> <td style="text-align: center;">274</td> <td style="text-align: center;">271</td> <td style="text-align: center;">545</td> <td>Bed-space</td> </tr> <tr> <td>Sanitary Flow (L/d):</td> <td style="text-align: center;">61560</td> <td style="text-align: center;">61020</td> <td style="text-align: center;">122580</td> <td>L/d</td> </tr> <tr> <td>Sanitary Flow (L/s):</td> <td style="text-align: center;">0.71</td> <td style="text-align: center;">0.71</td> <td style="text-align: center;">1.42</td> <td>L/s</td> </tr> </tbody> </table> <p>Harmon Peak Factor: $M = \frac{4.10}{2.92}$ Peak Factor = $\frac{4.10}{2.89}$ $\frac{3.95}{5.61}$ L/s</p> <p>Hotel Common Area:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: center;">Public-use Washrooms</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3.00</td> <td>L/s</td> </tr> </tbody> </table> <p>Restaurant:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: center;">Restaurant</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">372</td> <td>m²</td> </tr> <tr> <td style="text-align: center;">186</td> <td>seats</td> </tr> <tr> <td style="text-align: center;">125</td> <td>L/seat</td> </tr> <tr> <td style="text-align: center;">23250</td> <td>L</td> </tr> <tr> <td style="text-align: center;">8.00</td> <td>hours</td> </tr> <tr> <td style="text-align: center;">0.81</td> <td>L/s</td> </tr> </tbody> </table> <p>Infiltration Flow:</p> <p>Infiltration = 0.286 L/ha/s Total Infiltration = 0.42 L/s</p> <p>Total Peak Flow = 9.84 L/s</p> <p>Summary Table</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: center;">Hotel Peak Flow (L/s)</th> <th style="text-align: center;">Common Area Peak Flow (L/s)</th> <th style="text-align: center;">Restaurant Peak Flow (L/s)</th> <th style="text-align: center;">Infiltration Flow (L/s)</th> <th style="text-align: center;">Total Peak Flow (L/s)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">5.61</td> <td style="text-align: center;">3.00</td> <td style="text-align: center;">0.81</td> <td style="text-align: center;">0.42</td> <td style="text-align: center;">9.84</td> </tr> </tbody> </table>		Fairfield	TownePlace	Total		Unit Sewage Flow:	225	225	225	(L/d)/Bed-space	Number of Rooms:	114	113	227	Rooms	Number of Bed Spaces/Population:	274	271	545	Bed-space	Sanitary Flow (L/d):	61560	61020	122580	L/d	Sanitary Flow (L/s):	0.71	0.71	1.42	L/s	Public-use Washrooms		3.00	L/s	Restaurant		372	m ²	186	seats	125	L/seat	23250	L	8.00	hours	0.81	L/s	Hotel Peak Flow (L/s)	Common Area Peak Flow (L/s)	Restaurant Peak Flow (L/s)	Infiltration Flow (L/s)	Total Peak Flow (L/s)	5.61	3.00	0.81	0.42	9.84	<p>MECP, Design Guidelines for Sewage Works (2024), Table 5-3 Common Sewage Flow Rates for Commercial and Institutional Uses</p> <p>2.4 occupied bed-spaces (population) per room (industry statistic - conservative).</p> <p>$M = 1 + (14 / (4 + (P / 1000)^{(1/2)}))$ Population (P): The total number of available bed-spaces (potential guests).</p> <p>55% of restaurant floorplate for seating patrons. 1.1 m² per restaurant patron (OBC, Table 3.1.17.1)</p> <p>The Ontario Building Code (OBC) Sewage System Design Flows: Food Service Operations, Restaurant (not 24hr) (OBC, Table 8.2.1.3.B Sewage)</p> <p>*Assume 8 hours of business operation.</p> <p>City of Niagara Falls Engineering Design Guidelines, Section 3 Sanitary Drainage Systems, Design Flows (</p> <p>Total Peak Flow = Peak Flow + Total Infiltration</p>
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APPENDIX D

Preliminary Stormwater Management



Project: 524 York Road
Project No.: 2570-7661
Created By: AM
Checked By: RB
Date: 2025-11-07
Updated: 2025-12-03

Modified Rational Calculations - Input Parameters

Storm Data: Town of Niagara-on-the-Lake

Time of Concentration: $T_c = 10.00$ min

Return Period	A	B	C	I (mm/hr)
2 yr	567	5.20	0.746	74.46
5 yr	664	4.70	0.744	89.88
10 yr	724	4.30	0.739	101.38
25 yr	821	4.00	0.735	118.02
50 yr	900	3.80	0.734	131.09
100 yr	980	3.70	0.732	144.26

Pre-Development Conditions

Land Use	Area (ha)	Area (m ²)	%Imp	Weighted Average C
Catchment 101 - Existing Site to DF	1.05	10500	0%	0.20
Catchment 102 - York Rd Frontage	0.13	1300	0%	0.20
Total Site	1.18	11800	-	0.20

Post Development Conditions

Land Use	Area (ha)	Area (m ²)	%Imp	Weighted Average C
Catchment 201 - Captured				
Buildings	0.21	2130	100%	0.90
At-Grade	0.91	9070	93%	0.85
Total Subcatchment	1.12	11200	94%	0.86
Catchment 202 - Uncontrolled				
York Street Frontage	0.07	700	14%	0.30
Total Subcatchment	0.07	700	14%	0.30
Total Site	1.19	11900	90%	0.83

References

Per Design Criteria for Sewers and Watermains, City of Toronto (January 2021)

$$I = A / (T+B)^C$$

$$Q = 0.0028 \cdot C \cdot I \cdot A$$



Project: 524 York Road
Project No.: 2570-7661
Created By: AM
Checked By: RB
Date: 2025-11-07
Updated: 2025-12-03

Modified Rational Calculations - Peak Flows

Storm Data: Town of Niagara-on-the-Lake

Time of Concentration: $T_c = 10.00$ min

Return Period	A	B	C	I (mm/hr)
2 yr	567	5.20	0.746	74.46
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25 yr	821	4.00	0.735	118.02
50 yr	900	3.80	0.734	131.09
100 yr	980	3.70	0.732	144.26

Pre-Development Conditions

Land Use	Area (ha)	C	Q2	Q5	Q10	Q25	Q50	Q100
C101 - Ex Site to DF	1.05	0.2	43.5	52.5	59.2	68.9	76.5	84.2
C102 - York Rd Frontage	0.13	0.2	5.4	6.5	7.3	8.5	9.5	10.4
Total Site	1.05	0.2	48.9	59.0	66.5	77.4	86.0	94.6

Post Development Conditions

Land Use	Area (ha)	C	Q2	Q5	Q10	Q25	Q50	Q100
Catchment 201 - Captured								
Buildings	0.21	0.90	39.7	47.9	54.0	62.9	69.9	76.9
At-Grade	0.91	0.85	159.6	192.6	217.3	252.9	309.2	309.2
Total Subcatchment	1.12	0.86	199.3	240.5	271.3	315.8	379.0	386.1
Catchment 202 - Uncontrolled								
York Street Frontage	0.07	0.30	4.3	5.2	5.9	6.9	7.7	8.4
Total Subcatchment	0.07	0.30	4.3	5.2	5.9	6.9	7.7	8.4
Total Site	1.19	0.83	203.6	245.8	277.2	322.7	386.7	394.5

References

Per Design Criteria for Sewers and Watermains, City of Toronto (January 2021)

$$I = A / (T+B)^C$$

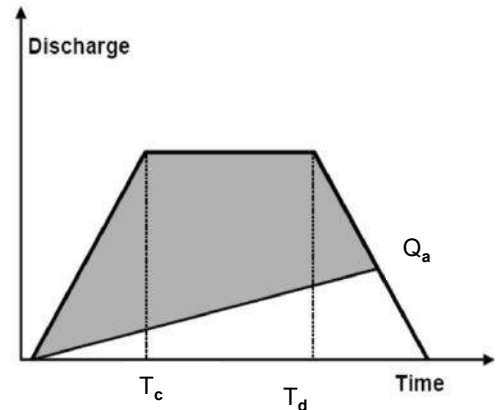
$$Q = 0.0028 \cdot C \cdot I \cdot A$$

(2 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF			Post Development		
A	567		Area	C	
B	5.20		C201	1.12	0.86
C	0.746		C202	0.07	0.30

Allowable =	Predev 5-year	- Q100(C202)		
=	52.47	-8.42	L/s	
=	44.05		L/s	<- Maximum Orifice Release Rate
=	38.27		L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
=	0.038		m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	100.27	300	0.270	63.86
10	74.46	600	0.201	97.46
15	60.23	900	0.162	117.40
20	51.07	1200	0.138	130.73
25	44.62	1500	0.120	140.20
30	39.80	1800	0.107	147.16
35	36.04	2100	0.097	152.35
40	33.03	2400	0.089	156.23
45	30.54	2700	0.082	159.10
50	28.45	3000	0.077	161.17
60	25.13	3600	0.068	163.46
70	22.59	4200	0.061	163.89
80	20.58	4800	0.055	162.95
90	18.95	5400	0.051	160.95
100	17.59	6000	0.047	158.10
110	16.43	6600	0.044	154.57
120	15.44	7200	0.042	150.47
130	14.58	7800	0.039	145.87
140	13.83	8400	0.037	140.86
150	13.16	9000	0.035	135.48
160	12.56	9600	0.034	129.78
170	12.02	10200	0.032	123.80
180	11.53	10800	0.031	117.56
190	11.09	11400	0.030	111.10
200	10.68	12000	0.029	104.43
210	10.31	12600	0.028	97.57
Required Storage Volume:				163.89



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

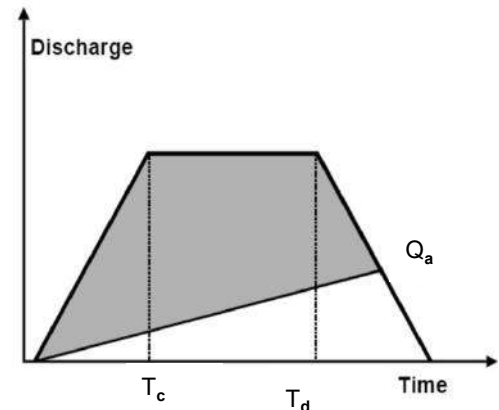
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(5 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF		Post Development		
A	664	Area	C	
B	4.70	C201	1.12	0.86
C	0.744	C202	0.07	0.30

Allowable =	Predev 5-year	- Q100(C202)		
=	52.47	-8.42	L/s	
=	44.05		L/s	<- Maximum Orifice Release Rate
=	38.27		L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
=	0.038		m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	122.46	300	0.330	81.81
10	89.88	600	0.242	122.40
15	72.29	900	0.195	146.66
20	61.09	1200	0.165	163.16
25	53.26	1500	0.144	175.17
30	47.44	1800	0.128	184.25
35	42.92	2100	0.116	191.28
40	39.30	2400	0.106	196.79
45	36.31	2700	0.098	201.13
50	33.81	3000	0.091	204.54
60	29.84	3600	0.080	209.22
70	26.82	4200	0.072	211.74
80	24.42	4800	0.066	212.67
90	22.48	5400	0.061	212.36
100	20.86	6000	0.056	211.07
110	19.49	6600	0.053	208.97
120	18.32	7200	0.049	206.21
130	17.29	7800	0.047	202.87
140	16.40	8400	0.044	199.04
150	15.60	9000	0.042	194.78
160	14.89	9600	0.040	190.15
170	14.25	10200	0.038	185.19
180	13.67	10800	0.037	179.92
190	13.15	11400	0.035	174.39
200	12.67	12000	0.034	168.62
210	12.23	12600	0.033	162.62
Required Storage Volume:				212.67



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

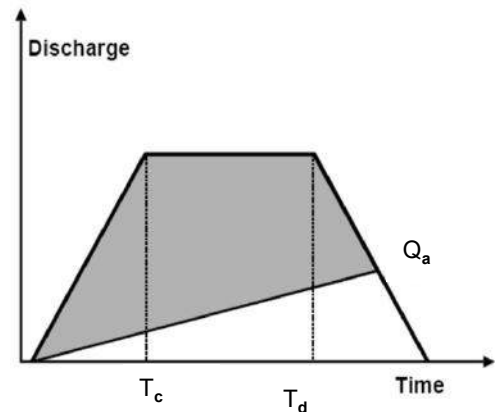
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(50 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF		Post Development		
A	724	Area	C	
B	4.30	C201	1.12	0.86
C	0.739	C202	0.07	0.30

Allowable =	Predev 5-year	- Q100(C202)		
=	52.47	-8.42	L/s	
=	44.05		L/s	<- Maximum Orifice Release Rate
=	38.27		L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
=	0.038		m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	139.33	300	0.376	95.44
10	101.38	600	0.273	140.99
15	81.23	900	0.219	168.35
20	68.51	1200	0.185	187.16
25	59.67	1500	0.161	201.05
30	53.11	1800	0.143	211.74
35	48.03	2100	0.129	220.18
40	43.96	2400	0.118	226.96
45	40.62	2700	0.109	232.46
50	37.82	3000	0.102	236.93
60	33.38	3600	0.090	243.52
70	30.00	4200	0.081	247.73
80	27.32	4800	0.074	250.19
90	25.15	5400	0.068	251.28
100	23.35	6000	0.063	251.28
110	21.82	6600	0.059	250.38
120	20.51	7200	0.055	248.74
130	19.37	7800	0.052	246.46
140	18.37	8400	0.050	243.63
150	17.48	9000	0.047	240.33
160	16.69	9600	0.045	236.61
170	15.97	10200	0.043	232.51
180	15.33	10800	0.041	228.08
190	14.74	11400	0.040	223.35
200	14.21	12000	0.038	218.35
210	13.71	12600	0.037	213.10
Required Storage Volume:				251.40



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

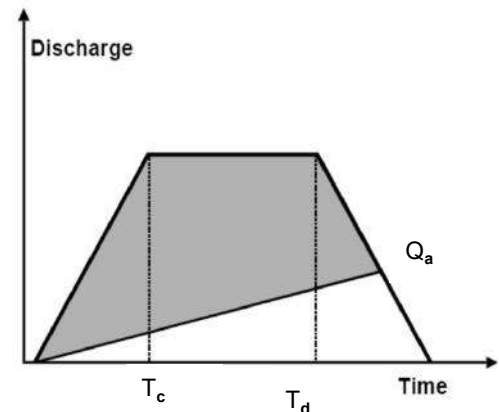
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(50 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF		Post Development			
A	821	Area	C		
B	4.00	C201	1.12	0.86	
C	0.735	C202	0.07	0.30	

Allowable =	Predev 5-year	- Q100(C202)		
=	52.47	-8.42	L/s	
=	44.05		L/s	<- Maximum Orifice Release Rate
=	38.27		L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
=	0.038		m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	163.30	300	0.440	114.82
10	118.02	600	0.318	167.90
15	94.29	900	0.254	200.03
20	79.41	1200	0.214	222.41
25	69.10	1500	0.186	239.20
30	61.48	1800	0.166	252.34
35	55.58	2100	0.150	262.93
40	50.86	2400	0.137	271.63
45	46.99	2700	0.127	278.86
50	43.76	3000	0.118	284.93
60	38.62	3600	0.104	294.37
70	34.71	4200	0.094	301.09
80	31.62	4800	0.085	305.80
90	29.11	5400	0.078	308.94
100	27.03	6000	0.073	310.82
110	25.26	6600	0.068	311.68
120	23.75	7200	0.064	311.67
130	22.43	7800	0.060	310.93
140	21.28	8400	0.057	309.56
150	20.25	9000	0.055	307.63
160	19.34	9600	0.052	305.22
170	18.52	10200	0.050	302.38
180	17.77	10800	0.048	299.16
190	17.09	11400	0.046	295.58
200	16.47	12000	0.044	291.69
210	15.90	12600	0.043	287.51
Required Storage Volume:				311.77



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

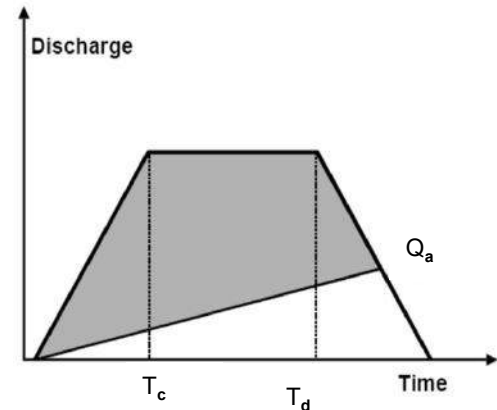
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(50 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF		Post Development		
A	900	Area	C	
B	3.80	C201	1.12	0.86
C	0.734	C202	0.07	0.30

Allowable =	Predev 5-year	- Q100(C202)		
=	52.47	-8.42	L/s	
=	44.05		L/s	<- Maximum Orifice Release Rate
=	38.27		L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
=	0.038		m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	182.39	300	0.492	130.26
10	131.09	600	0.353	189.04
15	104.47	900	0.282	224.74
20	87.87	1200	0.237	249.77
25	76.39	1500	0.206	268.68
30	67.92	1800	0.183	283.62
35	61.38	2100	0.165	295.78
40	56.16	2400	0.151	305.87
45	51.87	2700	0.140	314.36
50	48.29	3000	0.130	321.59
60	42.61	3600	0.115	333.09
70	38.29	4200	0.103	341.62
80	34.88	4800	0.094	347.95
90	32.11	5400	0.087	352.56
100	29.81	6000	0.080	355.79
110	27.86	6600	0.075	357.90
120	26.19	7200	0.071	359.06
130	24.74	7800	0.067	359.42
140	23.47	8400	0.063	359.09
150	22.34	9000	0.060	358.15
160	21.33	9600	0.057	356.68
170	20.42	10200	0.055	354.73
180	19.60	10800	0.053	352.36
190	18.85	11400	0.051	349.60
200	18.17	12000	0.049	346.50
210	17.54	12600	0.047	343.08
Required Storage Volume:				359.42



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

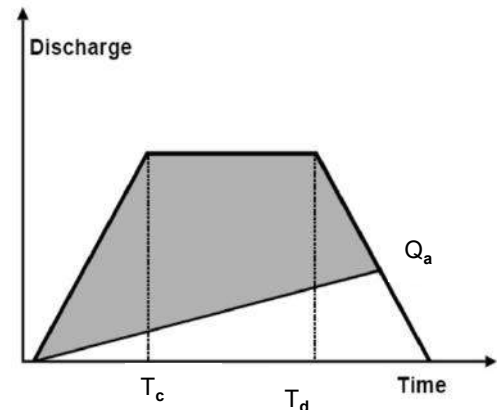
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(100 Year) Modified Rational Calculation - Storage Volume - TOTAL SITE

IDF		Post Development			
A	980	Area	C		
B	3.70	C201	1.12	0.86	
C	0.732	C202	0.07	0.30	

Allowable =	Predev 5-year	- Q100(C202)		
= 52.47		-8.42	L/s	
= 44.05			L/s	<- Maximum Orifice Release Rate
= 38.27			L/s	<- Actual Orifice Release Rate (<= Allowable Rate)
= 0.038			m3/s	

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
5	201.14	300	0.542	145.42
10	144.26	600	0.389	210.34
15	114.88	900	0.310	249.98
20	96.59	1200	0.260	277.96
25	83.96	1500	0.226	299.26
30	74.65	1800	0.201	316.23
35	67.46	2100	0.182	330.16
40	61.72	2400	0.166	341.83
45	57.01	2700	0.154	351.75
50	53.07	3000	0.143	360.28
60	46.84	3600	0.126	374.12
70	42.10	4200	0.113	384.70
80	38.35	4800	0.103	392.87
90	35.31	5400	0.095	399.15
100	32.79	6000	0.088	403.92
110	30.65	6600	0.083	407.45
120	28.81	7200	0.078	409.94
130	27.22	7800	0.073	411.55
140	25.82	8400	0.070	412.39
150	24.58	9000	0.066	412.57
160	23.47	9600	0.063	412.16
170	22.47	10200	0.061	411.23
180	21.57	10800	0.058	409.83
190	20.75	11400	0.056	408.01
200	20.00	12000	0.054	405.80
210	19.31	12600	0.052	403.25
Required Storage Volume:				412.57



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

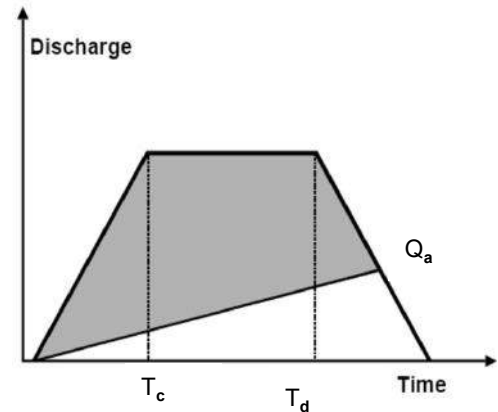
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(100 Year) Modified Rational Calculation - Storage Volume - HOTEL

IDF			Post Development		
A	980		Area	C	
B	3.70	Hotel		0.18	0.90
C	0.732				

Allowable =	2.20	L/s	#Roof Drains	2
	= 0.002	m3/s	# Notches/drain	1
	= 12.5	L/s/ha	Release Rater/drain/notch	1.1

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
50	53.07	3000	0.024	66.66
100	32.79	6000	0.015	79.98
150	24.58	9000	0.011	87.56
200	20.00	12000	0.009	92.59
250	17.03	15000	0.008	96.15
300	14.93	18000	0.007	98.74
350	13.35	21000	0.006	100.62
400	12.12	24000	0.005	101.98
450	11.13	27000	0.005	102.91
500	10.31	30000	0.005	103.51
600	9.03	36000	0.004	103.91
700	8.07	42000	0.004	103.49
800	7.32	48000	0.003	102.44
900	6.72	54000	0.003	100.90
1000	6.22	60000	0.003	98.96
1100	5.81	66000	0.003	96.69
1200	5.45	72000	0.002	94.13
1250	5.29	75000	0.002	92.76
1300	5.14	78000	0.002	91.34
1350	5.00	81000	0.002	89.86
1400	4.87	84000	0.002	88.33
1450	4.75	87000	0.002	86.76
1500	4.63	90000	0.002	85.14
1550	4.52	93000	0.002	83.48
1600	4.42	96000	0.002	81.78
1650	4.32	99000	0.002	80.05
Required Storage Volume:				103.91



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

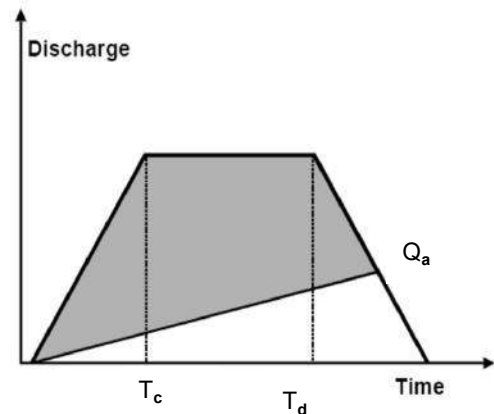
$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$

(100 Year) Modified Rational Calculation - Storage Volume - RESTAURANT

IDF			Post Development		
A	980		Area	C	
B	3.70	Hotel		0.037	0.90
C	0.732				

Allowable = 1.10	L/s		#Roof Drains	1
= 0.001	m3/s	L/s	# Notches/drain	1
= 29.7	L/s/ha	m3/s	Release Rater/drain/notch	1.1

Storage Volume Determination				
T _d (min)	i (mm/hr)	T _d (sec)	Q _{post} (m ³ /s)	S _d (m ³)
10	144.26	600	0.013	7.41
20	96.59	1200	0.009	9.82
30	74.65	1800	0.007	11.21
40	61.72	2400	0.006	12.16
50	53.07	3000	0.005	12.87
60	46.84	3600	0.004	13.41
70	42.10	4200	0.004	13.85
80	38.35	4800	0.004	14.19
90	35.31	5400	0.003	14.48
100	32.79	6000	0.003	14.71
120	28.81	7200	0.003	15.05
140	25.82	8400	0.002	15.27
160	23.47	9600	0.002	15.40
180	21.57	10800	0.002	15.45
200	20.00	12000	0.002	15.45
220	18.68	13200	0.002	15.40
240	17.54	14400	0.002	15.30
250	17.03	15000	0.002	15.24
260	16.56	15600	0.002	15.17
270	16.11	16200	0.002	15.10
280	15.69	16800	0.001	15.01
290	15.30	17400	0.001	14.92
300	14.93	18000	0.001	14.83
310	14.58	18600	0.001	14.73
320	14.25	19200	0.001	14.62
330	13.94	19800	0.001	14.51
Required Storage Volume:				15.46



$$Q_{\text{post}} \text{ (L/s)} = 2.78 \cdot C_{\text{post}} \cdot i(T_d) \cdot A$$

$$S_d = Q_{\text{post}} \cdot T_d - Q_{\text{target}} (T_d + T_c) / 2$$



Project: 524 York Road
Project No.: 2570-7661
Created By: AM
Checked By: RB
Date: 2025-11-07
Updated: 2025-12-03

ORIFICE SIZING

Orifice Type	=	Tube	
Invert Elevation	=	112.10	m
Diameter of Orifice	=	100	mm
Area of Orifice (A)	=	0.0079	m ²
Orifice Coefficient (Cd)	=	0.820	

Calculation of Head

Centroid Elevation	=	112.15	m
Water Elevation	=	113.95	m
Upstream Head*, (h)	=	1.80	m

Allowable Release Rate = 44.05 L/s

$$Q_a = (C_d)(A)(2gh)^{0.5}$$

Actual Controlled Discharge, Qa	=	0.03827	m ³ /s
Qa	=	38.3	L/s



Project:
Project No:
Created By: AC/AM
Checked By: RB
Date:
Updated: 2025-12-03

STORAGE SUMMARY

Rooftop Storage

	Area (m ²)	Min # Drains	Max Depth (m)	Max Volume Provided (m ³)	Actual Volume Used (m ³)	Actual Storage Depth (m)
Hotel	1760	2.0	0.15	185	104	0.059
Restaurant	370	1.0	0.15	39	15	0.042
Total	2130	3.0	0.15	224	119	

Note: minimum Roof Drains based on 1 roof drain per maximum 900m² roof area

Note: Max Volume provided taken at 70% of total roof area

Ponding Storage

	Min CB Elev (m)	Max Pond Elev (m)	Max Pond Ht (m)	Total Ponded Area (m ²)	Max Ponding Volume (m ³)
Parking Lot	113.70	114.0	0.3	2000	240

Underground Storage

Underground (Pipe, MH, CB) & Modular Storage = **100**

<u>Total Storage Provided</u>	459.4	=Roof+Ponding+Underground
Total Storage Required @ 5-yr	212.7	
Total Storage Required @ 100-yr	412.6	



Project: 524 York Road
Project No.: 2570-7661
Created By: AM
Checked By: RB
Date: 2025-11-07
Updated: 2025-12-03

Pre and Post Development Controlled Flow Summary

Pre-Development Conditions

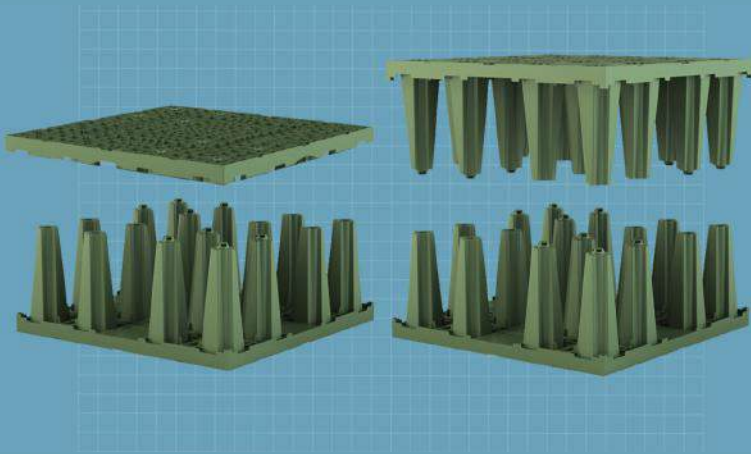
Catchment	Area (ha)	C	Q2	Q5	Q10	Q25	Q50	Q100
<i>C101 - Ex Site to DF</i>	1.05	0.2	43.5	52.5	59.2	68.9	76.5	84.2
<i>C102 - York Rd Frontage</i>	0.13	0.2	5.4	6.5	7.3	8.5	9.5	10.4
Total Site	1.05	0.2	48.9	59.0	66.5	77.4	86.0	94.6

Post-Development Controlled Flows

Catchment	Area (ha)	C	Q2	Q5	Q10	Q25	Q50	Q100
<i>C201 - Phase 2 to Phase 1 HW</i>	1.12	0.9	33	34	35	36	37	38
<i>C202 - York Rd Frontage</i>	0.07	0.3	4.3	5.2	5.9	6.9	7.7	8.4
Total Site	1.12	0.86	37.3	39.2	40.9	42.9	44.7	46.7

Change from Pre to Post Dev Flows

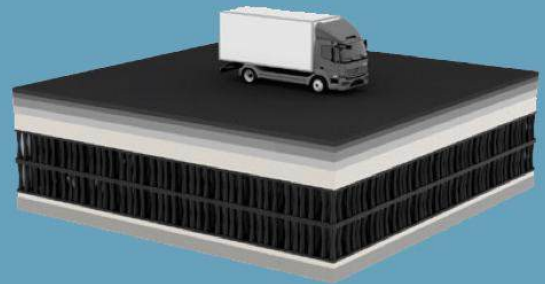
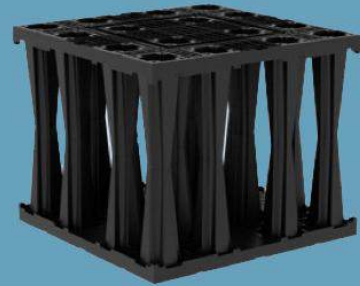
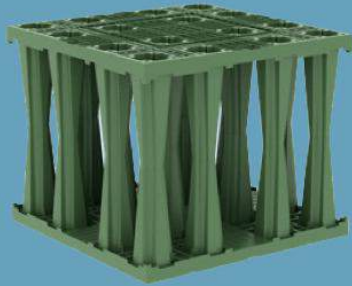
Catchment	Area (ha)	C	Q2	Q5	Q10	Q25	Q50	Q100
<i>To Drainage Feature</i>	0.07	0.66	-10.5	-18.5	-24.2	-32.9	-39.5	-45.9
<i>To York Road</i>	-0.06	0.10	-1.0	-1.2	-1.4	-1.6	-1.8	-2.0
Total Site	0.07	0.66	-11.5	-19.7	-25.6	-34.5	-41.4	-48.0



GREENSTORM ST GREENSTORM ST-B

UNDERGROUND STORAGE INFILTRATION MODULES

Certification CSTB

**EXTREMELY HIGH VOLUME VERY EASY TO INSTALL 100% INSPECTABLE****NB**

In what follows, an illustrative explanation of the GreenStorm system will be given by means of the green module. All properties and advantages also apply to the GreenStorm ST-B system. The systems have been optimised for different installation situations.

In the following, please be sure to pay attention to these signs:

Statements marked with this sign apply to both GreenStorm ST and GreenStorm ST-B.

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STORING STORMWATER WITH STORAGE/ INFILTRATION SYSTEMS

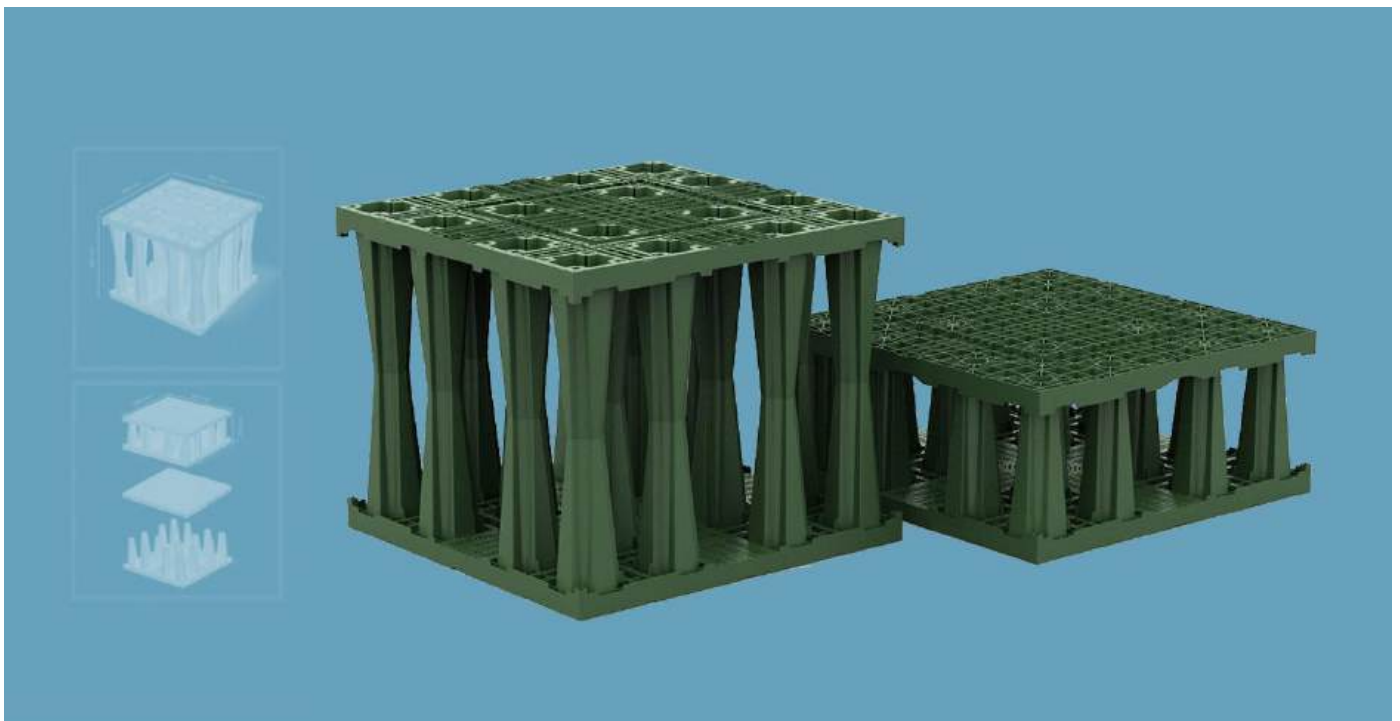
Basic element for underground water storage facilities

GreenStorm ST* are plastic tanks to be installed underground (storage/ infiltration modules) in which water is collected and stored. Storage/infiltration systems temporarily collect stormwater and discharge it later. In addition to infiltration using underdrained swale systems, pipe swales, and gravel swales common in the past, increasingly more storage/infiltration systems are being built today.

The storage space of the storage/ infiltration system consists of numerous GreenStorm ST* modules which can be combined three - dimensionally to form large systems.

The advantage of this method is that the void ratio is up to three times larger in these infiltration systems than in gravel swales which saves space and excavation work.

GreenStorm ST* is a modular system which is characterised by high flexibility, rapid installation and a high level of user-friendliness.



APPLICATION – INFILTRATION

Stormwater infiltration – giving back to nature

Large amounts of stormwater can reduce the performance of wastewater treatment systems. Infiltrating unpolluted stormwater nearby has therefore several advantages.

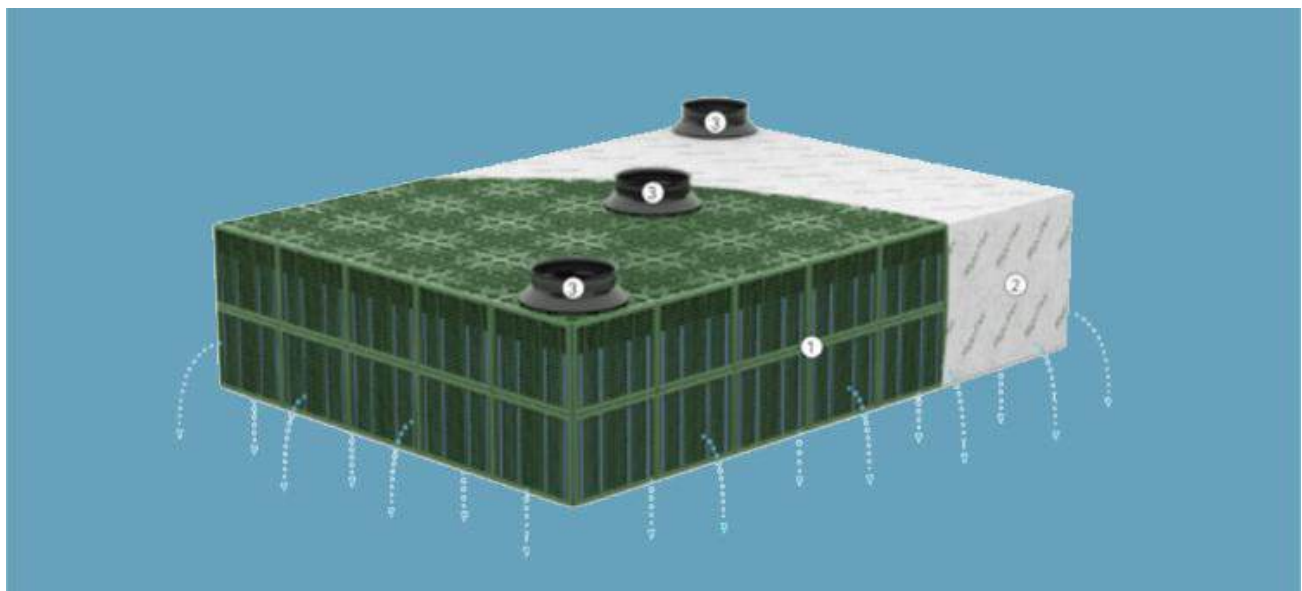
A constant growth in built-up areas and increase in impervious surfaces prevent natural infiltration of stormwater into the soil. Special infiltration systems are used in order to discharge it to the water cycle. In addition to infiltration using pipe swales, increasingly more storage/infiltration systems are being built.

The advantage of this method is that the storage volume of the infiltration system is increased, and space and excavation are saved as compared to gravel swales.

Stormwater is thus returned to the natural water cycle and can contribute to producing new groundwater. Infiltration systems are subject to very high requirements. Consequently, they have become an important component of urban drainage.

Storage/infiltration systems considerably increase the underground storage volume. High-performance storage/infiltration systems can be installed even in confined space.

In particular in urban construction no additional space is required and precious building ground is saved.



① GreenStorm ST* storage/infiltration module ② Geotextile ③ QuadrControl ST system shaft

APPLICATION – RETENTION

Retaining stormwater – instead of flooding

If subsoil conditions are unfavourable to infiltration, the goal is to retain the stormwater and ensure a retarded, timelagged discharge. Exposure to impulsive stress can be eliminated or reduced in sewer networks, wastewater treatment systems and waterbodies.

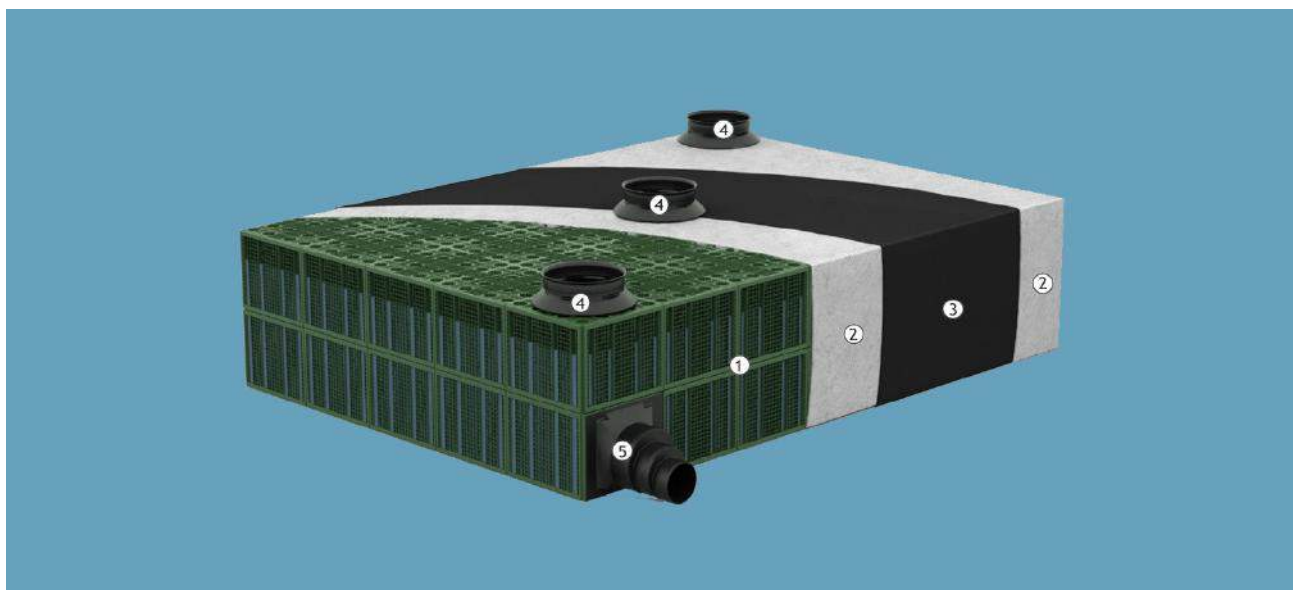
Stormwater retention systems retard the infiltration of stormwater. They are comprised of a watertight retaining element, an inlet and a vortex outlet.

The stormwater distributes evenly in the system where it can be stored and is then discharged in a controlled manner through throttle shafts. If infiltration must be avoided or to prevent unintended

discharge of groundwater or strata water (e.g., in case of contaminated soil), it is necessary to waterproof the retention system.

Stormwater runoff from impervious surfaces that cannot infiltrate naturally leads to peak loads in sewer systems.

Stormwater retention facilities collect stormwater in an underground storage tank and discharge it in a retarded manner but continuously. Their very short construction times make storage/ infiltration systems an inexpensive alternative to conventional retention facilities such as retention channels or underground concrete tanks.



- ① GreenStorm ST* storage/infiltration module
- ② Geotextile
- ③ Impermeable membrane
- ④ QuadroControl ST system shaft
- ⑤ Adapter

APPLICATION – HARVESTING / FIRE WATER STORAGE

Retaining stormwater – instead of flooding

Water – particularly drinking water – is a priceless resource which should be treated responsibly and used sparingly. It is therefore wise to collect, store and use stormwater if the water must not necessarily be suitable for drinking purposes, instead of allowing the water to infiltrate into the soil unused or diverting it into the sewer system.

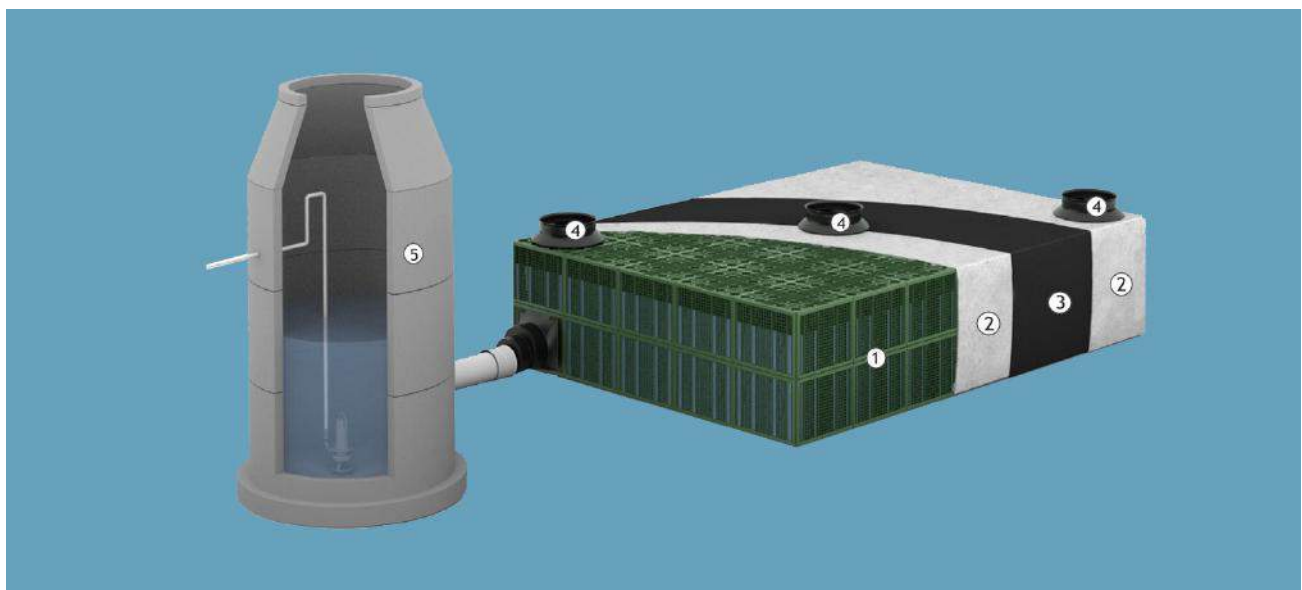
There are many examples: irrigation for greens, car wash, use in toilets, etc.

Water is diverted into a waterproof storage/ infiltration system and can be supplied for use via a pumping system

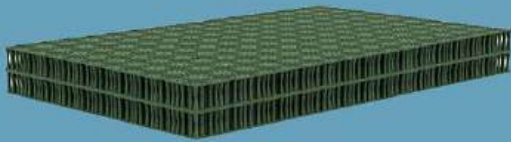
The use of the GreenStorm inspect system allows for finding solutions that fit project-specific requirements – even under the most difficult conditions such as very tight space, narrow conditions, low cover, high groundwater level, etc.

Stormwater harvesting systems provide water for different domestic and industrial water uses. They comprise a watertight retaining element, an inlet with upstream stormwater treatment system, a pump shaft and a system control.

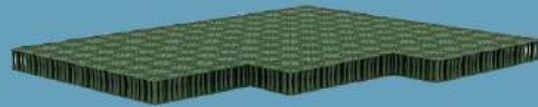
Using GreenStorm ST* for fire water storage also saves water, since system checks can be made in a filled state and water does not have to be pumped out as is the case with conventional concrete tanks.



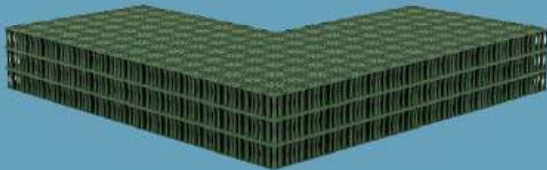
- ① GreenStorm ST* storage/infiltration module
- ② Geotextile
- ③ Impermeable membrane
- ④ QuadroControl ST system shaft
- ⑤ Adapter

POSSIBLE SYSTEM GEOMETRIES

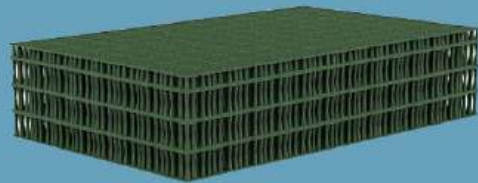
GreenStorm ST*
2 Layer



GreenStorm ST*
1 Layer



GreenStorm ST*
3 Layer



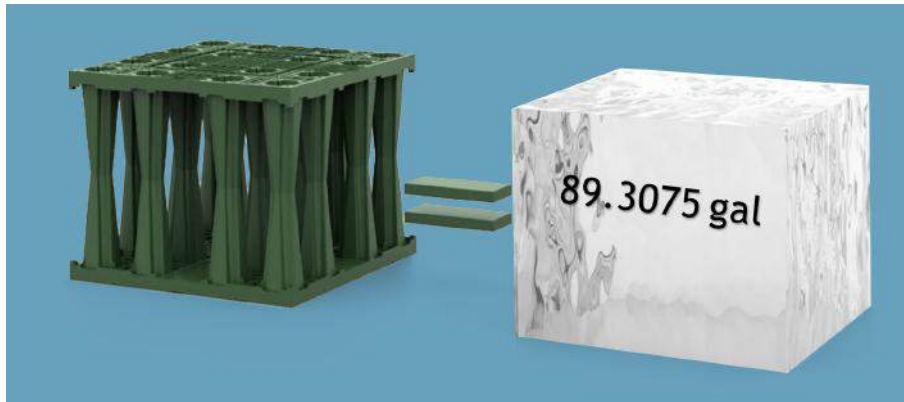
GreenStorm ST*
3 1/2 Layer

STORAGE VOLUME

Extremely high volume

The GreenStorm ST* full block provides a storage volume of 89.3075 gallons with a gross volume of 92.827 gallons. With a storage volume of more than 96 %, it stores three times as much water as gravel swales.

The half block has a height of 13.7795 in and is used if shallow systems are required, e.g, in case of high groundwater levels. With a gross volume of 49.2731 gallons, it offers a storage volume of 46.6335 gallons.



Pipe and gravel swales only use approx. 30 % of their volume to store water. Therefore, three times the required water storage volume must be provided by excavation.

Thus, subsoil storage spaces for stormwater can be built in a very efficient and cost-saving way.

This requires lots of space which is frequently not available in urban areas. GreenStorm ST* storage/infiltration systems save an enormous amount of space and excavation work.

Storage/infiltration systems considerably increase the storage space. High- performance storage/infiltration systems can be installed even in confined space.



INSTALLATION

Easy construction site handling

REQUIRES LITTLE SPACE FOR STORAGE.

The storage/infiltration modules are delivered in compact, stacked units with 17 modules per pallet. The easy stackability of the GreenStorm ST* and ST-B modules allows them to be stored even in confined construction space, even outside the excavation pit. This facilitates installation, since no additional storage space must be provided in the excavation pit. Installation is neither impeded nor constrained.



PRE-ASSEMBLY

Depending on the requirements, GreenStorm ST and GreenStorm ST*-B modules can be pre-assembled in no time at all, both outside and inside the excavation pit with just one easy move. Easy high tensile strength snap connections allow for combining two half elements to create a reliable unit in only a short period of time. This can easily be done by one person alone without requiring any additional tools. The moveable parts of the snap connection are recessed and thus protected from damage.



EASY ASSEMBLY

There is no need to adhere to any complex installation pattern – the pre-assembled modules or half blocks can just as well be connected to create a single unit. The low weight allows this to be done by one person only. Connectors establish firm connections between the individual modules. The surface can be accessed immediately without any risk of accidents, since the hole size of the columns is dimensioned respectively (< 3.93701 in). Thus, no additional covers of column holes are required.



UP TO 88%
The storage/infiltration modstorage space saved as compared to unstackable storage/infiltration modules

INSPECTION

CCTV inspection even when filled ■ ■

Storage/infiltration systems are durable structures for urban drainage; they must work reliably for decades. Durability and reliability are essential requirements. The best way to inspect the state of a system using state-of-the-art technology

is CCTV inspection. Thus, a storage/infiltration system can be inspected excellently – for final acceptance or later. This provides safety for authorities, engineers, construction companies, customers, and operators.

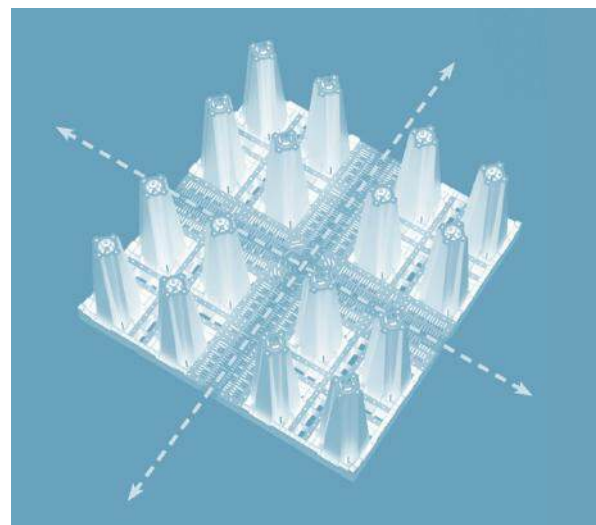
Cross-shaped inspection tunnel

GreenStorm ST* modules have a cross-shaped tunnel which makes the storage/infiltration system camera-accessible and flushable in two axes and thus in four dimensions. The special and open design of the inspection tunnel allows for an unobstructed view of the entire interior and not only the inspection tunnel.

The ideal, level and vibration-free running surface and the slim column structure allow for an unobstructed view of the entire module volume. The Quadro Control ST shaft for GreenStorm ST*, which can be integrated, allows for easy access of the automotive dolly for both professional final acceptance inspection and flushing technology.

For example, the statically relevant load-bearing elements, the condition of the geotextile and the entire soil area can be viewed. GreenStorm ST* and GreenStorm ST*-B thus provide excellent options to control the “inner life” of a storage/ infiltration system at any time.

100%
INSPECTABLE



INSPECTION

Recommended camera equipment

A standard sewer camera is sufficient for camera inspection. A rotatable and height-adjustable camera head allows for an optimal view of the lateral soil area,

a controllable carriage ensures a centred positioning, and high-performance optics together with lighting allow for a perfect picture.



Recommended: tender invitation for final acceptance inspection

Final acceptance of sewers using camera inspection has long since become a matter of course in sewer construction. Also in the construction of storage/ infiltration systems, the final acceptance inspection is important! Planning engineers should absolutely include this in their tender documents.



Certified CCTV accessibility

GreenStorm ST* has been designed for the use of modern CCTV inspection technology. The inspectability of the GreenStorm ST* and QuadroControl ST system unit has been tested and confirmed by leading manufacturers of pipe CCTV inspection technology.

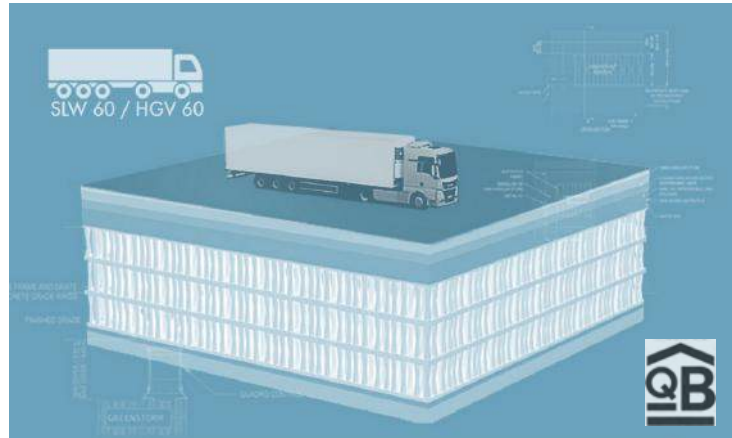


LOADING

Heavy traffic

Storage/infiltration systems are subsoil structures and must have sufficient load-carrying capacity against impacting soil and traffic loads.

GreenStorm ST* storage/ infiltration systems are extremely strong and have been designed with various applications in mind: While GreenStorm ST* has been designed in particular for traffic loads of up to 13 tons axle load.



High resistance

When installed under traffic areas, relevant national guidelines must be observed. To build the planum for the road construction, an upper levelling layer must be provided.

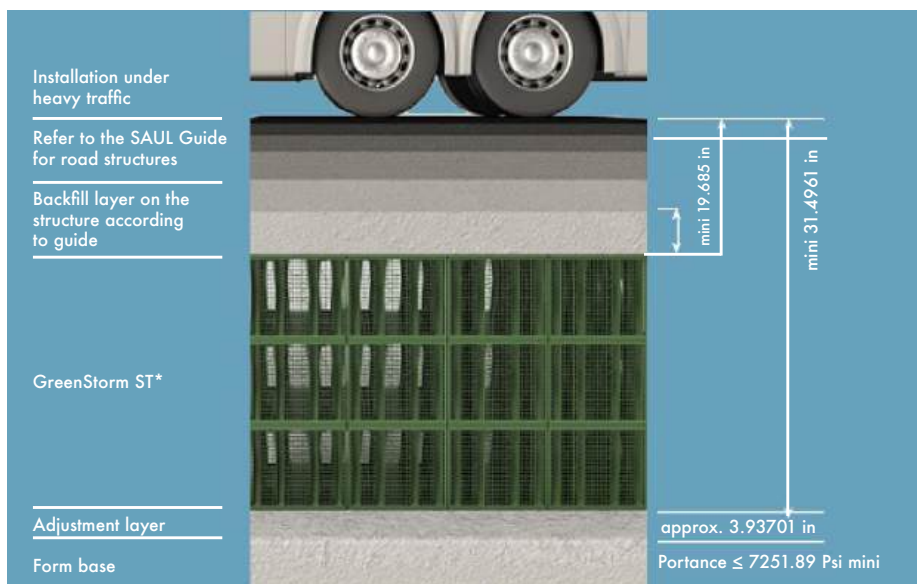
It should preferably be built as a gravel sub-base with a thickness of at least 13.7795 in, other materials usually result in larger covers.

Generally, a uniform modulus of deformation $EV2 \geq 45 \text{ MN/m}^2$ must be proven on the planum.

Installation under traffic area

The subsoil structures must have sufficient load-carrying capacity against impacting soil and traffic loads to ensure reliable stability.

This is why GreenStorm ST* is suitable for traffic loads of up to 15 tons axle load (20 tons possible, please refer to our technical department).



With conventional installation parameters*, depths of cover of DC 157.48 in and soil depths DSof 236.22 in are possible for infiltration systems. A project-specific stability analysis can be prepared by STORMCON.

*specific weight of soil 18 kN/m³ Mean soil temperature max. 73.4°F, 236.22 in. soil depth, = 0.3, 4-layer

LOADING

Light traffic, green spaces

The special material composition of GreenStorm ST-B* makes it ideal for surfaces with less traffic such as sports fields or green spaces. STORMCON storage/ infiltration systems have been designed for a minimum lifetime of 50 years.



Installation under traffic areas

When installed under traffic areas, relevant national guidelines must be observed. To build the planum for the road construction, an upper levelling layer must be provided.

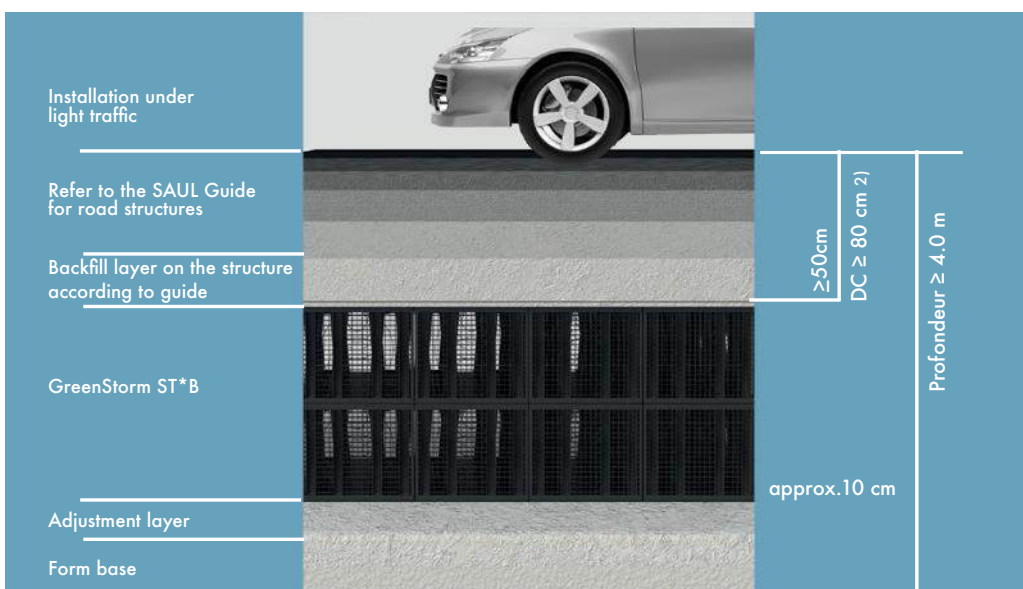
It should preferably be built as a gravel sub-base with a thickness of at least 13.7795 in, other materials usually result in larger covers.

Generally, a uniform modulus of deformation EV2 $\geq 45 \text{ MN/m}^2$ must be proven on the planum.

Standard installation under a traffic area

The GreenStorm ST-B* storage/infiltration module is suitable for traffic loads of up to 10 tons axle load and therefore also

suitable for the construction of systems under parks, greens and car parks.

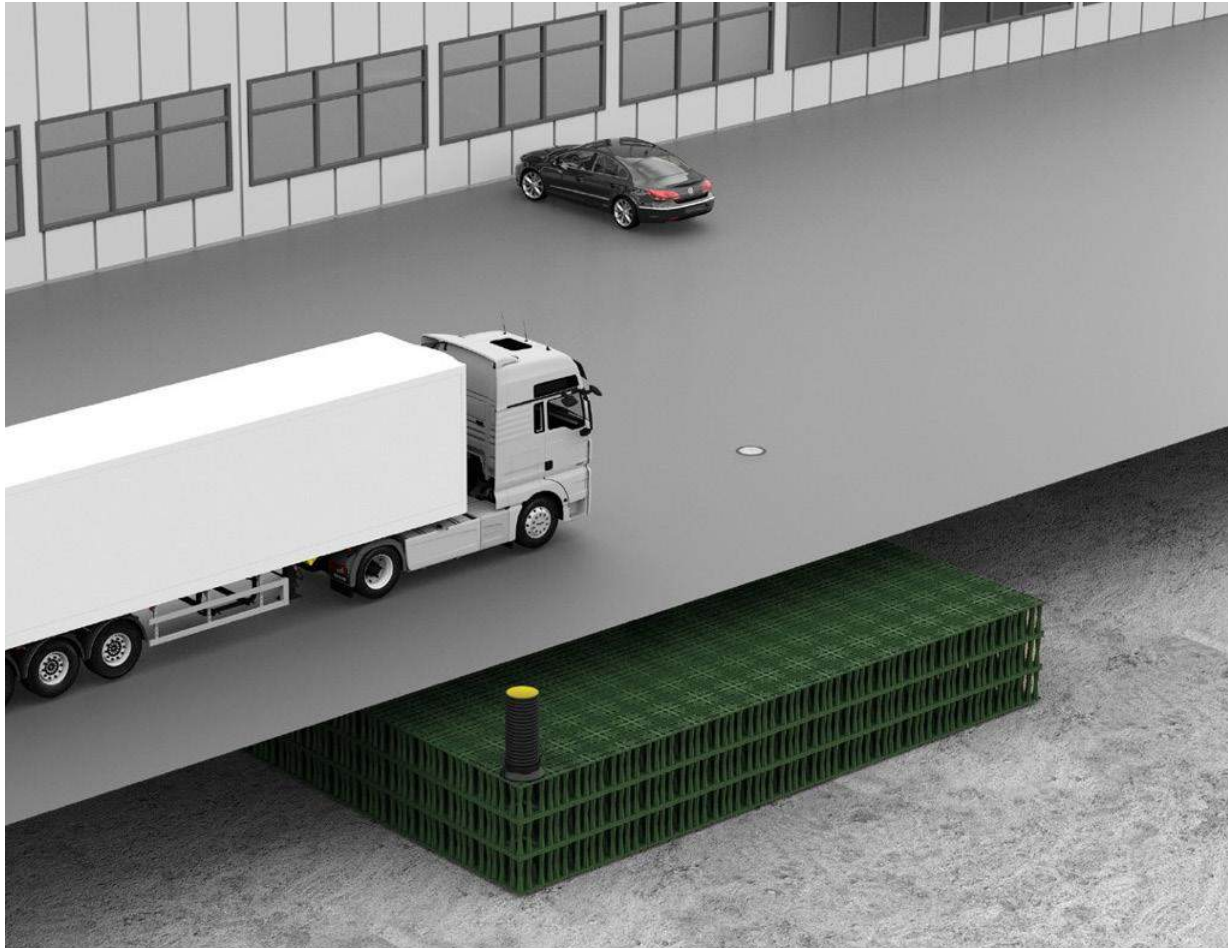


With conventional installation parameters*, depths of cover up to 2.5 m and soil depths up to 4m are possible for infiltration systems. A project-specific stability analysis can be prepared by STORMCON.

*Light traffic, specific weight of soil 18 kN/m^3
Mean soil temperature max. $23 \text{ }^\circ\text{C}$, $= 0.3$

LOADING

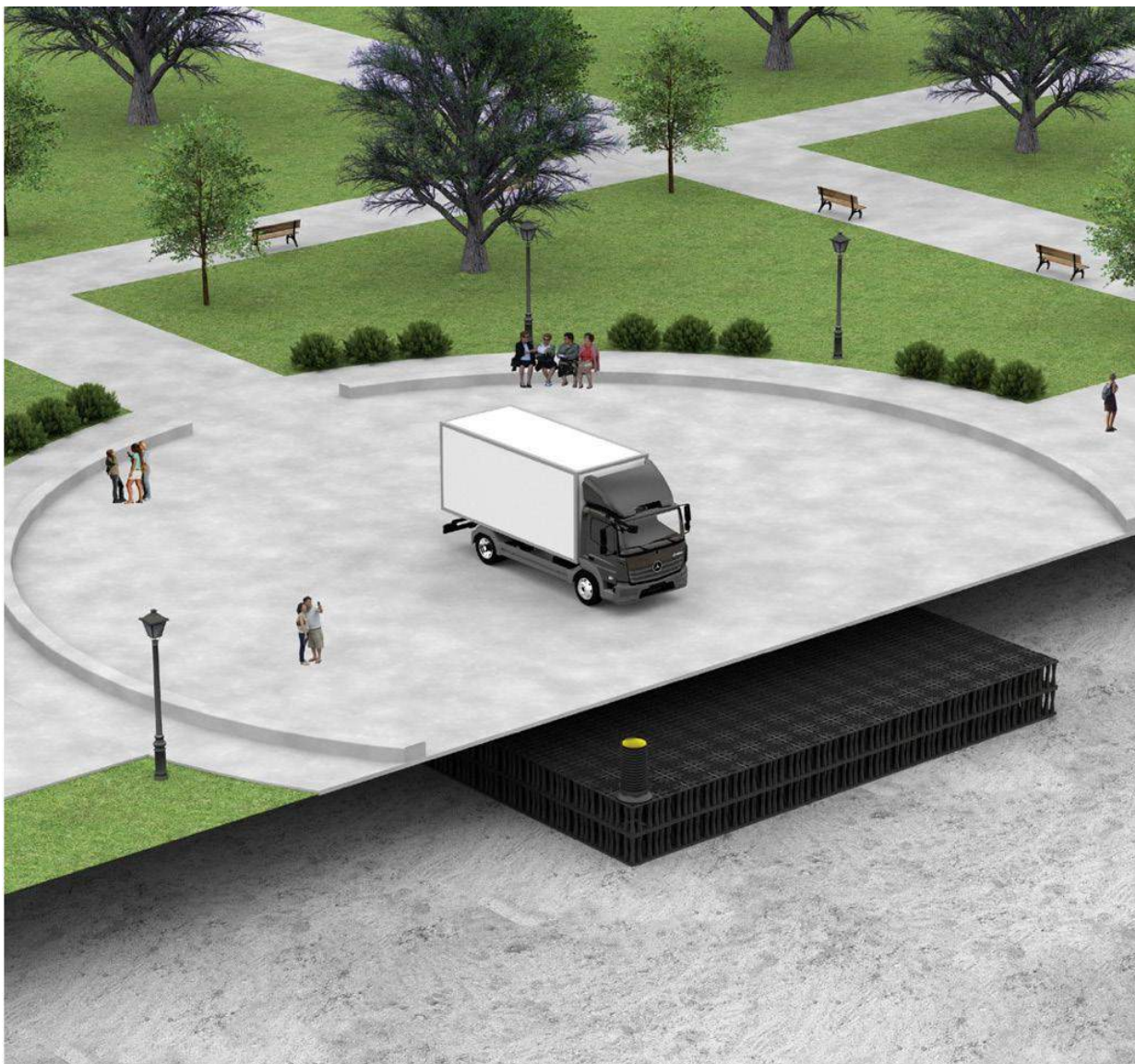
Heavy traffic example GreenStorm ST*



*GreenStorm ST/STB underground infiltration/storage modules *Rigofill ST RigofillST-B

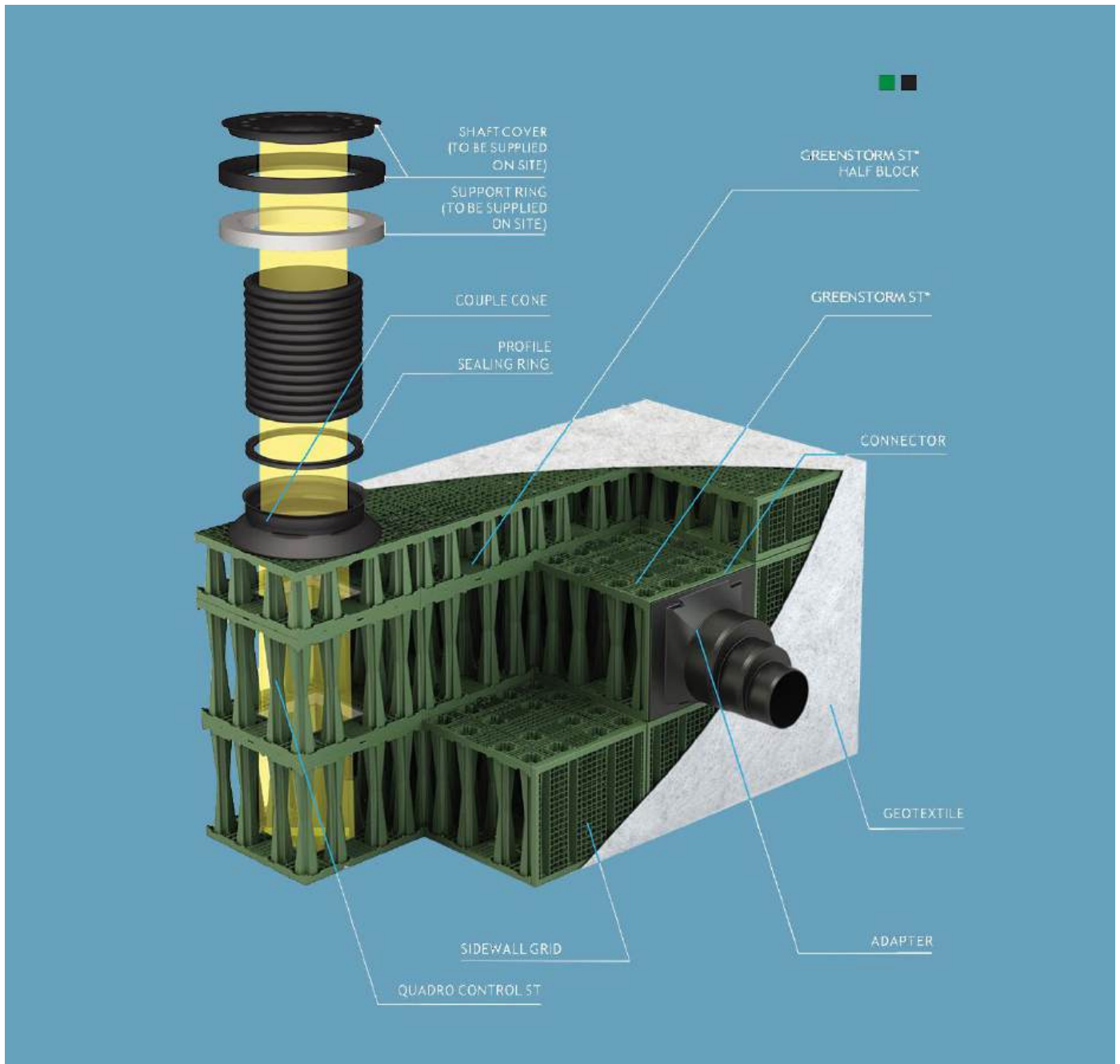
LOADING

Light traffic example GreenStorm ST*



*GreenStorm ST/STB underground infiltration/storage modules *Rigofill ST RigofillST-B

Quadro® Control ST – system shaft



INTEGRATED INSPECTION SHAFTS

Quadro® Control ST is a polypropylene inspection shaft which can be integrated in the storage/infiltration system.

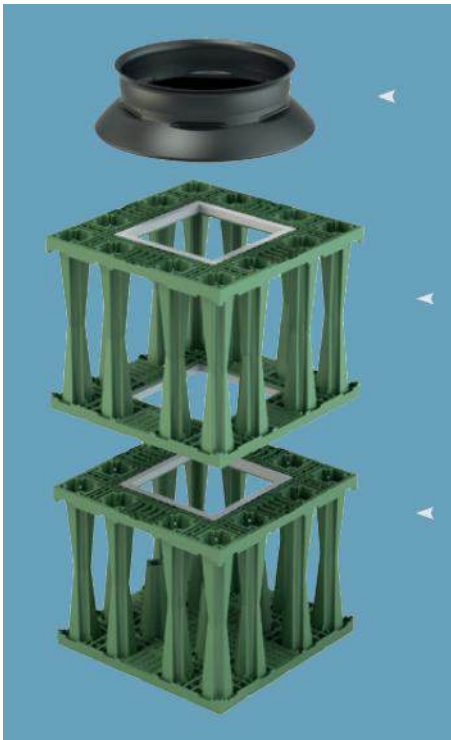
It is square with a base of 800 x 800 mm and can be used in any position of the layout.

Its height results from the number of layers of the connected storage/infiltration system. The shaft allows for comfortable access to the inspection tunnel from aboveground. High-performance inspection and flushing equipment can easily be inserted into the inspection

tunnel. The shaft is integrated in the storage/infiltration system and grows layer by layer as construction progresses. QuadroControl ST is delivered with all required components and will be assembled on site.



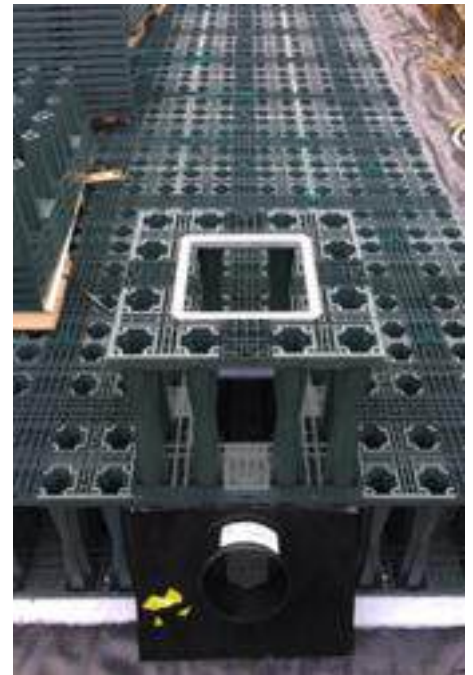
Structure



The shaft cone is the transition to the extension pipe. The length of the extension pipe is chosen depending on the installation depth.

The shaft is integrated in the storage/infiltration system and grows layer by layer as construction progresses.

The shaft components are stackable and delivery includes the cone with all required components as shaft package.



Arrangement of inspection shafts

Number of and position in the system are above all determined by the size of the system, access, pipe connections and design of the outdoor facilities.

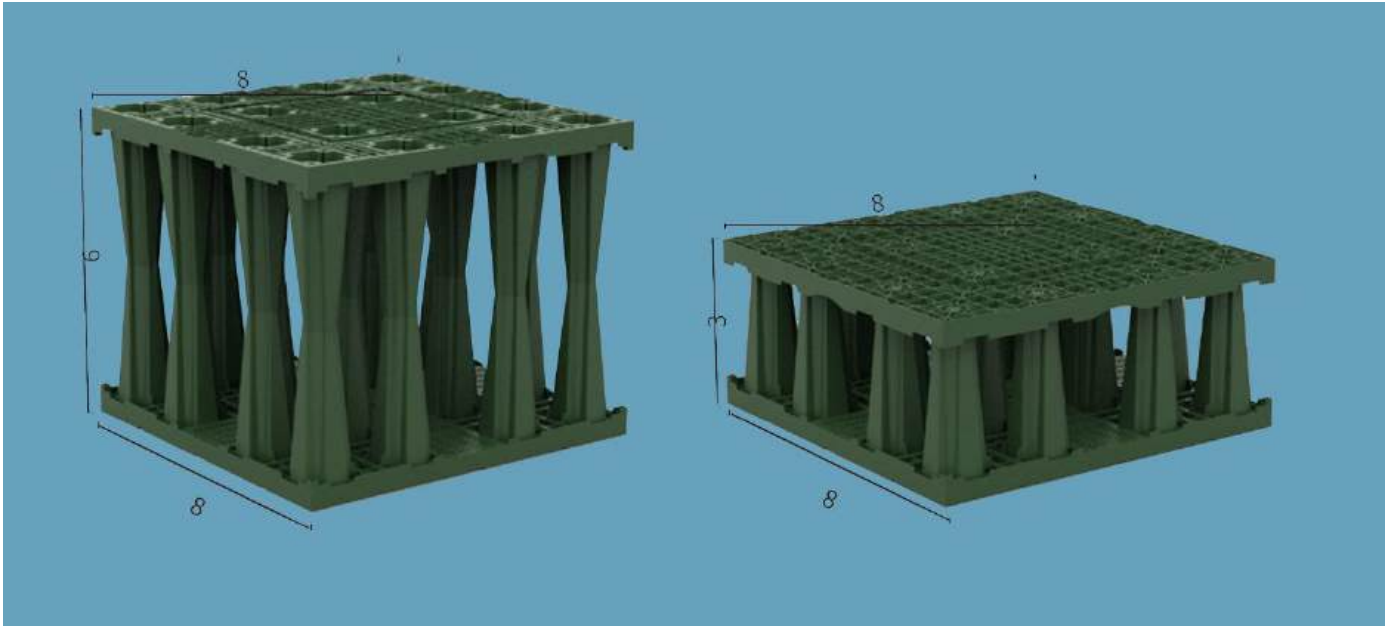
In order to ensure that flushing of the complete system is possible, each module should comprise at least one inspection shaft. In addition, the shafts should be positioned such that the shaft covers do

not interfere with the design of the outdoor facilities, but can easily be accessed by vehicles for maintenance purposes.

Adjacent shafts should be staggered in the layout.

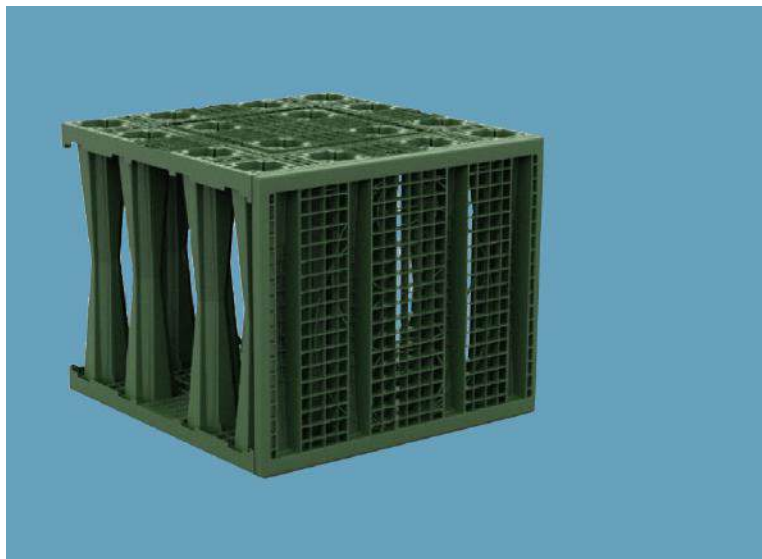


DESIGN-RELEVANT DIMENSIONS



Sidewall grid connection options

Full block connection options
 Dia 100 mm, 135 mm, 150 mm, 200 mm,
 250 mm, 300 mm, 375 mm et 450 mm



This allows all available nominal diameters to be realised both at the top and the bottom of the module.

SIDEWALL GRID CONNECTION OPTIONS



Sidewall grid connection options

Half block connection options
 Dia 100 mm, 135 mm, 150 mm,
 200 mm et 250 mm



The side plates can be drilled to the height and desired position within the frame.

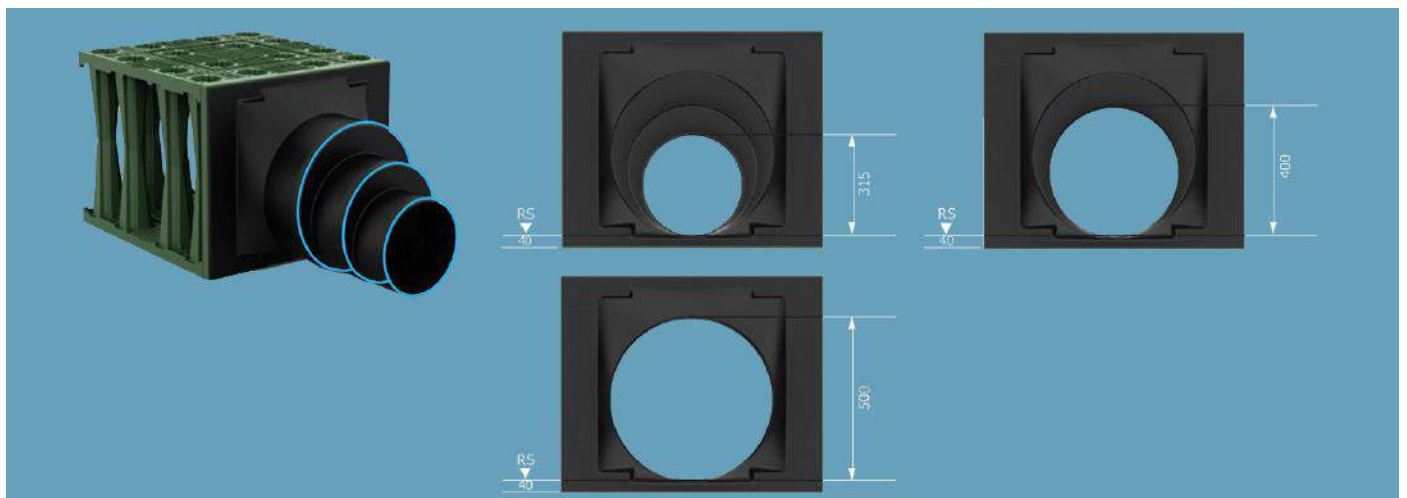


ADAPTER CONNECTION OPTIONS

Connections:
 Dia 300 mm, 450 mm
 et 525 mm

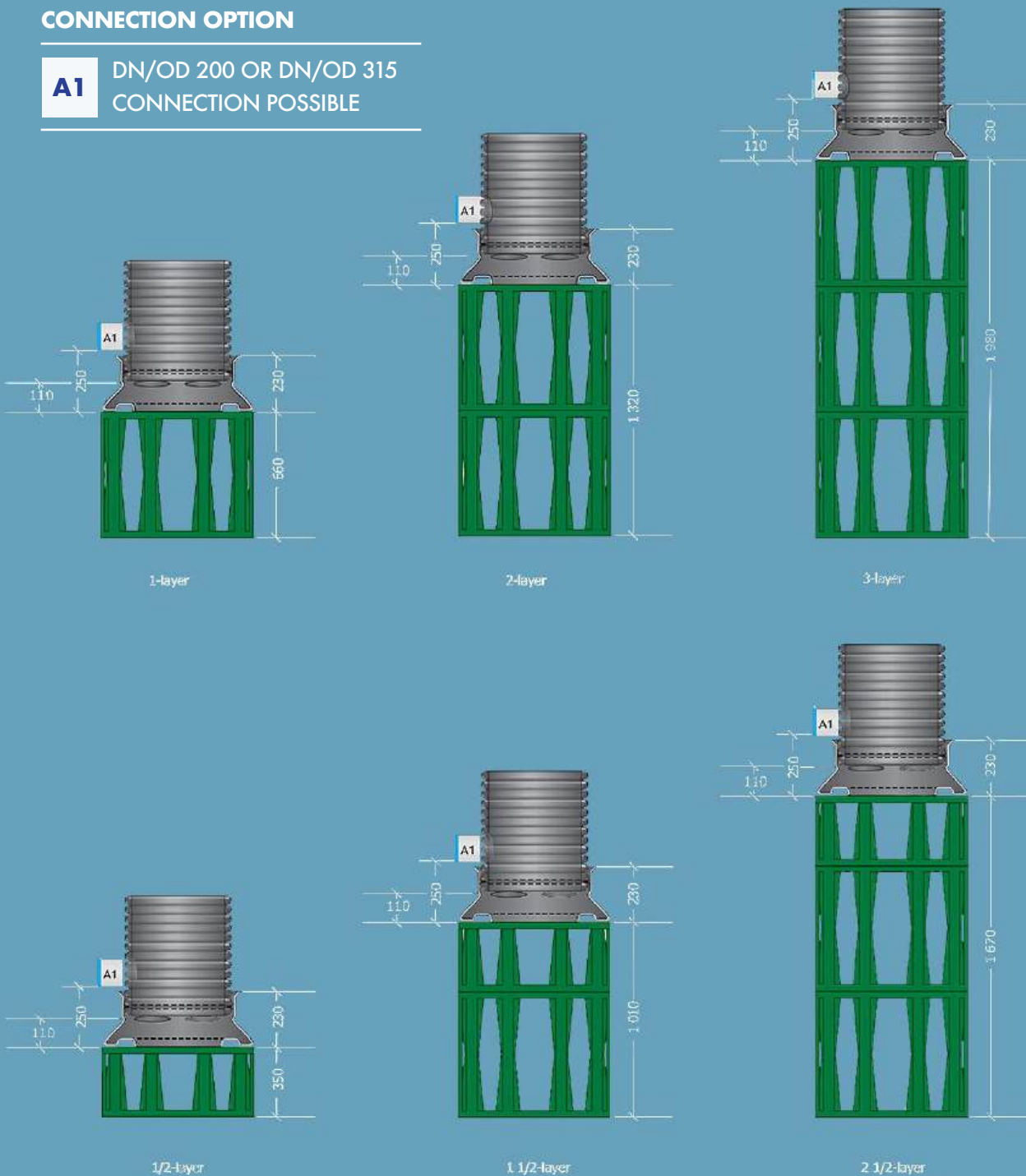
Outside diameter 315 mm for
 a pipe diameter 300 mm PVC

Outside diameter 400 mm for a pipe
 diameter 450 mm PVC. A flexible
 sleeve off center is required.



Outside diameter 500 mm for a pipe
 of diameter 525 mm.
 A flexible sleeve off center is required

DIMENSIONS OF QUADRO® CONTROL ST
CONNECTION OPTION
A1

 DN/OD 200 OR DN/OD 315
CONNECTION POSSIBLE


SHAFT DESIGN OF QUADRO® CONTROL ST

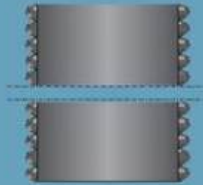
Structure of inspection shaft



Class B or D
shaft cover acc. to DIN EN 124,
CW 610



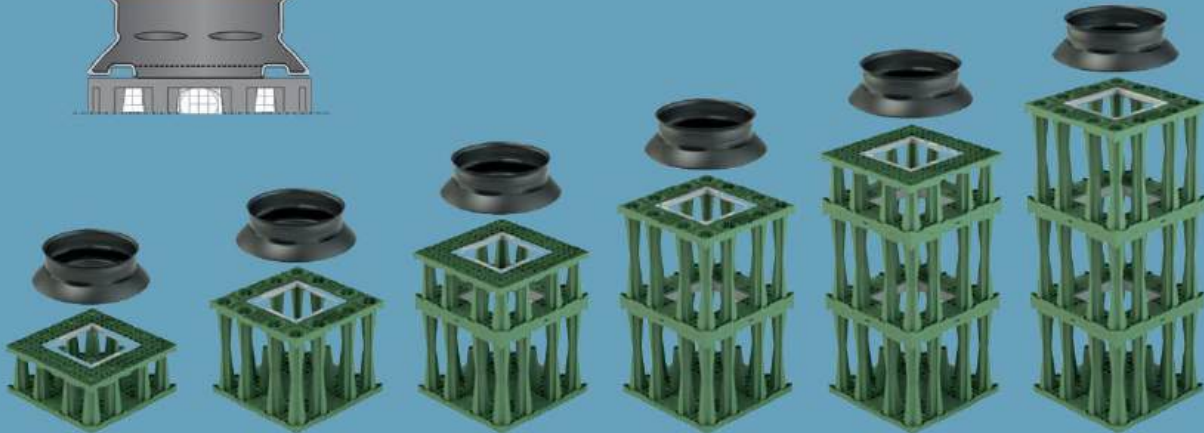
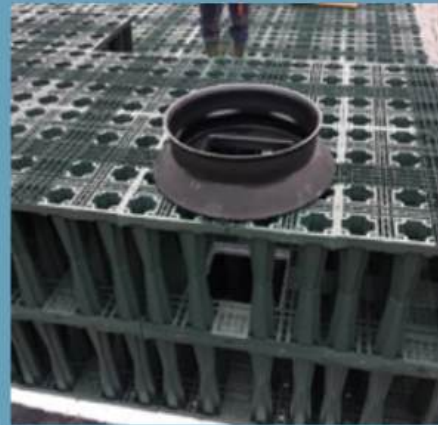
Support ring acc. to DIN 4034,
 $D_1 = 625 \text{ mm}$



Extension pipe
 $D_o 600$



Sealing ring



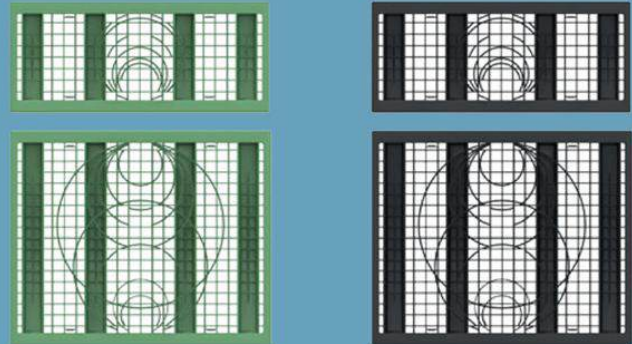
Sidewall grid

The sidewall grids serve as external boundary.

They can be assembled easily using snap connections. The predefined position of the connections at the sidewall grids guarantees that the connections of inlet pipe and outlet pipe and the tunnel are same level. The sidewall grids can be assembled easily also outside the excavation pit.

The sidewall grid for the full block and Quadro® Control ST and Quadro® Control ST-B has a size of $W \times D \times H = 800 \times 30 \times 660$ mm and is suited for connecting lateral solid wall pipes DN 110, 125, 160, 200, 225, 250, 315, 400 and 500.

The sidewall grid for the half block or the half-layer shaft has a size of $W \times D \times H = 800 \times 30 \times 350$ mm and is suited for connecting lateral solid wall pipes DN 110, 125, 160, 200, 225 and 250. In storage/infiltration designs with inside corners, shortened sidewall grids are used at one side.



Different connection heights (regardless of the nominal diameter) are required above the bottom depending on the number of floors:

ST	ST-B	Number of floors	Connection height
●	●	0.5-layer	40 mm
●	●	1-layer	40 mm
●	●	1.5-layer	700 mm
●	●	2-layer	700 mm
●	●	2.5-layer	1 360 mm
●	●	3-layer	1 360 mm

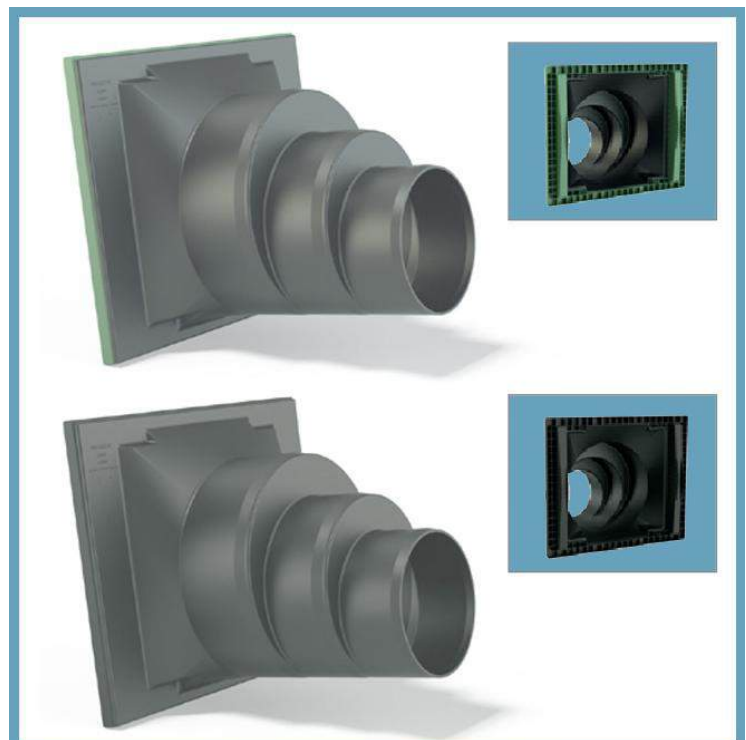
Adapter

The adapter for GreenStorm ST* and GreenStorm ST-B* has a length of 800 mm and a height of 660 mm and serves as an inlet and outlet connection.

It provides an inlet connection with an optimised flow design with diffusor effect for solid wall pipes DN 315, 400 and 500. It can be connected to GreenStorm ST* and GreenStorm ST-B* easily and quickly thanks to the snap connection.

The predefined position of the snap connection at the module guarantees that inlet pipe and outlet pipe and tunnel connect same level.

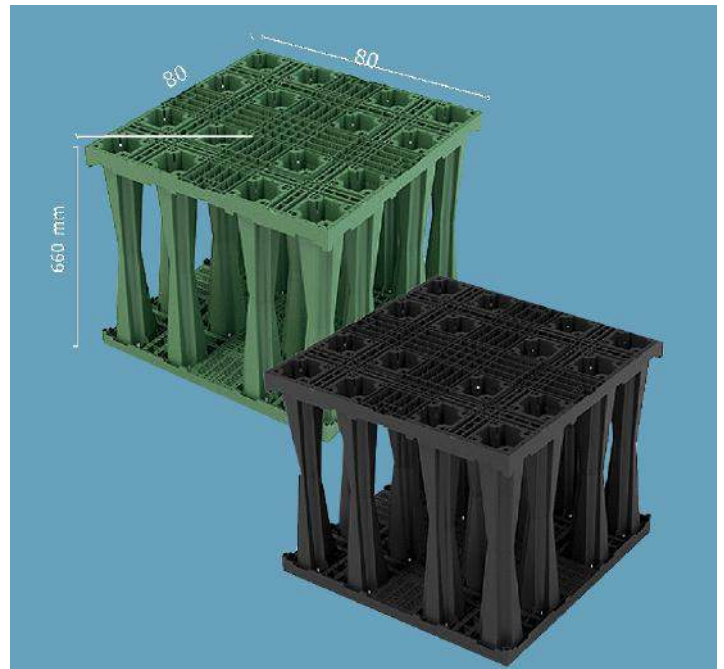
The adapter ensures a connection with the same crown, as it is installed turned by 180°.



GreenStorm ST* and GreenStorm ST-B* are highly durable and hard-wearing storage/infiltration module with a base of 800 x 800 mm and a height of 660 mm full blocks.

The polypropylene full block consists of two half elements to be installed on site and has a void ratio of more than 96 %. Water can flow through the module three-dimensionally almost without any obstacles. GreenStorm ST* and GreenStorm ST-B* allows for virtually any size and geometry of the systems.

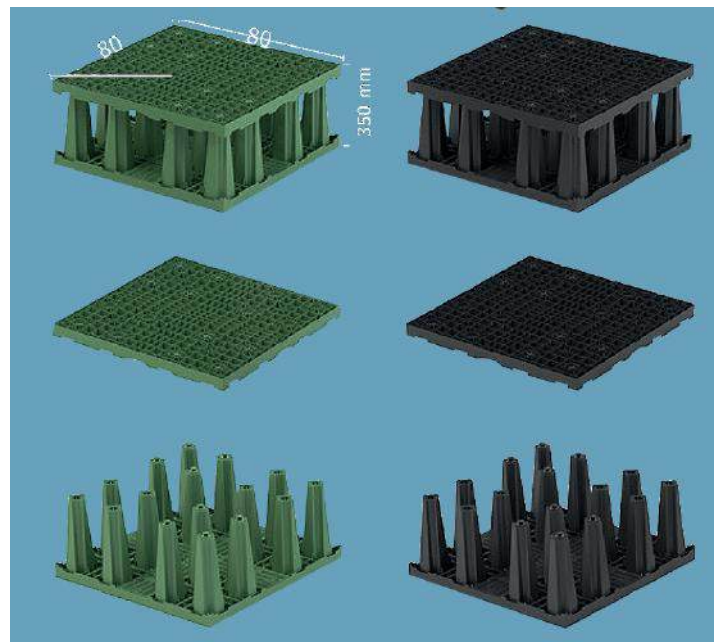
The cross-shaped inspection tunnel in the storage/infiltration modules has been designed for the use of automotive dollies. This allows the effective drainage surface and the entire system volume with all statically relevant bearing-type fixtures to be inspected.



The GreenStorm ST* and GreenStorm ST-B* half block have a base of 800 x 800 mm and a height of 350 mm

It consists of only one half element which must be assembled with a roof slab on site. This roof slab is only required for the half block. The GreenStorm ST* and GreenStorm ST-B* half block are used in particular for systems with shallow installation depths, e.g. in case of high groundwater levels.

Systems in various heights can be realised in 35cm steps and adjusted to almost any layout in combination with the full block.



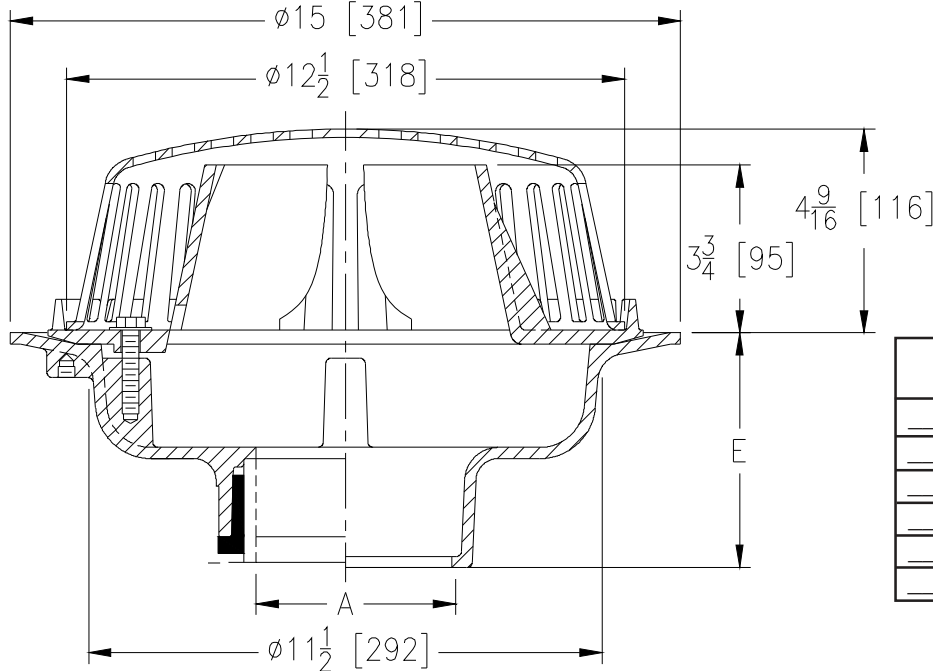


Z105
CONTROL-FLO ROOF DRAIN
W/ PARABOLIC WEIR

SPECIFICATION SHEET

TAG _____

Dimensional Data (inches and [mm]) are Subject to Manufacturing Tolerances and Change Without Notice



Specify Number of Notches in Weir	
___-N1	One Notch
___-N2	Two Notches
___-N3	Three Notches
___-N4	Four Notches
___-N5	Five Notches
___-N6	Six Notches

A- Pipe Size In.[mm]	Approx. Wt. Lbs. [kg]	Dome Open Area Sq. In. [cm ²]
2,3,4 [51,76,102]	34 [15]	103 [665]

ENGINEERING SPECIFICATION: ZURN Z105

15" [381mm] Diameter Control-Flo roof drain for dead-level roof construction, Dura-Coated cast iron body, Control-Flo weir shall be linear functioning with integral membrane flashing clamp/gravel guard and Poly-Dome. All data shall be verified proportional to flow rates. Each notch will allow 10 GPM [LPM] of flow per 1" [25mm] of rain water build up above the drain.

OPTIONS (Check/specify appropriate options)

PIPE SIZE

- 3, 4 [76, 102]
- 2, 3, 4 [51, 76, 102]
- 2, 3, 4 [51, 76, 102]

(Specify size/type) **OUTLET**

- ___ IC Inside Caulk
- ___ NH No-Hub
- ___ NL Neo-Loc

E BODY HT. DIM.

- 5-1/4 [133]
- 5-1/4 [133]
- 4-9/16 [116]

PREFIXES

- ___ Z D.C.C.I. Body with Poly-Dome*
- ___ ZA D.C.C.I. Body with Aluminum Dome
- ___ ZC D.C.C.I. Body with Cast Iron Dome

SUFFIXES

- ___ -C Underdeck Clamp
- ___ -DP Top-Set® Deck Plate (Replaces both -C & -R)
- ___ -E Static Extension 1 [25] thru 4 [102] (Specify Ht.)
- ___ -EA Adjustable Extension Assembly
2-1/8 [54] thru 3-1/2 [89]
- ___ -G Galvanized Cast Iron
- ___ -R Roof Sump Receiver
- ___ -TC Neo-Loc Test Cap Gasket (2,3,4 [51,76,102] NL Bottom Outlet Only)
- ___ -VP Vandal Proof Secured Top
- ___ -10 6 [152] High Parabolic Weir for Sloped Roof (ZC or ZA)

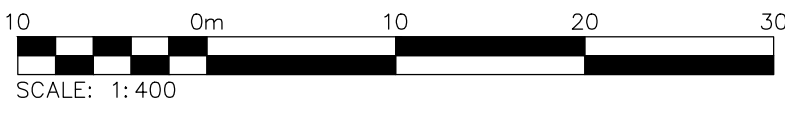
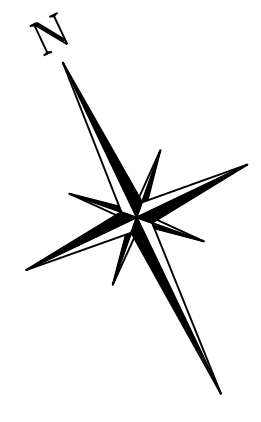
* Regularly furnished unless otherwise specified.

FIGURES & DRAWINGS



LEGEND

- PROPERTY LINE
- STORM DRAINAGE CATCHMENT
- EXISTING OVERLAND FLOW DIRECTION
- ID
ARC* CATCHMENT I.D.
AREA (ha) | RUNOFF COEFFICIENT



0	ISSUED FOR ZBA SUBMISSION	2025/DEC/18
No.	ISSUE / REVISION	YYYY/MM/DD

ELEVATION NOTE:
ELEVATIONS SHOWN ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE ON TOP OF CONCRETE CULVERT OLD YORK ROAD, WEST OF TOWNLINE ROAD HAVING AN ELEVATION OF 113.276 METRES.

BEARING NOTE:
BEARINGS HEREON ARE GRID, UTM ZONE 17, (NAD 83-CSR5 (EPOCH 2010)), USING THE CAN-NET VRS NETWORK.

SURVEY NOTES:
SURVEY COMPLETED BY J.D.BARNES LMT. DATED 2024/DEC/23. REFERENCE No.: 22-49-034-01_210POSKECH

SITE PLAN NOTES:
DESIGN ELEMENTS ARE BASED ON SITE PLAN BY MATAJ ARCHITECT INCORPORATED. PROJECT No.: 24-012 (2025/NOV/11)

DRAWING NOTES:
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THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTS APPLICABLE TO THIS PROJECT. DO NOT SCALE THIS DRAWING.
ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

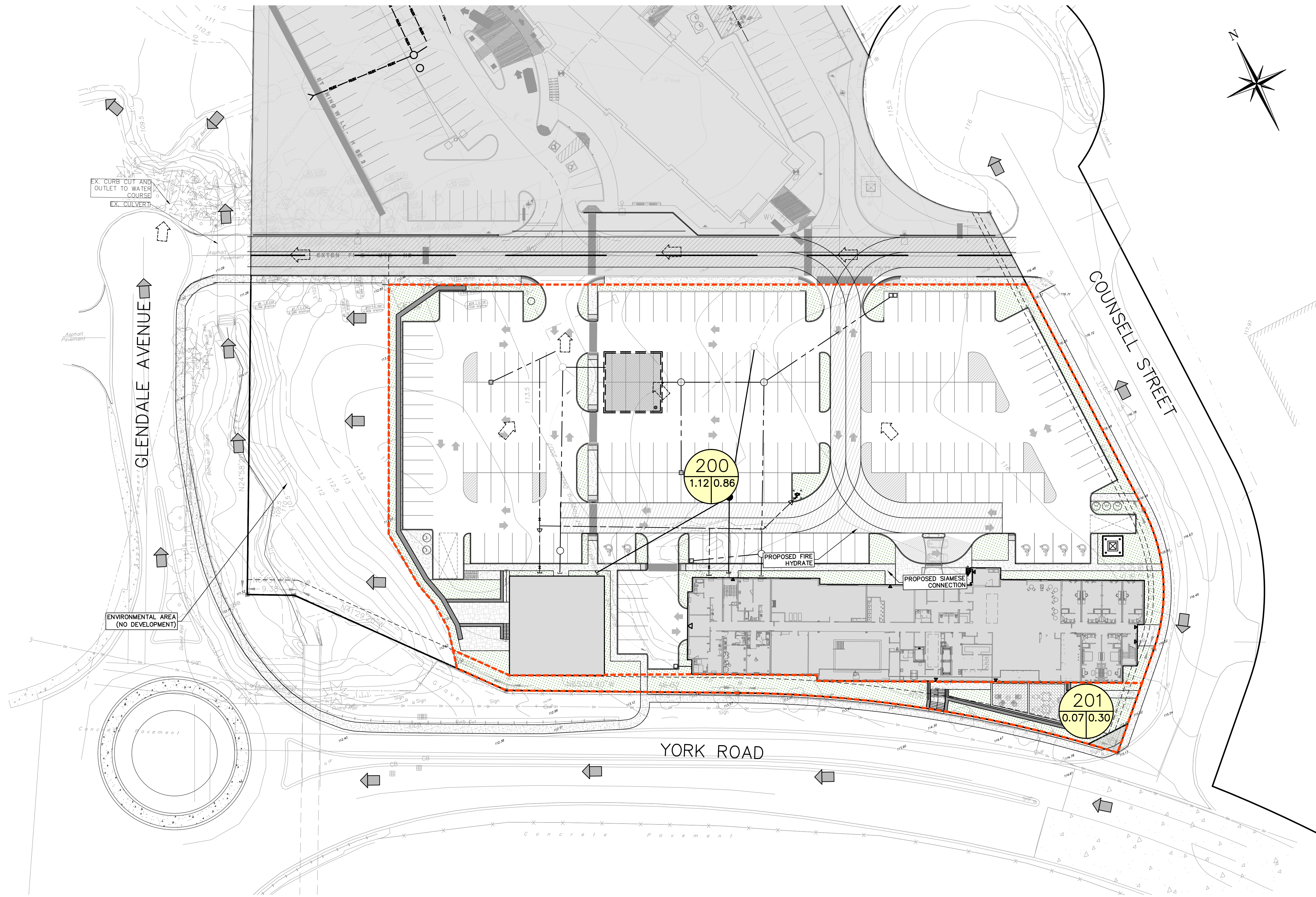
Project
**524 YORK ROAD
TOWN OF NIAGARA-ON-THE-LAKE**

Drawing
**PRE DEVELOPMENT
DRAINAGE AREA PLAN**

CROZIER CONSULTING ENGINEERS
211 YONGE STREET
SUITE 600
TORONTO, ON, M5B 1M4
416-477-3392 T
WWW.CROZIER.CA
INFO@CROZIER.CA

Drawn	A.A.	Design	A.M.	Project No.	2570-7661
Check	R.B.	Check	R.B.	Scale	1:400
				Dwg.	FIG 1

Stamp



LEGEND

	PROPERTY LINE
	STORM DRAINAGE CATCHMENT
	CATCHMENT I.D.
	AREA (sq m) RUNOFF COEFFICIENT
	PROPOSED OVERLAND FLOW DIRECTION
	EXISTING OVERLAND FLOW DIRECTION
	GRASS AREA
	ROOFTOP

0	ISSUED FOR ZBA SUBMISSION	2025/DEC/18
No.	ISSUE / REVISION	YYYY/MM/DD

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BEARING NOTE:
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SURVEY NOTES:
SURVEY COMPLETED BY J.D.BARNES LMT. DATED 2024/DEC/23. REFERENCE No: 22-49-034-01_210PSKETCH

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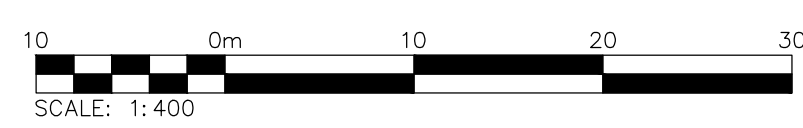
Project
**524 YORK ROAD
TOWN OF NIAGARA-ON-THE-LAKE**

Drawing
**POST DEVELOPMENT
DRAINAGE AREA PLAN**

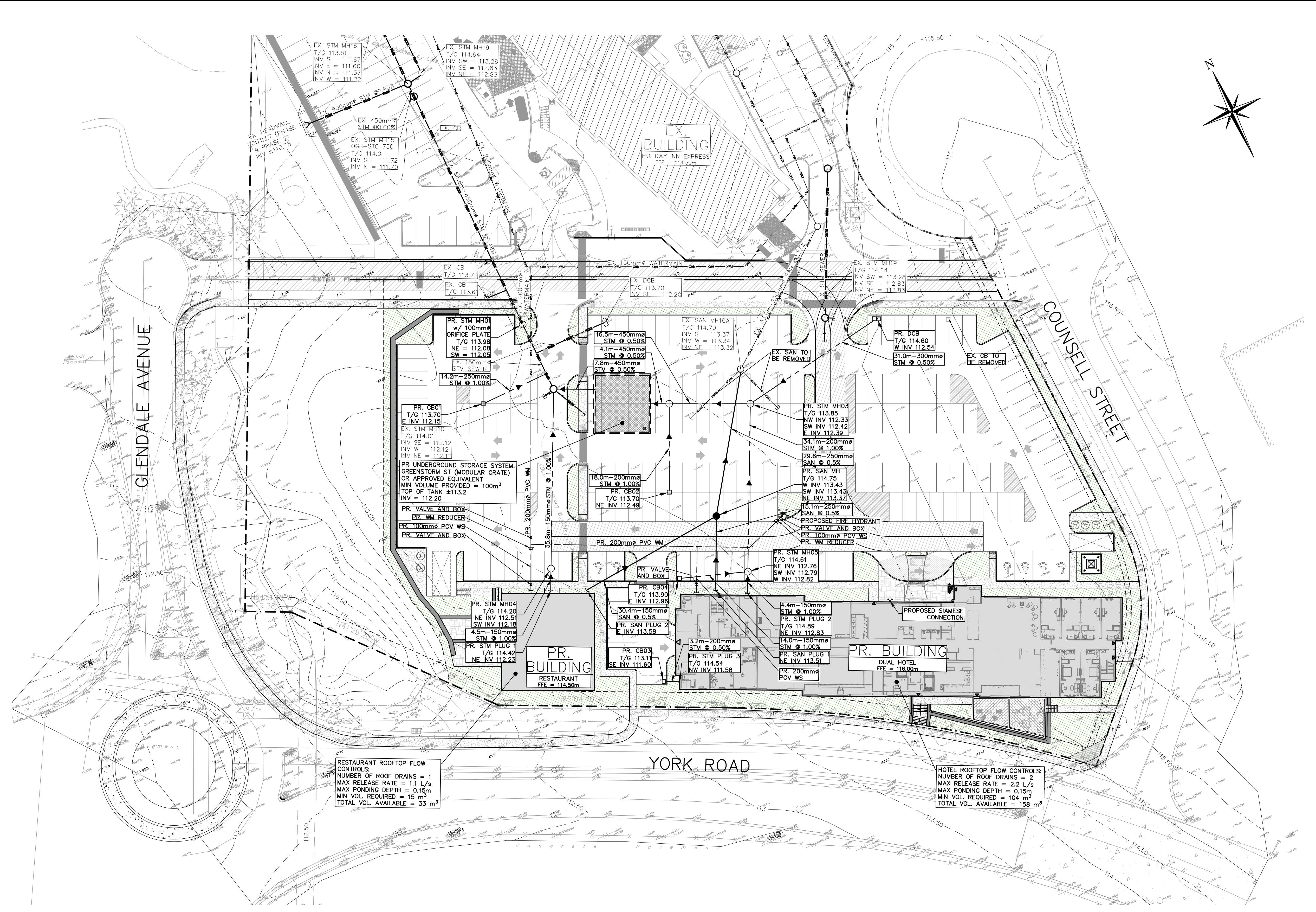
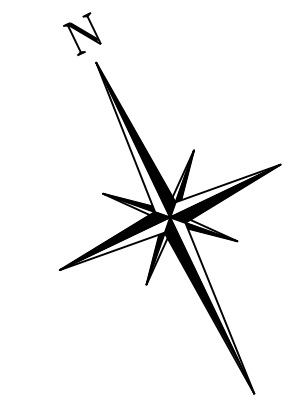
CROZIER
CONSULTING ENGINEERS

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416-477-3392 T
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INFO@CFCROZIER.CA

Drawn	A.A.	Design	A.M.	Project No.	2570-7661
Check	R.B.	Check	R.B.	Scale	1:400
				Dwg.	FIG 2



Stamp	Stamp



LEGEND

- PROPERTY LINE
- EXTENT OF UNDERGROUND
- LIMIT OF SUE INVESTIGATION
- EXISTING WATERMAIN
- EXISTING HYDRANT
- EXISTING STORM SEWER & MANHOLE
- EXISTING SANITARY SEWER & MANHOLE
- PROPOSED STORM SEWER & MANHOLE
- PROPOSED SANITARY SEWER & MANHOLE
- PROPOSED WATER CONNECTION
- PROPOSED CAST IN PLACE STM MANHOLE
- PROPOSED CAST IN PLACE SAN MANHOLE
- PROPOSED SIAMESE CONNECTION
- PROPOSED STORM TANK

0	ISSUED FOR ZBA SUBMISSION	2025/DEC/18
No.	ISSUE / REVISION	YYYY/MM/DD

ELEVATION NOTE:
ELEVATIONS SHOWN ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE ON TOP OF CONCRETE CULVERT OLD YORK ROAD, WEST OF TOWNLINE ROAD HAVING AN ELEVATION OF 113.276 METRES.

BEARING NOTE:
BEARINGS HEREON ARE GRID, UTM ZONE 17, (NAD 83-CRS (EPOCH 2010)), USING THE CAN-NET VRS NETWORK.

SURVEY NOTES:
SURVEY COMPLETED BY J.D.BARNES LMT, DATED 2024/DEC/23. REFERENCE No: 22-49-034-01_210POSKETCH

SITE PLAN NOTES:
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Project
**524 YORK ROAD
TOWN OF NIAGARA-ON-THE-LAKE**

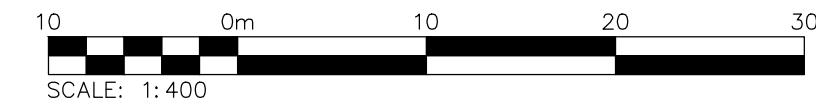
Drawing
SERVICING PLAN

Stamp

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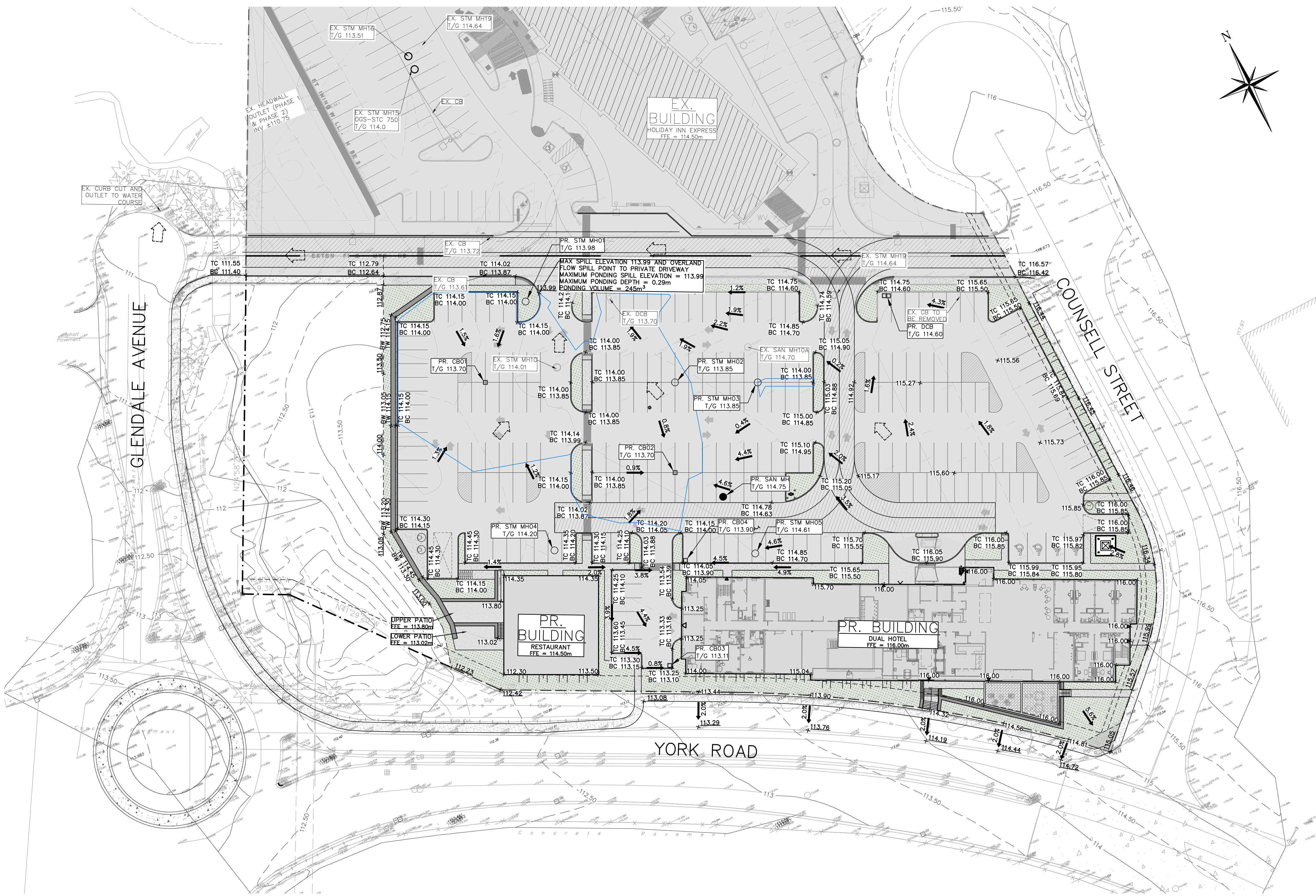
211 YONGE STREET
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Drawn	A.A.	Design	A.M.	Project No.	2570-7661
Check	R.B.	Check	R.B.	Scale	1:400
				Dwg.	C 102



RESTAURANT ROOFTOP FLOW CONTROLS:
NUMBER OF ROOF DRAINS = 1
MAX RELEASE RATE = 1.1 L/s
MAX PONDING DEPTH = 0.15m
MIN VOL. REQUIRED = 15 m³
TOTAL VOL. AVAILABLE = 33 m³

HOTEL ROOFTOP FLOW CONTROLS:
NUMBER OF ROOF DRAINS = 2
MAX RELEASE RATE = 2.2 L/s
MAX PONDING DEPTH = 0.15m
MIN VOL. REQUIRED = 104 m³
TOTAL VOL. AVAILABLE = 158 m³



LEGEND

	PROPERTY LINE
	EXISTING EASEMENT
	EXTENT OF UNDERGROUND
	EXTENT OF ABOVE GROUND
	TREE PROTECTION ZONE
	EXISTING GRADE
	PROPOSED GRADE
	PROPOSED GRADE (TO MATCH EXISTING)
	PROPOSED MINOR FLOW DIRECTION
	EXISTING FIRE HYDRANT & GATE VALVE
	EXISTING STORM MANHOLE
	EXISTING SANITARY MANHOLE
	PROPOSED STORM MANHOLE
	PROPOSED SANITARY MANHOLE
	EXISTING SINGLE / DOUBLE CATCHBASIN
	PROPOSED AREA DRAIN
	BUILDING ENTRANCE (PERSONNEL DOOR)
	BUILDING ENTRANCE (OVERHEAD DOOR)
	PROPOSED OVERLAND FLOW DIRECTION
	EXISTING OVERLAND FLOW DIRECTION
	PROPOSED 1.2m CHAIN LINK FENCE
	PROPOSED 1.8m FENCING

0	ISSUED FOR ZBA SUBMISSION	2025/DEC/18
No.	ISSUE / REVISION	YYYY/MM/DD

ELEVATION NOTE:
ELEVATIONS SHOWN ON THE TOWN OF NIAGARA-ON-THE-LAKE DATUM AND WERE DERIVED FROM CUT SQUARE ON TOP OF CONCRETE CULVERT OLD YORK ROAD, WEST OF TOWNLINE ROAD HAVING AN ELEVATION OF 113.276 METRES.

BEARING NOTE:
BEARINGS HEREON ARE GRID, UTM ZONE 17, (NAD 83-CSR5 (EPOCH 2010)), USING THE CAN-NET VRS NETWORK.

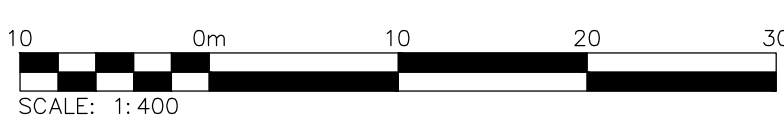
SURVEY NOTES:
SURVEY COMPLETED BY J.D.BARNES LMT. DATED 2024/DEC/23. REFERENCE No. 22-49-034-01_2TPO5KETCH

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Project
**524 YORK ROAD
TOWN OF NIAGARA-ON-THE-LAKE**

Drawing
GRADING PLAN



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Drawn	A.A.	Design	A.M.	Project No.	2570-7661
Check	R.B.	Check	R.B.	Scale	1:400
				Dwg.	C 103

Stamp
Stamp

SUPPLEMENTAL INFORMATION

STORMWATER MANAGEMENT REPORT

Intercontinental Combo Hotel

525 York Road
Niagara-on-the-Lake, Ontario

Submitted on behalf of: **Vrancor Group Inc.**

Prepared by: **Quartek Group Inc.**
Engineers, Architects and Planners
89-91 St. Paul Street, Suite 100
St. Catharines, Ontario, L2R 3M3
(905) 984-8676
www.quartekgroup.ca



October 2015

INTERCONTINENTAL COMBO HOTEL
525 York Road, Niagara-on-the-Lake, Ontario

STORMWATER MANAGEMENT REPORT

1. Background Information and Design Criteria

1.1 Site Conditions

Site Address: 525 York Road, Niagara-on-the-Lake

Total Area of Property: 2.831 ha

Total Drainage Area: 2.408 ha

Existing: primarily fallow agricultural field with woodlot along west limit

Proposed: hotel and restaurant buildings, asphalt parking lot, landscaped boulevards and curb islands, with much of the woodlot preserved

Receiving Watercourse: East Branch of Six Mile Creek

Existing Site Drainage: overland to west limit; east-west swale drains three adjacent properties to the east

1.2 Background

The subject site is located in Niagara-on-the-Lake, Ontario, northeast of the intersection of York Road and Glendale Avenue (see Figure 1). The south half of the site is bounded by York Road, Counsell Street and Glendale Avenue. The site and adjacent properties have been zoned for Prestige Industrial. The property abuts the Purolator Sort Facility to the east and the Hilton Garden Inn to the West. A drainage channel begins within the Purolator property and conveys most of the drainage from said site to the ditch along the Counsell Street turning bulb and through the proponent's property to reach the drainage course along the east side Glendale Avenue turning bulb.

Existing downstream stormwater management works have been in place for over 30 years which had been designed to cater for development of the contributing Prestige Industrial Lands. It is understood that post-development controls are not required if impervious coverage is limited to 75%. Development of the Purolator site had proceeded in 1999 under this assumption and, since total impervious coverage did not exceed 75%, no quantity detention had been proposed for this site.

This stormwater management report summarizes the rationale for and design of stormwater management provisions for the proposed hotel and restaurant buildings.



- Legend
- Streets Labels
 - Address Points
 - Assessment Parcels



0.1 0 0.06 0.1 Kilometers

Figure 1
Intercontinental Combo Hotel - SWM Report



Notes
1:2500 Scale

1.3 Development Proposal

Two hotels sharing a common building footprint are proposed north of the new east-west running street and five restaurants one with drive-through access are proposed in the southerly half.

1.4 Runoff Characteristics and Criteria

The runoff characteristics and design criteria for the property can be summarized as follows:

- the portion of the property identified for development currently exists as fallow agricultural field land with virtually no tree cover
- the proposed development will consist primarily of asphalt pavement, roof, concrete walk, and landscaped or grassed areas
- majority of site runoff conveys by swale and discharges at west limit
- a three-hour Chicago design storm of a 5-year return period has been selected for modelling as required by the Town of Niagara-on-the-Lake
- Level 2 (Normal) fish habitat protection is required for all stormwater effluent

1.5 Design Storm Characteristics

The standard Chicago Storm Hyetograph, 3-hour duration, design storm was identified for modelling, as per Town standards. The defining parameters for the intensity-duration-frequency relationship are based upon the Town of Niagara-on-the-Lake Engineering Standards (2011). These parameters are summarized in Table 1-1 below and have been incorporated in our computerized modelling.

Table 1-1: Design Storm Parameters

Return Period (year)	Defining Parameters*		
	a	b	c
5	664	4.7	0.744

*time to peak = 0.375*rainfall intensity, $I = a/(b+t)^c$, where t = time of concentration (min.)*

2. Minor Storm Drainage System

Minor system design involved modelling fifteen sub-catchments as shown on drawing 13254-STM. Post-development catchment characteristics are in Table 2-1 and proposed post-development impervious area is shown in Table 2-2.

Table 2-1: Post-Development Areas

Area No.	Pervious Area (m²)	Impervious Area (m²)	Sub-Catchment Area (ha)	Imp. Prop. (%)
Internal North Side Sub Catchments				
201	170	453	0.067	68.1%
202	758	1042	0.180	57.9%
203	332	2,756	0.313	88.0%
204	258	2,273	0.253	86.6%
205	145	847	0.099	66.0%
206	220	2,312	0.253	91.3%
SUM	2029	9,411	1.165	80.8%
Internal South Side Sub Catchments				
207	50	1,352	0.140	96.4%
208	450	2,162	0.267	81.0%
209	24	1,234	0.126	98.1%
210	215	2,731	0.295	92.7%
211	0	750	0.075	100.0%
212	169	1,584	0.175	90.4%
213	242	1,408	0.165	96.0%
SUM	974	11,397	1.242	91.8%
TOTAL SUM	3,003	20,808	2.408	86.4%
External Catchments				
301	17,873	14,591	2.651	55.0%
302	8,486	6,125	1.461	41.9%

Table 2-2: Proposed Post-Development Impervious Coverage

Impervious (m²)	Property Area (m²)	Impervious Coverage (%)
20,808	28,310	73.5%

Software modelling for the two identified design storms was carried out using MIDUSS (Micro Interactive Design of Urban Storm Sewers) to demonstrate runoff conveyance under the anticipated storm event (see program output in Appendix A).

The subject property receives external drainage from easterly lands which collects in the drainage ditch at the turnaround bulb at Counsell Street. This drainage is to be received into a separate parallel storm sewer system and combined at the proposed outfall for the subject development. These external 5-year storm flows have been modelled under the assumption of a future impervious coverage reaching 75% before on-site quantity detention measures would be required. However, for conveyance design the external areas were modelled as 86% total impervious, corresponding to a runoff coefficient of 0.80, which was employed as a conservative approach to build in reserve capacity. The flow will be received by a high-capacity ditch inlet catchbasin structure and then pass through a 750mm diameter pipe to combine with the development's treated flows at the outfall.

3. Major Storm Drainage System

In general, surface runoff will pond at each catchbasin if the minor system is inundated and flows will pass through parking lot areas to the Glendale Avenue turnaround bulb and the adjacent Six Mile Creek East Branch. Major overland flow routing is demonstrated on drawing 13254-STM.

4. Stormwater Quality

All runoff collected within the minor system will pass through oil-grit separator units which have been sized to ensure at least 70% of total suspended solids and hydrocarbon are captured within the permanent pool of each unit which comprises a 'Normal' level of fish habitat protection. The proposed stormwater minor system has been generally split into northerly and southerly catchments, which ultimately combine at the outfall. Drainage areas 201 through 206 mainly comprise the northerly half and 207 through 213 comprise the southerly. Drainage from each catchment area passes through an appropriately-sized OGS unit after which the flows combine with the external area flow and pass through the proposed concrete headwall.

5. Maintenance Program

The proposed oil grit separators are projected to require cleanout every 12 months. The units should be inspected after 6 months and the depth of sediment measured to ensure that capacity has not been reached.

Attachments

1. Drawing 13254-SS: Proposed Servicing
2. Drawing 12254-G: Proposed Grading
3. Drawing 13254-STM: Storm Drainage Areas
4. Appendix A: MIDUSS Model Output
5. Appendix B: Oil/Grit Separator Sizing Report

Stormwater Management Report prepared by: J. Prinzen, B.Eng., EIT, Quartek Group Inc.
D. Peters, P.Eng., Quartek Group Inc.





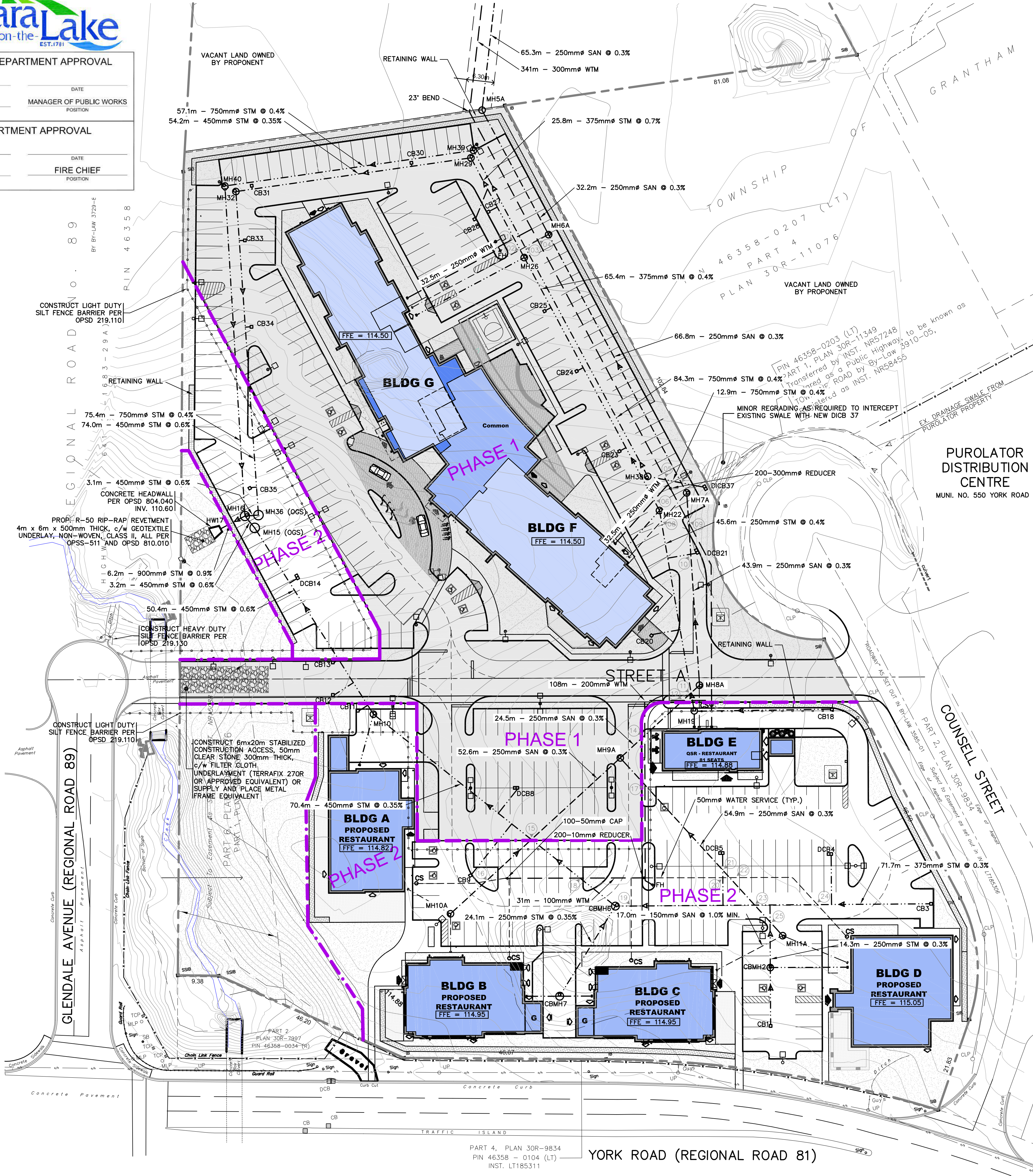
OPERATIONS DEPARTMENT APPROVAL

SIGNATURE: DOUG KERR, DATE: MANAGER OF PUBLIC WORKS

FIRE DEPARTMENT APPROVAL

SIGNATURE: ALEX BURBIDGE, DATE: FIRE CHIEF

SEE DRAWING 13254-EXT

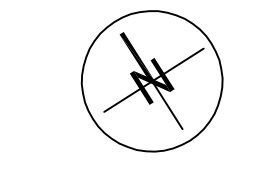


SERVICING PLAN NOTES: 1. ALL SANITARY LATERALS TO BE 150mm @ MINIMUM 1.0% SLOPE... REFER TO SITE PLAN FOR SITE DIMENSIONS...

STORM SEWER STRUCTURE DETAILS table with columns: MH NO., RIM EL., INVERT EL., SIZE (mm), OPS DRAWING, COMMENTS.

SANITARY SEWER STRUCTURE DETAILS table with columns: MH NO., RIM EL., INVERT EL., SIZE (mm), OPS DRAWING, COMMENTS.

SERVICING CROSSING TABLE with columns: LOCATION, SERVICE INVERT, ELEV., CLEARANCE (m).



Professional Engineer seal for J. K. Peters, Province of Ontario.

Do not scale drawings. Report any discrepancies to Quartek Group Inc. before proceeding.

Quartek Group Inc. logo and contact information: Architects, Engineers, Planners, Project Managers.

89-91 St. Paul St. Suite 100, St. Catharines, ON L2R 3M3, www.quartekgroup.com

INTERCONTINENTAL COMBO HOTEL, 525 York Road, Niagara-on-the-Lake, ON

PROPOSED SITE SERVICES

drawn by: JTB, designed by: JRP/DKP

scale: 1:500, date: 30 JAN 2015

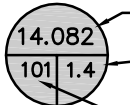


job number: 13254, issue: A

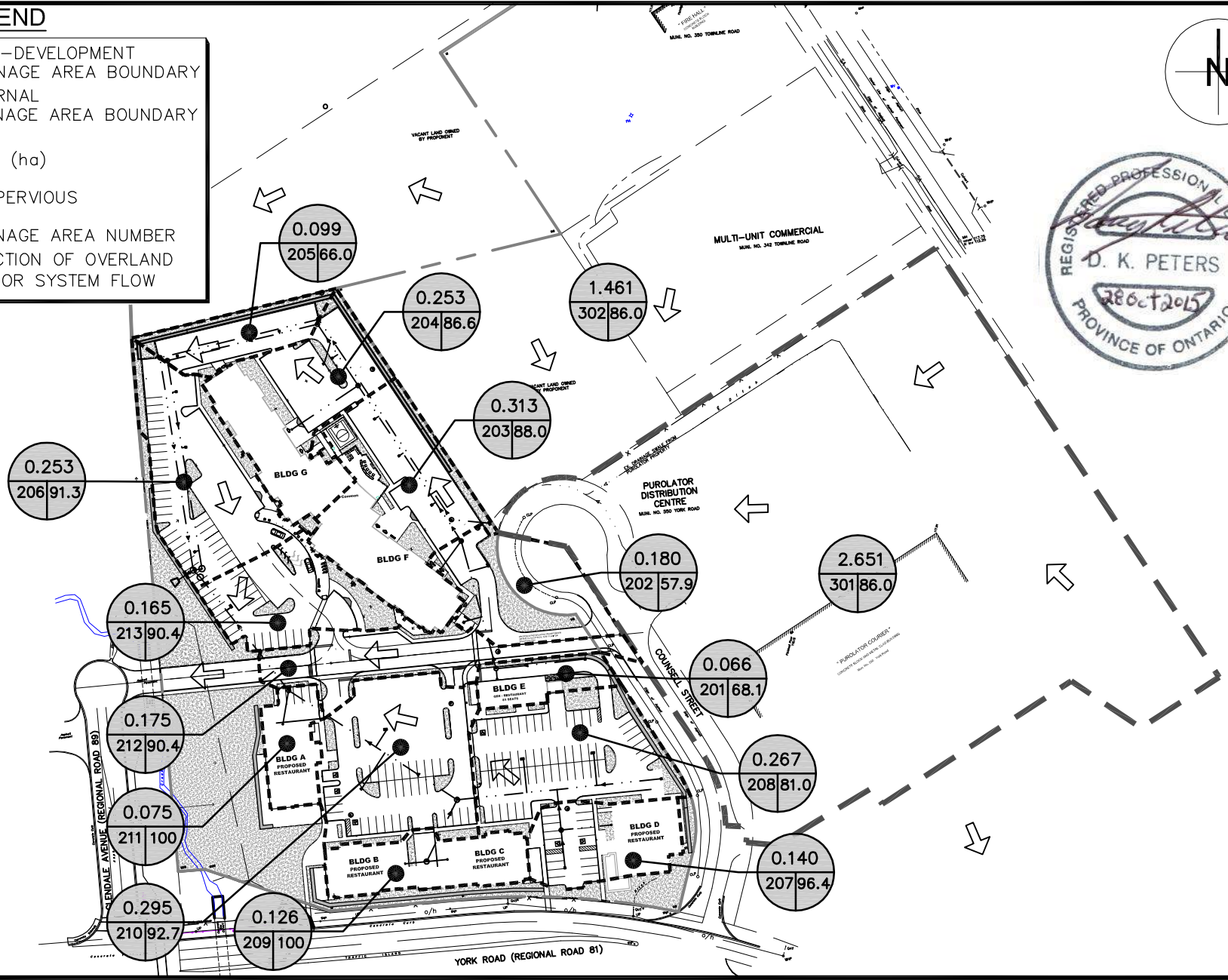
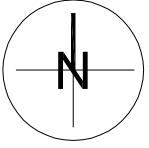
drawing number: 13254-SS

P:2013 Project:13254 York, Glendale Hotel Complex Drawings:DWG:13254-SS.dwg, dmm:13254-SS

LEGEND

-  POST-DEVELOPMENT DRAINAGE AREA BOUNDARY
-  EXTERNAL DRAINAGE AREA BOUNDARY

-  AREA (ha)
14.082
101 | 1.4
-  DRAINAGE AREA NUMBER
-  DIRECTION OF OVERLAND MAJOR SYSTEM FLOW



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• architects • engineers •
 • planners • project managers •

T • 905 984 8676
 F • 905 682 5896

project title

INTERCONTINENTAL COMBO HOTEL

525 York Road,
 Niagara-on-the-Lake, ON

drawing title

STORM DRAINAGE AREAS

drawn by	designed by
JRP	JRP
scale	date
1:1250	28 OCT 2015
job number	Issue
13254	A
drawing number	
13254-STM	

Letter Metric
 P:\2013 Projects\Drawings\Civil\13254-BP.dwg drawing tab. 13254-STM
 P:\2013 Projects\Drawings\Civil\13254-BP.dwg drawing tab. 13254-STM

STORMWATER MANAGEMENT REPORT

INTERCONTINENTAL COMBO HOTEL

**525 York Road
Niagara-on-the-Lake, Ontario**

APPENDIX A

MIDUSS MODEL OUTPUT

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
5-YR Storm – Post-Development Condition

```
"      MIDUSS Output ----->"
"      MIDUSS version          Version 2.25 rev. 465"
"      MIDUSS created          Tuesday, February 05, 2008"
"  10  Units used:              ie METRIC"
"      Job folder:              P:\2013 Projects\
"          13254 York Glendale Hotel Complex\Design\Detailed\MIDUSS"
"      Output filename:        5-YR_POST_E.out"
"      Licensee name:          Quartek"
"      Company                  Quartek Group Inc."
"      Date & Time last used:   10/28/2015 at 11:24:39 AM"
" 31  TIME PARAMETERS"
"      5.000  Time Step"
"      180.000  Max. Storm length"
"      1500.000  Max. Hydrograph"
" 32  STORM Chicago storm"
"      1  Chicago storm"
"      664.000  Coefficient A"
"      4.700  Constant B"
"      0.744  Exponent C"
"      0.375  Fraction R"
"      180.000  Duration"
"      1.000  Time step multiplier"
"      Maximum intensity      120.814  mm/hr"
"      Total depth            41.024  mm"
"      6 005hyd Hydrograph extension used in this file"
" 33  CATCHMENT 201"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      201  Restaurant - Bldg. 'E'"
"      68.100  % Impervious"
"      0.067  Total Area"
"      14.000  Flow length"
"      1.500  Overland Slope"
"      0.021  Pervious Area"
"      14.000  Pervious length"
"      1.500  Pervious slope"
"      0.046  Impervious Area"
"      14.000  Impervious length"
"      1.500  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      75.000  Pervious SCS Curve No."
"      0.220  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      8.467  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.861  Impervious Runoff coefficient"
```

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
5-YR Storm – Post-Development Condition

" 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.012 0.000 0.000 0.000 c.m/sec"
 " Catchment 201 Pervious Impervious Total Area "
 " Surface Area 0.021 0.046 0.067 hectare"
 " Time of concentration 16.307 1.460 3.047 minutes"
 " Time to Centroid 121.643 88.214 91.789 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 8.77 18.72 27.49 c.m"
 " Rainfall losses 32.000 5.721 14.104 mm"
 " Runoff depth 9.024 35.303 26.920 mm"
 " Runoff volume 1.93 16.11 18.04 c.m"
 " Runoff coefficient 0.220 0.861 0.656 "
 " Maximum flow 0.001 0.012 0.012 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.012 0.012 0.000 0.000"
 " 51 PIPE DESIGN"
 " 0.012 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.200 Diameter metre"
 " 0.500 Gradient %"
 " Depth of flow 0.095 metre"
 " Velocity 0.784 m/sec"
 " Pipe capacity 0.025 c.m/sec"
 " Critical depth 0.091 metre"
 " 53 ROUTE Pipe Route 30"
 " 30.40 Pipe Route 30 Reach length (metre)"
 " 0.318 X-factor <= 0.5"
 " 29.086 K-lag (seconds)"
 " 0.000 Default(0) or user spec.(1) values used"
 " 0.500 X-factor <= 0.5"
 " 30.000 K-lag (seconds)"
 " 0.500 Beta weighting factor"
 " 37.500 Routing time step (seconds)"
 " 1 No. of sub-reaches"
 " Peak outflow 0.011 c.m/sec"
 " 0.012 0.012 0.011 0.000 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.012 0.011 0.011 0.000"
 " 33 CATCHMENT 202"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 202 ROW & Hotel East"
 " 57.900 % Impervious"
 " 0.180 Total Area"

" 45.000 Flow length"
 " 1.500 Overland Slope"
 " 0.076 Pervious Area"
 " 45.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.104 Impervious Area"
 " 45.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.862 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.024 0.011 0.011 0.000 c.m/sec"
 " Catchment 202 Pervious Impervious Total Area "
 " Surface Area 0.076 0.104 0.180 hectare"
 " Time of concentration 32.857 2.941 7.631 minutes"
 " Time to Centroid 141.359 90.541 98.509 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 31.09 42.76 73.84 c.m"
 " Rainfall losses 31.986 5.681 16.756 mm"
 " Runoff depth 9.038 35.343 24.268 mm"
 " Runoff volume 6.85 36.83 43.68 c.m"
 " Runoff coefficient 0.220 0.862 0.592 "
 " Maximum flow 0.001 0.023 0.024 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.024 0.033 0.011 0.000"
 " 51 PIPE DESIGN"
 " 0.033 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.250 Diameter metre"
 " 0.400 Gradient %"
 " Depth of flow 0.172 metre"
 " Velocity 0.926 m/sec"
 " Pipe capacity 0.041 c.m/sec"
 " Critical depth 0.148 metre"
 " 53 ROUTE Pipe Route 46"
 " 45.60 Pipe Route 46 Reach length (metre)"
 " 0.143 X-factor <= 0.5"
 " 36.934 K-lag (seconds)"
 " 0.000 Default(0) or user spec.(1) values used"
 " 0.500 X-factor <= 0.5"

" 30.000 K-lag (seconds)"
 " 0.500 Beta weighting factor"
 " 60.000 Routing time step (seconds)"
 " 1 No. of sub-reaches"
 " Peak outflow 0.033 c.m/sec"
 " 0.024 0.033 0.033 0.000 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.024 0.033 0.033 0.000"
 " 33 CATCHMENT 203"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 203 Hotel - East Side"
 " 88.000 % Impervious"
 " 0.313 Total Area"
 " 52.000 Flow length"
 " 1.500 Overland Slope"
 " 0.038 Pervious Area"
 " 52.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.275 Impervious Area"
 " 52.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.861 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.063 0.033 0.033 0.000 c.m/sec"
 " Catchment 203 Pervious Impervious Total Area "
 " Surface Area 0.038 0.275 0.313 hectare"
 " Time of concentration 35.835 3.208 4.308 minutes"
 " Time to Centroid 144.904 90.985 92.803 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 15.41 113.00 128.41 c.m"
 " Rainfall losses 31.986 5.697 8.852 mm"
 " Runoff depth 9.038 35.327 32.172 mm"
 " Runoff volume 3.39 97.30 100.70 c.m"
 " Runoff coefficient 0.220 0.861 0.784 "
 " Maximum flow 0.001 0.063 0.063 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "

" 0.063 0.095 0.033 0.000"
" 51 PIPE DESIGN"
" 0.095 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.375 Diameter metre"
" 0.400 Gradient %"
" Depth of flow 0.252 metre"
" Velocity 1.206 m/sec"
" Pipe capacity 0.120 c.m/sec"
" Critical depth 0.227 metre"
" 53 ROUTE Pipe Route 65"
" 65.40 Pipe Route 65 Reach length (metre)"
" 0.145 X-factor <= 0.5"
" 40.657 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 60.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.094 c.m/sec"
" 0.063 0.095 0.094 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.063 0.094 0.094 0.000"
" 33 CATCHMENT 204"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 204 Hotel - NE Side"
" 86.600 % Impervious"
" 0.253 Total Area"
" 53.000 Flow length"
" 1.500 Overland Slope"
" 0.034 Pervious Area"
" 53.000 Pervious length"
" 1.500 Pervious slope"
" 0.219 Impervious Area"
" 53.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.220 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.861 Impervious Runoff coefficient"

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
5-YR Storm – Post-Development Condition

" 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.050 0.094 0.094 0.000 c.m/sec"
 " Catchment 204 Pervious Impervious Total Area "
 " Surface Area 0.034 0.219 0.253 hectare"
 " Time of concentration 36.247 3.244 4.502 minutes"
 " Time to Centroid 145.394 91.047 93.117 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 13.91 89.88 103.79 c.m"
 " Rainfall losses 31.984 5.707 9.228 mm"
 " Runoff depth 9.040 35.317 31.796 mm"
 " Runoff volume 3.06 77.38 80.44 c.m"
 " Runoff coefficient 0.220 0.861 0.775 "
 " Maximum flow 0.001 0.050 0.050 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.050 0.144 0.094 0.000"
 " 51 PIPE DESIGN"
 " 0.144 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.375 Diameter metre"
 " 0.700 Gradient %"
 " Depth of flow 0.280 metre"
 " Velocity 1.630 m/sec"
 " Pipe capacity 0.159 c.m/sec"
 " Critical depth 0.280 metre"
 " 53 ROUTE Pipe Route 26"
 " 25.80 Pipe Route 26 Reach length (metre)"
 " 0.000 X-factor <= 0.5"
 " 11.871 K-lag (seconds)"
 " 0.000 Default(0) or user spec.(1) values used"
 " 0.500 X-factor <= 0.5"
 " 30.000 K-lag (seconds)"
 " 0.566 Beta weighting factor"
 " 27.273 Routing time step (seconds)"
 " 1 No. of sub-reaches"
 " Peak outflow 0.143 c.m/sec"
 " 0.050 0.144 0.143 0.000 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.050 0.143 0.143 0.000"
 " 33 CATCHMENT 205"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 205 Hotel North Limit"
 " 66.000 % Impervious"
 " 0.099 Total Area"

" 18.000 Flow length"
 " 1.500 Overland Slope"
 " 0.034 Pervious Area"
 " 18.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.065 Impervious Area"
 " 18.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.863 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.016 0.143 0.143 0.000 c.m/sec"
 " Catchment 205 Pervious Impervious Total Area "
 " Surface Area 0.034 0.065 0.099 hectare"
 " Time of concentration 18.961 1.697 3.703 minutes"
 " Time to Centroid 124.785 88.520 92.734 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 13.81 26.81 40.61 c.m"
 " Rainfall losses 31.994 5.640 14.600 mm"
 " Runoff depth 9.030 35.384 26.424 mm"
 " Runoff volume 3.04 23.12 26.16 c.m"
 " Runoff coefficient 0.220 0.863 0.644 "
 " Maximum flow 0.001 0.016 0.016 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.016 0.156 0.143 0.000"
 " 51 PIPE DESIGN"
 " 0.156 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.450 Diameter metre"
 " 0.350 Gradient %"
 " Depth of flow 0.321 metre"
 " Velocity 1.291 m/sec"
 " Pipe capacity 0.183 c.m/sec"
 " Critical depth 0.278 metre"
 " 53 ROUTE Pipe Route 54"
 " 54.20 Pipe Route 54 Reach length (metre)"
 " 0.000 X-factor <= 0.5"
 " 31.484 K-lag (seconds)"
 " 0.000 Default(0) or user spec.(1) values used"
 " 0.500 X-factor <= 0.5"

" 30.000 K-lag (seconds)"
 " 0.588 Beta weighting factor"
 " 60.000 Routing time step (seconds)"
 " 1 No. of sub-reaches"
 " Peak outflow 0.154 c.m/sec"
 " 0.016 0.156 0.154 0.000 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.016 0.154 0.154 0.000"
 " 33 CATCHMENT 206"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 206 Hotel - NW Side"
 " 91.300 % Impervious"
 " 0.253 Total Area"
 " 32.000 Flow length"
 " 1.500 Overland Slope"
 " 0.022 Pervious Area"
 " 32.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.231 Impervious Area"
 " 32.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.863 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.053 0.154 0.154 0.000 c.m/sec"
 " Catchment 206 Pervious Impervious Total Area "
 " Surface Area 0.022 0.231 0.253 hectare"
 " Time of concentration 26.779 2.397 2.976 minutes"
 " Time to Centroid 134.102 89.692 90.747 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 9.03 94.76 103.79 c.m"
 " Rainfall losses 31.990 5.620 7.914 mm"
 " Runoff depth 9.034 35.404 33.110 mm"
 " Runoff volume 1.99 81.78 83.77 c.m"
 " Runoff coefficient 0.220 0.863 0.807 "
 " Maximum flow 0.000 0.053 0.053 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "

" 0.053 0.203 0.154 0.000"
" 51 PIPE DESIGN"
" 0.203 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.450 Diameter metre"
" 0.600 Gradient %"
" Depth of flow 0.319 metre"
" Velocity 1.689 m/sec"
" Pipe capacity 0.239 c.m/sec"
" Critical depth 0.318 metre"
" 53 ROUTE Pipe Route 74"
" 74.00 Pipe Route 74 Reach length (metre)"
" 0.218 X-factor <= 0.5"
" 32.868 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 50.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.201 c.m/sec"
" 0.053 0.203 0.201 0.000 c.m/sec"
" 40 HYDROGRAPH Combine 2"
" 6 Combine "
" 2 Node #"
" O/G Separator(s)"
" Maximum flow 0.201 c.m/sec"
" Hydrograph volume 352.789 c.m"
" 0.053 0.203 0.201 0.201"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.053 0.000 0.201 0.201"
" 33 CATCHMENT 207"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 207 Restaurant - Bldg. 'D'"
" 96.400 % Impervious"
" 0.140 Total Area"
" 47.000 Flow length"
" 1.500 Overland Slope"
" 0.005 Pervious Area"
" 47.000 Pervious length"
" 1.500 Pervious slope"
" 0.135 Impervious Area"
" 47.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"

```

" 75.000 Pervious SCS Curve No."
" 0.220 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.861 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.030 0.000 0.201 0.201 c.m/sec"
" Catchment 207 Pervious Impervious Total Area "
" Surface Area 0.005 0.135 0.140 hectare"
" Time of concentration 33.726 3.019 3.309 minutes"
" Time to Centroid 142.386 90.677 91.166 minutes"
" Rainfall depth 41.024 41.024 41.024 mm"
" Rainfall volume 2.07 55.37 57.43 c.m"
" Rainfall losses 31.984 5.686 6.632 mm"
" Runoff depth 9.040 35.338 34.392 mm"
" Runoff volume 0.46 47.69 48.15 c.m"
" Runoff coefficient 0.220 0.861 0.838 "
" Maximum flow 0.000 0.030 0.030 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.030 0.030 0.201 0.201"
" 51 PIPE DESIGN"
" 0.030 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.250 Diameter metre"
" 0.300 Gradient %"
" Depth of flow 0.178 metre"
" Velocity 0.808 m/sec"
" Pipe capacity 0.035 c.m/sec"
" Critical depth 0.141 metre"
" 53 ROUTE Pipe Route 14"
" 14.30 Pipe Route 14 Reach length (metre)"
" 0.000 X-factor <= 0.5"
" 13.275 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.804 Beta weighting factor"
" 50.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.030 c.m/sec"
" 0.030 0.030 0.030 0.201 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.030 0.030 0.030 0.201"

```

" 33 CATCHMENT 208"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 208 Restaurant - East Lot"
 " 81.000 % Impervious"
 " 0.267 Total Area"
 " 36.000 Flow length"
 " 1.500 Overland Slope"
 " 0.051 Pervious Area"
 " 36.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.216 Impervious Area"
 " 36.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.862 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.049 0.030 0.030 0.201 c.m/sec"
 " Catchment 208 Pervious Impervious Total Area "
 " Surface Area 0.051 0.216 0.267 hectare"
 " Time of concentration 28.740 2.573 4.052 minutes"
 " Time to Centroid 136.447 89.928 92.559 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 20.81 88.72 109.53 c.m"
 " Rainfall losses 31.990 5.668 10.669 mm"
 " Runoff depth 9.034 35.356 30.355 mm"
 " Runoff volume 4.58 76.46 81.05 c.m"
 " Runoff coefficient 0.220 0.862 0.740 "
 " Maximum flow 0.001 0.049 0.049 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.049 0.077 0.030 0.201"
 " 51 PIPE DESIGN"
 " 0.077 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.375 Diameter metre"
 " 0.300 Gradient %"
 " Depth of flow 0.240 metre"
 " Velocity 1.031 m/sec"
 " Pipe capacity 0.104 c.m/sec"

" Critical depth 0.203 metre"
" 53 ROUTE Pipe Route 72"
" 71.70 Pipe Route 72 Reach length (metre)"
" 0.110 X-factor <= 0.5"
" 52.143 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 75.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.077 c.m/sec"
" 0.049 0.077 0.077 0.201 c.m/sec"
" 40 HYDROGRAPH Combine 3"
" 6 Combine "
" 3 Node #"
" STM MH"
" Maximum flow 0.077 c.m/sec"
" Hydrograph volume 129.195 c.m"
" 0.049 0.077 0.077 0.077"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.049 0.000 0.077 0.077"
" 33 CATCHMENT 209"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 209 Resturant Bldgs. 'B' & 'C'
" 98.100 % Impervious"
" 0.126 Total Area"
" 66.000 Flow length"
" 1.500 Overland Slope"
" 0.002 Pervious Area"
" 66.000 Pervious length"
" 1.500 Pervious slope"
" 0.124 Impervious Area"
" 66.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.220 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.857 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"

```

"      0.029  0.000  0.077  0.077 c.m/sec"
"      Catchment 209      Pervious Impervious Total Area "
"      Surface Area      0.002  0.124  0.126  hectare"
"      Time of concentration 41.345  3.701  3.887  minutes"
"      Time to Centroid  151.481  91.812  92.108  minutes"
"      Rainfall depth  41.024  41.024  41.024  mm"
"      Rainfall volume  0.98  50.71  51.69  c.m"
"      Rainfall losses  31.988  5.848  6.345  mm"
"      Runoff depth  9.036  35.176  34.679  mm"
"      Runoff volume  0.22  43.48  43.70  c.m"
"      Runoff coefficient  0.220  0.857  0.845  "
"      Maximum flow  0.000  0.029  0.029  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.029  0.029  0.077  0.077"
" 51  PIPE DESIGN"
"      0.029 Current peak flow c.m/sec"
"      0.012 Manning 'n'"
"      0.250 Diameter metre"
"      0.350 Gradient %"
"      Depth of flow  0.162 metre"
"      Velocity  0.853 m/sec"
"      Pipe capacity  0.038 c.m/sec"
"      Critical depth  0.137 metre"
" 53  ROUTE Pipe Route 24"
"      24.10 Pipe Route 24 Reach length (metre)"
"      0.000 X-factor <= 0.5"
"      21.197 K-lag (seconds)"
"      0.000 Default(0) or user spec.(1) values used"
"      0.500 X-factor <= 0.5"
"      30.000 K-lag (seconds)"
"      0.588 Beta weighting factor"
"      42.857 Routing time step (seconds)"
"      1 No. of sub-reaches"
"      Peak outflow  0.028 c.m/sec"
"      0.029  0.029  0.028  0.077 c.m/sec"
" 40  HYDROGRAPH Combine 3"
"      6 Combine "
"      3 Node #"
"      STM MH"
"      Maximum flow  0.105 c.m/sec"
"      Hydrograph volume  172.891 c.m"
"      0.029  0.029  0.028  0.105"
" 40  HYDROGRAPH Start - New Tributary"
"      2 Start - New Tributary"
"      0.029  0.000  0.028  0.105"
" 40  HYDROGRAPH Confluence 3"
"      7 Confluence "

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"      3 Node #"
"      STM MH"
"      Maximum flow          0.105 c.m/sec"
"      Hydrograph volume     172.891 c.m"
"      0.029  0.105  0.028  0.000"
" 40  HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.029  0.105  0.105  0.000"
" 40  HYDROGRAPH Next link "
"      5 Next link "
"      0.029  0.105  0.105  0.000"
" 33  CATCHMENT 210"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      210 Restaurant - Central"
"      92.700 % Impervious"
"      0.295 Total Area"
"      57.000 Flow length"
"      1.500 Overland Slope"
"      0.022 Pervious Area"
"      57.000 Pervious length"
"      1.500 Pervious slope"
"      0.273 Impervious Area"
"      57.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.220 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.859 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      0.063  0.105  0.105  0.000 c.m/sec"
"      Catchment 210      Pervious Impervious Total Area "
"      Surface Area      0.022  0.273  0.295  hectare"
"      Time of concentration 37.864  3.389  4.071  minutes"
"      Time to Centroid    147.330  91.268  92.377  minutes"
"      Rainfall depth      41.024  41.024  41.024  mm"
"      Rainfall volume     8.83    112.19  121.02  c.m"
"      Rainfall losses     31.987  5.770  7.684  mm"
"      Runoff depth        9.037  35.254  33.340  mm"
"      Runoff volume       1.95   96.41  98.35  c.m"
"      Runoff coefficient   0.220  0.859  0.813  "
"      Maximum flow       0.000  0.063  0.063  c.m/sec"

```

" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.063 0.168 0.105 0.000"
" 51 PIPE DESIGN"
" 0.168 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.450 Diameter metre"
" 0.350 Gradient %"
" Depth of flow 0.340 metre"
" Velocity 1.304 m/sec"
" Pipe capacity 0.183 c.m/sec"
" Critical depth 0.288 metre"
" 53 ROUTE Pipe Route 70"
" 70.40 Pipe Route 70 Reach length (metre)"
" 0.000 X-factor <= 0.5"
" 40.502 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.549 Beta weighting factor"
" 75.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.165 c.m/sec"
" 0.063 0.168 0.165 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.063 0.165 0.165 0.000"
" 33 CATCHMENT 211"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 211 Restaurant Bldg. 'A'"
" 100.000 % Impervious"
" 0.075 Total Area"
" 38.000 Flow length"
" 1.500 Overland Slope"
" 0.000 Pervious Area"
" 38.000 Pervious length"
" 1.500 Pervious slope"
" 0.075 Impervious Area"
" 38.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.000 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"

" 98.000 Impervious SCS Curve No."
 " 0.861 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.017 0.165 0.165 0.000 c.m/sec"
 " Catchment 211 Pervious Impervious Total Area "
 " Surface Area 0.000 0.075 0.075 hectare"
 " Time of concentration 29.687 2.657 2.657 minutes"
 " Time to Centroid 137.578 90.056 90.056 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 0.00 30.77 30.77 c.m"
 " Rainfall losses 31.989 5.703 5.703 mm"
 " Runoff depth 9.035 35.321 35.321 mm"
 " Runoff volume 0.00 26.49 26.49 c.m"
 " Runoff coefficient 0.000 0.861 0.861 "
 " Maximum flow 0.000 0.017 0.017 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.017 0.182 0.165 0.000"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.017 0.165 0.165 0.000"
 " 33 CATCHMENT 212"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 212 Street 'A'"
 " 90.400 % Impervious"
 " 0.175 Total Area"
 " 97.000 Flow length"
 " 1.500 Overland Slope"
 " 0.017 Pervious Area"
 " 97.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.158 Impervious Area"
 " 97.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.870 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.037 0.165 0.165 0.000 c.m/sec"

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
5-YR Storm – Post-Development Condition

"	Catchment 212	Pervious	Impervious	Total Area	"
"	Surface Area	0.017	0.158	0.175	hectare"
"	Time of concentration	52.091	4.663	5.905	minutes"
"	Time to Centroid	164.296	93.145	95.009	minutes"
"	Rainfall depth	41.024	41.024	41.024	mm"
"	Rainfall volume	6.89	64.90	71.79	c.m"
"	Rainfall losses	31.983	5.338	7.896	mm"
"	Runoff depth	9.041	35.686	33.128	mm"
"	Runoff volume	1.52	56.45	57.97	c.m"
"	Runoff coefficient	0.220	0.870	0.808	"
"	Maximum flow	0.000	0.037	0.037	c.m/sec"
" 40	HYDROGRAPH Add Runoff "				
"	4 Add Runoff "				
"		0.037	0.202	0.165	0.000"
" 40	HYDROGRAPH Copy to Outflow"				
"	8 Copy to Outflow"				
"		0.037	0.202	0.202	0.000"
" 40	HYDROGRAPH Next link "				
"	5 Next link "				
"		0.037	0.202	0.202	0.000"
" 33	CATCHMENT 213"				
"	1 Triangular SCS"				
"	1 Equal length"				
"	1 SCS method"				
"	213 Hotel - SW Side"				
"	96.000 % Impervious"				
"	0.165 Total Area"				
"	37.000 Flow length"				
"	1.500 Overland Slope"				
"	0.007 Pervious Area"				
"	37.000 Pervious length"				
"	1.500 Pervious slope"				
"	0.158 Impervious Area"				
"	37.000 Impervious length"				
"	1.500 Impervious slope"				
"	0.250 Pervious Manning 'n'"				
"	75.000 Pervious SCS Curve No."				
"	0.220 Pervious Runoff coefficient"				
"	0.100 Pervious Ia/S coefficient"				
"	8.467 Pervious Initial abstraction"				
"	0.015 Impervious Manning 'n'"				
"	98.000 Impervious SCS Curve No."				
"	0.861 Impervious Runoff coefficient"				
"	0.100 Impervious Ia/S coefficient"				
"	0.518 Impervious Initial abstraction"				
"		0.035	0.202	0.202	0.000 c.m/sec"
"	Catchment 213 Pervious Impervious Total Area "				
"	Surface Area	0.007	0.158	0.165	hectare"

5-YR Storm – Post-Development Condition

```

"      Time of concentration 29.216  2.615  2.896  minutes"
"      Time to Centroid   137.016  89.989  90.485  minutes"
"      Rainfall depth     41.024  41.024  41.024  mm"
"      Rainfall volume    2.71   64.98  67.69  c.m"
"      Rainfall losses    31.988  5.684  6.736  mm"
"      Runoff depth       9.036  35.340  34.288  mm"
"      Runoff volume      0.60   55.98  56.58  c.m"
"      Runoff coefficient  0.220  0.861  0.836  "
"      Maximum flow       0.000  0.035  0.035  c.m/sec"
" 40    HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"          0.035  0.237  0.202  0.000"
" 51    PIPE DESIGN"
"      0.237 Current peak flow  c.m/sec"
"      0.012 Manning 'n'"
"      0.450 Diameter  metre"
"      0.600 Gradient  %"
"          Depth of flow      0.365  metre"
"          Velocity           1.715  m/sec"
"          Pipe capacity      0.239  c.m/sec"
"          Critical depth     0.343  metre"
" 53    ROUTE  Pipe Route 50"
"      50.40 Pipe Route 50 Reach length  ( metre)"
"      0.000 X-factor <= 0.5"
"      22.042 K-lag  ( seconds)"
"      0.000 Default(0) or user spec.(1) values used"
"      0.500 X-factor <= 0.5"
"      30.000 K-lag  ( seconds)"
"      0.530 Beta weighting factor"
"      42.857 Routing time step  ( seconds)"
"          1 No. of sub-reaches"
"          Peak outflow      0.234  c.m/sec"
"              0.035  0.237  0.234  0.000 c.m/sec"
" 40    HYDROGRAPH Combine  2"
"      6 Combine "
"      2 Node #"
"          O/G Separator(s)"
"          Maximum flow      0.435  c.m/sec"
"          Hydrograph volume  738.583  c.m"
"              0.035  0.237  0.234  0.435"
" 40    HYDROGRAPH Confluence  2"
"      7 Confluence "
"      2 Node #"
"          O/G Separator(s)"
"          Maximum flow      0.435  c.m/sec"
"          Hydrograph volume  738.583  c.m"
"              0.035  0.435  0.234  0.000"
" 51    PIPE DESIGN"

```

" 0.435 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.600 Diameter metre"
" 0.500 Gradient %"
" Depth of flow 0.455 metre"
" Velocity 1.888 m/sec"
" Pipe capacity 0.470 c.m/sec"
" Critical depth 0.432 metre"
" 53 ROUTE Pipe Route 6"
" 6.20 Pipe Route 6 Reach length (metre)"
" 0.000 X-factor <= 0.5"
" 2.463 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.928 Beta weighting factor"
" 33.333 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.434 c.m/sec"
" 0.035 0.435 0.434 0.000 c.m/sec"
" 38 START/RE-START TOTALS 2"
" 3 Runoff Totals on EXIT"
" Total Catchment area 2.408 hectare"
" Total Impervious area 2.081 hectare"
" Total % impervious 86.404"
" 19 EXIT"

INTERCONTINENTAL COMBO HOTEL – AREAS 301 & 302
5-YR Storm – Post-Development Condition

```
"      MIDUSS Output ----->"
"      MIDUSS version          Version 2.25 rev. 465"
"      MIDUSS created          Tuesday, February 05, 2008"
"      10 Units used:          ie METRIC"
"      Job folder:             P:\2013 Projects\
"          13254 York Glendale Hotel Complex\Design\Detailed\MIDUSS"
"      Output filename:        5-YR_EXT.out"
"      Licensee name:          Quartek"
"      Company                  Quartek Group Inc."
"      Date & Time last used:   10/5/2015 at 4:43:20 PM"
" 31      TIME PARAMETERS"
"      5.000 Time Step"
"      180.000 Max. Storm length"
"      1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"      1 Chicago storm"
"      664.000 Coefficient A"
"      4.700 Constant B"
"      0.744 Exponent C"
"      0.375 Fraction R"
"      180.000 Duration"
"      1.000 Time step multiplier"
"      Maximum intensity      120.814 mm/hr"
"      Total depth            41.024 mm"
"      6 005hyd Hydrograph extension used in this file"
" 33      CATCHMENT 301"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      101 Purolator Catchment"
"      86.000 % Impervious"
"      2.651 Total Area"
"      250.000 Flow length"
"      1.000 Overland Slope"
"      0.371 Pervious Area"
"      250.000 Pervious length"
"      1.000 Pervious slope"
"      2.280 Impervious Area"
"      250.000 Impervious length"
"      1.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.220 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.470 Impervious SCS Curve No."
"      0.897 Impervious Runoff coefficient"
```

" 0.132 Impervious Ia/S coefficient"
 " 0.517 Impervious Initial abstraction"
 " 0.447 0.000 0.000 0.000 c.m/sec"
 " Catchment 301 Pervious Impervious Total Area "
 " Surface Area 0.371 2.280 2.651 hectare"
 " Time of concentration 103.823 9.203 12.844 minutes"
 " Time to Centroid 226.004 99.287 104.162 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 152.26 935.29 1087.55 c.m"
 " Rainfall losses 31.982 4.239 8.123 mm"
 " Runoff depth 9.042 36.785 32.901 mm"
 " Runoff volume 33.56 838.65 872.21 c.m"
 " Runoff coefficient 0.220 0.897 0.802 "
 " Maximum flow 0.003 0.447 0.447 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.447 0.447 0.000 0.000"
 " 40 HYDROGRAPH Copy to Outflow"
 " 8 Copy to Outflow"
 " 0.447 0.447 0.447 0.000"
 " 40 HYDROGRAPH Combine 1"
 " 6 Combine "
 " 1 Node #"
 " DICB"
 " Maximum flow 0.447 c.m/sec"
 " Hydrograph volume 872.207 c.m"
 " 0.447 0.447 0.447 0.447"
 " 40 HYDROGRAPH Start - New Tributary"
 " 2 Start - New Tributary"
 " 0.447 0.000 0.447 0.447"
 " 33 CATCHMENT 302"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 102 342 Townline & Easterly Area Catchment"
 " 86.000 % Impervious"
 " 1.461 Total Area"
 " 80.000 Flow length"
 " 1.000 Overland Slope"
 " 0.205 Pervious Area"
 " 80.000 Pervious length"
 " 1.000 Pervious slope"
 " 1.256 Impervious Area"
 " 80.000 Impervious length"
 " 1.000 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.220 Pervious Runoff coefficient"

" 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.550 Impervious SCS Curve No."
 " 0.894 Impervious Runoff coefficient"
 " 0.182 Impervious Ia/S coefficient"
 " 0.682 Impervious Initial abstraction"
 " 0.303 0.000 0.447 0.447 c.m/sec"
 " Catchment 302 Pervious Impervious Total Area "
 " Surface Area 0.205 1.256 1.461 hectare"
 " Time of concentration 52.406 4.640 6.483 minutes"
 " Time to Centroid 164.670 92.560 95.342 minutes"
 " Rainfall depth 41.024 41.024 41.024 mm"
 " Rainfall volume 83.91 515.45 599.36 c.m"
 " Rainfall losses 31.983 4.346 8.215 mm"
 " Runoff depth 9.041 36.678 32.809 mm"
 " Runoff volume 18.49 460.85 479.34 c.m"
 " Runoff coefficient 0.220 0.894 0.800 "
 " Maximum flow 0.003 0.303 0.303 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.303 0.303 0.447 0.447"
 " 40 HYDROGRAPH Copy to Outflow"
 " 8 Copy to Outflow"
 " 0.303 0.303 0.303 0.447"
 " 40 HYDROGRAPH Combine 1"
 " 6 Combine "
 " 1 Node #"
 " DICB"
 " Maximum flow 0.750 c.m/sec"
 " Hydrograph volume 1351.547 c.m"
 " 0.303 0.303 0.303 0.750"
 " 40 HYDROGRAPH Confluence 1"
 " 7 Confluence "
 " 1 Node #"
 " DICB"
 " Maximum flow 0.750 c.m/sec"
 " Hydrograph volume 1351.547 c.m"
 " 0.303 0.750 0.303 0.000"
 " 51 PIPE DESIGN"
 " 0.750 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.750 Diameter metre"
 " 0.400 Gradient %"
 " Depth of flow 0.604 metre"
 " Velocity 1.968 m/sec"
 " Pipe capacity 0.763 c.m/sec"
 " Critical depth 0.537 metre"

" 53 ROUTE Pipe Route 229"
" 229.00 Pipe Route 229 Reach length (metre)"
" 0.197 X-factor <= 0.5"
" 87.265 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 100.000 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.659 c.m/sec"
" 0.303 0.750 0.659 0.000 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Outfall"
" Maximum flow 0.659 c.m/sec"
" Hydrograph volume 1351.547 c.m"
" 0.303 0.750 0.659 0.659"
" 38 START/RE-START TOTALS 1"
" 3 Runoff Totals on EXIT"
" Total Catchment area 4.112 hectare"
" Total Impervious area 3.536 hectare"
" Total % impervious 86.000"
" 19 EXIT"

STORMWATER MANAGEMENT REPORT

INTERCONTINENTAL COMBO HOTEL

**525 York Road
Niagara-on-the-Lake, Ontario**

APPENDIX B

OIL/GRIT SEPARATOR SIZING REPORT



Stormceptor Sizing Detailed Report PCSWMM for Stormceptor

Project Information

Date	10/8/2015
Project Name	525 York Rd
Project Number	N/A
Location	Niagara on the Lake

INTERCONTINENTAL COMBO HOTEL
TREATMENT OF POST-DEVELOPMENT AREAS
201 THROUGH 206

Stormwater Quality Objective

This report outlines how Stormceptor System can achieve a defined water quality objective through the removal of total suspended solids (TSS). Attached to this report is the Stormceptor Sizing Summary.

Stormceptor System Recommendation

The Stormceptor System model STC 750 achieves the water quality objective removing 71% TSS for a Fine (organics, silts and sand) particle size distribution and 86% runoff volume.

The Stormceptor System

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for all rainfall events, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur.

Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Stormceptor is the only oil and sediment separator on the market sized to remove TSS for a wide range of particle sizes, including fine sediments (clays and silts), that are often overlooked in the design of other stormwater treatment devices.



Small storms dominate hydrologic activity, US EPA reports

“Early efforts in stormwater management focused on flood events ranging from the 2-yr to the 100-yr storm. Increasingly stormwater professionals have come to realize that small storms (i.e. < 1 in. rainfall) dominate watershed hydrologic parameters typically associated with water quality management issues and BMP design. These small storms are responsible for most annual urban runoff and groundwater recharge. Likewise, with the exception of eroded sediment, they are responsible for most pollutant washoff from urban surfaces. Therefore, the small storms are of most concern for the stormwater management objectives of ground water recharge, water quality resource protection and thermal impacts control.”

“Most rainfall events are much smaller than design storms used for urban drainage models. In any given area, most frequently recurrent rainfall events are small (less than 1 in. of daily rainfall).”

“Continuous simulation offers possibilities for designing and managing BMPs on an individual site-by-site basis that are not provided by other widely used simpler analysis methods. Therefore its application and use should be encouraged.”

– US EPA Stormwater Best Management Practice Design Guide, Volume 1 – General Considerations, 2004

Design Methodology

Each Stormceptor system is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology from up-to-date local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective.

The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing (summary of analysis presented in Appendix 2):

- Site parameters
- Continuous historical rainfall, including duration, distribution, peaks (Figure 1)
- Interevent periods
- Particle size distribution
- Particle settling velocities (Stokes Law, corrected for drag)
- TSS load (Figure 2)
- Detention time of the system

The Stormceptor System maintains continuous positive TSS removal for all influent flow rates. Figure 3 illustrates the continuous treatment by Stormceptor throughout the full range of storm events analyzed. It is clear that large events do not significantly impact the average annual TSS removal. There is no decline in cumulative TSS removal, indicating scour does not occur as the flow rate increases.

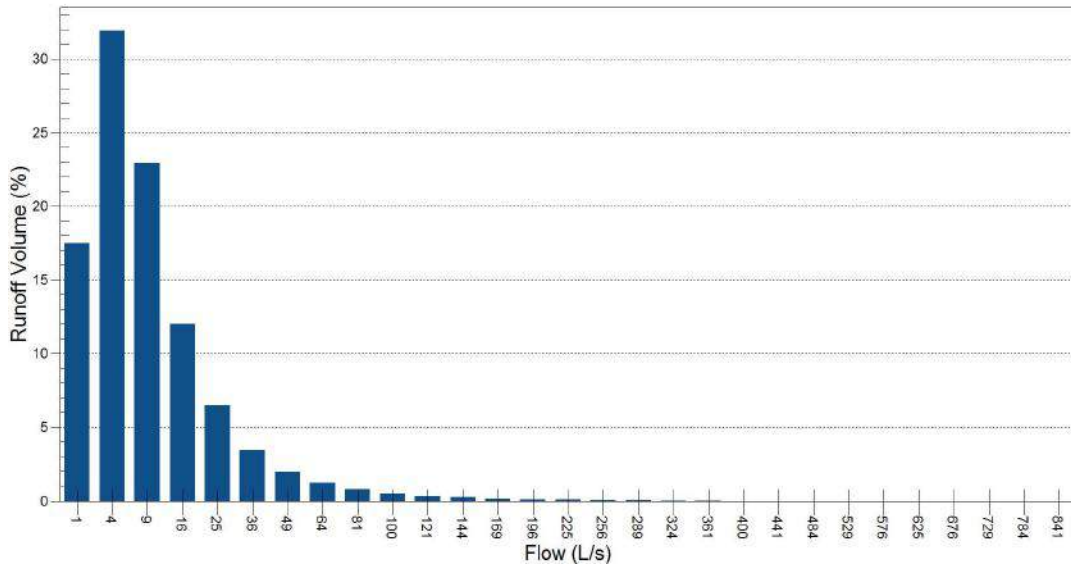


Figure 1. Runoff Volume by Flow Rate for ST CATHARINES A – ON 7287, 1971 to 2003 for 1.17 ha, 87.3% impervious. Small frequent storm events represent the majority of annual rainfall volume. Large infrequent events have little impact on the average annual TSS removal, as they represent a small percentage of the total annual volume of runoff.

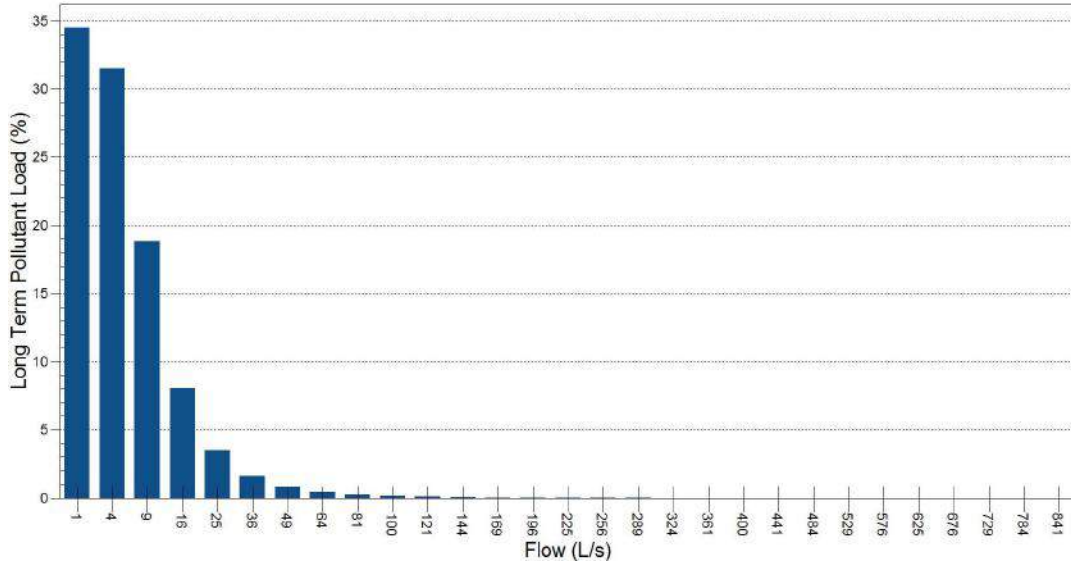
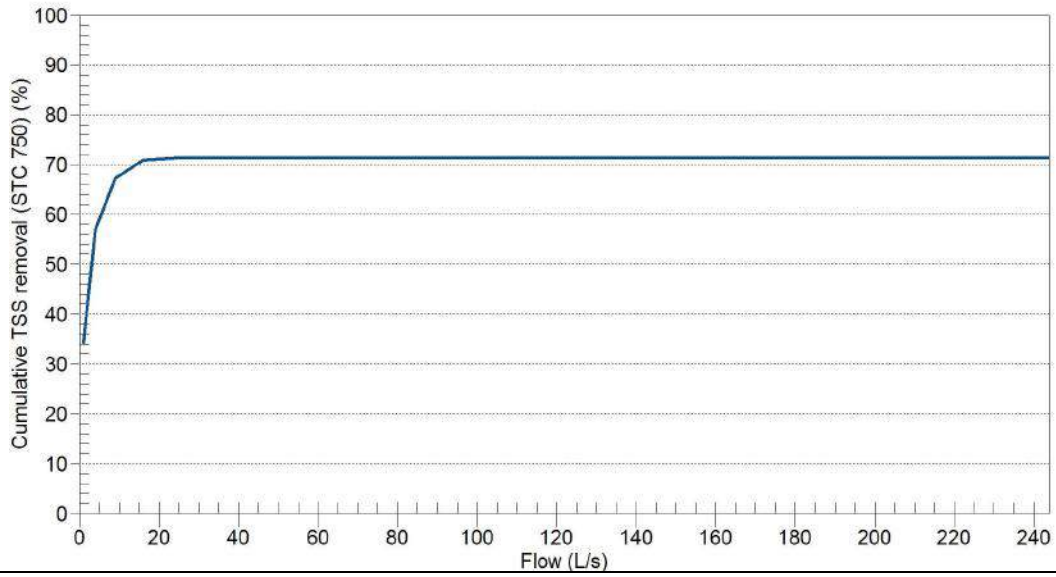


Figure 2. Long Term Pollutant Load by Flow Rate for ST CATHARINES A – 7287, 1971 to 2003 for 1.17 ha, 87.3% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.



Stormceptor Model	STC 750	Drainage Area (ha)	1.17
TSS Removal (%)	71	Impervious (%)	87.3

Figure 3. Cumulative TSS Removal by Flow Rate for ST CATHARINES A – 7287, 1971 to 2003. Stormceptor continuously removes TSS throughout the full range of storm events analyzed. Note that large events do not significantly impact the average annual TSS removal. Therefore no decline in cumulative TSS removal indicates scour does not occur as the flow rate increases.



Appendix 1 Stormceptor Design Summary

Project Information

Date	10/8/2015
Project Name	525 York Rd
Project Number	N/A
Location	Niagara on the Lake

Designer Information

Company	Quartek
Contact	John P

Notes

N/A

Drainage Area

Total Area (ha)	1.17
Imperviousness (%)	87.3

The Stormceptor System model STC 750 achieves the water quality objective removing 71% TSS for a Fine (organics, silts and sand) particle size distribution and 86% runoff volume.

Rainfall

Name	ST CATHARINES A
State	ON
ID	7287
Years of Records	1971 to 2003
Latitude	43°12'N
Longitude	79°10'W

Water Quality Objective

TSS Removal (%)	70
Runoff Volume (%)	85

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal	Runoff Volume
	%	%
STC 300	61	69
STC 750	71	86
STC 1000	72	86
STC 1500	73	86
STC 2000	78	93
STC 3000	79	93
STC 4000	82	96
STC 5000	83	96
STC 6000	86	98
STC 9000	89	99
STC 10000	89	99
STC 14000	91	99



Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)							
Particle Size	Distribution	Specific Gravity	Settling Velocity	Particle Size	Distribution	Specific Gravity	Settling Velocity
μm	%		m/s	μm	%		m/s
20	20	1.3	0.0004				
60	20	1.8	0.0016				
150	20	2.2	0.0108				
400	20	2.65	0.0647				
2000	20	2.65	0.2870				

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.



Appendix 2 Summary of Design Assumptions

SITE DETAILS

Site Drainage Area

Total Area (ha)	1.17	Imperviousness (%)	87.3
-----------------	------	--------------------	------

Surface Characteristics

Width (m)	216
Slope (%)	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Infiltration Parameters

Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/h)	61.98
Min. Infiltration Rate (mm/h)	10.16
Decay Rate (s ⁻¹)	0.00055
Regeneration Rate (s ⁻¹)	0.01

Maintenance Frequency

Sediment build-up reduces the storage volume for sedimentation. Frequency of maintenance is assumed for TSS removal calculations.	
Maintenance Frequency (months)	12

Evaporation

Daily Evaporation Rate (mm/day)	2.54
---------------------------------	------

Dry Weather Flow

Dry Weather Flow (L/s)	No
------------------------	----

Winter Months

Winter Infiltration	False
---------------------	-------

Upstream Attenuation

Stage-storage and stage-discharge relationship used to model attenuation upstream of the Stormceptor System is identified in the table below.

Storage ha-m	Discharge L/s
0	0



PARTICLE SIZE DISTRIBUTION

Particle Size Distribution

Removing fine particles from runoff ensures the majority of pollutants, such as heavy metals, hydrocarbons, free oils and nutrients are not discharged into natural water resources. The table below identifies the particle size distribution selected to define TSS removal for the design of the Stormceptor System.

Fine (organics, silts and sand)							
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s	Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004				
60	20	1.8	0.0016				
150	20	2.2	0.0108				
400	20	2.65	0.0647				
2000	20	2.65	0.2870				

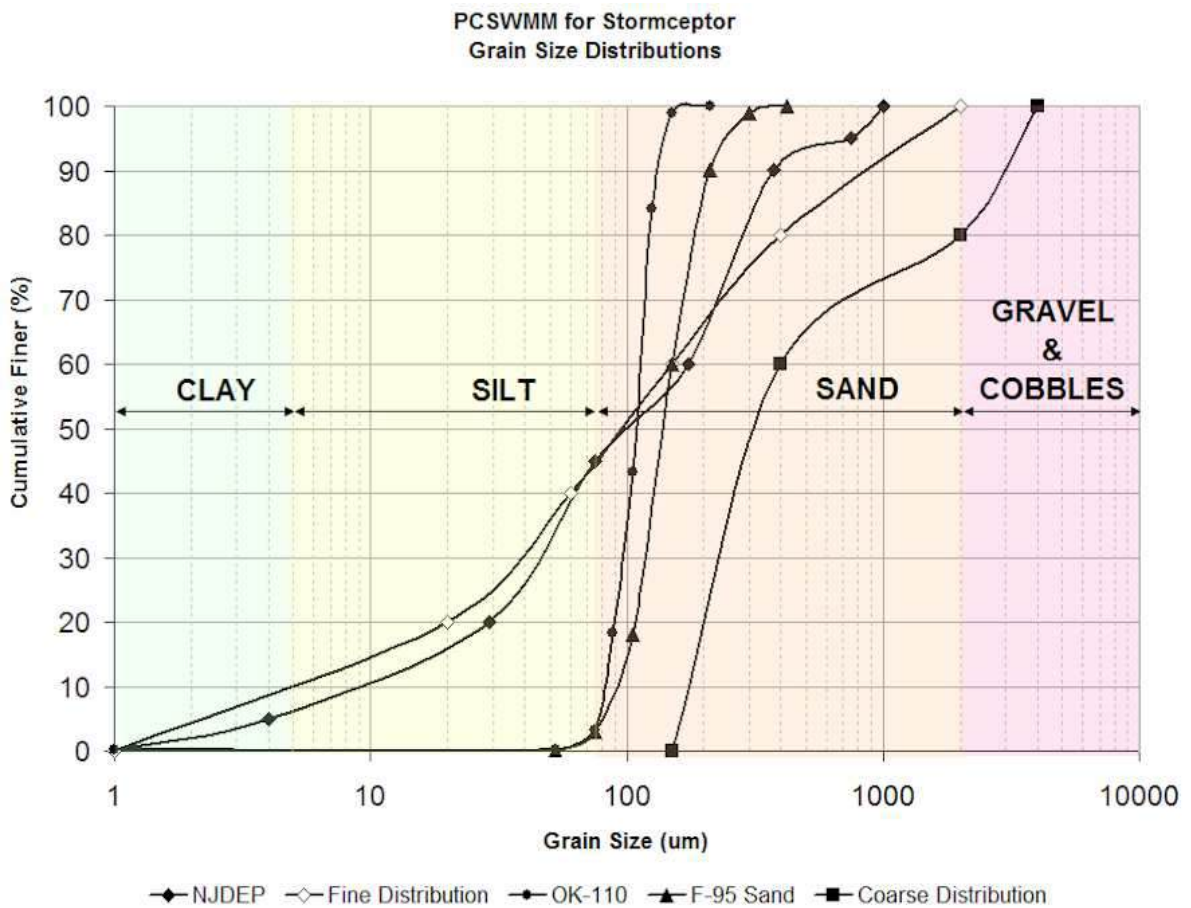


Figure 1. PCSWMM for Stormceptor standard design grain size distributions.



TSS LOADING

TSS Loading Parameters

TSS Loading Function	Buildup / Washoff
----------------------	-------------------

Buildup/Washoff Parameters

Target Event Mean Concentration (EMC) (mg/L)	125
Exponential Buildup Power	0.4
Exponential Washoff Exponential	0.2

TSS Availability Parameters

Availability = $A + B_i^C$	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.1
Min. Particle Size Affected by Availability (μm)	400

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters. The Stormceptor System is engineered to capture fine particles (silts and sands) by focusing on average annual runoff volume ensuring positive removal efficiency is maintained during all rainfall events, while preventing the opportunity for negative removal efficiency (scour).

Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

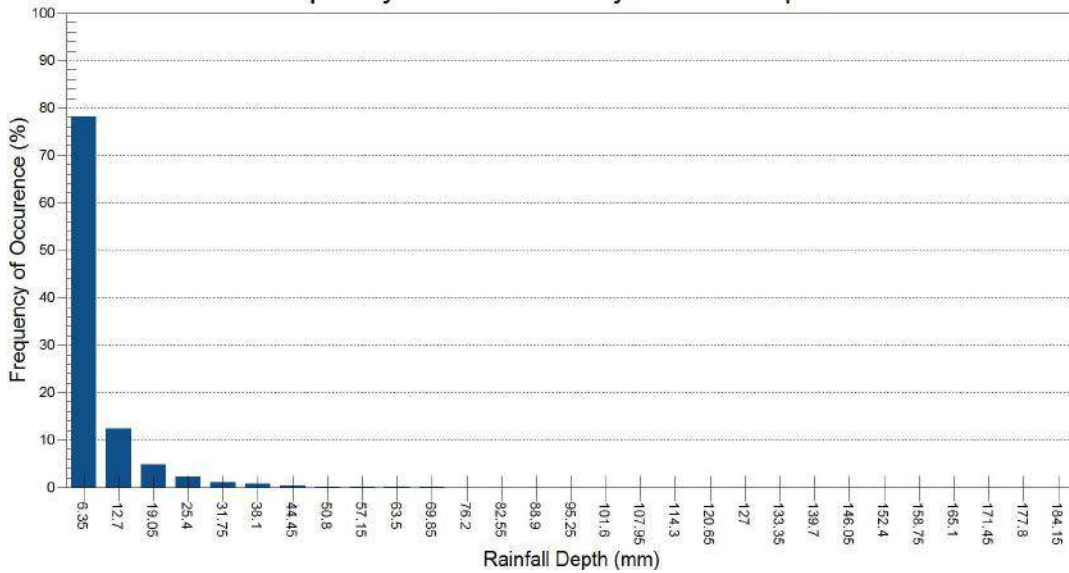
Rainfall Station

Rainfall Station	ST CATHARINES A		
Rainfall File Name	ON7287.NDC	Total Number of Events	3641
Latitude	43°12'N	Total Rainfall (mm)	16277.3
Longitude	79°10'W	Average Annual Rainfall (mm)	493.3
Elevation (m)	318	Total Evaporation (mm)	1381.5
Rainfall Period of Record (y)	33	Total Infiltration (mm)	2057.7
Total Rainfall Period (y)	33	Percentage of Rainfall that is Runoff (%)	79.3

Rainfall Event Analysis

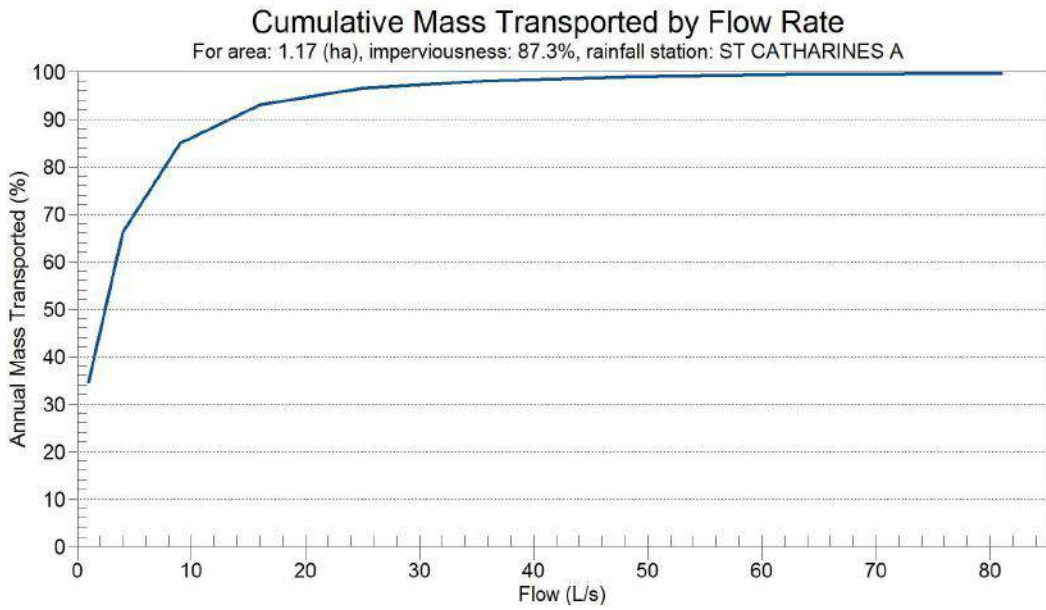
Rainfall Depth	No. of Events	Percentage of Total Events	Total Volume	Percentage of Annual Volume
mm		%	mm	%
6.35	2843	78.1	4486	27.6
12.70	452	12.4	4074	25.0
19.05	176	4.8	2743	16.9
25.40	79	2.2	1717	10.6
31.75	40	1.1	1139	7.0
38.10	27	0.7	923	5.7
44.45	10	0.3	402	2.5
50.80	3	0.1	143	0.9
57.15	4	0.1	210	1.3
63.50	4	0.1	237	1.5
69.85	2	0.1	130	0.8
76.20	1	0.0	73	0.4
82.55	0	0.0	0	0.0
88.90	0	0.0	0	0.0
95.25	0	0.0	0	0.0
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0
114.30	0	0.0	0	0.0
120.65	0	0.0	0	0.0
127.00	0	0.0	0	0.0
133.35	0	0.0	0	0.0
139.70	0	0.0	0	0.0
146.05	0	0.0	0	0.0
152.40	0	0.0	0	0.0
158.75	0	0.0	0	0.0
165.10	0	0.0	0	0.0
171.45	0	0.0	0	0.0
177.80	0	0.0	0	0.0
184.15	0	0.0	0	0.0
190.50	0	0.0	0	0.0
196.85	0	0.0	0	0.0
203.20	0	0.0	0	0.0
209.55	0	0.0	0	0.0
>209.55	0	0.0	0	0.0

Frequency of Occurrence by Rainfall Depths



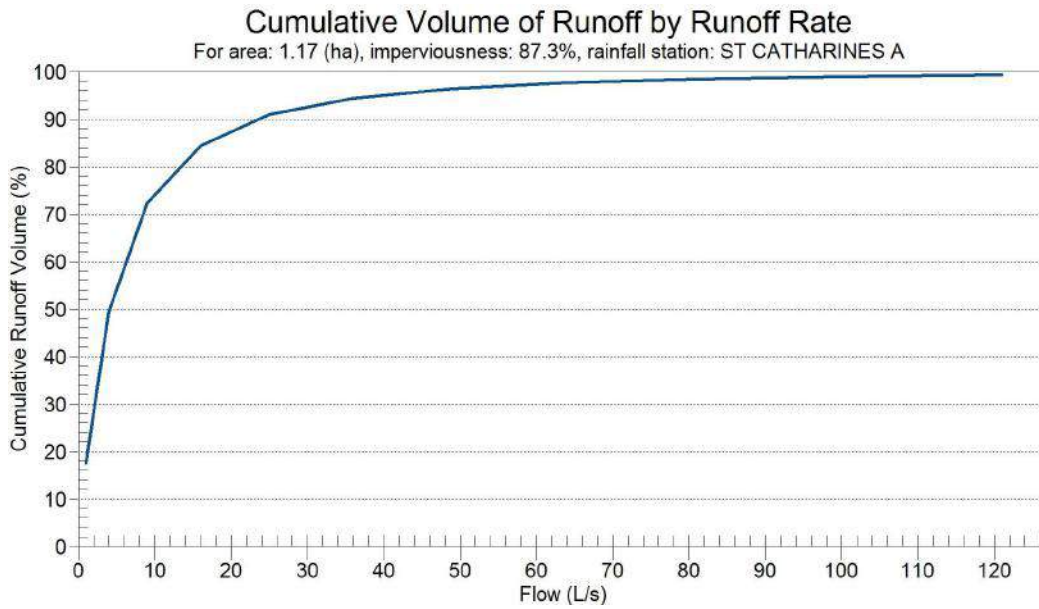
Pollutograph

Flow Rate	Influent Mass	Effluent Mass	Total Mass	Cumulative Mass
L/s	kg	kg	kg	%
1	22580	42843	65335	34.6
4	43175	22217	65335	66.1
9	55482	9877	65335	84.9
16	60744	4603	65335	93.0
25	63047	2293	65335	96.5
36	64095	1243	65335	98.1
49	64618	718	65335	98.9
64	64917	420	65335	99.4
81	65082	253	65335	99.6
100	65182	153	65335	99.8
121	65247	89	65335	99.9
144	65288	48	65335	99.9
169	65303	33	65335	99.9
196	65315	21	65335	100.0
225	65324	12	65335	100.0
256	65330	6	65335	100.0
289	65334	1	65335	100.0
324	65335	0	65335	100.0
361	65335	0	65335	100.0
400	65335	0	65335	100.0
441	65335	0	65335	100.0
484	65335	0	65335	100.0
529	65335	0	65335	100.0
576	65335	0	65335	100.0
625	65335	0	65335	100.0
676	65335	0	65335	100.0
729	65335	0	65335	100.0
784	65335	0	65335	100.0
841	65335	0	65335	100.0
900	65335	0	65335	100.0



Cumulative Runoff Volume by Runoff Rate

Runoff Rate	Runoff Volume	Volume Overflowed	Cumulative Runoff Volume
L/s	m ³	m ³	%
1	26434	124523	17.5
4	74620	76319	49.4
9	109254	41700	72.4
16	127405	23530	84.4
25	137226	13711	90.9
36	142450	8479	94.4
49	145418	5510	96.4
64	147292	3634	97.6
81	148494	2433	98.4
100	149273	1653	98.9
121	149797	1129	99.3
144	150185	740	99.5
169	150376	549	99.6
196	150533	392	99.7
225	150672	253	99.8
256	150785	140	99.9
289	150866	59	100.0
324	150907	18	100.0
361	150925	0	100.0
400	150925	0	100.0
441	150925	0	100.0
484	150925	0	100.0
529	150925	0	100.0
576	150925	0	100.0
625	150925	0	100.0
676	150925	0	100.0
729	150925	0	100.0
784	150925	0	100.0
841	150925	0	100.0
900	150925	0	100.0





Stormceptor Sizing Detailed Report PCSWMM for Stormceptor

Project Information

Date	10/8/2015
Project Name	525 York Rd
Project Number	N/A
Location	Niagara on the Lake

INTERCONTINENTAL COMBO HOTEL
TREATMENT OF POST-DEVELOPMENT AREAS
207 THROUGH 213

Stormwater Quality Objective

This report outlines how Stormceptor System can achieve a defined water quality objective through the removal of total suspended solids (TSS). Attached to this report is the Stormceptor Sizing Summary.

Stormceptor System Recommendation

The Stormceptor System model STC 750 achieves the water quality objective removing 70% TSS for a Fine (organics, silts and sand) particle size distribution and 85% runoff volume.

The Stormceptor System

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for all rainfall events, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur.

Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Stormceptor is the only oil and sediment separator on the market sized to remove TSS for a wide range of particle sizes, including fine sediments (clays and silts), that are often overlooked in the design of other stormwater treatment devices.



Small storms dominate hydrologic activity, US EPA reports

“Early efforts in stormwater management focused on flood events ranging from the 2-yr to the 100-yr storm. Increasingly stormwater professionals have come to realize that small storms (i.e. < 1 in. rainfall) dominate watershed hydrologic parameters typically associated with water quality management issues and BMP design. These small storms are responsible for most annual urban runoff and groundwater recharge. Likewise, with the exception of eroded sediment, they are responsible for most pollutant washoff from urban surfaces. Therefore, the small storms are of most concern for the stormwater management objectives of ground water recharge, water quality resource protection and thermal impacts control.”

“Most rainfall events are much smaller than design storms used for urban drainage models. In any given area, most frequently recurrent rainfall events are small (less than 1 in. of daily rainfall).”

“Continuous simulation offers possibilities for designing and managing BMPs on an individual site-by-site basis that are not provided by other widely used simpler analysis methods. Therefore its application and use should be encouraged.”

– US EPA Stormwater Best Management Practice Design Guide, Volume 1 – General Considerations, 2004

Design Methodology

Each Stormceptor system is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology from up-to-date local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective.

The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing (summary of analysis presented in Appendix 2):

- Site parameters
- Continuous historical rainfall, including duration, distribution, peaks (Figure 1)
- Interevent periods
- Particle size distribution
- Particle settling velocities (Stokes Law, corrected for drag)
- TSS load (Figure 2)
- Detention time of the system

The Stormceptor System maintains continuous positive TSS removal for all influent flow rates. Figure 3 illustrates the continuous treatment by Stormceptor throughout the full range of storm events analyzed. It is clear that large events do not significantly impact the average annual TSS removal. There is no decline in cumulative TSS removal, indicating scour does not occur as the flow rate increases.

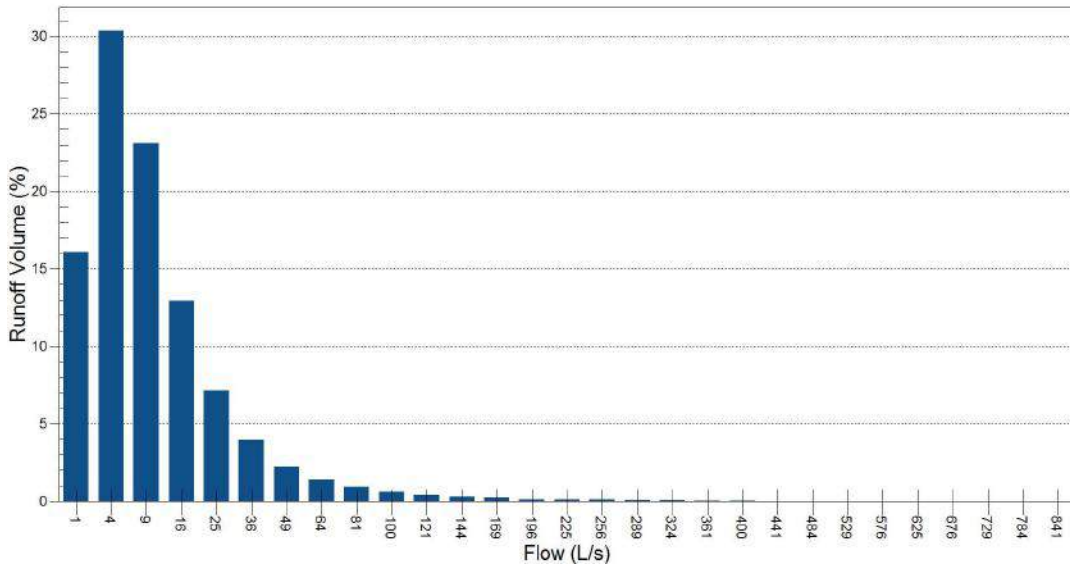


Figure 1. Runoff Volume by Flow Rate for ST CATHARINES A – ON 7287, 1971 to 2003 for 1.25 ha, 91.8% impervious. Small frequent storm events represent the majority of annual rainfall volume. Large infrequent events have little impact on the average annual TSS removal, as they represent a small percentage of the total annual volume of runoff.

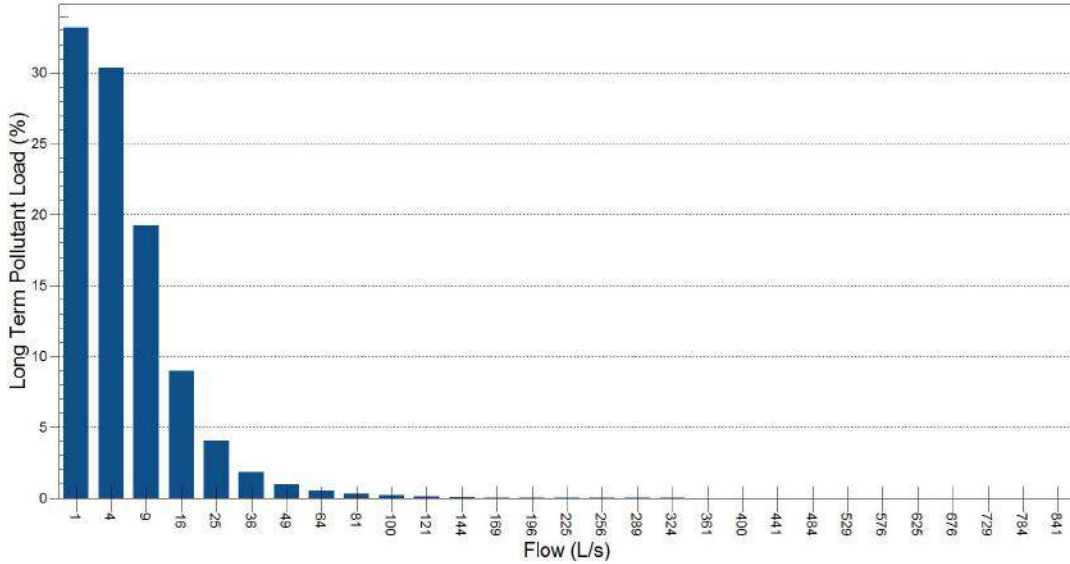
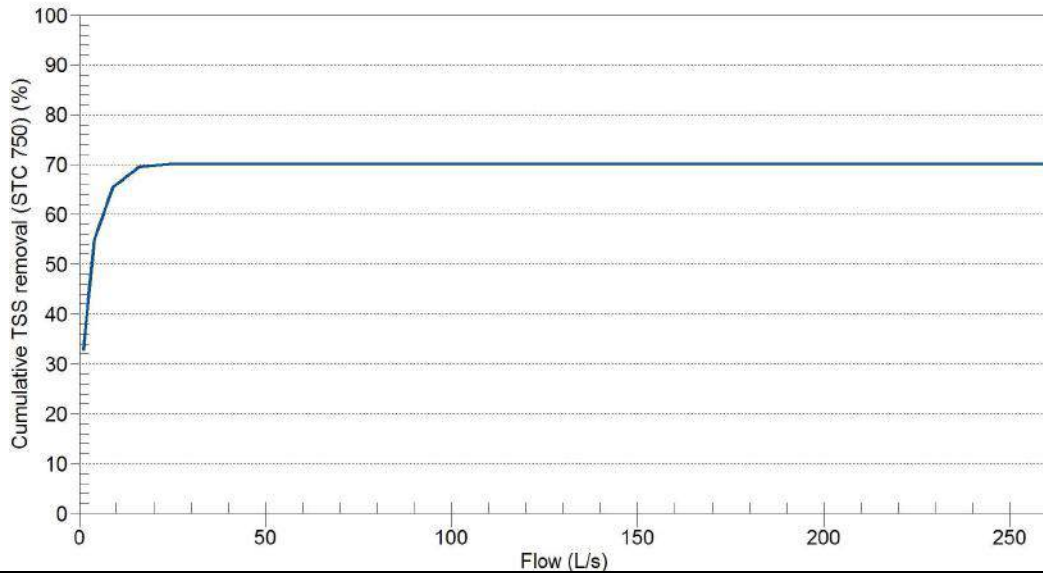


Figure 2. Long Term Pollutant Load by Flow Rate for ST CATHARINES A – 7287, 1971 to 2003 for 1.25 ha, 91.8% impervious. The majority of the annual pollutant load is transported by small frequent storm events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.



Stormceptor Model	STC 750	Drainage Area (ha)	1.25
TSS Removal (%)	70	Impervious (%)	91.8

Figure 3. Cumulative TSS Removal by Flow Rate for ST CATHARINES A – 7287, 1971 to 2003. Stormceptor continuously removes TSS throughout the full range of storm events analyzed. Note that large events do not significantly impact the average annual TSS removal. Therefore no decline in cumulative TSS removal indicates scour does not occur as the flow rate increases.



Appendix 1 Stormceptor Design Summary

Project Information

Date	10/8/2015
Project Name	525 York Rd
Project Number	N/A
Location	Niagara on the Lake

Designer Information

Company	Quartek
Contact	John P

Notes

N/A

Drainage Area

Total Area (ha)	1.25
Imperviousness (%)	91.8

The Stormceptor System model STC 750 achieves the water quality objective removing 70% TSS for a Fine (organics, silts and sand) particle size distribution and 85% runoff volume.

Rainfall

Name	ST CATHARINES A
State	ON
ID	7287
Years of Records	1971 to 2003
Latitude	43°12'N
Longitude	79°10'W

Water Quality Objective

TSS Removal (%)	70
Runoff Volume (%)	85

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal	Runoff Volume
	%	%
STC 300	59	66
STC 750	70	85
STC 1000	71	85
STC 1500	71	85
STC 2000	77	92
STC 3000	78	92
STC 4000	81	96
STC 5000	82	96
STC 6000	85	98
STC 9000	88	99
STC 10000	88	99
STC 14000	90	99



Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size	Distribution	Specific Gravity	Settling Velocity		Particle Size	Distribution	Specific Gravity	Settling Velocity
μm	%		m/s		μm	%		m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.



Appendix 2 Summary of Design Assumptions

SITE DETAILS

Site Drainage Area

Total Area (ha)	1.25	Imperviousness (%)	91.8
-----------------	------	--------------------	------

Surface Characteristics

Width (m)	224
Slope (%)	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Infiltration Parameters

Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/h)	61.98
Min. Infiltration Rate (mm/h)	10.16
Decay Rate (s ⁻¹)	0.00055
Regeneration Rate (s ⁻¹)	0.01

Maintenance Frequency

Sediment build-up reduces the storage volume for sedimentation. Frequency of maintenance is assumed for TSS removal calculations.	
Maintenance Frequency (months)	12

Evaporation

Daily Evaporation Rate (mm/day)	2.54
---------------------------------	------

Dry Weather Flow

Dry Weather Flow (L/s)	No
------------------------	----

Winter Months

Winter Infiltration	False
---------------------	-------

Upstream Attenuation

Stage-storage and stage-discharge relationship used to model attenuation upstream of the Stormceptor System is identified in the table below.

Storage ha-m	Discharge L/s
0	0



PARTICLE SIZE DISTRIBUTION

Particle Size Distribution

Removing fine particles from runoff ensures the majority of pollutants, such as heavy metals, hydrocarbons, free oils and nutrients are not discharged into natural water resources. The table below identifies the particle size distribution selected to define TSS removal for the design of the Stormceptor System.

Fine (organics, silts and sand)							
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s	Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004				
60	20	1.8	0.0016				
150	20	2.2	0.0108				
400	20	2.65	0.0647				
2000	20	2.65	0.2870				

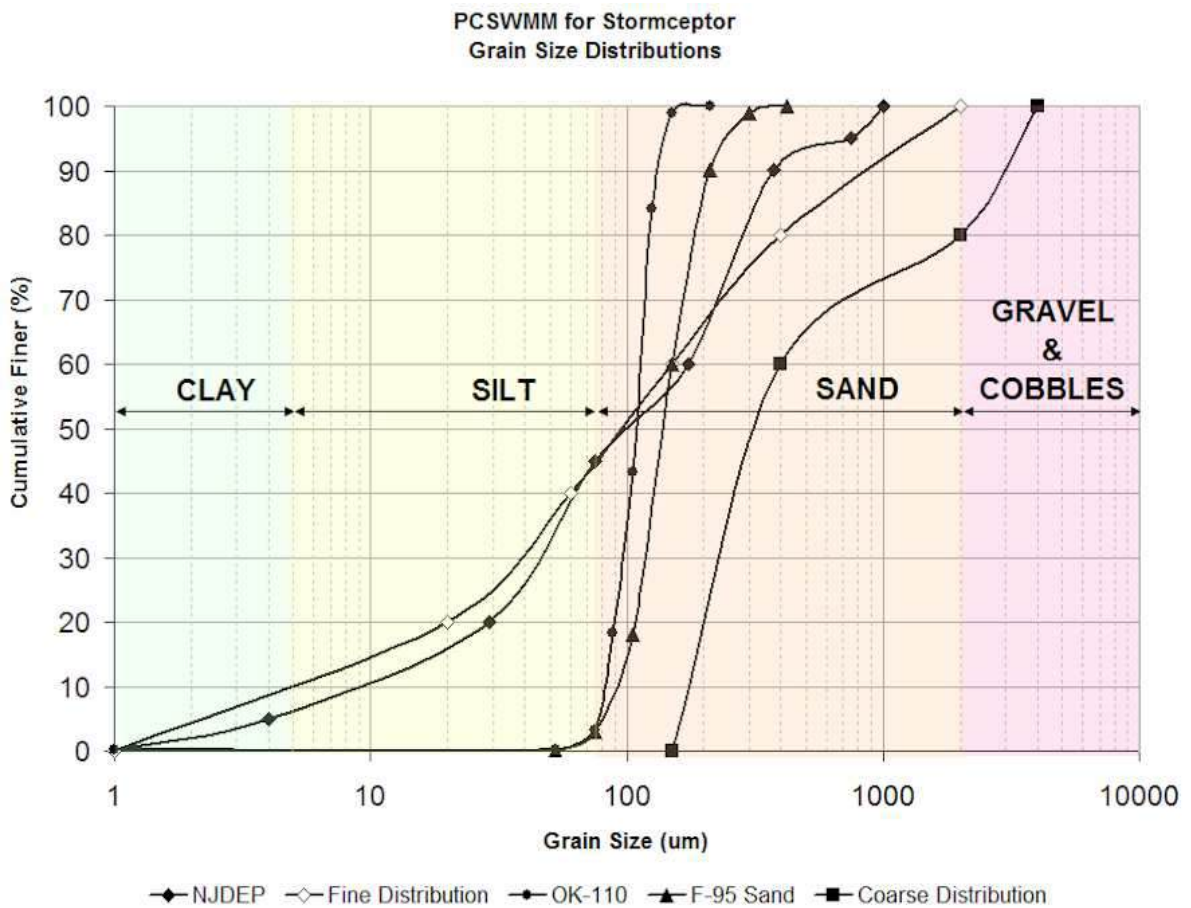


Figure 1. PCSWMM for Stormceptor standard design grain size distributions.



TSS LOADING

TSS Loading Parameters

TSS Loading Function	Buildup / Washoff
----------------------	-------------------

Buildup/Washoff Parameters

Target Event Mean Concentration (EMC) (mg/L)	125
Exponential Buildup Power	0.4
Exponential Washoff Exponential	0.2

TSS Availability Parameters

Availability = $A + B_i C^i$	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.1
Min. Particle Size Affected by Availability (μm)	400

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters. The Stormceptor System is engineered to capture fine particles (silts and sands) by focusing on average annual runoff volume ensuring positive removal efficiency is maintained during all rainfall events, while preventing the opportunity for negative removal efficiency (scour).

Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

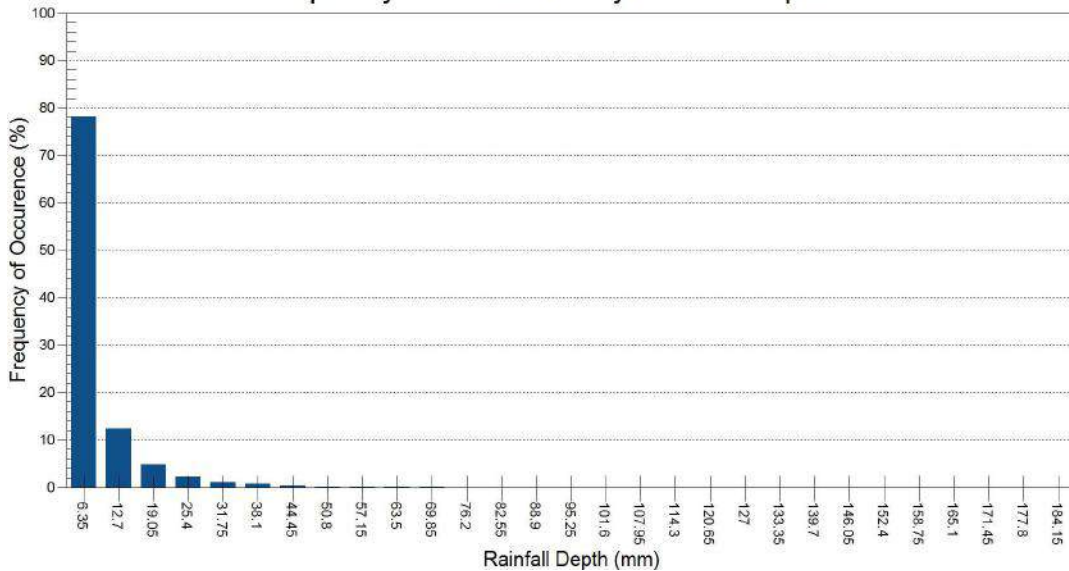
Rainfall Station

Rainfall Station	ST CATHARINES A		
Rainfall File Name	ON7287.NDC	Total Number of Events	3640
Latitude	43°12'N	Total Rainfall (mm)	16246.3
Longitude	79°10'W	Average Annual Rainfall (mm)	492.3
Elevation (m)	318	Total Evaporation (mm)	1471.1
Rainfall Period of Record (y)	33	Total Infiltration (mm)	1328.3
Total Rainfall Period (y)	33	Percentage of Rainfall that is Runoff (%)	83.4

Rainfall Event Analysis

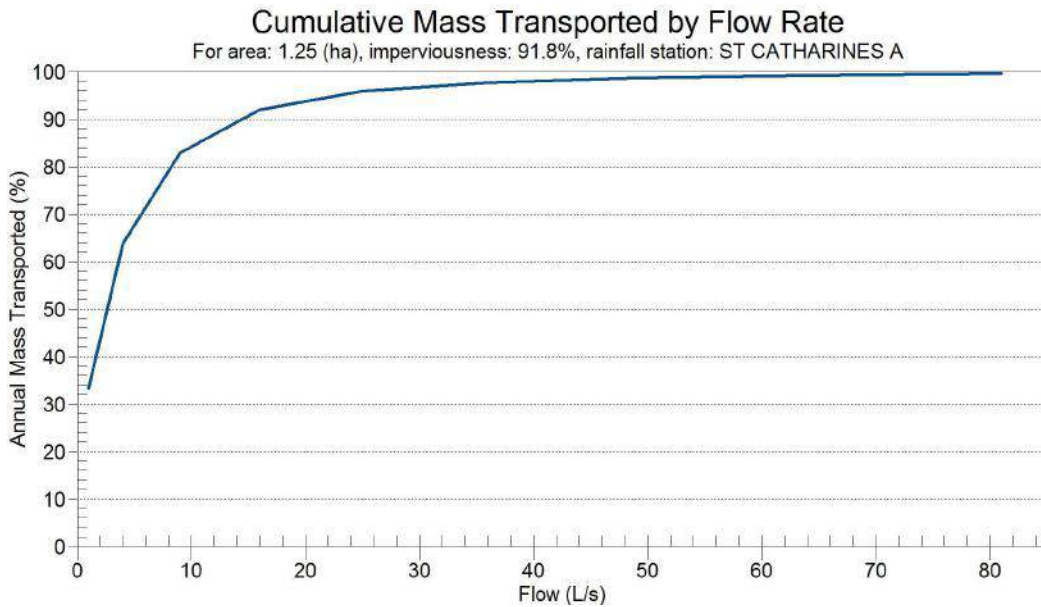
Rainfall Depth	No. of Events	Percentage of Total Events	Total Volume	Percentage of Annual Volume
mm		%	mm	%
6.35	2843	78.1	4486	27.6
12.70	452	12.4	4074	25.1
19.05	176	4.8	2743	16.9
25.40	79	2.2	1717	10.6
31.75	39	1.1	1108	6.8
38.10	27	0.7	923	5.7
44.45	10	0.3	402	2.5
50.80	3	0.1	143	0.9
57.15	4	0.1	210	1.3
63.50	4	0.1	237	1.5
69.85	2	0.1	130	0.8
76.20	1	0.0	73	0.5
82.55	0	0.0	0	0.0
88.90	0	0.0	0	0.0
95.25	0	0.0	0	0.0
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0
114.30	0	0.0	0	0.0
120.65	0	0.0	0	0.0
127.00	0	0.0	0	0.0
133.35	0	0.0	0	0.0
139.70	0	0.0	0	0.0
146.05	0	0.0	0	0.0
152.40	0	0.0	0	0.0
158.75	0	0.0	0	0.0
165.10	0	0.0	0	0.0
171.45	0	0.0	0	0.0
177.80	0	0.0	0	0.0
184.15	0	0.0	0	0.0
190.50	0	0.0	0	0.0
196.85	0	0.0	0	0.0
203.20	0	0.0	0	0.0
209.55	0	0.0	0	0.0
>209.55	0	0.0	0	0.0

Frequency of Occurrence by Rainfall Depths



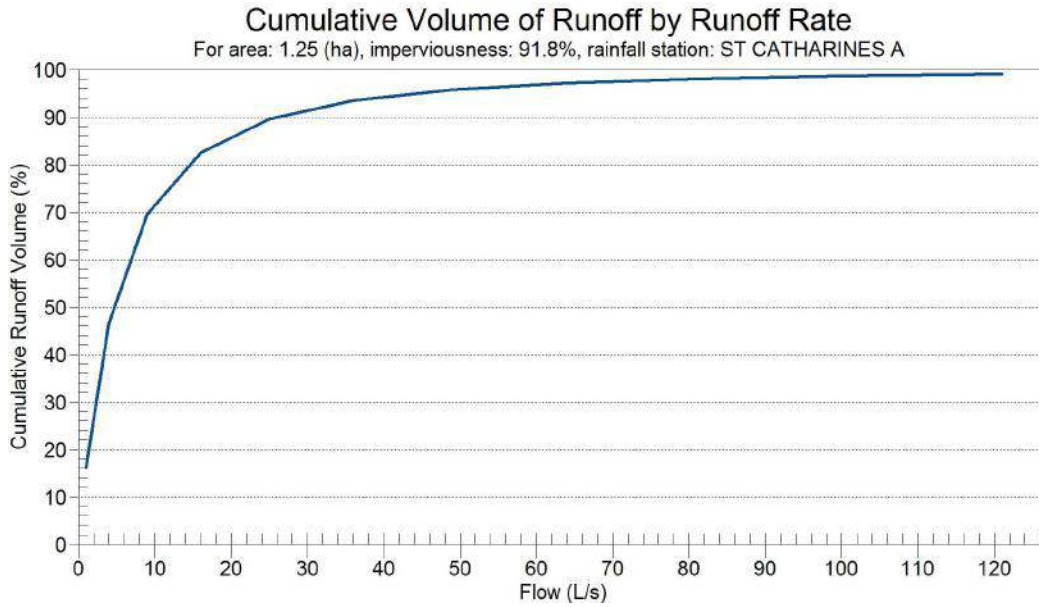
Pollutograph

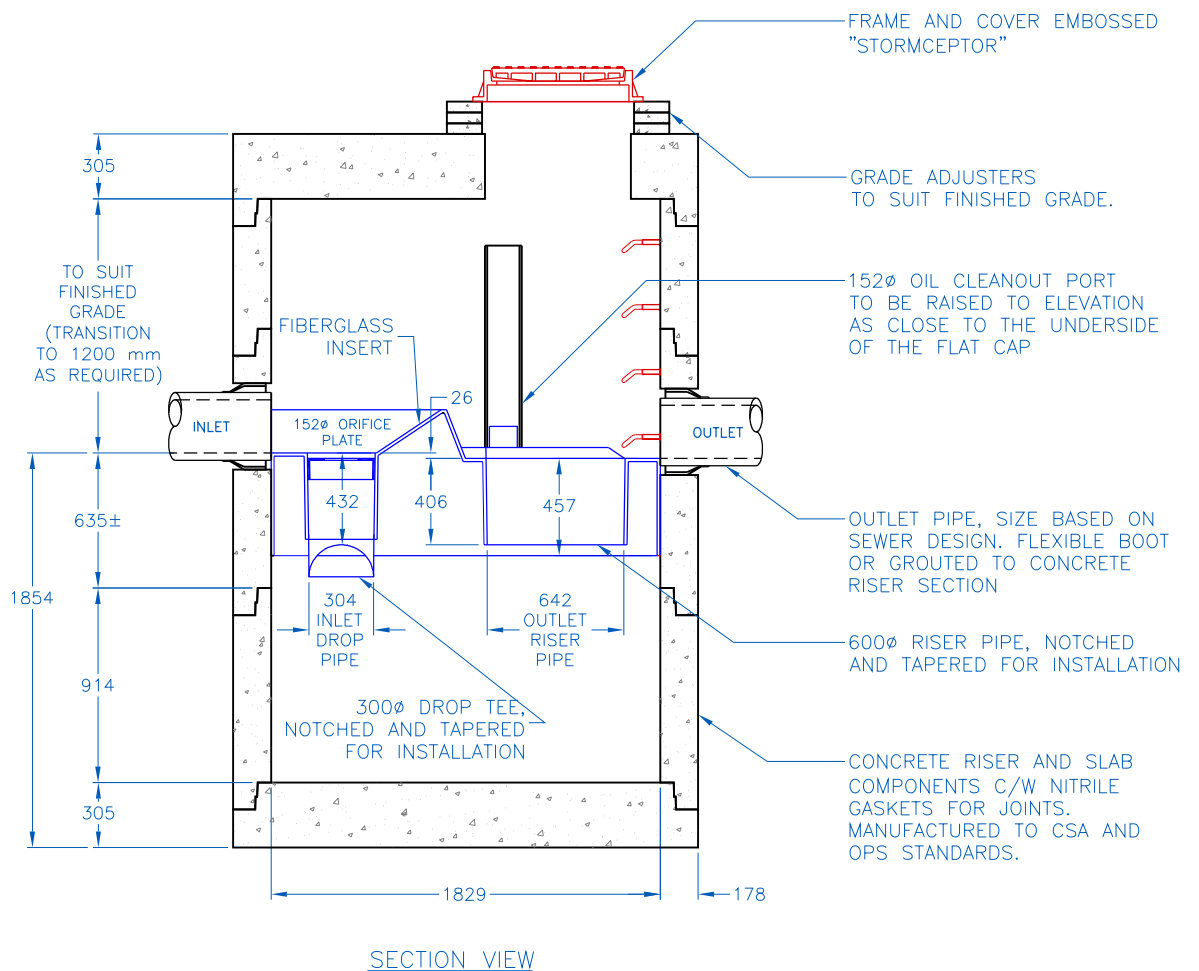
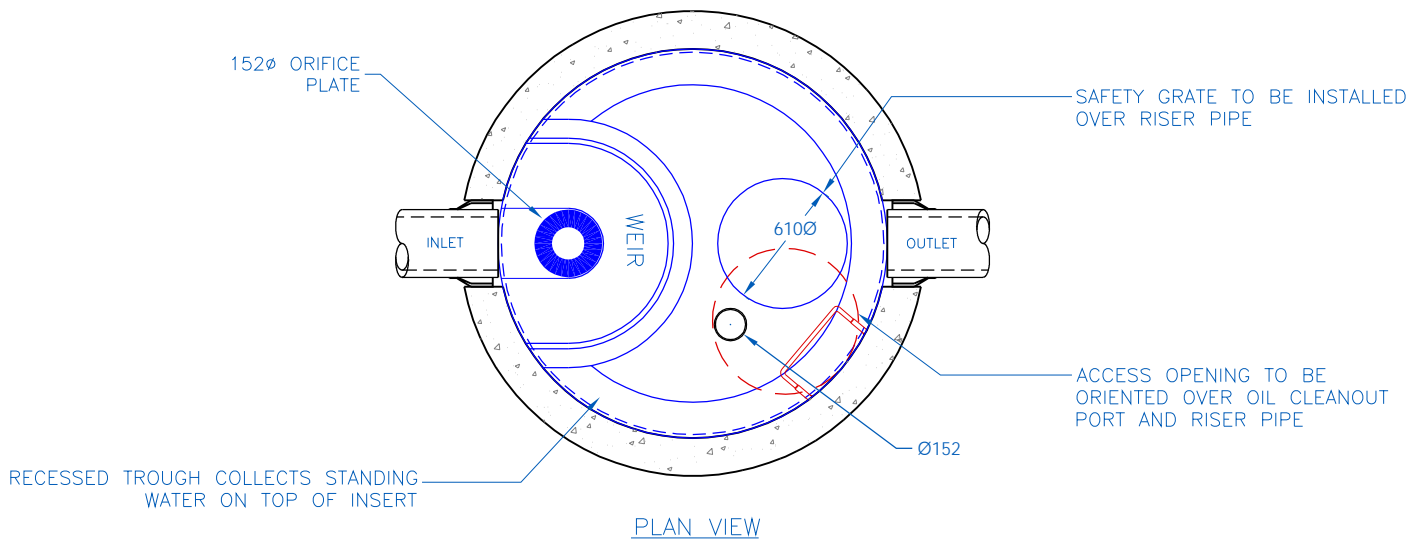
Flow Rate	Influent Mass	Effluent Mass	Total Mass	Cumulative Mass
L/s	kg	kg	kg	%
1	24324	48945	73149	33.3
4	46560	26670	73149	63.7
9	60627	12575	73149	82.9
16	67192	5990	73149	91.9
25	70146	3024	73149	95.9
36	71485	1674	73149	97.7
49	72175	981	73149	98.7
64	72580	577	73149	99.2
81	72802	354	73149	99.5
100	72933	220	73149	99.7
121	73016	135	73149	99.8
144	73075	77	73149	99.9
169	73105	46	73149	99.9
196	73119	32	73149	100.0
225	73130	20	73149	100.0
256	73138	11	73149	100.0
289	73144	5	73149	100.0
324	73148	1	73149	100.0
361	73149	0	73149	100.0
400	73149	0	73149	100.0
441	73149	0	73149	100.0
484	73149	0	73149	100.0
529	73149	0	73149	100.0
576	73149	0	73149	100.0
625	73149	0	73149	100.0
676	73149	0	73149	100.0
729	73149	0	73149	100.0
784	73149	0	73149	100.0
841	73149	0	73149	100.0
900	73149	0	73149	100.0



Cumulative Runoff Volume by Runoff Rate

Runoff Rate	Runoff Volume	Volume Overflowed	Cumulative Runoff Volume
L/s	m ³	m ³	%
1	27217	142137	16.1
4	78672	90681	46.5
9	117773	51599	69.5
16	139678	29669	82.5
25	151769	17585	89.6
36	158402	10948	93.5
49	162168	7184	95.8
64	164527	4824	97.2
81	166093	3258	98.1
100	167118	2233	98.7
121	167794	1557	99.1
144	168284	1066	99.4
169	168621	730	99.6
196	168797	553	99.7
225	168957	393	99.8
256	169102	249	99.9
289	169214	137	99.9
324	169295	55	100.0
361	169333	18	100.0
400	169351	0	100.0
441	169351	0	100.0
484	169351	0	100.0
529	169351	0	100.0
576	169351	0	100.0
625	169351	0	100.0
676	169351	0	100.0
729	169351	0	100.0
784	169351	0	100.0
841	169351	0	100.0
900	169351	0	100.0





THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OF THE FOLLOWING PATENTS:

CANADIAN PATENT NO. 2,009,208
 CANADIAN PATENT NO. 2,137,942
 CANADIAN PATENT NO. 2,175,277
 CANADIAN PATENT NO. 2,180,305
 CANADIAN PATENT NO. 2,206,338

STC 750 CAPACITIES		
SEDIMENT CAPACITY (L)	OIL CAPACITY (L)	TOTAL CAPACITY L (IMP GAL)
3000	915	4070 (895)



IN-LINE STORMCEPTOR MODEL STC 750

JAN
2003

PAGE
G-2

ADDENDUM

STORMWATER MANAGEMENT REPORT

TO OCTOBER 2015 SUBMISSION

Intercontinental Combo Hotel

525 York Road
Niagara-on-the-Lake, Ontario



89-91 St. Paul Street, Suite 100
St. Catharines, ON
L2R 3M3

This addendum is to be read in conjunction with the Stormwater Management Report, dated October 2015, completed for the Intercontinental Combo Hotel development proposal at 525 York Road, Niagara-on-the-Lake.

Table 2-1 below is revised based upon recalculation of areas.

Table 2-1: Post-Development Areas

Area No.	Pervious Area (m ²)	Impervious Area (m ²)	Sub-Catchment Area (ha)	Imp. Prop. (%)
Internal North Side Sub Catchments				
201	212	453	0.067	68.1%
202	758	1042	0.180	57.9%
203	378	2,756	0.313	88.0%
204	338	2,193	0.253	86.6%
205	337	655	0.099	66.0%
206	220	2,312	0.253	91.3%
SUM	2,243	9,411	1.165	80.8%
Internal South Side Sub Catchments				
207	50	1,352	0.140	96.4%
208	450	2,162	0.267	81.0%
209	24	1,234	0.126	98.1%
210	215	2,731	0.295	92.7%
211	0	750	0.075	100.0%
212	169	1,584	0.175	90.4%
213	242	1,408	0.165	96.0%
SUM	974	11,397	1.242	91.8%

TOTAL SUM	3,003	20,808	2.408	86.4%
External Catchments				
301	17,873	14,591	2.651	55.0%*
302	8,486	6,125	1.461	41.9%*

* These values represent actual site conditions; however, the model uses a higher imperviousness consistent with the Prestige Industrial Lands maximum allowable.

The MIDUSS model for the 100-year storm was run for both the internal (200-series) and the external (300-series) sub-catchments. Output results in Appendix AA.

Stormwater Analysis under 100-year Storm

A. Pipe Conveyance Analysis for Sub-Catchments 301 & 302 Runoff

Combined runoff from sub-catchments 301 and 302 under 100-year flow: 1.387 m³/s (per MIDUSS output). As per Table 2.1 above, the hydraulic model assumes a higher level of imperviousness that comport with the maximum permitted in this area as a conservative measure for future development.

Available elevation differential from outlet obvert to flooded inlet surface:

Top-of-curb near subject ditch inlet catchbasin (DICB37) is 114.32m + 0.15m = 114.47m
The obvert of the headwall outlet is 110.93m + 0.92m = 111.85m.

$$\Delta_V = 114.47 - 111.85 = 2.62m$$

Employing the Hazen-Williams formula, assuming Q=peak flowrate (m³/s), C=130, L=229m, D=762mm (actual pipe diameter), the major losses are computed as:

$$h_f = \frac{K_u L Q^{1.85}}{D^{4.87} C^{1.85}} \quad h_f = \frac{10.66 * (229m) 1.387 cu.m.^{1.85}}{0.762m^{4.87} 130^{1.85}} \quad h_f = 2.06m$$

Minor losses computed:

Given there are, in essence, four 90° bends, using K = 0.25 and substituting V = Q/A

$$h_m = K \frac{V^2}{2g} = (0.25 + 0.25 + 0.25 + 0.25) \frac{\left(\frac{1.387}{\frac{0.756 \pi}{2}}\right)^2}{2(9.81)} = 0.49m$$

Totalling major and minor losses,

$$H_{loss} = 2.06m + 0.49m = 2.55m > 2.62m \rightarrow \mathbf{OK} \therefore \text{storm sewer will convey the 100-year peak flow in surcharged state without spillage onto the Intercontinental Combo Hotel site.}$$

B. Inlet Analysis for Sub-Catchments 301 & 302 Runoff

Proposed storm structure, DICB37 has been revised to a DICBMH37 per OPSD 706.031 with inner diameter of 2400mm and twin 600mm x 1200mm grated top inlets at a 3:1 slope. The proposed rim inlet elevation for this structure is revised to 113.87m (yielding upper grate elevation of 114.19m). The grate specification is standard galvanized steel honeycomb per OPSD 403.010.

Checking grate admittance of the peak flow rate of 1.387 m³/s using a submerged orifice equation,

$$Q_o = C_o A_o \sqrt{2g(H - E_o)}$$

where:

Q_o = flowrate (cu.m/s)

C_o = 0.616 (twinned rectangle → square)

A_o = 2 x 0.600m x 1.265m = 1.52m² x 83% net opening = 1.26m²

g = 9.81m/s²

H = water stage elevation (m)

E_o = elevation of centre of orifice (m)

$$Q_o = (0.616)(1.26)\sqrt{2(9.81)(114.47 - (113.87 + 0.25))}$$

$Q_o = 2.04 \text{ m}^3/\text{s} > 1.387 \text{ m}^3/\text{s} \rightarrow \text{OK} \therefore$ Grate inlet per OPSD 403.010 admits the 100-year peak flow without spillage onto the Intercontinental Combo Hotel site.

C. Surcharging and Ponding Analysis

The 100-year MIDUSS model demonstrated that a surcharging may occur on the hotel site and a minor area of ponding in subcatchment 202. The surcharging development is shown in Table 1 and the area of ponding is depicted in Figure 1 below.

Catchment Area No.	DS MH	US MH	Length (m)	HGL	Rise (m)	Water Surface Elev.(m)	US MH RIM (m)	Ponding Depth (m)	Comment
n/a	n/a	MH36	-	-		111.80			HGL begins at pipe obvert
206	MH36 ←	MH32	74	1.448%	1.07	112.87	114.08	n/a	water surface below rim
205	MH32 ←	MH29	54	0.804%	0.43	113.31	114.08	n/a	water surface below rim
204	MH29 ←	MH26	26	1.705%	0.44	113.75	114.04	n/a	water surface below rim
203	MH26 ←	MH22	65	0.756%	0.49	114.24	114.26	n/a	water surface below rim
202	MH22 ←	MH19	46	0.883%	0.41	114.65	114.55	0.10	ponding occurs in 202 V = 10.01 m ³
n/a	n/a	MH15	-	-		111.82			HGL begins at pipe obvert
213, 212, 211	MH15 ←	MH10	50	1.695%	0.85	112.67	114.26	n/a	water surface below rim
210	MH10 ←	CBMH6	69	0.861%	0.59	113.26	114.54	n/a	water surface below rim
209	CBMH6 ←	CBMH7	24	0.503%	0.12	113.38	114.65	n/a	water surface below rim
208	CBMH6 ←	CB3	72	0.542%	0.39	113.65	114.74	n/a	water surface below rim
207	CBMH6 ←	CBMH2	14	0.656%	0.09	113.35	114.55	n/a	water surface below rim

Table 1 – Minor System Surcharging under 100-year event



Figure 1 – Ponding in Subcatchment 202

The hydraulic grade line and ponding volume data is presented in the MIDUSS output in the appendix. In order to determine the 100-year HGL and the runoff volume that could pond, two separate runs were required for each internal and external set of subcatchment areas. To determine the occurrence for surface ponding, the HGL is projected onto the proposed minor system per Table 1 above and checked where finished ground elevation is exceeded. For a given location where the HGL projects above finished ground (e.g. catchment 202), the volume of surface ponding is derived from the 'Major & Minor System Separation' MIDUSS model. This modelling exercise seeks to separate runoff into major and minor components by limiting pipe flow in the minor system to unsurcharged or full-flow capacity and diverting the remainder as major. Given the HGL analysis in Table 1 above, the only actual instance of flow not accepted into the minor system was subcatchment 202.

Ponding Calculation in Catchment 202:

$$V_c = \pi \frac{r^2 h}{3} = \pi \frac{(10.5m)^2 (0.173m)}{3} * \frac{180}{360} = 10.0m^3$$

Thus the peak ponding depth around DCB21 is anticipated as 0.17m for the 100-year storm.

D. Open Channel Analysis

The following is a modelling of the open-channel flow of the 100-year peak discharge rate from the proposed stormwater collection system. The modelled section shown is located on the west limit property line, downstream of the proposed headwall. The peak flows have been added arithmetically for simplicity and functions as a conservative measure. The height of the channelized flow was computed by Manning's open channel flow formula shown below.

$$V_c = \frac{k}{n} R h^{2/3} * S^{1/2}$$

The roughness coefficient 'n' was based upon the channel being naturalized with short grasses, minimal brush and no stones. Figure 2 shows the channel under peak flow conditions based on the surveyed existing ground.

From MIDUSS output in Appendix AA, 100-year peak flow as follows:

Sub-catchments 201 through 201 – 213 inclusive: 0.774 m³/s

Sub-catchments 301 & 302: 1.387 m³/s

Total flow = **2.161 m³/s**

525 - York Road - Incontinental Combo Hotel

Analysis of Naturalized Drainage Channel at Property Line

Date Created: 6-Dec-16

Author: J Prinzen

Colour Coding	Base Parameter
	Driven Value

Open-Channel Flow Model					
Primary Channel Dimensions			Driven Variables		
Height of Water 'y'	0.27 m		2.164	'Q' - FLOW (m ³ /s)	
Top Water Surface Width 'B'	20.3 m		0.529	'V' - Average Velocity (m/s)	
Bottom Width 'b'	10 m		87.00	'α' Side Slope Angle (deg)	
			5.157	'λ' Side length (m)	
Flow Variables			20.314	'P' Wetted Perimeter (m)	
Longitudinal Slope 'S' (m/m)	0.0048	0.480%	4.091	'A' Flow X-Sec Area (m ²)	
Manning's 'n'	0.045		0.201	'R' Hydraulic Radius (m)	
			5.150	'zy' Side Slope Width (m)	

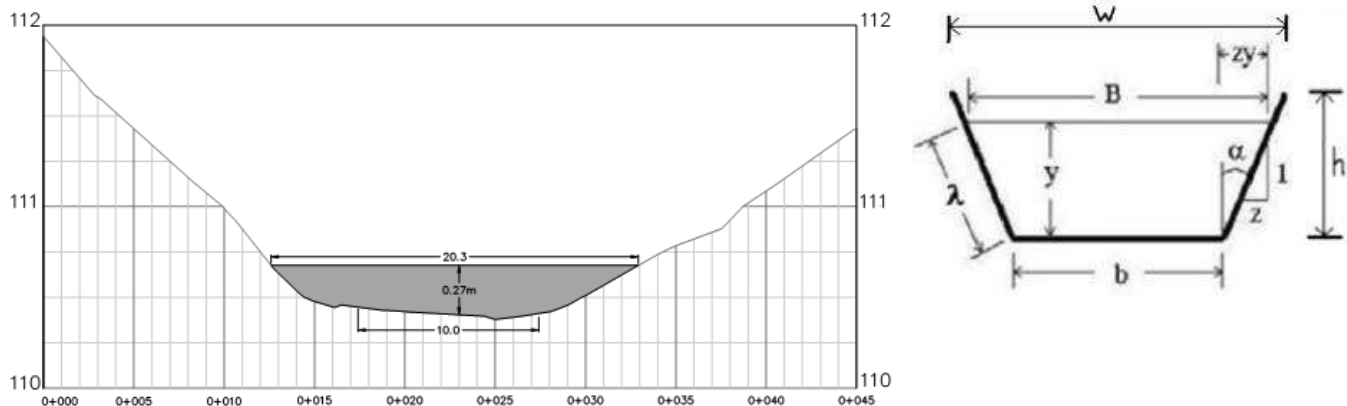


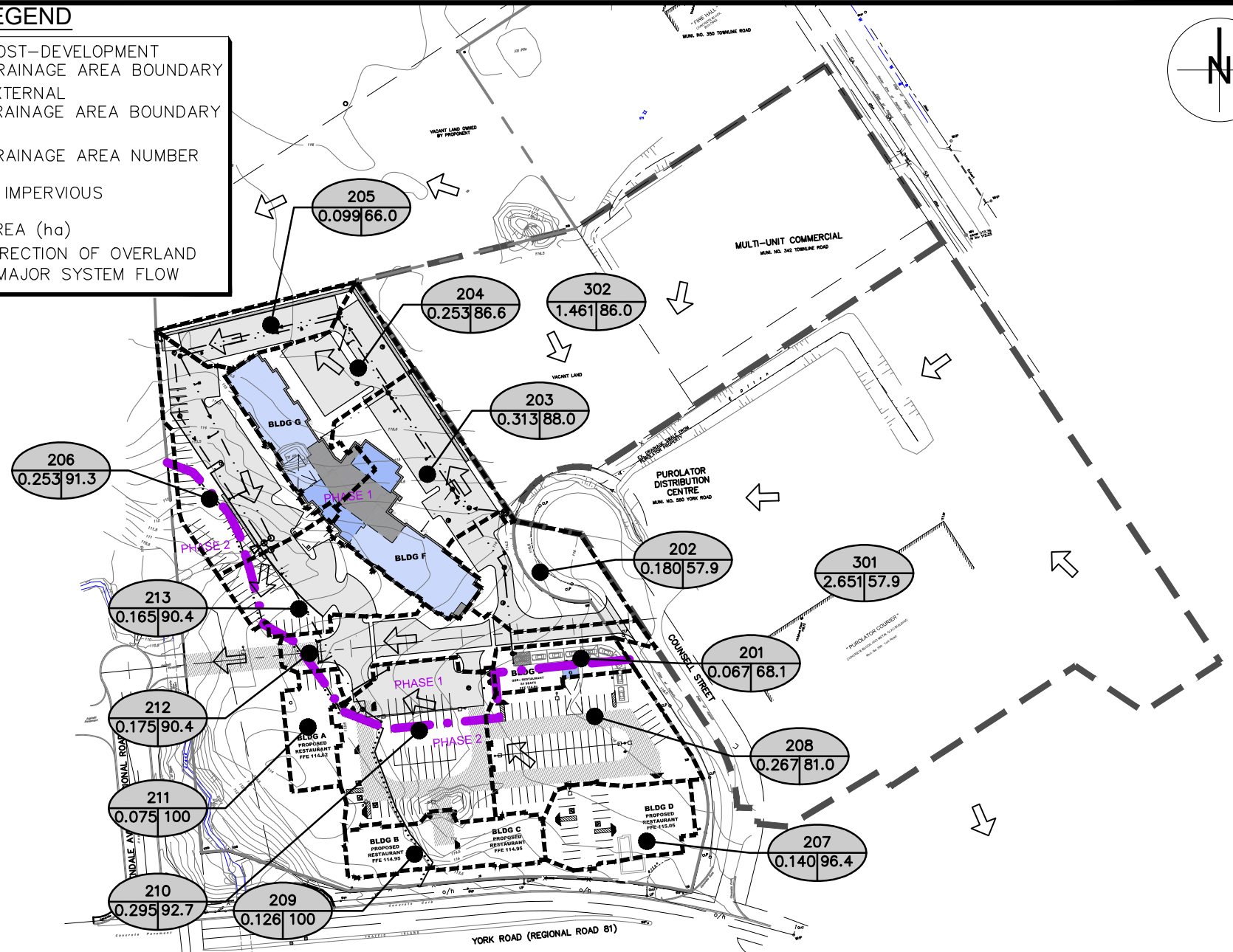
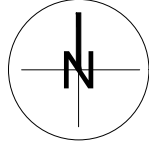
Figure 2 - Open-Channel Flow Modelling of 100-year Peak Flow at Property Line

Prepared by:


 John Prinzen, Civil EIT
 Project Designer

LEGEND

- - - - - POST-DEVELOPMENT DRAINAGE AREA BOUNDARY
 - - - - - EXTERNAL DRAINAGE AREA BOUNDARY
 ○ DRAINAGE AREA NUMBER
 0.9 | 1.4 % IMPERVIOUS
 AREA (ha)
 ← DIRECTION OF OVERLAND MAJOR SYSTEM FLOW



P:\2013 Projects\13254-York Glendale Hotel Complex\Design\Detailed\13254-STM.dwg drawing tab: 13254-STM



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project title

INTERCONTINENTAL COMBO HOTEL

525 York Road,
 Niagara-on-the-Lake, ON

drawing title

STORM DRAINAGE AREAS

drawn by	designed by
JRP	JRP
scale	date
1:1250	06 DEC 2016
job number	issue
13254	B
drawing number	
13254-STM	

STORMWATER MANAGEMENT REPORT ADDENDUM

INTERCONTINENTAL COMBO HOTEL

525 York Road

Niagara-on-the-Lake, Ontario

APPENDIX AA

100-YR STORM MIDUSS MODEL OUTPUT

- i. **HGL Model – Area 201 to 213**
- ii. **Minor & Major System Separation – Area 201 to 213**
- iii. **Model – Area 301 & 302**



```

"      MIDUSS Output ----->"
"      MIDUSS version          Version 2.25 rev. 465"
"      MIDUSS created          Tuesday, February 05, 2008"
"      10 Units used:          ie METRIC"
"      Job folder:              P:\2013 Projects\
"          13254 York Glendale Hotel Complex\Design\Detailed\MIDUSS"
"      Output filename:        100-YR_POST_B.out"
"      Licensee name:          Quartek"
"      Company                  Quartek Group Inc."
"      Date & Time last used:   12/5/2016 at 2:50:35 PM"
" 31  TIME PARAMETERS"
"      5.000 Time Step"
"      180.000 Max. Storm length"
"      1500.000 Max. Hydrograph"
" 32  STORM Chicago storm"
"      1 Chicago storm"
"      980.000 Coefficient A"
"      3.700 Constant B"
"      0.732 Exponent C"
"      0.375 Fraction R"
"      180.000 Duration"
"      1.000 Time step multiplier"
"      Maximum intensity      198.433 mm/hr"
"      Total depth             64.717 mm"
"      6 005hyd Hydrograph extension used in this file"
" 33  CATCHMENT 201"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      201 Restaurant - Bldg. 'E'"
"      68.100 % Impervious"
"      0.067 Total Area"
"      14.000 Flow length"
"      1.500 Overland Slope"
"      0.021 Pervious Area"
"      14.000 Pervious length"
"      1.500 Pervious slope"
"      0.046 Impervious Area"
"      14.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.346 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
    
```

100-YR Storm – Post-Development Condition



HGL Model

```

" 0.894 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.021 0.000 0.000 0.000 c.m/sec"
" Catchment 201 Pervious Impervious Total Area "
" Surface Area 0.021 0.046 0.067 hectare"
" Time of concentration 10.221 1.179 2.565 minutes"
" Time to Centroid 111.891 86.476 90.372 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 13.83 29.53 43.36 c.m"
" Rainfall losses 42.354 6.860 18.182 mm"
" Runoff depth 22.364 57.857 46.535 mm"
" Runoff volume 4.78 26.40 31.18 c.m"
" Runoff coefficient 0.346 0.894 0.719 "
" Maximum flow 0.002 0.020 0.021 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.021 0.021 0.000 0.000"
" 51 PIPE DESIGN"
" 0.021 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.200 Diameter metre"
" 0.500 Gradient %"
" Depth of flow 0.138 metre"
" Velocity 0.893 m/sec"
" Pipe capacity 0.025 c.m/sec"
" Critical depth 0.124 metre"
" 53 ROUTE Pipe Route 30"
" 30.40 Pipe Route 30 Reach length (metre)"
" 0.154 X-factor <= 0.5"
" 25.536 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 42.857 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.019 c.m/sec"
" 0.021 0.021 0.019 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.021 0.019 0.019 0.000"
" 33 CATCHMENT 202"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 202 ROW & Hotel East"
    
```



```

" 57.900 % Impervious"
" 0.180 Total Area"
" 45.000 Flow length"
" 1.500 Overland Slope"
" 0.076 Pervious Area"
" 45.000 Pervious length"
" 1.500 Pervious slope"
" 0.104 Impervious Area"
" 45.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.905 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.041 0.019 0.019 0.000 c.m/sec"
" Catchment 202 Pervious Impervious Total Area "
" Surface Area 0.076 0.104 0.180 hectare"
" Time of concentration 20.594 2.376 6.345 minutes"
" Time to Centroid 125.567 88.513 96.585 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 49.04 67.45 116.49 c.m"
" Rainfall losses 42.274 6.126 21.345 mm"
" Runoff depth 22.443 58.591 43.373 mm"
" Runoff volume 17.01 61.06 78.07 c.m"
" Runoff coefficient 0.347 0.905 0.670 "
" Maximum flow 0.005 0.041 0.041 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.041 0.061 0.019 0.000"
" 51 PIPE DESIGN"
" 0.061 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.250 Diameter metre"
" 0.400 Gradient %"
" Surcharged HGL 0.883 %"
" Velocity 1.233 m/sec"
" Pipe capacity 0.041 c.m/sec"
" Critical depth 0.000 metre"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
" 0.041 0.061 0.061 0.000"
    
```



```

" 40    HYDROGRAPH Next link "
"      5 Next link "
"      0.041  0.061  0.061  0.000"
" 33    CATCHMENT 203"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      203 Hotel - East Side"
"      88.000 % Impervious"
"      0.313 Total Area"
"      52.000 Flow length"
"      1.500 Overland Slope"
"      0.038 Pervious Area"
"      52.000 Pervious length"
"      1.500 Pervious slope"
"      0.275 Impervious Area"
"      52.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.346 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.903 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      0.105  0.061  0.061  0.000 c.m/sec"
"      Catchment 203    Pervious  Impervious Total Area "
"      Surface Area    0.038  0.275  0.313  hectare"
"      Time of concentration  22.460  2.592  3.579  minutes"
"      Time to Centroid    128.057  88.814  90.765  minutes"
"      Rainfall depth    64.717  64.717  64.717  mm"
"      Rainfall volume    24.31  178.26  202.56  c.m"
"      Rainfall losses    42.295  6.263  10.587  mm"
"      Runoff depth    22.423  58.454  54.130  mm"
"      Runoff volume    8.42  161.00  169.43  c.m"
"      Runoff coefficient  0.346  0.903  0.836  "
"      Maximum flow    0.002  0.104  0.105  c.m/sec"
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"      4 Add Runoff "
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" 51    PIPE DESIGN"
"      0.165 Current peak flow  c.m/sec"
"      0.012 Manning 'n'"
"      0.375 Diameter  metre"
    
```



```

" 0.400 Gradient %"
"   Surcharged HGL      0.756 %"
"   Velocity           1.495 m/sec"
"   Pipe capacity      0.120 c.m/sec"
"   Critical depth     0.000 metre"
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"   5 Next link "
"     0.105  0.165  0.165  0.000"
" 33  CATCHMENT 204"
"   1 Triangular SCS"
"   1 Equal length"
"   1 SCS method"
"   204 Hotel - NE Side"
" 86.600 % Impervious"
" 0.253 Total Area"
" 53.000 Flow length"
" 1.500 Overland Slope"
" 0.034 Pervious Area"
" 53.000 Pervious length"
" 1.500 Pervious slope"
" 0.219 Impervious Area"
" 53.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.903 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
"   0.083  0.165  0.165  0.000 c.m/sec"
"   Catchment 204   Pervious Impervious Total Area "
"   Surface Area   0.034  0.219  0.253  hectare"
"   Time of concentration  22.719  2.621  3.748  minutes"
"   Time to Centroid   128.386  88.859  91.075  minutes"
"   Rainfall depth    64.717  64.717  64.717  mm"
"   Rainfall volume   21.94   141.79  163.73  c.m"
"   Rainfall losses   42.289  6.280  11.105  mm"
"   Runoff depth      22.428  58.437  53.612  mm"
"   Runoff volume     7.60   128.03  135.64  c.m"
"   Runoff coefficient 0.347  0.903  0.828  "
    
```

100-YR Storm – Post-Development Condition

HGL Model



" Maximum flow 0.002 0.083 0.083 c.m/sec"

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" 4 Add Runoff "

" 0.083 0.248 0.165 0.000"

" 51 PIPE DESIGN"

" 0.248 Current peak flow c.m/sec"

" 0.012 Manning 'n'"

" 0.375 Diameter metre"

" 0.700 Gradient %"

" Surcharged HGL 1.705 %"

" Velocity 2.246 m/sec"

" Pipe capacity 0.159 c.m/sec"

" Critical depth 0.000 metre"

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" 5 Next link "

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" 33 CATCHMENT 205"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 205 Hotel North Limit"

" 66.000 % Impervious"

" 0.099 Total Area"

" 18.000 Flow length"

" 1.500 Overland Slope"

" 0.034 Pervious Area"

" 18.000 Pervious length"

" 1.500 Pervious slope"

" 0.065 Impervious Area"

" 18.000 Impervious length"

" 1.500 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.347 Pervious Runoff coefficient"

" 0.100 Pervious Ia/S coefficient"

" 8.467 Pervious Initial abstraction"

" 0.015 Impervious Manning 'n'"

" 98.000 Impervious SCS Curve No."

" 0.900 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.029 0.248 0.248 0.000 c.m/sec"

" Catchment 205 Pervious Impervious Total Area "

" Surface Area 0.034 0.065 0.099 hectare"



" Time of concentration 11.884 1.371 3.111 minutes"

" Time to Centroid 114.039 86.907 91.398 minutes"

" Rainfall depth 64.717 64.717 64.717 mm"

" Rainfall volume 21.78 42.29 64.07 c.m"

" Rainfall losses 42.289 6.466 18.646 mm"

" Runoff depth 22.428 58.251 46.072 mm"

" Runoff volume 7.55 38.06 45.61 c.m"

" Runoff coefficient 0.347 0.900 0.712 "

" Maximum flow 0.003 0.028 0.029 c.m/sec"

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" 4 Add Runoff "

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" 51 PIPE DESIGN"

" 0.277 Current peak flow c.m/sec"

" 0.012 Manning 'n'"

" 0.450 Diameter metre"

" 0.350 Gradient %"

" Surcharged HGL 0.804 %"

" Velocity 1.741 m/sec"

" Pipe capacity 0.183 c.m/sec"

" Critical depth 0.000 metre"

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" 5 Next link "

" 0.029 0.277 0.277 0.000"

" 33 CATCHMENT 206"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 206 Hotel - NW Side"

" 91.300 % Impervious"

" 0.253 Total Area"

" 32.000 Flow length"

" 1.500 Overland Slope"

" 0.022 Pervious Area"

" 32.000 Pervious length"

" 1.500 Pervious slope"

" 0.231 Impervious Area"

" 32.000 Impervious length"

" 1.500 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.346 Pervious Runoff coefficient"

" 0.100 Pervious Ia/S coefficient"

" 8.467 Pervious Initial abstraction"

100-YR Storm – Post-Development Condition

HGL Model



```

" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.905 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.095 0.277 0.277 0.000 c.m/sec"
" Catchment 206 Pervious Impervious Total Area "
" Surface Area 0.022 0.231 0.253 hectare"
" Time of concentration 16.784 1.937 2.459 minutes"
" Time to Centroid 120.544 87.721 88.877 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 14.24 149.49 163.73 c.m"
" Rainfall losses 42.294 6.169 9.311 mm"
" Runoff depth 22.423 58.549 55.406 mm"
" Runoff volume 4.94 135.24 140.18 c.m"
" Runoff coefficient 0.346 0.905 0.856 "
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" 4 Add Runoff "
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" 51 PIPE DESIGN"
" 0.372 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.450 Diameter metre"
" 0.600 Gradient %"
" Surcharged HGL 1.448 %"
" Velocity 2.337 m/sec"
" Pipe capacity 0.239 c.m/sec"
" Critical depth 0.000 metre"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
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" 40 HYDROGRAPH Combine 2"
" 6 Combine "
" 2 Node #"
" O/G Separator(s)"
" Maximum flow 0.372 c.m/sec"
" Hydrograph volume 600.101 c.m"
" 0.095 0.372 0.372 0.372"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.095 0.000 0.372 0.372"
" 33 CATCHMENT 207"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 207 Restaurant - Bldg. 'D'"
    
```



```

" 96.400 % Impervious"
" 0.140 Total Area"
" 47.000 Flow length"
" 1.500 Overland Slope"
" 0.005 Pervious Area"
" 47.000 Pervious length"
" 1.500 Pervious slope"
" 0.135 Impervious Area"
" 47.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.905 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.052 0.000 0.372 0.372 c.m/sec"
" Catchment 207 Pervious Impervious Total Area "
" Surface Area 0.005 0.135 0.140 hectare"
" Time of concentration 21.139 2.439 2.703 minutes"
" Time to Centroid 126.284 88.599 89.130 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 3.26 87.34 90.60 c.m"
" Rainfall losses 42.285 6.144 7.445 mm"
" Runoff depth 22.432 58.574 57.272 mm"
" Runoff volume 1.13 79.05 80.18 c.m"
" Runoff coefficient 0.347 0.905 0.885 "
" Maximum flow 0.000 0.052 0.052 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.052 0.052 0.372 0.372"
" 51 PIPE DESIGN"
" 0.052 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.250 Diameter metre"
" 0.300 Gradient %"
" Surcharged HGL 0.656 %"
" Velocity 1.063 m/sec"
" Pipe capacity 0.035 c.m/sec"
" Critical depth 0.000 metre"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
" 0.052 0.052 0.052 0.372"
    
```



```

" 40    HYDROGRAPH Next link "
"      5 Next link "
"      0.052  0.052  0.052  0.372"
" 33    CATCHMENT 208"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      208 Restaurant - East Lot"
"      81.000 % Impervious"
"      0.267 Total Area"
"      36.000 Flow length"
"      1.500 Overland Slope"
"      0.051 Pervious Area"
"      36.000 Pervious length"
"      1.500 Pervious slope"
"      0.216 Impervious Area"
"      36.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.347 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.904 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      0.088  0.052  0.052  0.372 c.m/sec"
"      Catchment 208    Pervious  Impervious Total Area "
"      Surface Area    0.051  0.216  0.267  hectare"
"      Time of concentration 18.013  2.079  3.394  minutes"
"      Time to Centroid   122.151  88.016  90.833  minutes"
"      Rainfall depth    64.717  64.717  64.717  mm"
"      Rainfall volume   32.83  139.96  172.79  c.m"
"      Rainfall losses   42.277  6.204  13.058  mm"
"      Runoff depth      22.441  58.513  51.659  mm"
"      Runoff volume     11.38  126.55  137.93  c.m"
"      Runoff coefficient 0.347  0.904  0.798  "
"      Maximum flow     0.003  0.087  0.088  c.m/sec"
" 40    HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.088  0.140  0.052  0.372"
" 51    PIPE DESIGN"
"      0.140 Current peak flow c.m/sec"
"      0.012 Manning 'n'"
"      0.375 Diameter  metre"
    
```



" 0.300 Gradient %"

" Surcharged HGL 0.542 %"

" Velocity 1.266 m/sec"

" Pipe capacity 0.104 c.m/sec"

" Critical depth 0.000 metre"

" 40 HYDROGRAPH Copy to Outflow"

" 8 Copy to Outflow"

" 0.088 0.140 0.140 0.372"

" 40 HYDROGRAPH Combine 3"

" 6 Combine "

" 3 Node #"

" STM MH"

" Maximum flow 0.140 c.m/sec"

" Hydrograph volume 218.111 c.m"

" 0.088 0.140 0.140 0.140"

" 40 HYDROGRAPH Start - New Tributary"

" 2 Start - New Tributary"

" 0.088 0.000 0.140 0.140"

" 33 CATCHMENT 209"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 209 Resturant Bldgs. 'B' & 'C'"

" 98.100 % Impervious"

" 0.126 Total Area"

" 66.000 Flow length"

" 1.500 Overland Slope"

" 0.002 Pervious Area"

" 66.000 Pervious length"

" 1.500 Pervious slope"

" 0.124 Impervious Area"

" 66.000 Impervious length"

" 1.500 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.347 Pervious Runoff coefficient"

" 0.100 Pervious Ia/S coefficient"

" 8.467 Pervious Initial abstraction"

" 0.015 Impervious Manning 'n'"

" 98.000 Impervious SCS Curve No."

" 0.904 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.046 0.000 0.140 0.140 c.m/sec"

" Catchment 209 Pervious Impervious Total Area "

" Surface Area 0.002 0.124 0.126 hectare"

" Time of concentration 25.914 2.990 3.159 minutes"



" Time to Centroid 132.606 89.502 89.819 minutes"

" Rainfall depth 64.717 64.717 64.717 mm"

" Rainfall volume 1.55 79.99 81.54 c.m"

" Rainfall losses 42.286 6.191 6.877 mm"

" Runoff depth 22.431 58.526 57.840 mm"

" Runoff volume 0.54 72.34 72.88 c.m"

" Runoff coefficient 0.347 0.904 0.894 "

" Maximum flow 0.000 0.046 0.046 c.m/sec"

" 40 HYDROGRAPH Add Runoff "

" 4 Add Runoff "

" 0.046 0.046 0.140 0.140"

" 51 PIPE DESIGN"

" 0.046 Current peak flow c.m/sec"

" 0.012 Manning 'n'"

" 0.250 Diameter metre"

" 0.350 Gradient %"

" Surcharged HGL 0.503 %"

" Velocity 0.931 m/sec"

" Pipe capacity 0.038 c.m/sec"

" Critical depth 0.000 metre"

" 40 HYDROGRAPH Copy to Outflow"

" 8 Copy to Outflow"

" 0.046 0.046 0.046 0.140"

" 40 HYDROGRAPH Combine 3"

" 6 Combine "

" 3 Node #"

" STM MH"

" Maximum flow 0.185 c.m/sec"

" Hydrograph volume 290.990 c.m"

" 0.046 0.046 0.046 0.185"

" 40 HYDROGRAPH Start - New Tributary"

" 2 Start - New Tributary"

" 0.046 0.000 0.046 0.185"

" 40 HYDROGRAPH Confluence 3"

" 7 Confluence "

" 3 Node #"

" STM MH"

" Maximum flow 0.185 c.m/sec"

" Hydrograph volume 290.990 c.m"

" 0.046 0.185 0.046 0.000"

" 40 HYDROGRAPH Copy to Outflow"

" 8 Copy to Outflow"

" 0.046 0.185 0.185 0.000"

" 40 HYDROGRAPH Next link "

" 5 Next link "

" 0.046 0.185 0.185 0.000"

" 33 CATCHMENT 210"



" 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 210 Restaurant - Central"
 " 92.700 % Impervious"
 " 0.295 Total Area"
 " 57.000 Flow length"
 " 1.500 Overland Slope"
 " 0.022 Pervious Area"
 " 57.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.273 Impervious Area"
 " 57.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.347 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.904 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.102 0.185 0.185 0.000 c.m/sec"
 " Catchment 210 Pervious Impervious Total Area "
 " Surface Area 0.022 0.273 0.295 hectare"
 " Time of concentration 23.732 2.738 3.354 minutes"
 " Time to Centroid 129.724 89.053 90.245 minutes"
 " Rainfall depth 64.717 64.717 64.717 mm"
 " Rainfall volume 13.94 176.98 190.92 c.m"
 " Rainfall losses 42.279 6.208 8.842 mm"
 " Runoff depth 22.438 58.509 55.876 mm"
 " Runoff volume 4.83 160.00 164.83 c.m"
 " Runoff coefficient 0.347 0.904 0.863 "
 " Maximum flow 0.001 0.102 0.102 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.102 0.287 0.185 0.000"
 " 51 PIPE DESIGN"
 " 0.287 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.450 Diameter metre"
 " 0.350 Gradient %"
 " Surcharged HGL 0.861 %"
 " Velocity 1.802 m/sec"
 " Pipe capacity 0.183 c.m/sec"



```

"      Critical depth      0.000  metre"
" 40  HYDROGRAPH Copy to Outflow"
"      8  Copy to Outflow"
"      0.102  0.287  0.287  0.000"
" 40  HYDROGRAPH Next link "
"      5  Next link "
"      0.102  0.287  0.287  0.000"
" 33  CATCHMENT 211"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      211  Restaurant Bldg. 'A'"
" 100.000  % Impervious"
"      0.075  Total Area"
"      38.000  Flow length"
"      1.500  Overland Slope"
"      0.000  Pervious Area"
"      38.000  Pervious length"
"      1.500  Pervious slope"
"      0.075  Impervious Area"
"      38.000  Impervious length"
"      1.500  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      75.000  Pervious SCS Curve No."
"      0.000  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      8.467  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.904  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"      0.030  0.287  0.287  0.000 c.m/sec"
"      Catchment 211      Pervious  Impervious Total Area "
"      Surface Area      0.000  0.075  0.075  hectare"
"      Time of concentration 18.607  2.147  2.147  minutes"
"      Time to Centroid  122.947  88.154  88.154  minutes"
"      Rainfall depth  64.717  64.717  64.717  mm"
"      Rainfall volume  0.00  48.54  48.54  c.m"
"      Rainfall losses  42.297  6.200  6.200  mm"
"      Runoff depth  22.420  58.517  58.517  mm"
"      Runoff volume  0.00  43.89  43.89  c.m"
"      Runoff coefficient  0.000  0.904  0.904  "
"      Maximum flow  0.000  0.030  0.030  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4  Add Runoff "
"      0.030  0.317  0.287  0.000"

```



```

" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.030 0.287 0.287 0.000"
" 33 CATCHMENT 212"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 212 Street 'A'"
" 90.400 % Impervious"
" 0.175 Total Area"
" 97.000 Flow length"
" 1.500 Overland Slope"
" 0.017 Pervious Area"
" 97.000 Pervious length"
" 1.500 Pervious slope"
" 0.158 Impervious Area"
" 97.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.900 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.061 0.287 0.287 0.000 c.m/sec"
" Catchment 212 Pervious Impervious Total Area "
" Surface Area 0.017 0.158 0.175 hectare"
" Time of concentration 32.650 3.767 4.903 minutes"
" Time to Centroid 141.517 90.793 92.789 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 10.87 102.38 113.26 c.m"
" Rainfall losses 42.271 6.497 9.932 mm"
" Runoff depth 22.446 58.220 54.786 mm"
" Runoff volume 3.77 92.10 95.87 c.m"
" Runoff coefficient 0.347 0.900 0.847 "
" Maximum flow 0.001 0.061 0.061 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.061 0.338 0.287 0.000"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
" 0.061 0.338 0.338 0.000"
" 40 HYDROGRAPH Next link "
    
```



```

"      5 Next link "
"      0.061  0.338  0.338  0.000"
" 33  CATCHMENT 213"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"    213 Hotel - SW Side"
" 96.000 % Impervious"
"    0.165 Total Area"
" 37.000 Flow length"
"    1.500 Overland Slope"
"    0.007 Pervious Area"
" 37.000 Pervious length"
"    1.500 Pervious slope"
"    0.158 Impervious Area"
" 37.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
"    0.347 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"
"    8.467 Pervious Initial abstraction"
"    0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
"    0.904 Impervious Runoff coefficient"
"    0.100 Impervious Ia/S coefficient"
"    0.518 Impervious Initial abstraction"
"      0.064  0.338  0.338  0.000 c.m/sec"
"    Catchment 213      Pervious Impervious Total Area "
"    Surface Area      0.007  0.158  0.165  hectare"
"    Time of concentration 18.312  2.113  2.368  minutes"
"    Time to Centroid  122.551  88.087  88.628  minutes"
"    Rainfall depth  64.717  64.717  64.717  mm"
"    Rainfall volume  4.27  102.51  106.78  c.m"
"    Rainfall losses  42.283  6.201  7.644  mm"
"    Runoff depth  22.434  58.516  57.073  mm"
"    Runoff volume  1.48  92.69  94.17  c.m"
"    Runoff coefficient  0.347  0.904  0.882  "
"    Maximum flow  0.000  0.064  0.064  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.064  0.402  0.338  0.000"
" 51  PIPE DESIGN"
"    0.402 Current peak flow  c.m/sec"
"    0.012 Manning 'n'"
"    0.450 Diameter  metre"
"    0.600 Gradient  %"

```



```

"      Surcharged HGL          1.695  %"
"      Velocity                2.528  m/sec"
"      Pipe capacity           0.239  c.m/sec"
"      Critical depth          0.000  metre"
" 40  HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"          0.064  0.402  0.402  0.000"
" 40  HYDROGRAPH Combine 2"
"      6 Combine "
"      2 Node #"
"      O/G Separator(s)"
"      Maximum flow           0.774  c.m/sec"
"      Hydrograph volume      1245.969 c.m"
"          0.064  0.402  0.402  0.774"
" 40  HYDROGRAPH Confluence 2"
"      7 Confluence "
"      2 Node #"
"      O/G Separator(s)"
"      Maximum flow           0.774  c.m/sec"
"      Hydrograph volume      1245.969 c.m"
"          0.064  0.774  0.402  0.000"
" 51  PIPE DESIGN"
"      0.774 Current peak flow c.m/sec"
"      0.012 Manning 'n'"
"      0.600 Diameter  metre"
"      0.500 Gradient  %"
"      Surcharged HGL          1.353  %"
"      Velocity                2.736  m/sec"
"      Pipe capacity           0.470  c.m/sec"
"      Critical depth          0.000  metre"
" 40  HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"          0.064  0.774  0.774  0.000"
" 38  START/RE-START TOTALS 2"
"      3 Runoff Totals on EXIT"
"      Total Catchment area      2.408  hectare"
"      Total Impervious area     2.081  hectare"
"      Total % impervious        86.404"
" 19  EXIT"

```



```

"      MIDUSS Output ----->"
"      MIDUSS version          Version 2.25 rev. 465"
"      MIDUSS created          Tuesday, February 05, 2008"
"      10 Units used:          ie METRIC"
"      Job folder:              P:\2013 Projects\
"          13254 York Glendale Hotel Complex\Design\Detailed\MIDUSS"
"      Output filename:        100-YR_POST_A.out"
"      Licensee name:          Quartek"
"      Company                  Quartek Group Inc."
"      Date & Time last used:   12/5/2016 at 2:01:04 PM"
" 31  TIME PARAMETERS"
"      5.000 Time Step"
"      180.000 Max. Storm length"
"      1500.000 Max. Hydrograph"
" 32  STORM Chicago storm"
"      1 Chicago storm"
"      980.000 Coefficient A"
"      3.700 Constant B"
"      0.732 Exponent C"
"      0.375 Fraction R"
"      180.000 Duration"
"      1.000 Time step multiplier"
"      Maximum intensity      198.433 mm/hr"
"      Total depth             64.717 mm"
"      6 005hyd Hydrograph extension used in this file"
" 33  CATCHMENT 201"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      201 Restaurant - Bldg. 'E'"
"      68.100 % Impervious"
"      0.067 Total Area"
"      14.000 Flow length"
"      1.500 Overland Slope"
"      0.021 Pervious Area"
"      14.000 Pervious length"
"      1.500 Pervious slope"
"      0.046 Impervious Area"
"      14.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.346 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
    
```

100-YR Storm – Post-Development Condition

Major & Minor System Separation



```

" 0.894 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.021 0.000 0.000 0.000 c.m/sec"
" Catchment 201 Pervious Impervious Total Area "
" Surface Area 0.021 0.046 0.067 hectare"
" Time of concentration 10.221 1.179 2.565 minutes"
" Time to Centroid 111.891 86.476 90.372 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 13.83 29.53 43.36 c.m"
" Rainfall losses 42.354 6.860 18.182 mm"
" Runoff depth 22.364 57.857 46.535 mm"
" Runoff volume 4.78 26.40 31.18 c.m"
" Runoff coefficient 0.346 0.894 0.719 "
" Maximum flow 0.002 0.020 0.021 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.021 0.021 0.000 0.000"
" 51 PIPE DESIGN"
" 0.021 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.200 Diameter metre"
" 0.500 Gradient %"
" Depth of flow 0.138 metre"
" Velocity 0.893 m/sec"
" Pipe capacity 0.025 c.m/sec"
" Critical depth 0.124 metre"
" 53 ROUTE Pipe Route 30"
" 30.40 Pipe Route 30 Reach length (metre)"
" 0.154 X-factor <= 0.5"
" 25.536 K-lag (seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag (seconds)"
" 0.500 Beta weighting factor"
" 42.857 Routing time step (seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.019 c.m/sec"
" 0.021 0.021 0.019 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.021 0.019 0.019 0.000"
" 33 CATCHMENT 202"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 202 ROW & Hotel East"
    
```



```

" 57.900 % Impervious"
" 0.180 Total Area"
" 45.000 Flow length"
" 1.500 Overland Slope"
" 0.076 Pervious Area"
" 45.000 Pervious length"
" 1.500 Pervious slope"
" 0.104 Impervious Area"
" 45.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.905 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.041 0.019 0.019 0.000 c.m/sec"
" Catchment 202 Pervious Impervious Total Area "
" Surface Area 0.076 0.104 0.180 hectare"
" Time of concentration 20.594 2.376 6.345 minutes"
" Time to Centroid 125.567 88.513 96.585 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 49.04 67.45 116.49 c.m"
" Rainfall losses 42.274 6.126 21.345 mm"
" Runoff depth 22.443 58.591 43.373 mm"
" Runoff volume 17.01 61.06 78.07 c.m"
" Runoff coefficient 0.347 0.905 0.670 "
" Maximum flow 0.005 0.041 0.041 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.041 0.061 0.019 0.000"
" 56 DIVERSION"
" 202 Node number"
" 0.040 Overflow threshold"
" 1.000 Required diverted fraction"
" 0 Conduit type; 1=Pipe;2=Channel"
" Peak of diverted flow 0.021 c.m/sec"
" Volume of diverted flow 10.006 c.m"
" DIV00202.005hyd"
" Major flow at 202"
" 0.041 0.061 0.040 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
    
```



```

"          0.041  0.040  0.040  0.000"
" 51  PIPE DESIGN"
"    0.061 Current peak flow  c.m/sec"
"    0.012 Manning 'n'"
"    0.250 Diameter  metre"
"    0.400 Gradient  %"
"      Surcharged HGL          0.883  %"
"      Velocity                1.233  m/sec"
"      Pipe capacity           0.041  c.m/sec"
"      Critical depth          0.000  metre"
" 53  ROUTE  Pipe Route 46"
"    45.60 Pipe Route 46 Reach length ( metre)"
"    0.000 X-factor <= 0.5"
"    27.733 K-lag ( seconds)"
"    0.000 Default(0) or user spec.(1) values used"
"    0.500 X-factor <= 0.5"
"    30.000 K-lag ( seconds)"
"    0.503 Beta weighting factor"
"    50.000 Routing time step ( seconds)"
"      1 No. of sub-reaches"
"      Peak outflow           0.040  c.m/sec"
"      0.041  0.040  0.040  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5 Next link "
"      0.041  0.040  0.040  0.000"
" 33  CATCHMENT 203"
"    1 Triangular SCS"
"    1 Equal length"
"    1 SCS method"
"    203 Hotel - East Side"
"    88.000 % Impervious"
"    0.313 Total Area"
"    52.000 Flow length"
"    1.500 Overland Slope"
"    0.038 Pervious Area"
"    52.000 Pervious length"
"    1.500 Pervious slope"
"    0.275 Impervious Area"
"    52.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
"    75.000 Pervious SCS Curve No."
"    0.346 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"
"    8.467 Pervious Initial abstraction"
"    0.015 Impervious Manning 'n'"
"    98.000 Impervious SCS Curve No."

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100-YR Storm – Post-Development Condition

Major & Minor System Separation



```

" 0.903 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.105 0.040 0.040 0.000 c.m/sec"
" Catchment 203 Pervious Impervious Total Area "
" Surface Area 0.038 0.275 0.313 hectare"
" Time of concentration 22.460 2.592 3.579 minutes"
" Time to Centroid 128.057 88.814 90.765 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 24.31 178.26 202.56 c.m"
" Rainfall losses 42.295 6.263 10.587 mm"
" Runoff depth 22.423 58.454 54.130 mm"
" Runoff volume 8.42 161.00 169.43 c.m"
" Runoff coefficient 0.346 0.903 0.836 "
" Maximum flow 0.002 0.104 0.105 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.105 0.142 0.040 0.000"
" 56 DIVERSION"
" 203 Node number"
" 0.119 Overflow threshold"
" 1.000 Required diverted fraction"
" 0 Conduit type; 1=Pipe;2=Channel"
" Peak of diverted flow 0.023 c.m/sec"
" Volume of diverted flow 13.044 c.m"
" DIV00203.005hyd"
" Major flow at 203"
" 0.105 0.142 0.119 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.105 0.119 0.119 0.000"
" 51 PIPE DESIGN"
" 0.119 Current peak flow c.m/sec"
" 0.012 Manning 'n'"
" 0.375 Diameter metre"
" 0.400 Gradient %"
" Depth of flow 0.304 metre"
" Velocity 1.240 m/sec"
" Pipe capacity 0.120 c.m/sec"
" Critical depth 0.254 metre"
" 53 ROUTE Pipe Route 65"
" 65.40 Pipe Route 65 Reach length ( metre)"
" 0.000 X-factor <= 0.5"
" 39.557 K-lag ( seconds)"
" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag ( seconds)"
    
```



```

"    0.521 Beta weighting factor"
"    75.000 Routing time step ( seconds)"
"      1 No. of sub-reaches"
"      Peak outflow      0.119 c.m/sec"
"      0.105  0.119  0.119  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"      5 Next link "
"      0.105  0.119  0.119  0.000"
" 33  CATCHMENT 204"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      204 Hotel - NE Side"
"    86.600 % Impervious"
"    0.253 Total Area"
"    53.000 Flow length"
"    1.500 Overland Slope"
"    0.034 Pervious Area"
"    53.000 Pervious length"
"    1.500 Pervious slope"
"    0.219 Impervious Area"
"    53.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
"    75.000 Pervious SCS Curve No."
"    0.347 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"
"    8.467 Pervious Initial abstraction"
"    0.015 Impervious Manning 'n'"
"    98.000 Impervious SCS Curve No."
"    0.903 Impervious Runoff coefficient"
"    0.100 Impervious Ia/S coefficient"
"    0.518 Impervious Initial abstraction"
"      0.083  0.119  0.119  0.000 c.m/sec"
"      Catchment 204      Pervious Impervious Total Area "
"      Surface Area      0.034  0.219  0.253  hectare"
"      Time of concentration 22.719  2.621  3.748  minutes"
"      Time to Centroid   128.386  88.859  91.075  minutes"
"      Rainfall depth     64.717  64.717  64.717  mm"
"      Rainfall volume    21.94   141.79  163.73  c.m"
"      Rainfall losses    42.289  6.280  11.105  mm"
"      Runoff depth       22.428  58.437  53.612  mm"
"      Runoff volume      7.60   128.03  135.64  c.m"
"      Runoff coefficient  0.347  0.903  0.828  "
"      Maximum flow      0.002  0.083  0.083  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4 Add Runoff "

```



```

"          0.083  0.198  0.119  0.000"
" 56  DIVERSION"
"    204 Node number"
"    0.157 Overflow threshold"
"    1.000 Required diverted fraction"
"    0 Conduit type; 1=Pipe;2=Channel"
"    Peak of diverted flow    0.041 c.m/sec"
"    Volume of diverted flow  22.888 c.m"
"    DIV00204.005hyd"
"    Major flow at 204"
"          0.083  0.198  0.157  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5 Next link "
"          0.083  0.157  0.157  0.000"
" 51  PIPE DESIGN"
"    0.157 Current peak flow c.m/sec"
"    0.012 Manning 'n'"
"    0.375 Diameter metre"
"    0.700 Gradient %"
"    Depth of flow          0.303 metre"
"    Velocity                1.640 m/sec"
"    Pipe capacity          0.159 c.m/sec"
"    Critical depth         0.292 metre"
" 53  ROUTE Pipe Route 26"
"    25.80 Pipe Route 26 Reach length ( metre)"
"    0.000 X-factor <= 0.5"
"    11.797 K-lag ( seconds)"
"    0.000 Default(0) or user spec.(1) values used"
"    0.500 X-factor <= 0.5"
"    30.000 K-lag ( seconds)"
"    0.609 Beta weighting factor"
"    30.000 Routing time step ( seconds)"
"    1 No. of sub-reaches"
"    Peak outflow          0.157 c.m/sec"
"          0.083  0.157  0.157  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5 Next link "
"          0.083  0.157  0.157  0.000"
" 33  CATCHMENT 205"
"    1 Triangular SCS"
"    1 Equal length"
"    1 SCS method"
"    205 Hotel North Limit"
"    66.000 % Impervious"
"    0.099 Total Area"
"    18.000 Flow length"
"    1.500 Overland Slope"

```



" 0.034 Pervious Area"

" 18.000 Pervious length"

" 1.500 Pervious slope"

" 0.065 Impervious Area"

" 18.000 Impervious length"

" 1.500 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.347 Pervious Runoff coefficient"

" 0.100 Pervious Ia/S coefficient"

" 8.467 Pervious Initial abstraction"

" 0.015 Impervious Manning 'n'"

" 98.000 Impervious SCS Curve No."

" 0.900 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.029 0.157 0.157 0.000 c.m/sec"

" Catchment 205 Pervious Impervious Total Area "

" Surface Area 0.034 0.065 0.099 hectare"

" Time of concentration 11.884 1.371 3.111 minutes"

" Time to Centroid 114.039 86.907 91.398 minutes"

" Rainfall depth 64.717 64.717 64.717 mm"

" Rainfall volume 21.78 42.29 64.07 c.m"

" Rainfall losses 42.289 6.466 18.646 mm"

" Runoff depth 22.428 58.251 46.072 mm"

" Runoff volume 7.55 38.06 45.61 c.m"

" Runoff coefficient 0.347 0.900 0.712 "

" Maximum flow 0.003 0.028 0.029 c.m/sec"

" 40 HYDROGRAPH Add Runoff "

" 4 Add Runoff "

" 0.029 0.182 0.157 0.000"

" 51 PIPE DESIGN"

" 0.182 Current peak flow c.m/sec"

" 0.012 Manning 'n'"

" 0.450 Diameter metre"

" 0.350 Gradient %"

" Depth of flow 0.368 metre"

" Velocity 1.310 m/sec"

" Pipe capacity 0.183 c.m/sec"

" Critical depth 0.300 metre"

" 53 ROUTE Pipe Route 54"

" 54.20 Pipe Route 54 Reach length (metre)"

" 0.000 X-factor <= 0.5"

" 31.036 K-lag (seconds)"

" 0.000 Default(0) or user spec.(1) values used"

" 0.500 X-factor <= 0.5"

" 30.000 K-lag (seconds)"

100-YR Storm – Post-Development Condition

Major & Minor System Separation



```

" 0.668 Beta weighting factor"
" 75.000 Routing time step ( seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.179 c.m/sec"
" 0.029 0.182 0.179 0.000 c.m/sec"
" 40 HYDROGRAPH Next link "
" 5 Next link "
" 0.029 0.179 0.179 0.000"
" 33 CATCHMENT 206"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 206 Hotel - NW Side"
" 91.300 % Impervious"
" 0.253 Total Area"
" 32.000 Flow length"
" 1.500 Overland Slope"
" 0.022 Pervious Area"
" 32.000 Pervious length"
" 1.500 Pervious slope"
" 0.231 Impervious Area"
" 32.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.346 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.905 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.095 0.179 0.179 0.000 c.m/sec"
" Catchment 206 Pervious Impervious Total Area "
" Surface Area 0.022 0.231 0.253 hectare"
" Time of concentration 16.784 1.937 2.459 minutes"
" Time to Centroid 120.544 87.721 88.877 minutes"
" Rainfall depth 64.717 64.717 64.717 mm"
" Rainfall volume 14.24 149.49 163.73 c.m"
" Rainfall losses 42.294 6.169 9.311 mm"
" Runoff depth 22.423 58.549 55.406 mm"
" Runoff volume 4.94 135.24 140.18 c.m"
" Runoff coefficient 0.346 0.905 0.856 "
" Maximum flow 0.002 0.094 0.095 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
    
```

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
100-YR Storm – Post-Development Condition
Major & Minor System Separation



```

"      0.095  0.266  0.179  0.000"
" 56  DIVERSION"
"      206 Node number"
"      0.237 Overflow threshold"
"      1.000 Required diverted fraction"
"      0 Conduit type; 1=Pipe;2=Channel"
"      Peak of diverted flow    0.029 c.m/sec"
"      Volume of diverted flow  13.898 c.m"
"      DIV00206.005hyd"
"      Major flow at 206"
"      0.095  0.266  0.237  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"      5 Next link "
"      0.095  0.237  0.237  0.000"
" 51  PIPE DESIGN"
"      0.237 Current peak flow c.m/sec"
"      0.012 Manning 'n'"
"      0.450 Diameter metre"
"      0.600 Gradient %"
"      Depth of flow          0.365 metre"
"      Velocity                1.715 m/sec"
"      Pipe capacity          0.239 c.m/sec"
"      Critical depth          0.343 metre"
" 53  ROUTE Pipe Route 74"
"      74.00 Pipe Route 74 Reach length ( metre)"
"      0.119 X-factor <= 0.5"
"      32.363 K-lag ( seconds)"
"      0.000 Default(0) or user spec.(1) values used"
"      0.500 X-factor <= 0.5"
"      30.000 K-lag ( seconds)"
"      0.500 Beta weighting factor"
"      50.000 Routing time step ( seconds)"
"      1 No. of sub-reaches"
"      Peak outflow          0.237 c.m/sec"
"      0.095  0.237  0.237  0.000 c.m/sec"
" 40  HYDROGRAPH Combine 2"
"      6 Combine "
"      2 Node #"
"      O/G Separator(s)"
"      Maximum flow          0.237 c.m/sec"
"      Hydrograph volume      540.264 c.m"
"      0.095  0.237  0.237  0.237"
" 40  HYDROGRAPH Start - New Tributary"
"      2 Start - New Tributary"
"      0.095  0.000  0.237  0.237"
" 33  CATCHMENT 207"
"      1 Triangular SCS"

```



" 1 Equal length"
 " 1 SCS method"
 " 207 Restaurant - Bldg. 'D'"
 " 96.400 % Impervious"
 " 0.140 Total Area"
 " 47.000 Flow length"
 " 1.500 Overland Slope"
 " 0.005 Pervious Area"
 " 47.000 Pervious length"
 " 1.500 Pervious slope"
 " 0.135 Impervious Area"
 " 47.000 Impervious length"
 " 1.500 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.347 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.905 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.052 0.000 0.237 0.237 c.m/sec"
 " Catchment 207 Pervious Impervious Total Area "
 " Surface Area 0.005 0.135 0.140 hectare"
 " Time of concentration 21.139 2.439 2.703 minutes"
 " Time to Centroid 126.284 88.599 89.130 minutes"
 " Rainfall depth 64.717 64.717 64.717 mm"
 " Rainfall volume 3.26 87.34 90.60 c.m"
 " Rainfall losses 42.285 6.144 7.445 mm"
 " Runoff depth 22.432 58.574 57.272 mm"
 " Runoff volume 1.13 79.05 80.18 c.m"
 " Runoff coefficient 0.347 0.905 0.885 "
 " Maximum flow 0.000 0.052 0.052 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.052 0.052 0.237 0.237"
 " 56 DIVERSION"
 " 207 Node number"
 " 0.035 Overflow threshold"
 " 1.000 Required diverted fraction"
 " 0 Conduit type; 1=Pipe;2=Channel"
 " Peak of diverted flow 0.017 c.m/sec"
 " Volume of diverted flow 8.852 c.m"
 " DIV00207.005hyd"
 " Major flow at 207"



```

"          0.052  0.052  0.035  0.237 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5 Next link "
"          0.052  0.035  0.035  0.237"
" 51  PIPE DESIGN"
"    0.035 Current peak flow  c.m/sec"
"    0.012 Manning 'n'"
"    0.250 Diameter  metre"
"    0.300 Gradient  %"
"      Depth of flow          0.203  metre"
"      Velocity                0.819  m/sec"
"      Pipe capacity          0.035  c.m/sec"
"      Critical depth         0.152  metre"
" 53  ROUTE  Pipe Route 14"
"    14.00  Pipe Route 14 Reach length  ( metre)"
"    0.000 X-factor <= 0.5"
"    12.813 K-lag  ( seconds)"
"    0.000 Default(0) or user spec.(1) values used"
"    0.500 X-factor <= 0.5"
"    30.000 K-lag  ( seconds)"
"    0.873 Beta weighting factor"
"    60.000 Routing time step  ( seconds)"
"      1 No. of sub-reaches"
"      Peak outflow          0.035  c.m/sec"
"          0.052  0.035  0.035  0.237 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5 Next link "
"          0.052  0.035  0.035  0.237"
" 33  CATCHMENT 208"
"    1 Triangular SCS"
"    1 Equal length"
"    1 SCS method"
"    208 Restaurant - East Lot"
"    81.000 % Impervious"
"    0.267 Total Area"
"    36.000 Flow length"
"    1.500 Overland Slope"
"    0.051 Pervious Area"
"    36.000 Pervious length"
"    1.500 Pervious slope"
"    0.216 Impervious Area"
"    36.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
"    75.000 Pervious SCS Curve No."
"    0.347 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"

```



" 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.000 Impervious SCS Curve No."
 " 0.904 Impervious Runoff coefficient"
 " 0.100 Impervious Ia/S coefficient"
 " 0.518 Impervious Initial abstraction"
 " 0.088 0.035 0.035 0.237 c.m/sec"
 " Catchment 208 Pervious Impervious Total Area "
 " Surface Area 0.051 0.216 0.267 hectare"
 " Time of concentration 18.013 2.079 3.394 minutes"
 " Time to Centroid 122.151 88.016 90.833 minutes"
 " Rainfall depth 64.717 64.717 64.717 mm"
 " Rainfall volume 32.83 139.96 172.79 c.m"
 " Rainfall losses 42.277 6.204 13.058 mm"
 " Runoff depth 22.441 58.513 51.659 mm"
 " Runoff volume 11.38 126.55 137.93 c.m"
 " Runoff coefficient 0.347 0.904 0.798 "
 " Maximum flow 0.003 0.087 0.088 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.088 0.122 0.035 0.237"
 " 56 DIVERSION"
 " 208 Node number"
 " 0.103 Overflow threshold"
 " 1.000 Required diverted fraction"
 " 0 Conduit type; 1=Pipe;2=Channel"
 " Peak of diverted flow 0.019 c.m/sec"
 " Volume of diverted flow 7.196 c.m"
 " DIV00208.005hyd"
 " Major flow at 208"
 " 0.088 0.122 0.103 0.237 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.088 0.103 0.103 0.237"
 " 51 PIPE DESIGN"
 " 0.103 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.375 Diameter metre"
 " 0.300 Gradient %"
 " Depth of flow 0.304 metre"
 " Velocity 1.074 m/sec"
 " Pipe capacity 0.104 c.m/sec"
 " Critical depth 0.236 metre"
 " 53 ROUTE Pipe Route 72"
 " 71.70 Pipe Route 72 Reach length (metre)"
 " 0.000 X-factor <= 0.5"
 " 50.077 K-lag (seconds)"



```

" 0.000 Default(0) or user spec.(1) values used"
" 0.500 X-factor <= 0.5"
" 30.000 K-lag ( seconds)"
" 0.578 Beta weighting factor"
" 100.000 Routing time step ( seconds)"
" 1 No. of sub-reaches"
" Peak outflow 0.103 c.m/sec"
" 0.088 0.103 0.103 0.237 c.m/sec"
" 40 HYDROGRAPH Combine 3"
" 6 Combine "
" 3 Node #"
" STM MH"
" Maximum flow 0.103 c.m/sec"
" Hydrograph volume 202.063 c.m"
" 0.088 0.103 0.103 0.103"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.088 0.000 0.103 0.103"
" 33 CATCHMENT 209"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 209 Resturant Bldgs. 'B' & 'C'"
" 98.100 % Impervious"
" 0.126 Total Area"
" 66.000 Flow length"
" 1.500 Overland Slope"
" 0.002 Pervious Area"
" 66.000 Pervious length"
" 1.500 Pervious slope"
" 0.124 Impervious Area"
" 66.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.904 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.046 0.000 0.103 0.103 c.m/sec"
" Catchment 209 Pervious Impervious Total Area "
" Surface Area 0.002 0.124 0.126 hectare"
" Time of concentration 25.914 2.990 3.159 minutes"
    
```



```

"      Time to Centroid   132.606  89.502  89.819  minutes"
"      Rainfall depth    64.717  64.717  64.717  mm"
"      Rainfall volume   1.55   79.99  81.54   c.m"
"      Rainfall losses   42.286  6.191  6.877  mm"
"      Runoff depth      22.431  58.526  57.840  mm"
"      Runoff volume     0.54   72.34  72.88   c.m"
"      Runoff coefficient 0.347  0.904  0.894   "
"      Maximum flow      0.000  0.046  0.046   c.m/sec"
" 40   HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"          0.046  0.046  0.103  0.103"
" 56   DIVERSION"
"      209 Node number"
"      0.038 Overflow threshold"
"      1.000 Required diverted fraction"
"      0 Conduit type; 1=Pipe;2=Channel"
"      Peak of diverted flow 0.008 c.m/sec"
"      Volume of diverted flow 4.325 c.m"
"      DIV00209.005hyd"
"      Major flow at 209"
"          0.046  0.046  0.038  0.103 c.m/sec"
" 40   HYDROGRAPH Next link "
"      5 Next link "
"          0.046  0.038  0.038  0.103"
" 51   PIPE DESIGN"
"      0.038 Current peak flow c.m/sec"
"      0.012 Manning 'n'"
"      0.250 Diameter metre"
"      0.350 Gradient %"
"      Depth of flow      0.204 metre"
"      Velocity           0.885 m/sec"
"      Pipe capacity      0.038 c.m/sec"
"      Critical depth     0.159 metre"
" 53   ROUTE Pipe Route 24"
"      24.10 Pipe Route 24 Reach length (metre)"
"      0.000 X-factor <= 0.5"
"      20.421 K-lag (seconds)"
"      0.000 Default(0) or user spec.(1) values used"
"      0.500 X-factor <= 0.5"
"      30.000 K-lag (seconds)"
"      0.715 Beta weighting factor"
"      60.000 Routing time step (seconds)"
"      1 No. of sub-reaches"
"      Peak outflow      0.038 c.m/sec"
"          0.046  0.038  0.038  0.103 c.m/sec"
" 40   HYDROGRAPH Combine 3"
"      6 Combine "
    
```



```

"      3 Node #"
"      STM MH"
"      Maximum flow      0.141 c.m/sec"
"      Hydrograph volume 270.617 c.m"
"      0.046 0.038 0.038 0.141"
" 40  HYDROGRAPH Start - New Tributary"
"      2 Start - New Tributary"
"      0.046 0.000 0.038 0.141"
" 40  HYDROGRAPH Confluence 3"
"      7 Confluence "
"      3 Node #"
"      STM MH"
"      Maximum flow      0.141 c.m/sec"
"      Hydrograph volume 270.617 c.m"
"      0.046 0.141 0.038 0.000"
" 40  HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.046 0.141 0.141 0.000"
" 40  HYDROGRAPH Next link "
"      5 Next link "
"      0.046 0.141 0.141 0.000"
" 33  CATCHMENT 210"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      210 Restaurant - Central"
"      92.700 % Impervious"
"      0.295 Total Area"
"      57.000 Flow length"
"      1.500 Overland Slope"
"      0.022 Pervious Area"
"      57.000 Pervious length"
"      1.500 Pervious slope"
"      0.273 Impervious Area"
"      57.000 Impervious length"
"      1.500 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.347 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.904 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      0.102 0.141 0.141 0.000 c.m/sec"
    
```



```

"      Catchment 210      Pervious Impervious Total Area "
"      Surface Area      0.022  0.273  0.295  hectare"
"      Time of concentration 23.732  2.738  3.354  minutes"
"      Time to Centroid   129.724  89.053  90.245  minutes"
"      Rainfall depth     64.717  64.717  64.717  mm"
"      Rainfall volume    13.94   176.98  190.92  c.m"
"      Rainfall losses    42.279  6.208  8.842  mm"
"      Runoff depth       22.438  58.509  55.876  mm"
"      Runoff volume      4.83    160.00  164.83  c.m"
"      Runoff coefficient  0.347   0.904  0.863  "
"      Maximum flow       0.001   0.102  0.102  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4  Add Runoff "
"          0.102  0.240  0.141  0.000"
" 56  DIVERSION"
"      210  Node number"
"      0.181  Overflow threshold"
"      1.000  Required diverted fraction"
"      0  Conduit type; 1=Pipe;2=Channel"
"      Peak of diverted flow  0.059  c.m/sec"
"      Volume of diverted flow  32.692  c.m"
"      DIV00210.005hyd"
"      Major flow at 210"
"          0.102  0.240  0.181  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"      5  Next link "
"          0.102  0.181  0.181  0.000"
" 51  PIPE DESIGN"
"      0.181  Current peak flow  c.m/sec"
"      0.012  Manning 'n'"
"      0.450  Diameter  metre"
"      0.350  Gradient  %"
"      Depth of flow      0.365  metre"
"      Velocity           1.310  m/sec"
"      Pipe capacity      0.183  c.m/sec"
"      Critical depth     0.299  metre"
" 53  ROUTE  Pipe Route 70"
"      70.40  Pipe Route 70 Reach length ( metre)"
"      0.000  X-factor <= 0.5"
"      40.312  K-lag ( seconds)"
"      0.000  Default(0) or user spec.(1) values used"
"      0.500  X-factor <= 0.5"
"      30.000  K-lag ( seconds)"
"      0.601  Beta weighting factor"
"      75.000  Routing time step ( seconds)"
"      1  No. of sub-reaches"
"      Peak outflow      0.181  c.m/sec"

```

100-YR Storm – Post-Development Condition



Major & Minor System Separation

```

"          0.102  0.181  0.181  0.000 c.m/sec"
" 40  HYDROGRAPH Next link "
"    5  Next link "
"          0.102  0.181  0.181  0.000"
" 33  CATCHMENT 211"
"    1  Triangular SCS"
"    1  Equal length"
"    1  SCS method"
"    211 Restaurant Bldg. 'A'"
" 100.000 % Impervious"
"    0.075 Total Area"
"    38.000 Flow length"
"    1.500 Overland Slope"
"    0.000 Pervious Area"
"    38.000 Pervious length"
"    1.500 Pervious slope"
"    0.075 Impervious Area"
"    38.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
"    75.000 Pervious SCS Curve No."
"    0.000 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"
"    8.467 Pervious Initial abstraction"
"    0.015 Impervious Manning 'n'"
"    98.000 Impervious SCS Curve No."
"    0.904 Impervious Runoff coefficient"
"    0.100 Impervious Ia/S coefficient"
"    0.518 Impervious Initial abstraction"
"          0.030  0.181  0.181  0.000 c.m/sec"
"    Catchment 211      Pervious Impervious Total Area "
"    Surface Area      0.000  0.075  0.075  hectare"
"    Time of concentration 18.607  2.147  2.147  minutes"
"    Time to Centroid  122.947  88.154  88.154  minutes"
"    Rainfall depth    64.717  64.717  64.717  mm"
"    Rainfall volume   0.00  48.54  48.54  c.m"
"    Rainfall losses   42.297  6.200  6.200  mm"
"    Runoff depth      22.420  58.517  58.517  mm"
"    Runoff volume     0.00  43.89  43.89  c.m"
"    Runoff coefficient 0.000  0.904  0.904  "
"    Maximum flow      0.000  0.030  0.030  c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"    4  Add Runoff "
"          0.030  0.206  0.181  0.000"
" 40  HYDROGRAPH Next link "
"    5  Next link "
"          0.030  0.181  0.181  0.000"

```



```

" 33    CATCHMENT 212"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      212 Street 'A'"
" 90.400 % Impervious"
" 0.175 Total Area"
" 97.000 Flow length"
" 1.500 Overland Slope"
" 0.017 Pervious Area"
" 97.000 Pervious length"
" 1.500 Pervious slope"
" 0.158 Impervious Area"
" 97.000 Impervious length"
" 1.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
" 0.900 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
"      0.061 0.181 0.181 0.000 c.m/sec"
"      Catchment 212      Pervious Impervious Total Area "
"      Surface Area      0.017 0.158 0.175 hectare"
"      Time of concentration 32.650 3.767 4.903 minutes"
"      Time to Centroid 141.517 90.793 92.789 minutes"
"      Rainfall depth 64.717 64.717 64.717 mm"
"      Rainfall volume 10.87 102.38 113.26 c.m"
"      Rainfall losses 42.271 6.497 9.932 mm"
"      Runoff depth 22.446 58.220 54.786 mm"
"      Runoff volume 3.77 92.10 95.87 c.m"
"      Runoff coefficient 0.347 0.900 0.847 "
"      Maximum flow 0.001 0.061 0.061 c.m/sec"
" 40    HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.061 0.242 0.181 0.000"
" 40    HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.061 0.242 0.242 0.000"
" 40    HYDROGRAPH Next link "
"      5 Next link "
"      0.061 0.242 0.242 0.000"
" 33    CATCHMENT 213"
    
```



```

"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"    213 Hotel - SW Side"
"  96.000 % Impervious"
"    0.165 Total Area"
"   37.000 Flow length"
"    1.500 Overland Slope"
"    0.007 Pervious Area"
"   37.000 Pervious length"
"    1.500 Pervious slope"
"    0.158 Impervious Area"
"   37.000 Impervious length"
"    1.500 Impervious slope"
"    0.250 Pervious Manning 'n'"
"   75.000 Pervious SCS Curve No."
"    0.347 Pervious Runoff coefficient"
"    0.100 Pervious Ia/S coefficient"
"    8.467 Pervious Initial abstraction"
"    0.015 Impervious Manning 'n'"
"   98.000 Impervious SCS Curve No."
"    0.904 Impervious Runoff coefficient"
"    0.100 Impervious Ia/S coefficient"
"    0.518 Impervious Initial abstraction"
"      0.064 0.242 0.242 0.000 c.m/sec"
"    Catchment 213 Pervious Impervious Total Area "
"    Surface Area 0.007 0.158 0.165 hectare"
"    Time of concentration 18.312 2.113 2.368 minutes"
"    Time to Centroid 122.551 88.087 88.628 minutes"
"    Rainfall depth 64.717 64.717 64.717 mm"
"    Rainfall volume 4.27 102.51 106.78 c.m"
"    Rainfall losses 42.283 6.201 7.644 mm"
"    Runoff depth 22.434 58.516 57.073 mm"
"    Runoff volume 1.48 92.69 94.17 c.m"
"    Runoff coefficient 0.347 0.904 0.882 "
"    Maximum flow 0.000 0.064 0.064 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
"    4 Add Runoff "
"      0.064 0.295 0.242 0.000"
" 56 DIVERSION"
"    213 Node number"
"    0.237 Overflow threshold"
"    1.000 Required diverted fraction"
"    0 Conduit type; 1=Pipe;2=Channel"
"    Peak of diverted flow 0.058 c.m/sec"
"    Volume of diverted flow 30.994 c.m"
"    DIV00213.005hyd"

```

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
100-YR Storm – Post-Development Condition
Major & Minor System Separation



" Major flow at 213"
 " 0.064 0.295 0.237 0.000 c.m/sec"
 " 40 HYDROGRAPH Next link "
 " 5 Next link "
 " 0.064 0.237 0.237 0.000"
 " 51 PIPE DESIGN"
 " 0.237 Current peak flow c.m/sec"
 " 0.012 Manning 'n'"
 " 0.450 Diameter metre"
 " 0.600 Gradient %"
 " Depth of flow 0.365 metre"
 " Velocity 1.715 m/sec"
 " Pipe capacity 0.239 c.m/sec"
 " Critical depth 0.343 metre"
 " 53 ROUTE Pipe Route 50"
 " 50.40 Pipe Route 50 Reach length (metre)"
 " 0.000 X-factor <= 0.5"
 " 22.042 K-lag (seconds)"
 " 0.000 Default(0) or user spec.(1) values used"
 " 0.500 X-factor <= 0.5"
 " 30.000 K-lag (seconds)"
 " 0.531 Beta weighting factor"
 " 42.857 Routing time step (seconds)"
 " 1 No. of sub-reaches"
 " Peak outflow 0.237 c.m/sec"
 " 0.064 0.237 0.237 0.000 c.m/sec"
 " 40 HYDROGRAPH Combine 2"
 " 6 Combine "
 " 2 Node #"
 " O/G Separator(s)"
 " Maximum flow 0.474 c.m/sec"
 " Hydrograph volume 1102.073 c.m"
 " 0.064 0.237 0.237 0.474"
 " 40 HYDROGRAPH Confluence 2"
 " 7 Confluence "
 " 2 Node #"
 " O/G Separator(s)"
 " Maximum flow 0.474 c.m/sec"
 " Hydrograph volume 1102.073 c.m"
 " 0.064 0.474 0.237 0.000"
 " 56 DIVERSION"
 " 2 Node number"
 " 0.466 Overflow threshold"
 " 1.000 Required diverted fraction"
 " 0 Conduit type; 1=Pipe;2=Channel"
 " Peak of diverted flow 0.008 c.m/sec"
 " Volume of diverted flow 2.400 c.m"

INTERCONTINENTAL COMBO HOTEL - AREAS 201 TO 213
100-YR Storm – Post-Development Condition
Major & Minor System Separation



```

"      DIV00002.005hyd"
"      Major flow at 2"
"          0.064  0.474  0.466  0.000 c.m/sec"
" 40    HYDROGRAPH Next link "
"      5 Next link "
"          0.064  0.466  0.466  0.000"
" 51    PIPE DESIGN"
"      0.466 Current peak flow  c.m/sec"
"      0.012 Manning 'n'"
"      0.600 Diameter  metre"
"      0.500 Gradient  %"
"      Depth of flow          0.487  metre"
"      Velocity                1.896  m/sec"
"      Pipe capacity          0.470  c.m/sec"
"      Critical depth         0.447  metre"
" 53    ROUTE  Pipe Route 6"
"      6.20  Pipe Route 6 Reach length ( metre)"
"      0.000 X-factor <= 0.5"
"      2.452 K-lag ( seconds)"
"      0.000 Default(0) or user spec.(1) values used"
"      0.500 X-factor <= 0.5"
"      30.000 K-lag ( seconds)"
"      0.944 Beta weighting factor"
"      37.500 Routing time step ( seconds)"
"      1 No. of sub-reaches"
"      Peak outflow          0.466  c.m/sec"
"          0.064  0.466  0.466  0.000 c.m/sec"
" 38    START/RE-START TOTALS 0"
"      3 Runoff Totals on EXIT"
"      Total Catchment area          2.408  hectare"
"      Total Impervious area         2.081  hectare"
"      Total % impervious            86.404"
" 19    EXIT"

```



```
" MIDUSS Output ----->"
" MIDUSS version          Version 2.25 rev. 465"
" MIDUSS created          Tuesday, February 05, 2008"
" 10 Units used:         ie METRIC"
" Job folder:             P:\2013 Projects\
"       13254 York Glendale Hotel Complex\Design\Detailed\MIDUSS"
" Output filename:        100-YR_EXT_A.out"
" Licensee name:          Quartek"
" Company                 Quartek Group Inc."
" Date & Time last used:   12/5/2016 at 3:07:29 PM"
" 31 TIME PARAMETERS"
" 5.000 Time Step"
" 180.000 Max. Storm length"
" 1500.000 Max. Hydrograph"
" 32 STORM Chicago storm"
" 1 Chicago storm"
" 980.000 Coefficient A"
" 3.700 Constant B"
" 0.732 Exponent C"
" 0.375 Fraction R"
" 180.000 Duration"
" 1.000 Time step multiplier"
" Maximum intensity      198.433 mm/hr"
" Total depth            64.717 mm"
" 6 005hyd Hydrograph extension used in this file"
" 33 CATCHMENT 301"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 301 Purolator Catchment"
" 86.000 % Impervious"
" 2.651 Total Area"
" 250.000 Flow length"
" 1.000 Overland Slope"
" 0.371 Pervious Area"
" 250.000 Pervious length"
" 1.000 Pervious slope"
" 2.280 Impervious Area"
" 250.000 Impervious length"
" 1.000 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.347 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.470 Impervious SCS Curve No."
" 0.929 Impervious Runoff coefficient"
```



" 0.132 Impervious Ia/S coefficient"
 " 0.521 Impervious Initial abstraction"
 " 0.894 0.000 0.000 0.000 c.m/sec"
 " Catchment 301 Pervious Impervious Total Area "
 " Surface Area 0.371 2.280 2.651 hectare"
 " Time of concentration 65.074 7.472 10.772 minutes"
 " Time to Centroid 184.395 95.902 100.971 minutes"
 " Rainfall depth 64.717 64.717 64.717 mm"
 " Rainfall volume 240.19 1475.46 1715.65 c.m"
 " Rainfall losses 42.265 4.565 9.843 mm"
 " Runoff depth 22.452 60.152 54.874 mm"
 " Runoff volume 83.33 1371.38 1454.71 c.m"
 " Runoff coefficient 0.347 0.929 0.848 "
 " Maximum flow 0.010 0.893 0.894 c.m/sec"
 " 40 HYDROGRAPH Add Runoff "
 " 4 Add Runoff "
 " 0.894 0.894 0.000 0.000"
 " 33 CATCHMENT 302"
 " 1 Triangular SCS"
 " 1 Equal length"
 " 1 SCS method"
 " 302 342 Townline & Easterly Area Catchment"
 " 86.000 % Impervious"
 " 1.461 Total Area"
 " 80.000 Flow length"
 " 1.000 Overland Slope"
 " 0.205 Pervious Area"
 " 80.000 Pervious length"
 " 1.000 Pervious slope"
 " 1.256 Impervious Area"
 " 80.000 Impervious length"
 " 1.000 Impervious slope"
 " 0.250 Pervious Manning 'n'"
 " 75.000 Pervious SCS Curve No."
 " 0.347 Pervious Runoff coefficient"
 " 0.100 Pervious Ia/S coefficient"
 " 8.467 Pervious Initial abstraction"
 " 0.015 Impervious Manning 'n'"
 " 98.550 Impervious SCS Curve No."
 " 0.916 Impervious Runoff coefficient"
 " 0.182 Impervious Ia/S coefficient"
 " 0.680 Impervious Initial abstraction"
 " 0.492 0.894 0.000 0.000 c.m/sec"
 " Catchment 302 Pervious Impervious Total Area "
 " Surface Area 0.205 1.256 1.461 hectare"
 " Time of concentration 32.847 3.769 5.457 minutes"
 " Time to Centroid 141.781 90.319 93.306 minutes"
 " Rainfall depth 64.717 64.717 64.717 mm"



"	Rainfall volume	132.37	813.15	945.52	c.m"
"	Rainfall losses	42.268	5.406	10.567	mm"
"	Runoff depth	22.449	59.311	54.150	mm"
"	Runoff volume	45.92	745.22	791.14	c.m"
"	Runoff coefficient	0.347	0.916	0.837	"
"	Maximum flow	0.009	0.490	0.492	c.m/sec"
" 40	HYDROGRAPH Add Runoff "				
"	4 Add Runoff "				
"		0.492	1.387	0.000	0.000"
"	8 Copy to Outflow"				
"		0.492	1.387	1.387	0.000"
" 40	HYDROGRAPH Combine 1"				
"	6 Combine "				
"	1 Node #"				
"	Outfall"				
"	Maximum flow		1.387	c.m/sec"	
"	Hydrograph volume		2245.844	c.m"	
"		0.492	1.387	1.387	1.387"
" 38	START/RE-START TOTALS 302"				
"	3 Runoff Totals on EXIT"				
"	Total Catchment area		4.112	hectare"	
"	Total Impervious area		3.536	hectare"	
"	Total % impervious		86.000	"	
" 19	EXIT"				